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USER MANUAL FOR PROGRAM STATIC —FIRST PART OF COAST GUARD SHIP MOTION PROGRAM.

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Hoffman Maritime Consultants

JULY 1979

FINAL REPORT.

PREPARED FOR

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Program SCOMOT is proprietary software. It has been made available to the U.S.C.G. and is intended for their internal use.

16. Abstract

A description of program STATIC, the first part of the revised and enhanced SCORES program is presented with the theoretical basis, organization and structure, data input and output format described. A sample computation using the SL-7 containership is included to aid in the understanding of the input and output format. The program has two major functions; calculating the hydrostatic properties of a vessel and preparing the two dimensional hydrodynamic properties for the ship motion program SCOMOT. The curves of form, shear force and bending moment, grounding, intact stability, balancing of buoyancy and weight forces and other calculations can be performed for both still water and quasi-static conditions. The two dimensional added mass and damping for heave, sway, roll and roll-sway cross coupling are calculated for each section using either a multi-efficient conformal mapping technique of the Frank Close Fit method.

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STATIC Program - User Manual
Record of Changes

Date	Module/ Subroutine	Page	Description

ABSTRACT

A description of program STATIC, the first part of the revised SCORES program, developed by Hoffman Maritime Consultants (HMC) for use by the U.S. Coast Guard, is presented. This program has two major functions; calculating hydrostatic properties of a vessel and preparing data for the ship motion computations. The curves of form, shear force and bending moment, grounding, intact stability, balancing of buoyancy and weight forces and other calculations can be performed for both static and quasi-static conditions. The two-dimensional added mass and damping for heave, sway and roll are calculated for each ship's section and stored as input for the ship motion program SCOMOT. Program theory, organization and structure, data input and output format are described. A sample computation is included to aid in the understanding of input and output formats.

I. INTRODUCTION

Program STATIC is a two part procedure that first calculates geometric quantities and then two-dimensional hydrodynamic data required for the new modified SCORES program (1)*. The first part of this program has similar capabilities to the Ship Hull Characteristics Program (SHCP) (2) but can perform many other tasks of specialized nature. Hydrostatics, curves of form, shear force and bending moment, grounding, intact stability and balancing of the vessel are specific tasks that can be performed. The quasi-static case, that is the ship poised in an oblique sea of any amplitude, wave length and phase as well as still water case for these calculations can be handled. Preparation of geometric description files for the Springing (3) and Motion (1) programs is also done by the first part of Program STATIC.

The primary calculation of the second part of STATIC is of two-dimensional hydrodynamic properties using the conformal mapping approach (4)(5)(6) and the Frank close fit technique (7)(8). The two-dimensional added mass and damping for heave, sway, roll and sway-roll cross couplings are calculated for each section at twenty-five frequencies. This program thereby separates the lengthy calculations of two-dimensional added mass and damping from the motion calculations by storing these results in a two-dimensional properties (TDP) file which is read by motions program SCOMOT.

Program STATIC is a separate program in the modified SCORES procedure, with a standalone capability. STATIC's greatest asset is that its operation is very simple. The command language used in its input scheme does not require strict formatting or remembering of lengthy input sequences and resembles a conversational type input.

STATIC is written in the FORTRAN IV language, checked out and run on the United Computing Services (UCS) CDC-6600

*Numbers in parentheses refer to list of references at end of this report.

computer system.

The method of analysis is outlined below in Section II. The type of inputting scheme, which facilitates the running of the hydrostatic and two-dimensional hydrodynamic quantities will be described in Section III.

Typical runs showing input and output will be shown in Section IV. Section V will contain error messages and their meaning as well as typical running times for various tasks.

II. OUTLINE OF THEORY

The basic analysis used in STATIC can be divided into two topics:

A) Hydrostatic properties and static shear force and bending moment

B) Hydrodynamic calculations using either conformal mapping or Frank close fit techniques.

The two areas will be discussed in the next two sections.

A. Hydrostatic Calculations

Since the first topic is extensively covered in most naval architecture textbooks (9)(10) only a short summary and explanation of unique calculations will be given in this section.

Table 1.1 shows a typical hydrostatic output for a vessel at an even keel draft. Using several of these tables for various drafts enables the drawing of a curve of form, Figure 1.1

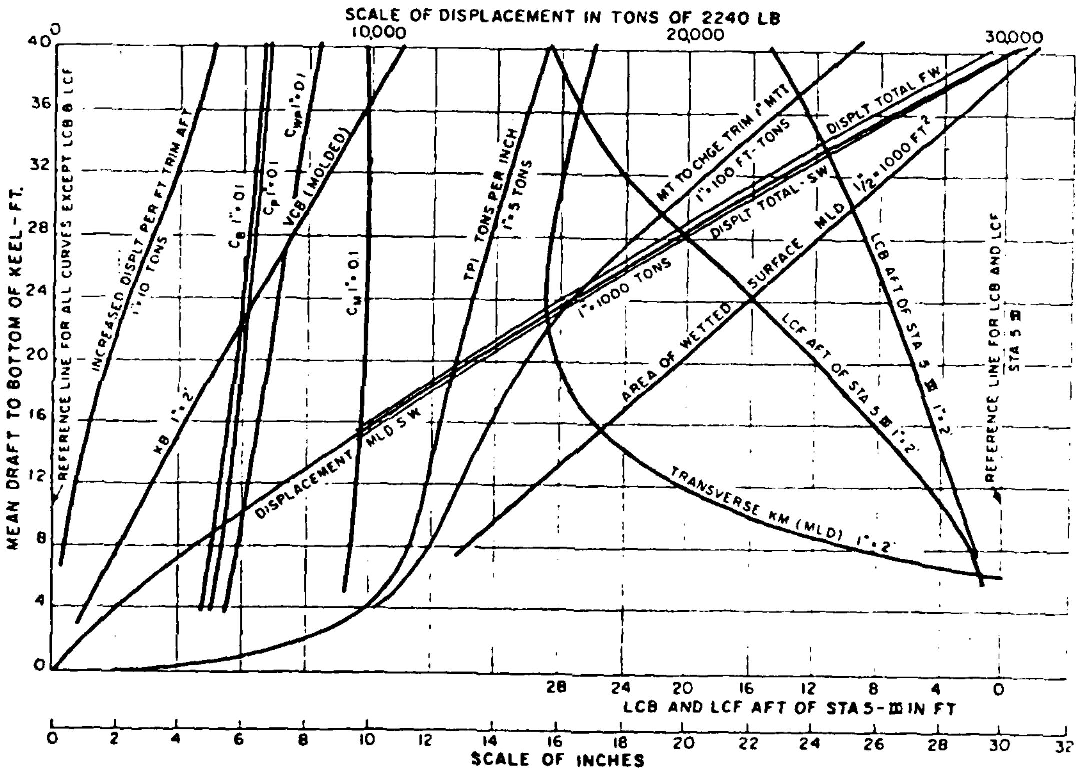


Figure 1.1 Displacement and other curves of form (8)

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	32.0000	0.0000	223.395	1.00000	10.2856	0.0000
11.0063	32.0000	2.0828	254.595	3.81988	11.5951	0.0000
22.0125	32.0000	2.9063	276.908	2.97745	12.1516	0.0000
44.0250	32.0000	5.8277	334.682	1.79468	13.2493	0.0000
66.0375	32.0000	9.6732	398.797	1.28835	14.3146	0.0000
88.0500	32.0000	15.4573	486.653	.98387	15.4437	0.0000
110.0625	32.0000	21.4845	584.891	.85074	16.4863	0.0000
132.0750	32.0000	28.4810	702.126	.77039	17.2379	0.0000
176.1000	32.0000	44.2626	1013.900	.71583	18.2078	0.0000
220.1250	32.0000	59.9864	1389.990	.72412	18.4163	0.0000
264.1500	32.0000	74.5541	1803.131	.75580	18.1851	0.0000
308.1750	32.0000	87.0524	2237.807	.80333	17.8366	0.0000
352.2000	32.0000	96.7617	2638.511	.85213	17.4280	0.0000
396.2250	32.0000	103.0452	2949.063	.89435	17.0969	0.0000
440.2500	32.0000	105.4858	3149.362	.93299	16.8180	0.0000
484.2750	32.0000	105.5000	3194.614	.94627	16.7137	0.0000
528.3000	32.0000	105.5000	3152.395	.93377	16.8377	0.0000
572.3250	32.0000	105.5000	3049.651	.90333	17.1364	0.0000
616.3500	32.0000	105.3572	2857.579	.84759	17.6514	0.0000
660.3750	32.0000	102.8107	2537.426	.77127	18.4691	0.0000
704.4000	32.0000	94.8440	2101.474	.69241	19.3413	0.0000
748.4250	32.0000	82.5323	1576.490	.59692	20.3563	0.0000
770.4375	32.0000	74.1002	1301.971	.54908	20.8848	0.0000
792.4500	32.0000	60.6923	1024.554	.52754	21.3989	0.0000
814.4625	32.0000	54.3116	767.438	.44157	21.9455	0.0000
836.4750	32.0000	42.7778	464.400	.51754	24.3791	0.0000
858.4875	32.0000	30.3031	231.897	.49068	26.3954	0.0000
869.4938	32.0000	23.9115	125.920	.58291	28.4712	0.0000
880.5000	32.0000	16.9388	60.208	.61781	29.7100	0.0000
902.5125	32.0000	3.6812	2.739	.50000	31.5039	0.0000

VOLUME (MLD.)	1620237.8	FEET **3
DISPLACEMENT (MLD.)	46292.509	L.TONS
BLOCK COEFFICIENT (MLD.)	.545137	
HALF-AREA MIDSHIP SECTION	1574.681	FEET **2
MIDSHIP SECTION COEFFICIENT	.932994	
PRISMATIC COEFFICIENT (MLD.),	.584288	
TRIM	0.000	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	17.782	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	477.509	FEET
BM,TRANSVERSE	27.351	FEET
BM,LONGITUDINAL	1471.064	FEET
MOMENT TO ALTER TRIM 0.1 FEET	7734.158	
L.TONS PER 0.1 FEET IMMERSION	181.422	
AREA OF WATERPLANE	63497.560	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.683650	
L.C.F. FROM F.P.	499.798	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-122.695	L.TONS
WETTED SURFACE (MLD.)	98304.577	FEET **2

The cross curves of stability and bending moment and shear force calculations (9) are also performed.

One of the unique features of STATIC is the ability to analyze a ship in a quasi-static condition. A ship can be frozen in a wave, which is comprised of several sine waves of varying amplitude,wave length, phase and heading. This is extremely important in considering the fluctuations in bending moment due to the sea. It has also been shown by Paulling (11) that the ship's static stability is very sensitive to a seaway.

An additional calculation performed by program STATIC is grounding. When a vessel runs aground, the ocean floor exerts a force on the vessel which causes the vessel to rise and trim. The maximum bending moment is affected by the grounding force and is a subject of concern for the U.S.C.G.

One important point needs mentioning in the hydrostatic calculations; all integrations and interpolations are linear. Straight line interpolation and trapazoidal integrations are used.

The specific hydrostatic procedures and options of program STATIC are discussed in Chapter III.

B. Hydrodynamic Calculations

The choice of two methods of analysis in the hydrodynamic calculations was necessary to handle a wider variety of ship sections. Each method has its advantages as well as shortcomings. Therefore, a brief description of each shall be given.

The conformal mapping technique involves the representation of a ship's section by a Fourier-like series whose coefficients are called mapping coefficients. Once the mapping coefficients are known, it is relatively a straight-forward procedure to obtain the hydrodynamic quantities; therefore, the basic problem is the mapping of the ship's section. Most normal ship sections can be adequately described by mapping coefficients but certain sections such as completely submerged sections and bulbous bows cannot be mapped.

A ship's section can be handled by the close fit method which utilizes the Green function to represent pulsating sources below the free surface. Most sections can be handled using this analysis, but a very serious drawback does exist. It can be shown that a set of discrete "irregular" frequencies in the Green's function-integral equation failed to give a solution. In the area around each of these frequencies, the results are also unreliable but they are usually at a high frequency and out of the range of interest. As the beam to draft ratio becomes large, these "irregular" frequencies approach the operating frequencies and seriously effect the accuracy of the results.

The conformal mapping technique does not have this problem, so that it was chosen as the preferable method of analysis. If a section could not be represented by mapping coefficients, the close fit method was chosen. It was found that both methods required approximately the same computation time for comparable accuracy.

The conformal mapping technique discussion is divided into two parts; the mapping of a section and the hydrodynamic properties once the mapping coefficients are known. The close fit method will also be discussed.

1. Conformal Mapping Technique

The one-to-one correspondence between the points on two distinct planes expressed by a single analytical function is the basis of conformal mapping. It finds application to ship problems when shapes whose equations and properties are unknown, can be mapped into shapes whose equations and properties are known in another plane. Most ship sections can be conformally mapped onto a circle of unit radius. The flow about an infinite cylinder of unit radius is known, therefore, the ship's section flow can be determined from the mapping transformation.

a) The Representation of Ship Sections by Conformal Mapping

The particular method discussed below was originally developed in (4) and has since been modified and updated in (5) and (12). The method described here is from (4). It is desired to represent a ship's section by the following equations:

$$x(\theta) = a_o \sin \theta - \sum_{m=1}^{N} a_{2m-1} \sin (2_{m-1}) \theta \qquad [1]$$

$$y(\theta) = a_o \cos \theta + \sum_{m=1}^{N} a_{2m-1} \cos (2_{m-1}) \theta \qquad [2]$$

where a_o, a_1, a_3 ...a_{2n-1} are the mapping coefficients, θ is the angle in the plane of the circle (note it is not in the plane ship), and

N is the number of mapping coefficients.
Figure 1 shows a typical ship's section.

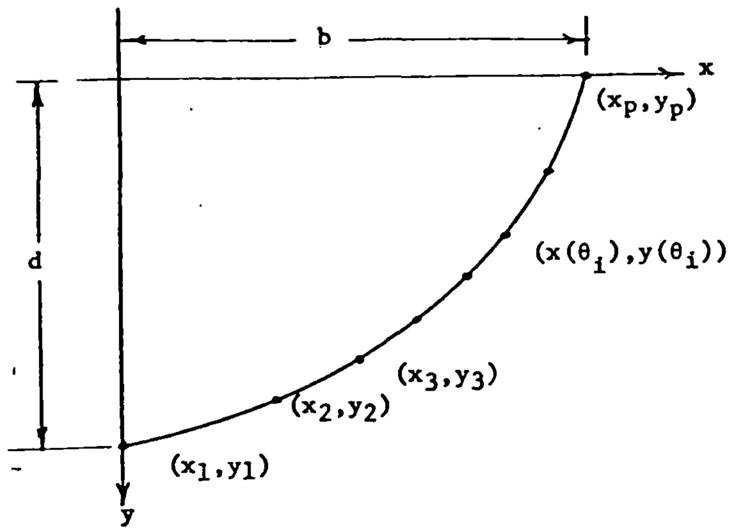


Figure 1.2

As can be seen from Equation 1 and 2, the unknowns are a_o, a_1; $a_3 \ldots a_{2n-1}$, and θ. It is not possible to obtain an analytic solution of N>2. Therefore, an iterative approach must be used. The values of x_i and y_i along the section contour are given to define the section.

The value of x and y for a specific value of θ and the mapping coefficients can be determined from the equation given above. However, x and y are the known quantities and the coefficients cannot be solved for directly, because the values of θ also depend on the coefficients. The first guess at the coefficients can be made rather arbitrarily, so long as the assumed curve does not deviate too far from the actual section shape. The better the guess, the fewer number of iterations to convergence. For this reason, a two-parameter mapping developed by Lewis (13) based upon the beam, draft and section area in use. Once the mapping coefficients are known, it is necessary to find a θ_i that represents x_i and y_i. This is performed by assuming that the points $x(\theta_i)$ and $y(\theta_i)$ be on the same radial line as x_i and y_i (See Figure 2).

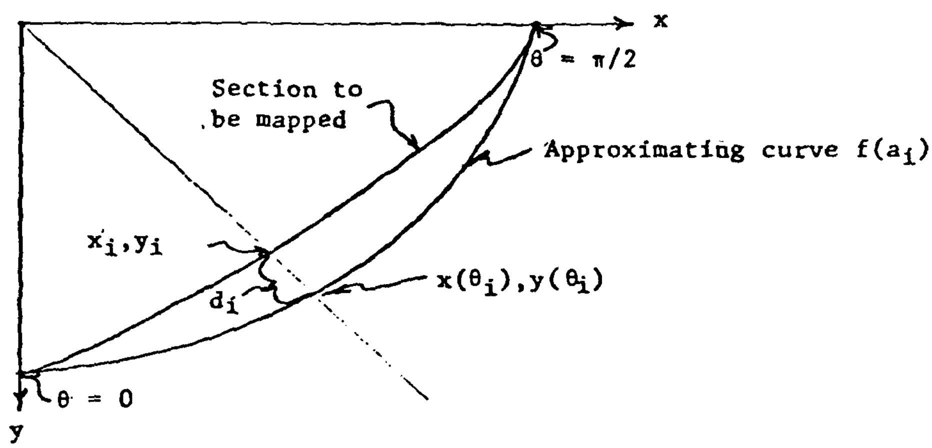


Figure 2

This can be re-stated as:

$$\frac{y(\theta_i)}{x(\theta_i)} = \frac{y_i}{x_i} \qquad [3]$$

which can be re-written as:

$$y(\theta_i)\, x_i - x(\theta_i)\, y_i = 0 . \qquad [4]$$

This equation is solved using an iterative procedure based on a combination of the "secant" and "regular-falsi" methods. This procedure assumes the mapping coefficients (a_i's) are known and solves for the angles (θ_i's).

Now a least squares technique is used to determine the mapping coefficients (a_i's) assuming that the angles (θ_i's) are correct. First a set of linear equations in the coefficients a_n may be set up in the following manner. The squared distance between any two points on a radial line between the actual and calculated curve is as follows:

$$e_i = d_i^2 = [\, x(\theta_i) - x_i \,]^2 + [\, y(\theta_i) - y_i \,]^2 \qquad [5]$$

or substituting equations [1] and [2] into [5]

$$e_i = \{ a_o \sin \theta_i - \sum_{m=1}^{N} a_{2m-1} \sin (2m-1)\, \theta_i - x_i \}^2$$

$$+ \{ a_o \cos \theta_i + \sum_{m=1}^{N} a_{2m-1} \cos (2m-1)\, \theta_i - y_i \}^2 \qquad [6]$$

Taking the sum of the above distances for each input point along the curve gives:

$$E = \sum_{i=1}^{P} e_i \qquad [7]$$

where there are P input points. Minimizing this sum with respect to each of the coefficients a_m gives what is called a least squares fit to the curve ($\theta = \theta_i$ is considered constant).

$$\frac{\partial E}{\partial a_m} = 0 \qquad m = 0, 1, 3, 5, \ldots 2N-1 \qquad [8]$$

This will yield N+1 linear equations in $a_o, a_1, a_3 \ldots$ where N+1 is the number of coefficients.

The values of a_m can then be computed so as to provide a solution for each of the equations. A matrix solution was chosen to accomplish this. The matrix solution is of the form:

$$X = [A]^{-1} B \qquad [9]$$

Each component is as follows:

$$X = \begin{Bmatrix} a_o \\ a_1 \\ a_3 \\ a_5 \\ a_7 \\ \vdots \\ a_{2N-1} \end{Bmatrix} \qquad [10]$$

$$A = \begin{Bmatrix} P & \Sigma\cos 2\theta & \Sigma\cos 4\theta & \ldots.\Sigma\cos 2N\theta \\ \Sigma\cos 2\theta & P & \Sigma\cos 2\theta & \ldots.\Sigma\cos 2(N-1)\theta \\ \Sigma\cos 4\theta & \Sigma\cos 2\theta & P & \ldots.\Sigma\cos 2(N-2)\theta \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \Sigma\cos 2N\theta & \Sigma\cos 2(N-1)\theta & \cdot \quad \cdot \quad \cdot & P \end{Bmatrix} \qquad [11]$$

$$B = \begin{Bmatrix} \Sigma\ y \cos\theta + x \sin\theta \\ \Sigma\ y \cos\theta - x \sin\theta \\ \Sigma\ y \cos 3\theta - x \sin 3\theta \\ \vdots \\ [\Sigma\ y \cos(2N-1)\theta - x \sin(2N-1)]\ \theta \end{Bmatrix} \qquad [12]$$

where all the summations are from 1 to P for each point on the curve.

b) Hydrodynamic Coefficients Using Conformal Mapping

The basic method used for the hydrodynamic portion was developed by Hoffman (4) for the case of vertical motions. It was later extended by van Hooff (6) based on the theory of Hoffman (4), Porter (14), and Ursell (15) for the case of lateral motions. HYDRO2D is based on the conformal mapping method (6) and the Frank close fit method (16).

Since a detailed development of the theory is given in (6), only a summary of the equations shall be given.

The section is defined by, as mentioned previously, the following equations:

$$x = x(\theta) = a_o \sin \theta - \sum_{m=1}^{N} a_{2m-1} \sin (2m-1)\,\theta \qquad [13]$$

$$y = y(\theta) = a_o \cos \theta + \sum_{m=1}^{N} a_{2m-1} \cos (2m-1)\,\theta \qquad [14]$$

whose derivatives are:

$$\frac{dx}{d\theta} = \frac{dx(\theta)}{d\theta} = a_o \cos \theta - \sum_{m=1}^{N} (2m-1)\, a_{2m-1} \cos (2m-1)\,\theta \qquad [15]$$

$$\frac{dy}{d\theta} = \frac{dy(\theta)}{d\theta} = a_o \sin \theta - \sum_{m=1}^{N} (2m-1)\, a_{2m-1} \sin (2m-1)\,\theta \qquad [16]$$

The hydrodynamic calculations are divided into vertical and lateral motions for a frequency, ω, or wave number, $k = \omega^2/g$.

<u>Vertical Motion</u>

The added mass, A_{33}', and damping, N_z', at a specific frequency are given as follows:

$$A_{33}' = 2\rho \int_0^{\pi/2} P_{aH}(\theta) \frac{dx}{d\theta} d\theta \qquad [17]$$

$$N_z' = 2\rho\omega \int_0^{\pi/2} P_{vH}(\theta) \frac{dx}{d\theta} d\theta \qquad [18]$$

where ρ is the mass density of the medium and ω is the wave frequency, $P_{aH}(\theta)$ is the hydrodynamic pressure in phase with acceleration and $P_{vH}(\theta)$ is in phase with the velocity as shown below:

$$P_{aH}(\theta) = b \frac{M_H(\theta) B_H + N_H(\theta) A_H}{A_H^2 + B_H^2} \qquad [19]$$

$$P_{vH}(\theta) = b \frac{M_H(\theta) A_H - N_H(\theta) B_H}{A_H^2 + B_H^2} \qquad [20]$$

where:

b = half beam of section

A_H = stream function in phase with acceleration

$$= \psi_{cH}\left(\frac{\pi}{2}\right) + \sum_{m=1}^{\infty} p_{2mH}\, \psi_{2mH}\left(\frac{\pi}{2}\right) \qquad [21]$$

B_H = stream function in phase with velocity

$$= \psi_{sH}\left(\frac{\pi}{2}\right) + \sum_{m=1}^{\infty} q_{2mH}\, \psi_{2mH}\left(\frac{\pi}{2}\right) \qquad [22]$$

$M_H(\theta)$ = sine component of the velocity potential at an arbitrary point on the contour

$$= \phi_{sH}(\theta) + \sum_{m=1}^{\infty} q_{2mH}\, \phi_{2mH}(\theta) \qquad [23]$$

$N_H(\theta)$ = cosine component of the velocity potential at an arbitrary point on the contour

$$= \phi_{cH}(\theta) + \sum_{m=1}^{\infty} p_{2mH}\, \phi_{2mH}(\theta) \qquad [24]$$

The cosine component of the multiple potential p_{2mH} and sine component q_{2mH} are found by a least squares involving the solution of the following matrix equations:

$$p_{2mH} = [X]^{-1}\, Y1 \qquad [25]$$

$$q_{2mH} = [X]^{-1}\, Y2 \qquad [26]$$

where:

$$X = X_{ij} = \sum_{\theta} D_{iH}(\theta)\; D_{jH}(\theta) \qquad [27]$$

$$Y1 = Y1_j = \sum_{\theta} D_{jH}(\theta)\left[\psi_{cH}(\theta) - \left(\frac{x}{b}\right)\psi_{cH}\left(\frac{\pi}{2}\right)\right] \qquad [28]$$

$$Y2 = Y2_j = \sum_{\theta} D_{jH}(\theta)\left[\psi_{sH}(\theta) - \left(\frac{x}{b}\right)\psi_{sH}\left(\frac{\pi}{2}\right)\right] \qquad [29]$$

$$D_{iH}(\theta) = \left(\frac{x}{b}\right)\psi_{2iH}\left(\frac{\pi}{2}\right) - \psi_{2iH}(\theta) \qquad [30]$$

The remaining equations are as follows:

Stream Functions:

$$\psi_{cH}(\theta) = \pi e^{-ky}\sin(kx) \qquad [31]$$

$$\psi_{sH}(\theta) = \pi e^{ky}\cos(kx) + \int_0^{\infty} e^{-\beta x}\left[\frac{k\cos(\beta y) + \beta\sin(\beta y)}{\beta^2 + k^2}\right] d\beta \qquad [32]$$

$$\psi_{2mH}(\theta) = \cos(2m\theta) - \sum_{n=1}^{N}\frac{k(2n-3)\, a_{2n-3}\cos(2m+2n-3)\theta}{2m+2n-3} \qquad [33]$$

Velocity Potential Functions:

$$\phi_{cH}(\theta) = \pi e^{-ky}\cos(kx) \qquad [34]$$

$$\phi_{sH}(\theta) = \pi e^{ky}\sin(kx) - \int_0^{\infty} e^{-\beta x}\left[\frac{\beta\cos(\beta y) - k\sin(\beta y)}{\beta^2 + k^2}\right] d\beta \qquad [35]$$

$$\phi_{2mH}(\theta) = \sin(2m\theta) + \sum_{n=1}^{N}\frac{k(2n-3)\, a_{2n-3}\sin(2m+2n-3)\theta}{2m+2n-3} \qquad [36]$$

Lateral Motion

The lateral motion calculations consist of added mass and damping for sway, roll, sway-roll cross coupling and roll-sway cross coupling. The equations for these values are given as follows:

$$\text{Sway Added Mass} = 2\rho \int_0^{\pi/2} P_{aS}(\theta) \frac{dy}{d\theta} \, d\theta \qquad [37]$$

$$\text{Sway Damping} = 2\rho\omega \int_0^{\pi/2} P_{vS}(\theta) \frac{dy}{d\theta} \, d\theta \qquad [38]$$

$$\text{Sway-Roll Added Mass} = 2\rho \int_0^{\pi/2} P_{aS}(\theta) \left(x \frac{dx}{d\theta} + y \frac{dy}{d\theta} \right) d\theta \qquad [39]$$

$$\text{Sway-Roll Damping} = 2\rho\omega \int_0^{\pi/2} P_{vS}(\theta) \left(x \frac{dx}{d\theta} + y \frac{dy}{d\theta} \right) d\theta \qquad [40]$$

$$\text{Roll Added Moment of Inertia} = 2\rho \int_0^{\pi/2} P_{aR}(\theta) \left(x \frac{dx}{d\theta} + y \frac{dy}{d\theta} \right) d\theta \qquad [41]$$

$$\text{Roll Damping} = 2\rho\omega \int_0^{\pi/2} P_{vR}(\theta) \left(x \frac{dx}{d\theta} + y \frac{dy}{d\theta} \right) d\theta \qquad [42]$$

$$\text{Roll-Sway Added Mass} = 2\rho \int_0^{\pi/2} P_{aR}(\theta) \frac{dy}{d\theta} \, d\theta \qquad [43]$$

$$\text{Roll-Sway Damping} = 2\rho\omega \int_0^{\pi/2} {}_{vR}(\theta) \frac{dy}{d\theta} \, d\theta \qquad [44]$$

where the pressures are defined as follows:

$$P_{aS}(\theta) = d \, \frac{M_S(\theta) B_S + N_S(\theta) A_S}{A_S^2 + B_S^2} \qquad [45]$$

$$P_{vS}(\theta) = d \, \frac{M_S(\theta) A_S - N_S(\theta) B_S}{A_S^2 + B_S^2} \qquad [46]$$

$$P_{aR}(\theta) = \left(\frac{d^2 - b^2}{2}\right) \frac{M_R(\theta)\, B_R + N_R(\theta)\, A_R}{A_R^2 + B_R^2} \qquad [47]$$

$$P_{vR}(\theta) = \left(\frac{d^2 - b^2}{2}\right) \frac{M_R(\theta)\, A_R - N_R(\theta)\, B_R}{A_R^2 + B_R^2} \qquad [48]$$

where d is the section draft and b the waterline half beam. For Sway:

A_S = stream function in phase with acceleration

$$= \psi_{cS}\left(\frac{\pi}{2}\right) + \sum_{m=1}^{\infty} p_{2mS}\, \psi_{2mS}\left(\frac{\pi}{2}\right) \qquad [49]$$

B_S = stream function in phase with velocity

$$= \psi_{sS}\left(\frac{\pi}{2}\right) + \sum_{m=1}^{\infty} q_{2mS}\, \psi_{2mS}\left(\frac{\pi}{2}\right) \qquad [50]$$

$M_S(\theta)$ = sine component of the velocity potential at an arbitrary point on the contour

$$= \phi_{sS}(\theta) + \sum_{m=1}^{\infty} q_{2mS}\, \phi_{2mS}(\theta) \qquad [51]$$

$N_S(\theta)$ = cosine component of the velocity potential at an arbitrary point on the contour

$$= \phi_{cS}(\theta) + \sum_{m=1}^{\infty} p_{2mS}\, \phi_{2mS}(\theta) \qquad [52]$$

For Roll:

A_R = stream function in phase with acceleration

$$= \psi_{cR}\left(\frac{\pi}{2}\right) + \sum_{m=1}^{\infty} p_{2mR}\, \psi_{2mR}\left(\frac{\pi}{2}\right) \qquad [53]$$

B_R = stream function in phase with velocity

$$= \psi_{sR}\left(\frac{\pi}{2}\right) + \sum_{m=1}^{\infty} q_{2mR}\, \psi_{2mR}\left(\frac{\pi}{2}\right) \qquad [54]$$

$M_R(\theta)$ = sine component of the velocity potential at an arbitrary point on the contour

$$= \phi_{sR}(\theta) + \sum_{m=1}^{\infty} q_{2mR}\ \phi_{2mR}(\theta) \qquad [55]$$

$N_R(\theta)$ = cosine component of the velocity potential at an arbitrary point on the contour

$$= \phi_{cR}(\theta) + \sum_{m=1}^{\infty} p_{2mR}\ \phi_{2mR}(\theta) \qquad [56]$$

The cosine components of the multiple potential p_{2mS} and p_{2mR} and sine components q_{2mS} and q_{2mR} are found by a least squares fit involving the solution of the matrix equations:

$$p_{2mS} = [X_S]^{-1}\ Y1_S \qquad [57]$$

$$q_{2mS} = [X_S]^{-1}\ Y2_S \qquad [58]$$

$$p_{2mR} = [X_R]^{-1}\ Y1_R \qquad [59]$$

$$q_{2mR} = [X_R]^{-1}\ Y2_R \qquad [60]$$

where:

$$X_S = X_{ij} = \sum_{\theta} D_{iS}(\theta)\ D_{jS}(\theta) \qquad [61]$$

$$Y1_S = Y1_j = \sum_{\theta} D_{jS}(\theta) \left\{ \psi_{cS}(\theta) - \psi_{cS}(\tfrac{\pi}{2}) - (\tfrac{y}{d}) \left[\psi_{cS}(0) - \psi_{cS}(\tfrac{\pi}{2})\right] \right\} \qquad [62]$$

$$Y2_S = Y2_j = \sum_{\theta} D_{jS}(\theta) \left\{ \psi_{sS}(\theta) - \psi_{sS}(\tfrac{\pi}{2}) - (\tfrac{y}{d}) \left[\psi_{sS}(0) - \psi_{sS}(\tfrac{\pi}{2})\right] \right\} \qquad [63]$$

$$D_{jS}(\theta) = (\tfrac{y}{d}) \left[\psi_{2jS}(0) - \psi_{2jS}(\tfrac{\pi}{2}) \right] + \psi_{2jS}(\tfrac{\pi}{2}) - \psi_{2jS}(\theta) \qquad [64]$$

$$X_R = X_{ij} = \sum_{\theta} D_{iR}(\theta) \; D_{jR}(\theta) \qquad [65]$$

$$YI_R = YI_j = \sum_{\theta} D_{jR} \left\{ \left(\frac{d^2 - b^2}{b^2} \right) \left[\psi_{cR}(\theta) - \psi_{cR}\left(\tfrac{\pi}{2}\right) \right] - \left(\frac{x^2 + y^2}{b^2} - 1 \right) \left[\psi_{cR}(0) - \psi_{cR}\left(\tfrac{\pi}{2}\right) \right] \right\} \qquad [66]$$

$$Y_{2R} = Y_{2j} = \sum_{\theta} D_{jR} \left\{ \left(\frac{d^2 - b^2}{b^2} \right) \left[\psi_{sR}(\theta) - \psi_{sR}\left(\tfrac{\pi}{2}\right) \right] - \left(\frac{x^2 + y^2}{b^2} - 1 \right) \left[\psi_{sR}(0) - \psi_{sR}\left(\tfrac{\pi}{2}\right) \right] \right\} \qquad [67]$$

$$D_{jR}(\theta) = \left(\frac{x^2 + y^2}{b^2} - 1 \right) \left[\psi_{2jR}(0) - \psi_{2jR}\left(\tfrac{\pi}{2}\right) \right] - \left(\frac{d^2 - b^2}{b^2} \right) \left[\psi_{2jR}(\theta) - \psi_{2jR}\left(\tfrac{\pi}{2}\right) \right] \qquad [68]$$

The remaining equations are as follows:

Stream functions:

$$\psi_{cR}(\theta) = \psi_{cS}(\theta) = \pi \, e^{-ky} \cos(kx) \qquad [69]$$

$$\psi_{sR}(\theta) = \psi_{sS}(\theta) = \phi_{sH}(\theta) - \frac{y}{k(x^2 + y^2)}$$

$$= \pi \, e^{ky} \sin(kx) + \int_0^{\infty} e^{-\beta x} \left[\frac{\beta \cos(\beta y) - k \sin(\beta y)}{\beta^2 + k^2} \right] d\beta - \frac{y}{k(x^2 + y^2)} \qquad [70]$$

$$\psi_{2mR}(\theta) = \psi_{2mS}(\theta) = -\cos(2m+1)\theta + \sum_{n=1}^{N} \cdot \frac{k(2n-3) \, a_{2n-3} \cos(2m+2n-2)\theta}{2m + 2n - 2} \qquad [71]$$

Velocity potential functions:

$$\phi_{cR}(\theta) = \phi_{cS}(\theta) = -\pi \; e^{-ky} \sin(kx) \qquad [72]$$

$$\phi_{sR}(\theta) = \phi_{sS}(\theta) = -\psi_{sH}(\theta) + \frac{x}{k(x^2 + y^2)} \qquad [73]$$

$$= \pi \, e^{ky} \cos(kx) + \int_0^{\infty} e^{-\beta x} \left[\frac{k \cos(\beta y) + \beta \sin(\beta y)}{\beta^2 + k^2} \right] d\beta + \frac{x}{k(x^2 + y^2)}$$

$$\phi_{2mR}(\theta) = \phi_{2mS}(\theta) = \sin(2m+1)\theta - \sum_{n=1}^{N} \cdot \frac{k(2n-3)\, a_{2n-3} \sin(2m+2n-2)\theta}{2m+2n-2} \qquad [74]$$

The accuracy of the least square fit for the description of p_{2m} and q_{2m} is expressed by the following equations shown in (4):

$$CHECK_H = \left| \frac{\text{HEAVE DAMPING} * (A_H^2 + B_H^2)}{\frac{1}{2} b^2 \pi^2} - 1.0 \right| \qquad [75]$$

$$CHECK_S = \left| \frac{\text{SWAY DAMPING} * (A_S^2 + B_S^2)}{\frac{1}{2} d^2 \pi^2} - 1.0 \right| \qquad [76]$$

$$CHECK_R = \left| \frac{\text{ROLL DAMPING} * (A_R^2 + B_R^2)}{\frac{1}{2} \pi^2 (d^2 - b^2)} - 1.0 \right| \qquad [77]$$

The closer these values are to zero, the better the fit. If any of these accuracies are greater than 2%, the number of terms used to describe p_{2m} and q_{2m} is increased by four for the next frequency calculation. The original number of terms in the p_{2m} and q_{2m} series is 4 and the maximum dimension is 24.

2. Close Fit Method

The close fit technique involves the determination of the two-dimensional hydrodynamic pressure on a section's contour using a method of distributing source singularities over the submerged portion of the hull. Each of the sources has a density which can be determined from the kinematic boundary condition. The hydrodynamic pressures are obtained by substituting the velocity potential, described by these piece-wise sources, into the linearized Bernoulli equation.

$$p^{(m)}(x_i,\ y_i,\ \omega_j t) = -\rho\phi_t^{(m)}(x_i,\ y_i,\ \omega_j t) \qquad [78]$$

or

$$p^{(m)}(x_i,\ y_i,\ \omega_j t) = P_a^{(m)}(x_i,\ y_i,\ \omega)\ \cos\omega t + P_v^{(m)}(x_i,\ y_i,\ \omega)\ \sin\omega t \qquad [79]$$

Each ship's section is described by N+1 offset pairs $(\xi_i,\ \eta_i)$ whose midpoint (x_i, y_i) can be determined from plane geometry.

In order to determine the pressure, the velocity potential $\phi_t^{(m)}$ is defined:

$$\phi^{(m)}(x,\ y;\ t) = R_e \int_{C_o} Q(s)\ G(z,\ \zeta)\ e^{-i\omega t}\ ds \qquad [80]$$

or as shown in (7) for point i:

$$\phi_i^{(m)} = \left[\frac{1}{2\pi} \sum_{j=1}^{N} Q_j\ R_e\ \{G_{1ij}\} - \sum_{j=1}^{N} Q_{N+j}\ R_e\ \{G_{2ij}\} \right] \cos\omega t + \left[\frac{1}{2\pi} \sum_{j=1}^{N} Q_{N+j}\ R_e\ \{G_{1ij}\} + \sum_{j=1}^{N} Q_j\ R_e\ \{G_{2ij}\} \right] \sin\omega t \qquad [81]$$

where Q_j is the density of the pulsating source at point j, G_{ij} is the point potential at i due to point j.

A detailed explanation of the point potential is given in the appendices of (7). The density of the source potential is determined by applying the kinematic boundary condition which can be summarized as follows:

$$\sum_{j=1}^{N} Q_j^{(m)} I_{ij}^{(m)} + \sum_{j=1}^{N} Q_{N+j}^{(m)} J_{ij}^{(m)} = 0$$

[82]

$$-\sum_{j=1}^{N} Q_j^{(m)} J_{ij}^{(m)} + \sum_{j=1}^{N} Q_{N+j}^{(m)} I_{ij}^{(m)} = \omega A^{(m)} n_i^{(m)}$$

where $I_{ij}^{(m)}$ is the influence coefficient in phase with displacement of the i^{th} midpoint due to the j^{th} segment in the m^{th} mode of motion; $J_{ij}^{(m)}$ is the same as $I_{ij}^{(m)}$ but in phase with velocity, $M_i^{(m)}$ is the direction cosine of the normal velocity at i^{th} midpoint for the m^{th} mode of oscillation; $Q_{ij}^{(m)}$ is the source strength in phase with displacement along j^{th} segment for the m^{th} mode of oscillation; $Q_{j+N}^{(m)}$ is the same as $Q_j^{(m)}$ but in phase with velocity; and $A^{(m)}$ is the oscillation of amplitude in the m^{th} mode.

The influence coefficients are defined in Appendix B of (7). Equation [82] can be solved for source density, Q_j, by solving the two simultaneous equations. The solution for the pressures and their added mass and damping is relatively straightforward.

The ship is described in a cartesian coordinate system with the origin at the forward perpendicular at its intersection with the ship's centerline and baseline (see Figure 3.1). The x-axis is positive aft from this point, the y-axis positive to starboard and z-axis positive vertically. Planes parallel to the x-y plane at different heights on the z-axis are referred to as waterplanes, whether they are in the water or not, and are usually symmetric about the ship's centerline. These half-waterplanes are shown graphical in the half breadth plan (Figure 3.2a). Planes that are parallel to the y-z plane at various distances from the forward perpendicular are called transverse sections or stations, and like the waterplanes are symmetric port and starboard. The half stations are shown in the body plan (Figure 3.2b) with the forward half of the ship on the right side and aft half on the left side. The final view, obtained by passing planes parallel to the x-z plane at certain distances from the centerline, gives us a picture of the ship's buttock lines. The sheer plan (Figure 3.2c) illustrates these lines.

III. DESCRIPTION OF INPUT SCHEME

There are three separate data files used in running program STATIC:

1) an offset data file
2) a weight distribution data file and
3) a job control data file.

An offset data file describes the ship geometry by means of coordinate points on the surface of the ship's hull. The weight data, a description of the loading along the length of the ship, determines where the vessel will float (i.e., drafts forward and aft). The job control file directs the execution of the program.

A. Physical Description of the Ship

A.1 Ship Geometry Input

A ship, like any other body, can be shown graphically in three views, the top view, the side view and the end view; or in naval architectural terms, the half breadth plan, the sheer plan and the body plan, respectively.

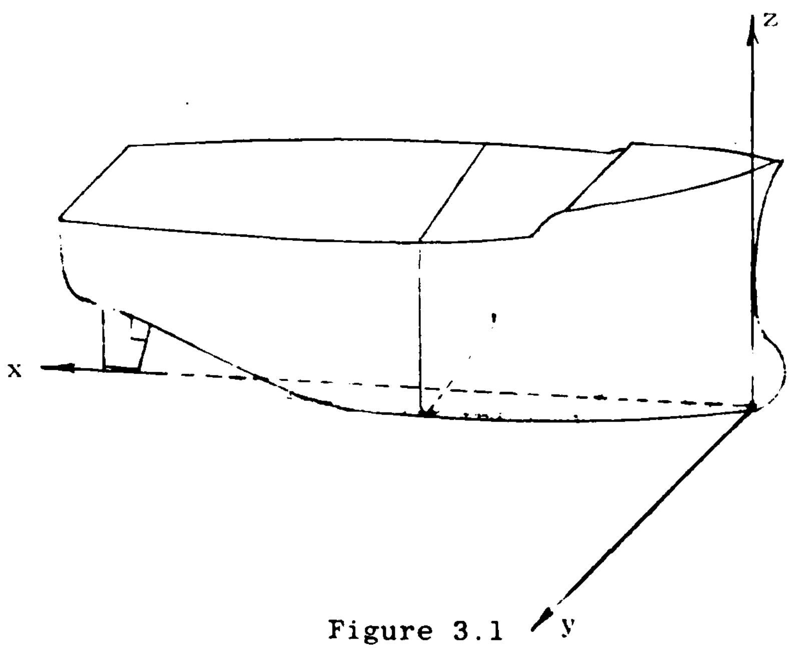
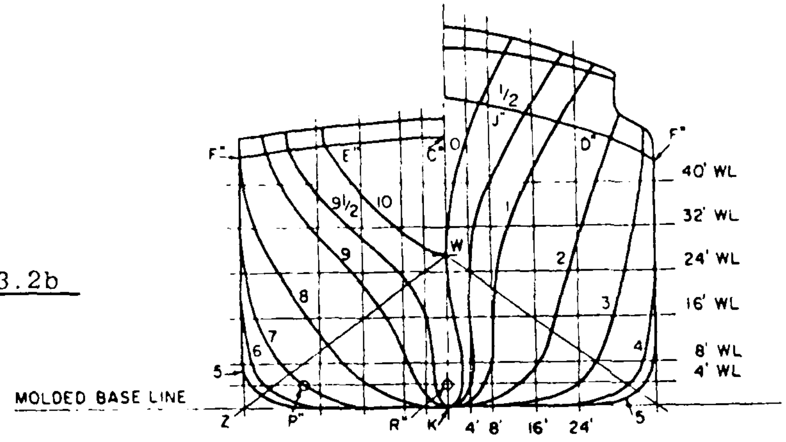


Figure 3.1

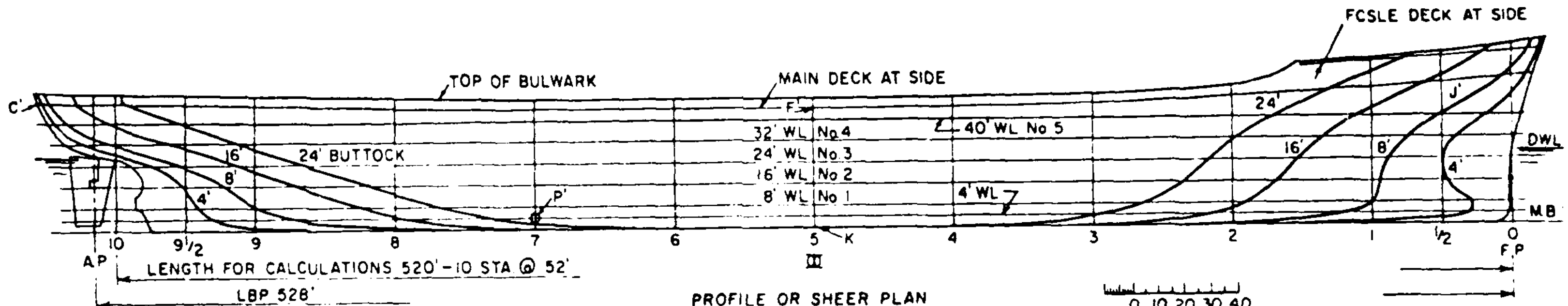


3.2b

BODY PLAN

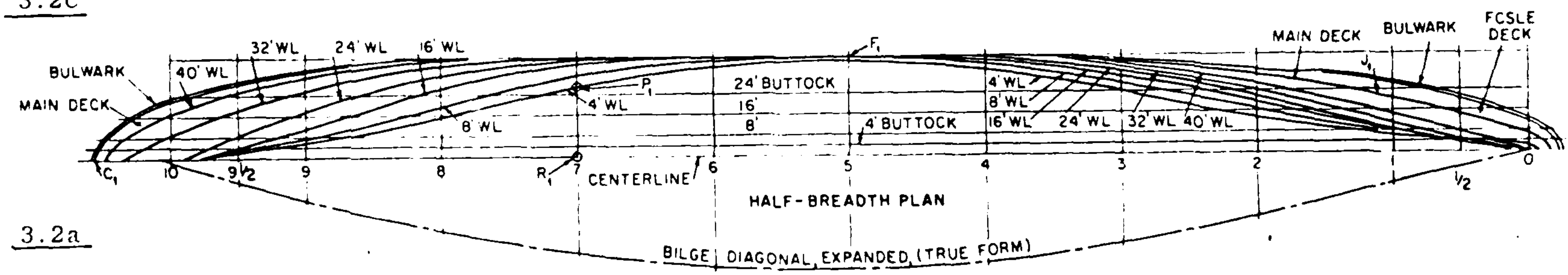
PRINCIPAL DIMENSIONS

LENGTH OVER ALL	563'-7 3/4"
LENGTH BETWEEN PERPENDICULARS	528'-0"
LENGTH FOR CALCULATIONS	520'-0"
BREADTH MOLDED	76'-0"
DEPTH MOLDED, TO MAIN DECK AT SIDE (STA 5)	44'-6"
DRAFT, MOLDED, TO DESIGNED WATERLINE (DWL)	27'-0"
DRAFT, TO LOAD WATERLINE (LWL)	29'-10"
DISPLACEMENT, MOLDED, SALT WATER-27' DWL	18,674 TONS
DISPLACEMENT, LOADED, SALT WATER-29'-10" LWL	21,093 TONS



PROFILE OR SHEER PLAN

3.2c



HALF-BREADTH PLAN

3.2a

Fig. 1 Lines drawing

Figure 3.2

Taken from (9)

The geometric description used in program STATIC is obtained from the ship's body plan. The input is given for each transverse section commencing with the forward perpendicular and proceeding aft. These sections are given numbers with the forward perpendicular (F.P.) as station 0.0 and aft perpendicular (A.P.) as station 20.0. A length scale of 20 is thus established and all sections are located according to the base dimension of 20. More or less than 21 stations may be used in defining the ship but the total number of stations cannot exceed 41. Stations forward of the F.P. and aft of the A.P. are allowed with stations forward of the F.P. being at a negative distance.

Any station spacing may be used in program STATIC. It is common to have more stations at the ends of the ship due to the rapid change of shape and various appendages. For the hydrodynamic computations there is a limit of 21 stations and it is preferable to have primarily equal station spacing. For this reason the program has a capability to generate a 21 station description at equal distances from any inputed station arrangement.

Each station represents a section (or cylinder) of uniform cross-section. The shape of a section is approximated by a polygon (see Figure 3.3) with corners at the offset points with up to 29 points for each station.

Selection of the offset points requires only one consideration; the points and the straight lines between them should provide a good geometric description of the station shape. Therefore, bow and stern sections typically use twice as many points as a midship section for the same accuracy.

The offsets begin at the intersection of the centerline with the section and proceed to the main deck as shown by points 1 to N in Figure 3.3.

The geometric properties of a station to a given waterline, such as area and centroids, are obtained using a

*Note: When digitizing care should be taken in following this procedure.

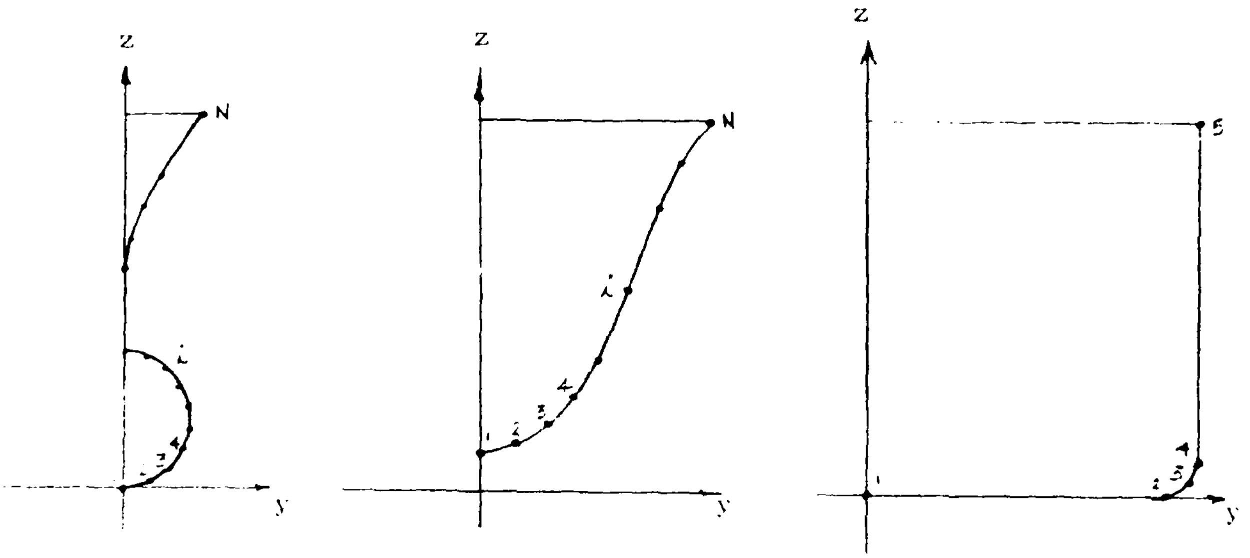


Figure 3.3

linear (i.e., straight line) integration of the offset points.

For the calculation of section added mass and damping for the hydrodynamic calculations, it is preferable to have equi-spaced offset points along the underwater contour. Again, rather than modifying the input offset description, program STATIC has the capability of inserting equi-spaced points (maximum of 21) along the underwater contour of a station. The offset geometry data format will be described in Section C.1.

A.2 Weight Description

The ship will float in a position such that it is in equilibrium, that is,the upward force (buoyancy) is equal and opposite to the downward force (weight).

The buoyancy force is a force caused by the ship displacing fluid and is equal to the product of the underwater volume of the ship and the density of the fluid in which the vessel is floating. The location of this force is given in the ship's coordinate system and has three dimensions:

1) distance from the forward perpendicular called the longitudinal center of buoyancy (LCB or XCB)
2) the distance above the keel called the vertical center of buoyancy (KB or ZCB) and
3) the distance from the ship's centerline called the horizontal center of buoyancy (HCB or YCB).

The center of buoyancy is the centroid of the underwater portion of the ship and is determined by the position of the ship in the water. If we displace a ship downward its displacement will increase and the KB will also increase. If we trim the stern down the LCB will move further aft. Heeling the ship to starboard will cause the HCB to move in that direction.

The weight force and its location must be given so that the ship can adjust itself (sink, trim and heel) so that it is in equilibrium. The location of the weight force is similar to buoyancy force:

1) longitudinal center of gravity (LCG or XCG), distance aft of forward perpendicular
2) vertical center of gravity (KG or ZCG), distance above the keel and
3) horizontal center of gravity (HCG or YCG), distance to the starboard of centerline.

In order to determine how the ship will float the weight, LCG, KG and HCG must be given. The following describes how each of these may be specified:

(1) WEIGHT

The ship weight can be specified directly or in two alternate ways. The first is to specify the ship's drafts forward and aft which enables the program to calculate the ship's buoyancy and hence due to the principle of equilibrium, its weight. The second is to give a longitudinal weight curve which describes the ship loading with the area under this curve being the ship's weight. This concept will be described later.

(2) LCB

LCB can either be given directly or by two other means. Again, if the drafts forward and aft are given, the ship's longitudinal center of buoyancy (LCB) can be determined. Due to our principle of equilibrium we can determine our LCG from the LCB. The final method of finding the LCG is to determine the centroid of the longitudinal weight curve.

(3) KG must be given.

(4) HCG

HCG can either be given or by specifying the ship's heel. By knowing the ship's heel, the center of buoyancy can be found and therefore the HCG can be determined.

All the different methods of describing the weight and centroid other than the longitudinal weight curve are specified in the control data file which will be described in Section C.3. The weight curve, which is of the standard USCG type, will be described now and the data format in Section C.2.

The weight curve is a graphic representation of the weight of the ship plotted as tons per foot (or any other desired units) on a vertical scale and the length of the ship on a horizontal scale (see Figure 3.4).

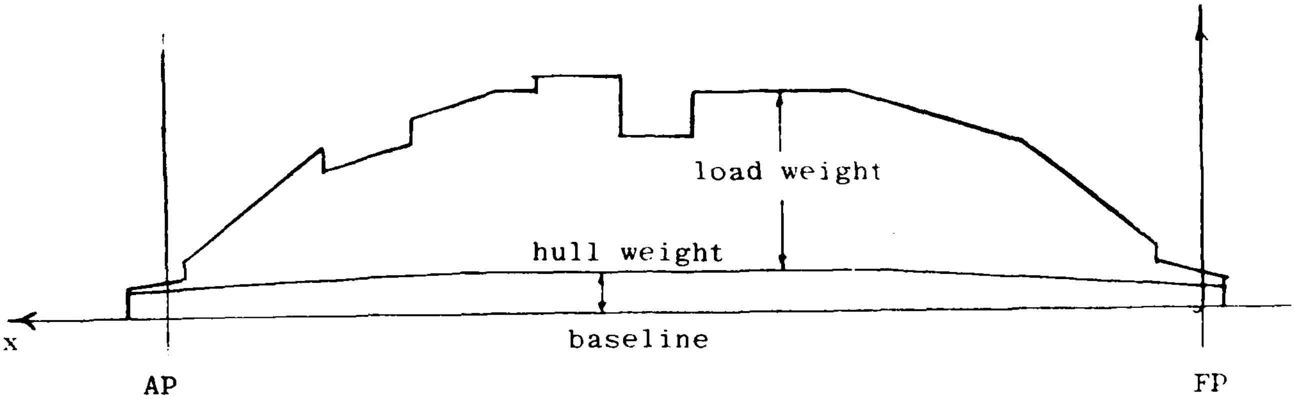


Figure 3.4

As mentioned above, the area under the curve represents the ship's weight and the longitudinal centroid is the LCG. The weight curve is usually calculated for both the light ship and full load conditions.

In order to calculate a weight curve, we generally take all the weights along a specified length of a vessel, usually a hold or station, and calculate the weight and centroid of this part of the ship. Knowing the weight, w, its location, lcg, and the limits of this weight, x_1 and x_2, we can determine a trapazoidal weight block to represent this load (see Figure 3.5).

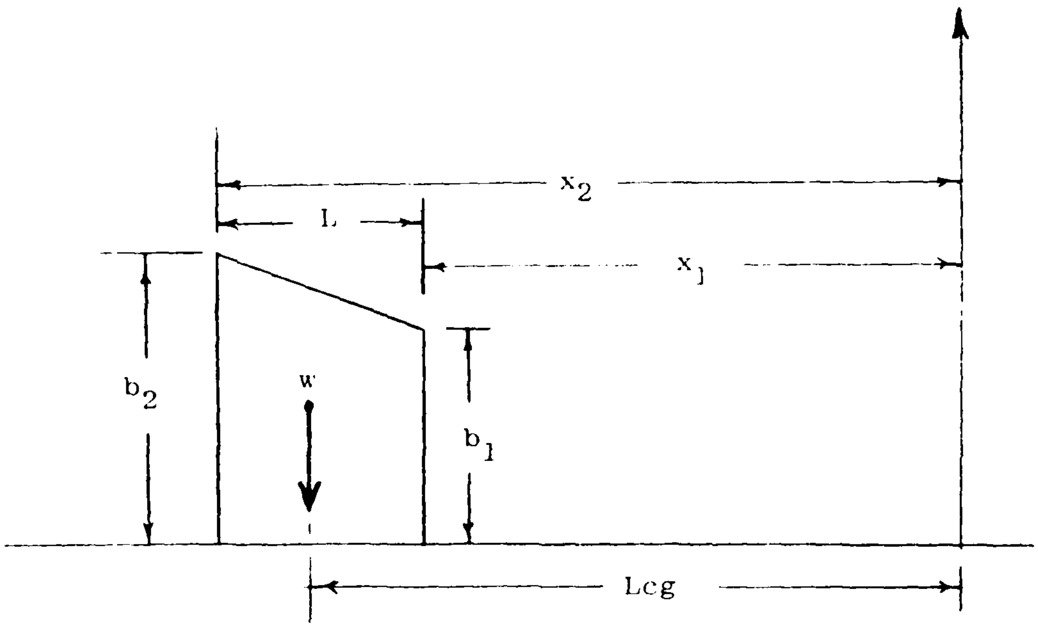


Figure 3.5

From statics it can be seen that

$$b_1 = 2w\ (2L - 3Lcg)\ /\ L^2$$

$$b_2 = 2w\ (3Lcg - L)\ /\ L^2$$

A given hold might have several of these blocks superimposed to give a final weight curve such as that shown in Figure 3.4. The ballast, lightship and cargo weights could be treated separately and the b_1's and b_2's added together for the final weight block. The input into program STATIC will be w, Lcg, x_1 and x_2 for various lengths of the ship and categories of load. These will be stored in a data file whose format will be described in Section C.2.

B. Program Control

B.1 Introduction

Practically all programs require some input data. A typical small program may do a short preliminary calculation, read a programmed amount of data, perform some calculation with the data, and terminate with the output of some useful information. A slightly more sophisticated program may read some miscellaneous constants, numerical values describing the lengths of input data tables, flag values that may control the execution of the program or its input and output scheduling, as well as tables of data. Usually these various data items must be furnished by the program user according to some rigid format scheme. The miscellaneous data items such as constants, lengths and control flags are often intermixed with the tables of data. The input setups of many programs become very complicated when the lengths of data tables may be varied, or the order of processing may be changed by control flags in the input deck. Often used constants must be supplied by the user although the program should be able to assume some default value.

The "Program Input and Control SYstem (PICSY)" (17) described here is intended to allow a great deal of flexibility in the execution of a FORTRAN program, while simplifying the input setup.

B.2 Control of Program Execution

Program STATIC consists of eight subprograms, each dealing with a particular step in the overall procedure. Some examples of these steps are: the definition of units whether English or Metric; reading in offset information; hydrostatic calculations; output definition; and so forth. The order in which you call each of these subprograms is flexible to a certain degree. The program control statement* is used to control the program execution.

*Underlining is used to indicated defined terms.

The program control statements form part or all of the input to a program using the PICSY. This control statement consists of a job name and an optional parameter list. The job name directs the main program to execute an associated subprogram. The parameter list is used to input data items and to control subprogram execution. The program control statements are lines (or cards) of Hollerith data (BCD characters) to be read by the program. The first line of data read by the program is usually a program control statement. Other lines of information may be program statements, other data, or a mixture of control statements and data depending on the nature of the program, the subprogram specified by the preceding program control statement and any parameters.

B.3 Syntax of Program Control Statement

The following definitions shall apply for the purpose of describing the structure of the program control statement:

Program control statement: This is alphanumeric data read by the program to allow the user to logically control the program execution. The program control statement may take any of the following forms:

1) The character (*) in column 1 of the first line of the statement; followed by a job name; and followed by a terminator.
2) The character (*) in column 1 of the first line of the statement; followed by a job name; followed by a separator; followed by a parameter list; followed by a terminator.

Job name: This name requests the main program to call a subprogram for execution. The job name must be one of the job names defined for use by the main program. A list of STATIC job names may be found in Section C.3. Blanks or spaces are ignored.

Parameter list: This is a list of one or more parameters. A parameter list may be a single parameter, or it may be several parameters separated by separators. The parameter list may not consist of more than 20 parameters.

Parameter: The parameter may take one of two forms: it may be a parameter name, or it may be a parameter name followed by the character (=) followed by a parameter value.

Parameter name: This name is used to control the execution of the subprogram corresponding to the given job name. The parameter name must be one defined for use by the particular subprogram. The list of valid parameters accompanies the description of each subprogram in Section C.3. A parameter name may consist of 1 to 10 alphanumeric characters. Blanks or spaces are ignored.

Parameter value: This value is a character string which may be associated with certain parameter names. The character string is used to input values into the program. Depending on the parameter name, the value may be of several types, viz. a real value, an integer value or alphanumeric value for identification or control purposes. The type of the value depends on the parameter name and job name. The subprogram descriptions specify the type of parameter value to be associated with each parameter name. A parameter value may consist of 1 to 20 alphanumeric characters. Blanks or spaces are being ignored.

Alphanumeric value: This is a parameter value used by the program for identification purposes or a data file name. It may consist of 1 to 20 alphanumeric characters. Here "alphanumeric" characters refers to the BCD characters in use within the particular computer operating system. They are the alphabetic characters A through Z, the numeric characters 0 and 1 through 9 and the set of punctuation and mathematical characters understood by the system.

Real value: This is a parameter value to be converted by the program into a REAL number. It must follow the syntax for FORTRAN real constants or FORTRAN integer constants. It is represented by a string of digits (numeric characters), preceded optionally by a sign character (+ or -); it may contain a decimal point; and it may be followed by an "exponent representation" indicating a power of 10. The "exponent representation" consists of the character (E) followed optionally by a (+) or a (-) followed by digits indicating the power of 10. The parameter value syntax limits the number of non-blank characters to 20.

Integer value: This is a parameter value to be converted by the program into an INTEGER number. The syntax is the same as for a real value.

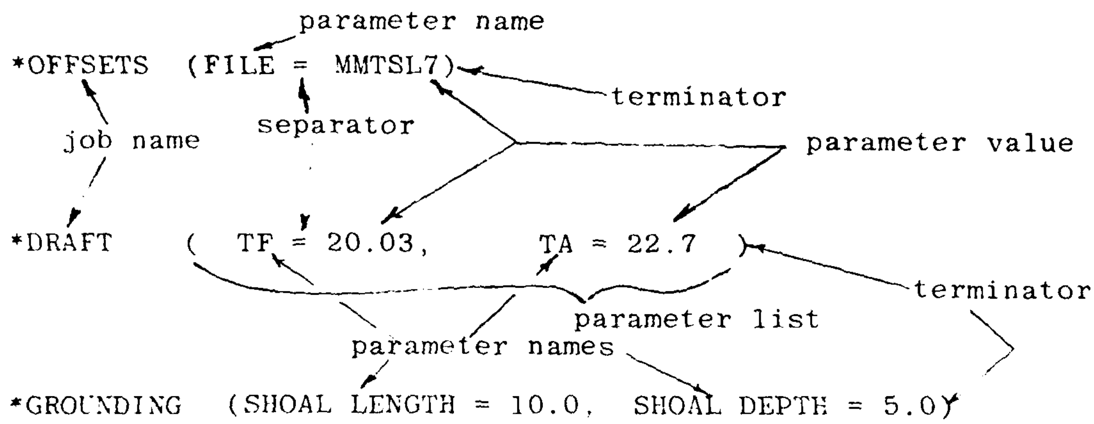
Separator: This is a character used to separate the job name from the parameter list and to separate parameters within the parameter list. A separator is either the character (,) or the character (().

Terminator: This is a character used to indicate the logical end of a program control statement. The character (() will always terminate the statement. The character (.) will terminate the program control statement if it occurs following a job name, a parameter name or a separator. The character (.) is not a terminator if it occurs following a parameter value. (In the last case the (.) is considered part of the parameter value).

A few additional remarks regarding the physical structure of the program control statement are in order at this point. The program reads the program control statement components from column 1 through 80 of each line. The job name must be completed on the first line of the control statement. The parameter list may be continued on more than one line, but the terminator must appear on or before the fifth line of the statement. Any characters following the terminator, and on the same line as the terminator, will be ignored.

Some examples of the program control statement follow.

Parameter List



*UNITS (RHO = 1.9905, FORCE = LB)

*UNITS .

The complete lists of job names, parameter names and parameter values will be given in Section C.3.

C. Data Card or Data File Input Description

C.1 Offset Data File

The offset data file is a geometric description of the ship following the SHCP "cook book" format. This information will be loaded into the computer core and stored as a file with a seven letter descriptive name. The convention that has been established requires that the first three letters of the file name be "MMT" with the remaining four letters being the users choice. A description of the card (or line) format for this file is given below.

1) TITLE CARD

Columns	Format	Entry
1-40	A	Any alphanumerica title information used to label job output, such as ship name

2) LENGTH CARD

Columns	Format	Entry
1-10	Real	Station or frame spacing in length units (feet, inches, meters, etc.)
11-20	Real	Vertical scale. If the offsets are in the desired units, vertical scale should be set equal to 0.005. If offsets are lifted from a body plan via Telecorder, submit scale factors as the scale of the drawing in inches per foot, adjusted for distortion as required. For example, if scale of drawing is 1/4 inch per foot, submit 0.25 for vertical scale.
21-30	Real	Horizontal scale. Same definition as vertical scale but for horizontal direction.
31-40	Real	Ship's length between perpendiculars.
41-50	Real	Scale to be used in plotting of body plan (this is not used in program STATIC).

3) OFFSET CARDS

Columns	Format	Entry
1-6	Real	Station distance (or number) from the FP as described below. Stations should be carefully selected to give an accurate representation of the hull form. Neither evenly-spaced stations nor integer station numbers are required.
7-13	Real	Half beam measured from the vessel's centerline for a given offset point.
14-20	Real	Waterline height, measured from the vessel's baseline for a given offset point.
21-26	Integer	Control integer which signifies end of station or end of ship. If: +88888 , this represents last point for station If: +99999,this represents last point of last station on ship (or end of data).

Card 3 is repeated for every offset point and every station.

The station spacing is multiplied by the station number on card 3 to obtain each station's distance from the FP. As long as this product gives the distance from the FP, the data may be any representation of the station's location. The following are valid combinations:

Card 2, Cols. 1-10	Card 3, Cols. 1-6
a. frame spacing	a. frame number
b. 1.0	b. distance from FP (feet)
c. LBP (feet)	c. %LBP
d. station spacing	d. station number

The following rules apply to station selection,(Columns 1-6, Card 3):

a. A minimum of three and a maximum of forty-one stations can be specified.

b. Each station must have a non-zero sectional area when entirely immersed.

c. The sequence of stations submitted must be from the bow aft. The tip of the bow and the stern should be included to define overall ship length (LOA). Since station distance from the FP is obtained by multiplying station number by station spacing, a station forward of the FP will have a negative number.

d. The minimum station must have a half-breadth of at least .01 feet, and an incremental height of at least .01 feet.

e. Regions of rapid change in station size or shape require many closely spaced stations (e.g., half and/or quarter stations should be submitted near the bow and stern).

f. Longitudinal breakpoints (end of raised forecastle, end of skeg, etc.) are represented by closely spaced stations. Do not confuse a station's position in the input sequence with its station number.

g. Only two stations need be specified for the parallel midbody.

The following rules must be observed for points on each station (columns 7-13 and 14-20 on card 3):

a) A minimum of two points and a maximum of twenty-nine points per station can be processed.

b) The points on each station must be submitted in a specific order. The first offset point is at the intersection of the station and the centerline, and the last point is the deck and can be at either the side or centerline.

c) The station is represented as a polygon. Therefore straight lines between two adjacent offset points should describe the section fairly accurately. There will be more points in areas of rapid curvature. Two points are required to describe a straight line, one at the beginning of the segment and one at the end.

An example of an offset file using the SL-7 follows.

```
PAGE    1 07/05/79. 11.32.14.   MMTSL7


SEA-LAND 7 CONTAINERSHIP
  44.0250    0.0050    0.0050  880.5000    0.2500
0.     0.       0.
0.     3.0349   .8202
0.     4.4801 1.6404
0.     6.0699 3.2808
0.     6.6479 4.9213
0.     7.0237 6.5617
0.     7.0815 8.2021
0.     6.7347 9.8425
0.     6.214411.4829
0.     5.491813.1234
0.     3.815316.4042
0.     2.341219.6850
0.     1.156222.9659
0.      .289026.2467
0.     0.      29.5276
0.     0.      32.8084
0.     1.011639.3701
0.     2.514745.9318
0.     4.277852.4934
0.     6.272259.0551
0.     8.237765.1247+88888
 .250 0.       0.
 .250 3.1795   .8202
 .250 4.6247 1.6404
 .250 6.2144 3.2808
 .250 6.9948 4.9213
 .250 7.2260 6.5617
 .250 7.2260 8.2021
 .250 6.9948 9.8425
 .250 6.590111.4829
 .250 5.838613.1234
 .250 4.277816.4042
 .250 2.890419.6850
 .250 1.792122.9659
 .250 1.156226.2467
 .250  .867129.5276
 .250 1.098432.8084
 .250 2.023339.3701
 .250 3.613045.9318
 .250 5.838652.4934
 .250 8.382259.0551
 .25010.896865.0262+88888
 .500 0.       0.
 .500 3.3240   .8202
 .500 4.7692 1.6404
 .500 6.3589 3.2808
 .500 7.0815 4.9213
 .500 7.5151 6.5617
```

<u>Note</u>:

Offsets were updated September 1980 to correct data point.

```
 .500 7.5729 8.2021
 .500 7.2838 9.8425
 .500 6.937011.4829
 .500 6.301113.1234
 .500 4.653616.4042
 .500 3.324019.6850
 .500 2.283422.9659
 .500 1.531926.2467
 .500 1.300729.5276
 .500 1.503032.8084
 .500 2.861539.3701
 .500 4.971545.9318
 .500 7.717452.4934
 .50010.607859.0551
 .50013.353764.9934+88888
1.000 0.      0.
1.000 3.7575  .8202
1.000 5.2027 1.6404
1.000 6.8792 3.2808
1.000 7.6596 4.9213
1.000 8.1510 6.5617
1.000 8.2377 8.2021
1.000 8.0932 9.8425
1.000 7.804111.4829
1.000 7.226013.1234
1.000 5.838616.4042
1.000 4.335619.6850
1.000 3.179522.9659
1.000 2.601426.2467
1.000 2.543629.5276
1.000 3.034932.8084
1.000 5.058239.3701
1.000 7.861945.9318
1.00011.272652.4934
1.00014.885659.0551
1.00018.007364.9606+88888
1.500 0.      0.
1.500 4.1911  .8202
1.500 5.5785 1.6404
1.500 7.3995 3.2808
1.500 8.5267 4.9213
1.500 8.6712 6.5617
1.500 8.9025 8.2021
1.500 8.8158 9.8425
1.500 8.526711.4829
1.500 8.093213.1234
1.500 6.647916.4042
1.500 5.347319.6850
1.500 4.393422.9659
1.500 4.133326.2467
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```
1.500 4.335629.5276
1.500 5.000432.8084
1.500 7.601839.3701
1.50010.983645.9318
1.50011.908552.4934
1.50018.787759.0551
1.50022.545264.8950+88888
2.000 0.      0.
2.000 4.6247   .8202
2.000 6.1277 1.6404
2.000 8.0353 3.2808
2.000 9.1626 4.9213
2.000 9.4805 6.5617
2.000 9.7696 8.2021
2.000 9.6829 9.8425
2.000 9.336011.4829
2.000 8.960313.1234
2.000 7.948616.4042
2.000 6.937019.6850
2.000 6.214422.9659
2.000 6.214426.2467
2.000 6.879229.5276
2.000 8.006432.8084
2.00010.925839.3701
2.00014.452145.9318
2.00018.267452.4934
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2.500 6.8792 1.6404
2.500 8.4689 3.2808
2.500 9.3938 4.9213
2.500 9.8274 6.5617
2.50010.2610 8.2021
2.50010.4055 9.8425
2.50010.203211.4829
2.50010.058613.1234
2.500 9.393816.4042
2.500 8.757919.6850
2.500 8.613422.9659
2.500 9.018126.2467
2.500 9.827429.5276
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2.50014.452139.3701
2.50018.267445.9318
2.50022.545252.4934
2.50027.112159.0551
2.50031.303264.6982+88888
3.000 0.      0.
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3.000 5.9253  .8202
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3.000 8.9603 3.2808
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3.00010.6656 6.5617
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3.00011.272613.1234
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3.00011.041419.6850
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3.00030.927459:0551
3.00034.974064.6325+88888
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4.000 6.9370  .8202
4.000 8.7579 1.6404
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5.000 8.9603  .8202
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5.00015.3192 4.9213
5.00016.9667 6.5617
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5.00027.458926.2467
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6.00050.351064.3373+88888
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7.00017.1979  .8202
7.00020.2329 1.6404
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8.00031.5055  3.2808
8.00033.9623  4.9213
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9.00038.2979  3.2808
9.00040.6103  4.9213
9.00042.7781  6.5617
9.00044.3100  8.2021
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9.00050.351022.9659
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10.00052.750064.3045+88888
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11.00035.6497   .8202
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11.00044.6346 3.2808
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12.00033.9107   .8202
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12.00042.7507 3.2808
12.00045.3592 4.9213
12.00047.1852 6.5617
12.00048.6923 8.2021
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12.00051.213913.1234
12.00052.083416.4042
12.00052.605119.6850
12.00052.750022.9659
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PAGE     8 07/05/79. 11.32.14.   MMTSL7

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13.00038.5481 3.2808
13.00041.5044 4.9213
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13.00048.547411.4829
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13.00051.880519.6850
13.00052.402222.9659
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14.00046.141813.1234
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14.00050.141519.6850
14.00051.242922.9659
14.00051.938526.2467
14.00052.460229.5276
14.00052.750032.8084
14.00052.750068.2415+88888
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15.000 3.1882 0.
15.00011.5934  .8202
15.00016.0279 1.6404
15.00022.3173 3.2808
15.00024.2012 4.9213
15.00031.3022 6.5617
15.00034.2295 8.2021
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16.000 4.8982  .8202
16.000 8.2023 1.6404
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16.00017.2452 4.9213
16.00021.3898 6.5617
16.00024.6940 8.2021
16.00028.0850 9.8425
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17.000 2.4636 0.
17.000 3.2462  .8202
17.000 4.2896 1.6404
17.000 6.7242 3.2808
17.000 9.4196 4.9213
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17.00052.025454.6260
17.00052.025468.2415+88888
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PAGE    10 07/05/79. 11.32.14.    MMTSL7

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17.500 2.1738 0.
17.500 2.6085  .8202
17.500 3.1882 1.6404
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17.500 6.5213 4.9213
17.500 8.8400 6.5617
17.50010.8688 8.2021
17.50013.2745 9.8425
17.50015.245311.4829
17.50017.622013.1234
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17.50048.692352.4934
17.50051.358854.6260
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18.000 0.      0.
18.000 2.0288 0.
18.000 2.1738  .8202
18.000 2.5216 1.6404
18.000 3.3331 3.2808
18.000 4.3475 4.9213
18.000 5.7967 6.5617
18.000 7.2749 8.2021
18.000 9.0139 9.8425
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18.00048.344554.6260
18.00048.344568.4383+88888
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18.500 1.7390  .8202
18.500 1.9709 1.6404
18.500 2.5216 3.2808
18.500 3.1302 4.9213
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18.500 4.7823 8.2021
18.500 5.8837 9.8425
18.500 6.956011.4829
18.500 8.289313.1234
18.50011.158716.4042
18.50014.317919.6850
18.50017.535022.9659
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18.50033.910739.3701
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18.50044.054952.4934
18.50045.301254.6260
18.50045.301268.5367+88888
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19.000 3.072311.0236
19.000 3.622911.4829
19.000 4.492413.1234
19.000 6.376416.4042
19.000 8.840019.6850
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19.00018.549529.5276
19.00022.317332.8084
19.00029.041539.3701
19.00034.780245.9318
19.00036.693152.4934
19.00041.475454.6260
19.00041.475468.6352+88888
19.500 0.     16.4042
19.500 2.753416.4042
19.500 3.738919.6850
19.500 5.506922.9659
19.500 8.463226.2467
19.50012.028229.5276
19.50016.172832.8084
19.50023.766539.3701
19.50029.997945.9318
19.50035.446852.4634
19.50037.098954.6260
19.50037.098968.8976+88888
19.750 0.     22.9659
19.750 2.753422.9659
19.750 5.506926.2467
19.750 8.897929.5276
19.75012.955632.8084
19.75020.607339.3701
19.75027.302545.9318
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19.75034.780254.6260
19.75034.780268.8976+88888
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20.000 2.057826.2467
20.000 5.651829.5276
20.000 9.390732.8084
20.00017.390139.3701
20.00024.346245.9318
20.00030.374752.4934
20.00032.084854.6260
20.00032.084868.8976+88888
20.500 0.     30.5118
20.500 2.840432.8084
20.50010.810939.3701
20.50018.114745.9318
20.50024.780952.4934
20.50026.664854.6260
20.50026.664868.8976+99999
```

C.2 Weight Data File

The weight data file is the input weight description of the vessel following a standard format used by the U.S.C.G. This information is loaded into the computer core and stored as a file with a seven letter descriptive name. The convention which has been established requires that the first two letters of the file name be "DW" with the remaining five letters being a description of the vessel and condition.

The weight curve may be described by an unlimited number (500) of weight "segments". These segments are defined by their associated weight, the fore and aft limits between which this weight acts (measured from the F.P.) and the center of gravity of the weight, also measured from the F.P. The position of the center of gravity of the segment (LCG) is constrained in that it must fall within the middle one-third of the segment (i.e., the weight distribution of each segment must be linear).

Segments may be submitted in any order. If desired, an integer code may be specified with each segment. The purpose of the code is to allow the submitted segments to be sorted on the basis of the code, followed by a computation of the total weight and associated LCG of all segments of the same code. Up to 10 different integer codes are permitted ("0" is not a possible I.D.) allowing the user to specify 10 separate weight classes for examination. A description of the card (or line) format for this file is given below.

1) WEIGHT CLASS CARD

Column	Format	Entry
5	Integer	Always a 2. Not used in present program.

2) LENGTH CARD

Columns	Format	Entry
1-10	Real	Ship's length between perpendiculars in length units.
11-15	Integer	Number of weight blocks for output weight curve (21 is used for ship motion program)

The data from cards 1 and 2 are not used in program STATIC but are used in other U.S.C.G. programs but must be included so that data files between programs can be used interchangeably.

3) WEIGHT CARDS (refer to figure 3.5, page 30 for definition of symbols)

Columns	Format	Entry
1-10	Real	Forward end of weight segment measured from the forward perpendicular (F.P.) $_1x$.
11-20	Real	The weight of this segment in force units (i.e., L. tons, pounds, etc.) $_1w$.
21-30	Real	Aft end of weight segment measured from the F.P. $_1x_2$.
31-40	Real	Center of gravity of the weight segment measured from the F.P., Lcg.
41-43	Integer	Integer code to specify different weight classes (i.e., lightship and deadweight could be two weight classes). These codes are used to subtotal weight classes.

If the forward end of the weight segment (columns 1-10) is greater than or equal to 999999. the reading of this file is terminated.

Examples of weight data files for the SL-7 full load, SL-7 light load and a 290 ft. by 52.5 ft. box barge are given:

Data file "DW428FU" - weight curve for 290 ft. by 52.5 ft. barge

```
          2
290.      21
.01       147.4     60.       30.       1
60.       55.9      82.75     71.4      1
82.75     132.56    136.75    109.75    1
136.75    127.04    188.5     162.6     1
188.5     127.04    240.25    214.4     1
240.25    122.6     290.00    265.13    1
8.0       622.5     68.       38.       2
68.       764.8     128.      98.       2
128.      758.8     188.      158.      2
188.      609.8     248.      218.      2
248.      295.8     282.      265.      2
9999999.
-1
```

Data file "DWSL7FU" - Full load weight curve for SL-7 from (18)

```
    2
  880.5000   22
  -20.0000  765.2000   42.0000   19.0000  1
   42.0000 1847.7000  115.2500   84.3200  1
  115.2500 1205.7000  167.7500  143.1800  1
  167.7500 1613.4000  207.7500  185.5200  1
  207.7500 1943.6000  247.7500  225.5000  1
  247.7500 2379.2000  287.7500  265.5400  1
  287.7500 2305.6000  327.7500  305.5300  1
  327.7500 2610.8000  367.7500  345.5300  1
  367.7500 3148.7000  407.7500  385.5200  1
  407.7500 3343.7000  447.7500  425.5100  1
  447.7500 3299.0000  492.7500  467.9900  1
  492.7500 3179.2000  537.7500  512.9900  1
  537.7500 3293.3000  562.7500  550.0000  1
  562.7500 3039.8000  612.7500  587.5000  1
  612.7500 2661.3000  652.7500  635.0000  1
  652.7500 2898.7000  697.7500  674.3500  1
  697.7500 2116.1000  737.7500  716.1000  1
  737.7500 1678.3000  777.7500  756.4000  1
  777.7500 1597.2000  817.7500  795.5500  1
  817.7500 1244.5000  852.5000  835.5000  1
  852.5000  897.7000  880.5000  869.5000  1
  880.5000  691.3000  920.5000  900.5000  1
9999999.
```

Data file "DWSL7BA" - Ballast weight curve for SL-7

```
    2
  880.5000   22
  -20.0000  777.4000   42.0000   19.0000  1
   42.0000 1859.9000  115.2500   84.3200  1
  115.2500 1217.9000  167.7500  143.1800  1
  167.7500 1151.8000  207.7500  185.5200  1
  207.7500 1379.2000  247.7500  225.5000  1
  247.7500 1844.3000  287.7500  265.5400  1
  287.7500 1990.6000  327.7500  305.5300  1
  327.7500 2429.0000  367.7500  345.5300  1
  367.7500 2547.5000  407.7500  385.5200  1
  407.7500 2707.6000  447.7500  425.5100  1
  447.7500 2714.9000  492.7500  467.9900  1
  492.7500 2697.9000  537.7500  512.9900  1
  537.7500 3284.9000  562.7500  550.0000  1
  562.7500 3031.4000  612.7500  587.5000  1
  612.7500 2726.3000  652.7500  635.0000  1
  652.7500 2757.4000  697.7500  674.3500  1
  697.7500 1631.3000  737.7500  716.1000  1
  737.7500 1217.7000  777.7500  756.4000  1
  777.7500  982.5000  817.7500  795.5500  1
  817.7500  901.2000  852.5000  835.5000  1
  852.5000  889.3000  880.5000  869.5000  1
  880.5000  682.9000  920.5000  900.5000  1
  9999999.0
```

C.3 Data Input

Program STATIC has eight operational jobs as follows:

Job Name and Subprogram Name	
*TERMINAL	TERMINAL sets the type of terminal used for output and the maximum line length for this output device.
*UNITS	UNITS sets the physical units of length, force, and time.The mass density & viscosity of water and acceleration of gravity may also be changed.
*OFFSETS	OFFSETS reads the ship's geometric description from a file that is described in Section C.1
*DRAFT	DRAFT is one of the main subprograms. It calculates the vessel's equilibrium position and hydrostatic properties associated with it. Bending moments and shear forces are also calculated. Data preparation for both the "Springing" and "Ship Motion" programs.
*GROUNDING	GROUNDING is a specialized subprogram that calculates the drafts and bending moments and shear forces associated with a grounded vessel.
*INTACT STABILITY	INTACT STABILITY calculates the cross curves of stability for the vessel.
*COEFFICIENTS	This subprogram calculates the two-dimensional added mass and damping for vertical and lateral motions, using either the conformal mapping technique or Frank close fit method.
*FINISH	This command will STOP program execution.

The order of execution of these subprograms is logical. Generally, TERMINAL and UNITS are the first two called if there is to be a change in the assumed default values of these subprograms. Next OFFSETS must be called to obtain the geometric description of the vessel. Subprograms DRAFT, GROUNDING, and INTACT STABILITY may be called in any order and as many times as desired. COEFFICIENT must follow the call to DRAFT but can be called numerous times. The last job called is subprogram FINISH which terminates the program execution.

On the following pages will be a description of the parameter names and values which control the execution in each subprogram. The explanation of the terminology used is found in Section B.2.

C.3.a Subprogram TERMINAL

This subprogram specifies what type of terminal is being used for the output of results from the program. The output can be printed at a high speed terminal (usually at the data center) or a 30 character per second terminal. In addition many terminals have only 80 columns for printouts rather than 132. This subprogram will specify which of the above terminals is being used. If output is being sent to a high speed, 132 column printer, this subprogram need not be called, for these are the default output devices.

(1)

<u>Output Parameter</u>	<u>Definition</u>
TERMINAL TYPE = n <u>Default:</u> TERMINAL TYPE = 0	This parameter specifies the type of terminal being used n = 0 High speed terminal n = 1 30 cps terminal
LINE LENGTH = n <u>Default:</u> LINE LENGTH = 132	This parameter specifies the number of output columns available on a printer. Usually it will be either 80 or 132

(2) Examples of use of *TERMINAL

(a) *TERMINAL (TERMINAL TYPE = 1, LINE LENGTH = 80)

<u>Action:</u>
The program will assume a terminal that works at a 30 cps rate without a form feed and has only 80 column width paper.

(b) *TERMINAL (LINE LENGTH = 80)

<u>Action:</u>
The program will output to a high speed terminal only using 80 columns.

C.3.b Subprogram UNITS

This subprogram presets the units to be used in all processing. It allows the user to use any combination of units within the allowable parameters. The values of the mass density of sea water and gravity are changed to match the units used. Gravity is initialized at 32.174 ft/sec^2, the mass density of sea water is 8.8880 x 10^{-4} ton sec^2/ft^4, and the kinematic viscosity of sea water is 1.1057 x 10^{-5} ft^2/sec, since the initial units are: Length - feet

Force - long tons

Time - seconds

If these initial values are acceptable, subprogram UNITS need not be called.

(1) Output Parameter

LIST Default: LIST OFF	If LIST is specified, a list of units, mass density, viscosity and acceleration of gravity will be printed.

(2) Processing Parameters

LENGTH = name Initial Value: LENGTH = FT	Length units are specified. The allowable length units are: FT : feet IN : inches M : meters CM : centimeters MM : millimeters If the length unit is changed, the physical constants are reset to the correct numerical values by the program.
FORCE = name Initial value: FORCE = LT	Force units are specified. The allowable force units are: LT : long tons ST : short tons LB : pounds MT : metric tons KG : kilograms Values are treated as forces, and the physical constants are adjusted accordingly.
RHO = n Initial value: RHO = 8.8880E · 10^{-4} ton sec^2/ ft^4	The program's assumed value for mass density of water is overridden by the given value, n. "n" is given in force - sec^2/length^4 units. It is also γ/G where γ is the density

	of sea water in weight/volume. The initial value is for salt water at 70°F.
G = n Initial value: G = 32.174 ft/sec^2	The gravitational constant is overriden by the indicated *n*. "*n*" is given in length/sec^2 units.
VISCOSITY = n Initial value: VISCOSITY = 1.1057 x 10^{-5} ft^2/sec	The initial value of kinematic viscosity for salt water at 70°F is overridden by the given value n. "n" is given in length squared per time units.
RESTORE	The length and force units will be restored to feet and long tons respectively. The value of gravity, viscosity and density will also be changed accordingly.

(3) Examples of use of *UNITS*

(a) *UNITS (FORCE = LB, LIST, RHO = 1.93945)

Action:
The program will use pounds for the force unit. It will reset the value of the mass density of water to 1.93945 lbs-sec^2/ft^4 which is the value for fresh water and then print a table of current units and constants.

(b) *UNITS (FORCE = MT, LENGTH = M)

Action:
The program will use metric tons as a force unit, meters as a length unit and reset the acceleration of gravity and mass density and viscosity of salt water to the appropriate units.

C.3.c Subprogram OFFSETS

This subprogram reads the ship geometry data from a data file which was explained in C.1. The ship hull is defined by offsets in a format compatible with the Navy's Ship Hull Characteristics Program.

(1) Input/Output Parameters

(a) FILE = MMTXXXX	Specifies the name of the offset data file describing the ship's geometry. The file name is "MMT" followed by four letters of the user's choice.
(b) LIST Default: LIST OFF	If LIST is specified then a list of the station offsets and the forward and aft profiles will be given.

(2) Example of use of OFFSETS

*OFFSET (FILE = MMTSL7 LIST)

Action:
The program will read the offset information from data file MMTSL7 which is stored on the system. It will also list the offsets for each station.

C.3.d Subprogram DRAFT

This subprogram determines the equilibrium position of the ship so that various calculations and tasks may be performed. As mentioned in A.2, the ship's weight and center of gravity must be determined so that an equilibrium floating position may be found. Subprogram DRAFT can only be called after subprogram OFFSETS has been called since the geometric description of the vessel is needed to establish equilibrium. To determine where the vessel will float one of three options must be given:

1) Input a weight curve from a data file as explained in A.2 and C.2; or
2) Input weight and the centers of gravity; or
3) Input the drafts forward and aft

Once the ship's equilibrium condition is determined, that is trim, heel and draft, various tasks can be performed:

1) Hydrostatics - volumes, centroids, trim and stability data
2) Strength - shear forces and bending moments at different longitudinal locations
3) Springing - preparation of offset data files for USCG springing program (3)
4) Motions - Preparation of ship motion data file for modified SCORES program (1)

In addition to the still water condition, the hydrostatics and strength calculations can be performed in waves.

The different control parameters for this subprogram are listed below:

(1) <u>Input/Output Parameters</u>

(a) NOLIST <u>Default:</u> NOLIST OFF	If NOLIST is specified, the printed output of balancing, hydrostatics and bending moment are suppressed.
(b) LIST <u>Default:</u> LIST OFF	If LIST is specified, the table of wetted offsets for each station is printed.

(c) SPRING = SPGXXXX	If SPRING is specified the offset data file for the SPRINGING program is prepared and written to a file and assigned the name of SPGXXXX. The filename is "SPG" followed by four letters of the user's choice.
(d) OUTPUT = DMXXXXX	If OUTPUT is specified, a ship motion data file is prepared for the modified SCORES program, written to a file and assigned the name "DMXXXXX". The file name is "DM" followed by five letters of the user's choice.
(e) TITLE Default: TITLE off	If TITLE is specified a new descriptive name of up to 40 letters will be read from the next line following the *DRAFT command.
(f) WTDIST = DWXXXXX	If WTDIST is specified a weight curve, as explained in 3.A.3 and 3.C.2, will be read from a file whose name is "DWXXXXX". The file name is "DW" followed by five letters of the user's choice.

(2) Processing Parameters

(a) XF = n Default: XF = first station distance from the FP	"n" is the distance from the forward perpendicular along the x-axis to the forward draft marks of the vessel.
(b) XA = n Default: XA = last station distance from the FP	"n" is the distance from the forward perpendicular, along the x-axis, to the aft draft marks of this vessel
(c) TF = n	"n" is the draft at the forward marks, which is at XF from the forward perpendicular
(d) TA = n	"n" is the draft at the aft marks which is at XA from the forward perpendicular
(e) DRAFT = n	"n" is the even keel draft the vessel is floating. Same as saying TF = TA = DRAFT
(f) WEIGHT = n or WT = n	"n" is the ship's weight in force units
(g) LCG = n or XCG = n Default: LCG = Length/2	"n" is the distance from the forward perpendicular to the ship's longitudinal center of gravity

(h) KG = n or VCG = n or ZCG = n Default: KG = Ship's depth/2	"n" is the distance from the base-line to the ship's vertical center of gravity
(i) HCG = n or YCG = n Default: HCG = 0.0	"n" is the distance from the center-line to the horizontal center of gravity (positive starboard)
(j) TRIM = n Default: TRIM = 0.0	"n" is the ship's trim in length units with bow up defined as positive
(k) HEEL = n Default: HEEL = 0.0	"n" is the ship's heel in degrees with starboard down defined as positive
(l) WAVE = n Default: WAVE OFF	"n" is the type of wave system n=0 trochoidal wave n=1 sinusoidal wave n=2,3,..9 irregular waves (sum of n sine waves) The format for inputting the wave data will be described at the end of this section
(m) EQUAL STATIONS = n Default: EQUAL STATIONS off	"n" is the number of equal stations that the wetted hull will be inter-polated to for use in ship motion and/or springing program input data
(n) POINTS = n Default: POINTS = 12	If EQUAL STATIONS is specified, "n" equally spaced points will describe each wetted contour

If WAVE is given, the ship will be analyzed for a quasi-static condition. A wave is described by giving the height location of the crest from the forward perpendicular, the wave length and the angle of the wave relative to the ship's centerline. 0^{o} is stern seas, 180^{o} head seas and 90^{o} port beam seas.

The input of the wave data is on cards (or lines) following the *DRAFT job parameter list and the TITLE line (only TITLE is specified on DRAFT card). The format of these cards are as follows:

Line 1 to ..... number of waves

Variable	Columns	Definition
HEIGHT	1-10	Height of wave crest to trough
WAVLEN	11-20	Wave length
CREST	21-30	Location of CREST of wave measured from the forward perpendicular
HEAD	31-40	Heading of wave relative to centerline. 0^{o} following seas, 180^{o} head seas and 90^{o} port beam seas.

Line 1 is repeated for each sine wave if irregular wave input is specified.

(3) Examples of Use of DRAFT

(a) *DRAFT (XCG = 350., WEIGHT = 40000., KG = 15. LIST)

Action:
The program will set the ship's weight to 40000, longitudinal center of gravity 350. from the forward perpendicular and the vertical center of gravity 15 from the baseline. The ship will be balanced and the hydrostatic properties of the equilibrium conditions will be printed. Since LIST is specified, a list of the wetted offsets will be printed.

(b) *DRAFT (WTDIST = DWMAR, ZCG = 29.0, NWAVE = 1, TITLE)

MARINER - FULL LOAD DEPARTURE IN WAVES

5,2000 520.000 260.0000 0.0000

Action:
The program will read the longitudinal weight curve from a file named "DWMAR" which was explained in Sections A.2 and C.2. The vertical center of gravity is 29.0 feet above the keel. The title that is printed on the top of each page of output will be "MARINER FULL LOAD DEPARTURE IN WAVES". The ship will be balanced in a sinusoidal wave of 5.2 feet length, crest at midships (260 ft. from FP) from the following seas. The hydrostatics and shear force and bending moment will be printed for this condition.

(c) *DRAFT (WTDIST = DWWOL2, ZCG = 20.0,
OUTPUT = DMWOL2, SPRING = SPGWOL2,
EQUAL STATIONS = 21, POINTS = 18)

Action:

The program will read the longitudinal weight curve from a file named "DWWOL2" and assigns the value of 20.0 to the ship's KG. The ship can now be balanced, that is, an equilibrium position can be found (i.e., drafts, trim and heel). Since equal stations was stipulated the wetted hull will be interpolated to 21 equally spaced stations with 18 points on each station. A ship motion data file, "DMWOL2", for the modified SCORES program and a springing offset data file, "SPGWOL2", are created.

C.3.e Subprogram GROUNDING

This subprogram determines the equilibrium position of a ship that has run aground. As explained in A,2, the ship's weight and LCG must be determined so that the equilibrium position can be found. As in subprogram DRAFT, subprogram GROUNDING can be executed only after OFFSETS has been called. The vessel's pre-grounding equilibrium condition is found using one of three options

(1) Input a weight curve from a data file as explained in A.2 and C.2

(2) Input ship's weight and centers of gravity

(3) Input the drafts forward and aft.

Once this condition has been determined the grounding force acting on the vessel can be calculated. Three parameters describe grounding; the shoal water depth, the shoal length and the location of the grounding point on the ship. (See Figure 3.6)

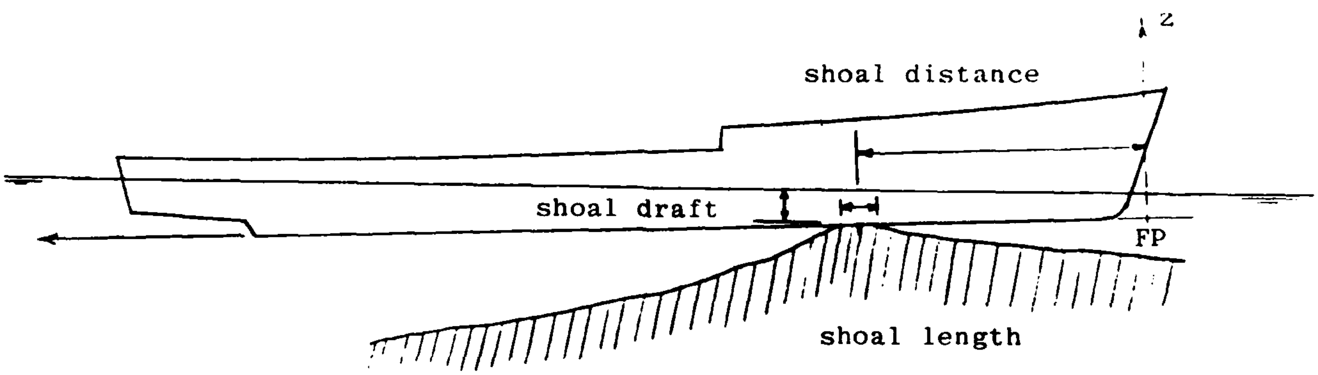

Figure 3.6

The hydrostatic properties are printed for the grounded condition. If the weight curve was used as input, a bending moment and shear force are also outputed.

The different control parameters for this subprogram are listed below.

(1) Input/Output Parameters

(a) TITLE — If TITLE is specified a new descriptive name, up to 40 letters will be read immediately following the *GROUNDING parameter list.

Default:
TITLE off

(b) WTDIST = DWXXXXX — If WTDIST is specified a weight curve, as explained in A.2 and C.2, it will be read from a file named DWXXXXX. The file name is "DW" followed by five letters of the user's choice.

(2) Processing Parameters

(a) XF = n — Same as subprogram DRAFT

(b) XA = n — Same as subprogram DRAFT

(c) TF = n — Same as subprogram DRAFT

(d) TA = n — Same as subprogram DRAFT

(e) DRAFT = n — Same as subprogram DRAFT

(f) WEIGHT = n — Same as subprogram DRAFT

(g) LCG = n — Same as subprogram DRAFT

(h) KG = n — Same as subprogram DRAFT

(i) TRIM = n — Same as subprogram DRAFT

(j) SHOAL DRAFT = n — "n" is the depth of water at the point where the ship has run aground

Default:
SHOAL DRAFT = 0.0

(k) SHOAL LOCATION = n — "n" is the point where the vessel has run aground measured from the F.P. in the ship's coordinate system

Default:
SHOAL LOCATION = 5% of ship's length

(l) SHOAL LENGTH = n — "n" is the length of shoal which the ship's bottom is aground on. This is used for distributing the grounding load

Default:
SHOAL LENGTH = 1% of ship's length

(3) Examples of use of GROUNDING

(a) *GROUNDING (XCG = 350.0, WT = 40000., KG = 15.0, SHOAL LOCATION = 30.0)

Action:
The program will set the ship's weight to 40,000, the longitudinal center of gravity 350.0 from the forward perpendicular and the vertical center of gravity 15.0 from the baseline. The ship will be balanced to establish the equilibrium condition.

The ship runs aground 30.0 from the forward perpendicular on a shoal of 0.0 depth. The hydrostatic properties will be printed for the grounded condition.

(b) *GROUNDING (WTDIST = DWMAR, SHOAL DRAFT = 5.0, ZCG = 29.0)

Action:
The program will read the longitudinal weight curve from a file named "DWMAR" and set the vertical center of gravity to 29.0 feet above the keel. The shoal depth is 5.0 feet, the shoal location 5% of the vessel's length aft of the F.P. and the length of the shoal touching the bottom will be assumed 1% of the vessel's length. First, the before grounding condition is found then the equilibrium condition for the grounded vessel is determined. Hydrostatic properties and shear forces and bending moments will be printed for the grounded vessel.

C.3.f Subprogram INTACT STABILITY

This subprogram calculates the cross curves of stability for a vessel. The cross curves of stability are a calculation of righting arm versus the angle of heel versus displacement. (See figure 3.7).

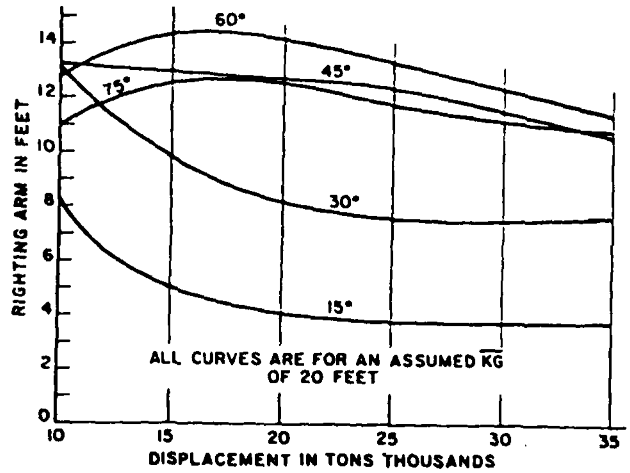

Figure 3.7 From (9)

The vessel's trim, vertical center of gravity and horizontal center of gravity are also needed.

The different control parameters for this subprogram are listed below:

(1) Input Parameter

TITLE Default: TITLE off	If TITLE is specified, a new descriptive name of up to 40 letters will be read from a line immediately following the *INTACT STABILITY control statement.

(2) Processing Parameters

(a) TRIM = n Default: TRIM = 0.0	"n" is the ship's trim in length units with positive defined as bow up. This is also defined as the difference between the aft and forward draft
(b) XF = n Default: XF = first station distance from the F.P.	"n" is the distance to the forward mark measured from the forward perpendicular in length units. Needed only if TRIM is not zero

(c) XA = n Default: XA = last station distance from A.P.	"n" is the distance to the aft mark measured from the forward perpendicular in length units. Needed only if TRIM is not zero.
(d) KG = n or VCG = n or ZCG = n Default: KG = ½ ship's depth	"n" is the distance from the baseline to the ship's vertical center of gravity following the *INTACT STABILITY parameter list.
(e) HCG = n or YCG = n Default: HCG = 0.0	"n" is the distance from the centerline to the horizontal center of gravity (positive to starboard)
(f) HEEL1 = n Default: HEEL1 = 10.0	"n" is the initial heel angle in degrees for the cross curves of stability
(g) HEEL2 = n Default: HEEL2 = 80.0	"n" is the final angle in degrees for the cross curves of stability
(h) HEELINC = n Default: HEELINC = 10.0	"n" is the heel increment in degrees used to go from HEEL1 to HEEL2 in the cross curves of stability
(i) DISP1 = n Default: DISP1 = 0.1 * L*B*Depth*Density	"n" is the initial displacement in force units for the cross curves of stability
(j) DISP2 = n Default: DISP2 = 10.0 * Default DISP1	"n" is the final displacement, in force units, for the cross curves of stability
(k) DISPINC = n Default: DISPINC = Default DISP1	"n" is the increment of displacement used to go from DISP1 to DISP2 in the cross curves of stability
(l) WAVE = n	Same description as in subprogram DRAFT so that cross curves of stability can be performed for quasi-static conditions

(3) Examples of use of INTACT STABILITY

(a) *INTACT STABILITY (DISP1 = 2000., DISP2 = 30000., DISPINC = 2000., KG = 28.0, TITLE, WAVE = 1)
MARINER - SINE WAVE - CREST MIDSHIPS
5.2000 520.0000 260.0000 0.0000

Action:
The program will calculate the cross curves of stability for a Mariner in a sinusoidal wave whose crest is at midships and amplitude of 5.2 feet. The KG is 28.0 feet, the displacements used will be 2000 to 30000 in steps of 2000 tons, and the heel angles will be 10 degrees to 80 degrees in steps of 10 degrees.

(b) *INTACT STABILITY.

Action:
The program will perform the calculations for 10^{o} to 80^{o} in steps of 10^{o} with an assumed KG of half the ship's depth. The default values for the displacement range will also be used.

C.3.g Subprogram COEFFICIENTS

The subprogram generates the two-dimensional pressures and added mass and damping coefficients for 25 frequencies. The pressures for heave, sway and roll and the added mass and damping for heave, sway, roll, sway-roll, cross-coupling and roll-away-coupling are calculated. The pressures are calculated at the midpoints of line segments described by consecutive offset points.

These values are calculated using conformal mapping or close-fit techniques. The accuracy obtained using the conformal mapping technique improves as more coefficients are added. Likewise, with the close-fit method, the more offset pairs used, the greater the accuracy. Using Frank, the offset pairs should be evenly spaced for best results, therefore, a midship section might need extra points for the side and bottom. This is automatically done by the program by specifying the maximum distance between points so that extra offset pairs can be inserted.

Subprograms OFFSETS and DRAFT must be called before calling this subprogram.

(1) Output Parameters

(a) NOLIST — If NOLIST is specified, the printing of the two-dimensional hydrodynamic properties is suppressed

Default: NOLIST off

(b) LIST — If LIST is specified, the mapping coefficients and the OFFSETS are listed

Default: LIST off

(c) OUTPUT = TDXXXXX — If OUTPUT is specified, two-dimensional hydrodynamic properties written to TAPE 3 are saved under a file name TDXXXXX. The file name is "TD" followed by five letters of the user's choice.

(2) Processing Parameters

(a) DMAX = n — Maximum distance between adjacent offset points. If distance greater than n, then additional offset pairs are inserted by the program.

(b) YMAX = n	Maximum horizontal distance between adjacent offset pairs, otherwise same as DMAX.
(c) ZMAX = n	Maximum vertical distance between adjacent offset pairs otherwise same as DMAX.
(d) FIRST STATION = n Default: FIRST STATION = 1	Specifies first station for which the two-dimensional hydrodynamic coefficients will be calculated.
(e) LAST STATION = n Default: LAST STATION = Maximum station	Specifies last station for which two-dimensional hydrodynamic coefficients will be calculated.
(f) MAPPING ERROR = n Default: MAPPING ERROR = 2.0%	Specifies the mapping error tolerance percent for determining if section is mapped accurately.
(g) NUMBER COEFFICIENTS = n Default: NUMBER COEFFICIENTS = 9	Specifies maximum number of mapping coefficients to be used. Maximum value is 9. If "n"is defined as 2 or less, then a Lewis form is assumed.
(h) MAXPOINTS = n Default: MAXPOINTS = 20	Specifies the maximum number of points to be used in Frank close fit method. Maximum is 20 points.
(i) MAPPING Default: MAPPING ON	If MAPPING is specified, all sections from FIRST STATION to LAST STATION will attempt to be mapped and two-dimensional coefficients will be calculated. If a section cannot be mapped, FRANK will be used.
(j) FRANK Default: FRANK off	If FRANK is specified hydrodynamic, properties of all sections from FIRST STATION to LAST STATION will be performed using the FRANK close fit method

(3) Example of use of COEFFICIENTS

(a) *COEFFICIENTS (DMAX = 1.0, OUTPUT = TDWOL2)

Action:
The program will calculate added mass and damping for heave, sway, roll and sway-roll cross couplings. The maximum distance between adjacent offset points is 1.0 (but a maximum of 20 points). The hydrodynamic results will be written to a file called TDWOL2.

IV. DESCRIPTION OF OUTPUT SCHEME

A description of the output format will be given with a sample run shown in Appendix A, using the input file given below:

```
*TERMINAL(LINE LENGTH=80)
*UNITS(LIST)
*OFFSETS(FILE=MMTSL7,LIST)
*DRAFT(DRAFT=20.0)
*DRAFT(TF=25.0,TA=25.0)
*DRAFT(WT=47760.0000,LCG=478.8632,KG=42.31,TITLE)
SL-7 FULL LOAD EXAMPLE
*GROUNDING(WTDIST=DWSL7FU,SHOAL LENGTH=5.0,SHOAL LOCATION=50.0,
 SHOAL DRAFT=5.0,KG=42.31,TITLE)
SL-7 FULL LOAD GROUNDING EXAMPLE
*INTACTSTABILITY(DISP1=15000,DISP2=50000,DISPINC=5000,KG=30.,
TITLE)
SL-7 INTACT STABILITY EXAMPLE
*DRAFT(WTDIST=DWSL7BA,KG=40.26,WAVE=1,TITLE)
SL-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS
    1
   44.0250  880.5000    0.0000    0.0000
*DRAFT(WTDIST=DWSL7FU,KG=42.31,TITLE,EQUALSTATION=21,
POINTS=19,LIST)
 SL-7 - NORMAL FULL LOAD DEPARTURE
*COEFFICIENT(FIRSTSTATION=1,LASTSTATION=1)
*COEFFICIENT(FIRSTSTATION=11,LASTSTATION=11,LIST)
*COEFFICIENT(FIRSTSTATION=11,LASTSTATION=11,FRANK)
*FINISH.
```

The *TERMINAL commands sets the output format to 80 columns per line. *UNITS indicates that the default units for the program will be used and will be printed (page A-2). The *OFFSETS job name reads the ship geometric data from file MMTSL7 and then lists the offsets (pg A-4 to A-10).

The *DRAFT job name runs the hydrostatic properties of the SL-7 for a 20 ft. draft (pgs A-12 to A-13). The next line uses a slightly different input for the same type of results for a 25 ft. draft (pg A-15 to A-16). The third call to *DRAFT involves the balancing of the vessel. The weight properties of the SL-7 are given and the ship will adjust itself until it is in equilibrium (page A-17). For this equilibrium condition the hydrostatic properties are printed (page A-18 to A-19). A title is read in for these calculations and is printed at the top of each page (pg A-17 to A-19).

The *GROUNDING job name indicates the ship has run aground on a shoal of 5.0 ft. in length and a water depth of 5.0 ft. at a point 50 ft. from the ship's forward perpendicular. Before the ship ran aground the weight conditions are found from data file DWSL7FU, which corresponds to a full load condition. This weight curve and weight summary (pg A-21) is used to determine the ship's drafts before running aground (pg. A-22). The shoal is an external force on the vessel which causes it to balance differently (pg A-23) and to have a considerable effect on shear force and bending moment (pg A-24). The hydrostatic properties are printed for this grounded condition (pg A-25 to A-26). Again a new title is read for the output and is printed at the top of each page (pg A-21 to A-26)

The *INTACT STABILITY command runs the calculation. The cross curves of stability are calculated for displacements of 15000 long tons to 50000 long tons in increments of 5000 long tons and angles of heel of 10 degrees to 80 degrees in steps of 10 degrees. The heel angles are program default values and were left unchanged. The cross curves of stability are righting arms and their tangents for various displacements and angles of heel (pg. A-28 to A-31). Again, a title is specified for the top of each page of output.

The next command, *DRAFT, reads the weight curve for a ballast condition of the SL-7 (pg A-33). The vessel will be balanced in a sinusoidal wave of amplitude 22 ft., wave length 380.5 ft. and trough amidships (pg A-34 to A-35). The shear force and bending moment for this condition (pg A-36) and hydrostatics (pg A-37 to A-38) are given. Again a new title is specifed for this job.

The final *DRAFT *command* is for a full load condition of the SL-7 whose weight curve is read from file DWSL7FU (pg A-40). The vessel is balanced for this condition and shear force and bending moments calculated (pg A-41 to A-42). The station arrangement for the vessel is changed to 21 equal stations with 19 points per station for subsequent calls of hydrodynamic calculations and for the hydrostatic properties (pg A-43 to A-47).

Rather than calculating the added mass and damping for all 21 stations, three stations were run. The first call to *COEFFICIENT calculates the added mass and damping for station 1 (pg A-49). Since it was a bulbous bow, the Frank close fit procedure was chosen. The nomenclature for the added mass and damping is given below:

		Dimensions
Frequency Parameter	$\frac{\omega^2 D}{g}$	Non-Dimensional
A'_{33}	heave added mass	$F\text{-sec}^2/L^2$
N'_z	heave damping	$F\text{-sec}/L^2$
M_s	sway added mass	$F\text{-sec}^2/L^2$
N_s	sway damping	$F\text{-sec}/L^2$
$M_{s.r.}$	added mass for sway-roll cross coupling	$F\text{-sec}^2/L^2$
$N_{s.r.}$	damping for sway-roll cross coupling	$F\text{-sec}/L^2$
I_r	added moment of inertia in roll	$F\text{-sec}^2$
N_r	roll damping	F-sec

where

F is force units

L is length units

D is station draft

ω is frequency (radians/second)

g is acceleration of gravity

The second call to *COEFFICIENTS is for station 11 which is midships. Since the section can be handled by conformal mapping and LIST is specified, the mapping coefficients are calculated (pg A-51). The added mass and damping are then outputted (pg A-52).

The final call to *COEFFICIENTS is again for station 11 but this time FRANK is specified. The Frank close fit method is used to calculate the added mass and damping (pg A-54) and corresponds fairly well to the conformal mapping technique.

The final call of this job is to *FINISH which terminates the execution of the program.

V. TIMING AND ERROR MESSAGES

The compilation time required for program STATIC is 6 CPU, with about 44K of core needed to load the program and 36K for execution. The job file needed for the compilation is shown in Table 1, Appendix B. The compiled (binary) version of STATIC is stored in a file called STATBIN and can be used for subsequent runs therefore saving the compilation costs. Table 2, Appendix B shows the job sequence needed for the execution of program STATIC using the compiled program.

The computation time for running STATIC varies tremendously and is a function of many variables. The number of stations and number of points per station effect the running time. Each subprogram requires various running times associated with it's task. The SL-7 is a representative ship whose computation times will be discussed. The example run shown in Chapter IV had running times as shown in the following Table.

```
LIST OF  STATIME

 CPU LAST JOB =    .371 SEC.     TOTAL CPU =     .371 SEC.
*TERMINAL(LINELENGTH=80,TERMINAL TYPE=-1)
 CPU LAST JOB =    .011 SEC.     TOTAL CPU =     .382 SEC.
*UNITS(LIST)
 CPU LAST JOB =    .034 SEC.     TOTAL CPU =     .416 SEC.
*OFFSETS(FILE=MMTSL7,LIST)
 CPU LAST JOB =    .631 SEC.     TOTAL CPU =    1.047 SEC.
*DRAFT(DRAFT=20.0)
 CPU LAST JOB =    .367 SEC.     TOTAL CPU =    1.414 SEC.
*DRAFT(TF=25.0,TA=25.0)
 CPU LAST JOB =    .380 SEC.     TOTAL CPU =    1.794 SEC.
*DRAFT(WT=47760.0000,LCG=478.8632,KG=42.31,TITLE)
 CPU LAST JOB =   1.430 SEC.     TOTAL CPU =    3.224 SEC.
*GROUNDING(WTDIST=DWSL7FU,SHOAL LENGTH=5.0,SHOAL LOCATION=50.0,
 SHOAL DRAFT=5.0,KG=42.31,TITLE)
 CPU LAST JOB =  29.612 SEC.     TOTAL CPU =   32.836 SEC.
*INTACTSTABILITY(DISP1=15000,DISP2=50000,DISPINC=5000,KG=30.,
TITLE)
 CPU LAST JOB =  40.375 SEC.     TOTAL CPU =   73.211 SEC.
*DRAFT(WTDIST=DWSL7BA,KG=40.26,WAVE=1,TITLE)
 CPU LAST JOB =   5.129 SEC.     TOTAL CPU =   78.340 SEC.
*DRAFT(WTDIST=DWSL7FU,KG=42.31,TITLE,EQUALSTATION=21,
POINTS=19,LIST)
 CPU LAST JOB =   1.593 SEC.     TOTAL CPU =   79.933 SEC.
*COEFFICIENT(FIRSTSTATION=1,LASTSTATION=1)
 CPU LAST JOB =  13.042 SEC.     TOTAL CPU =   92.975 SEC.
*COEFFICIENT(FIRSTSTATION=11,LASTSTATION=11,LIST)
 CPU LAST JOB =   3.468 SEC.     TOTAL CPU =   96.443 SEC.
*COEFFICIENT(FIRSTSTATION=11,LASTSTATION=11,FRANK)
 CPU LAST JOB =  16.049 SEC.     TOTAL CPU =  112.492 SEC.
*FINISH.
```

The total time for running *TERMINAL, *UNITS, and *OFFSETS is around one computational unit (CPU). This is fairly constant for all types of ships. The *DRAFT sub-program can have various tasks and the times are all relatively small. If the vessel's position is given, that is the drafts and/or heel, the hydrostatic calculations will require about 1/2 CPU. If balancing of the vessel is performed, the typical running time is from 1 to 2 CPU provided there is no heel. As the heel angle becomes larger the computation time will increase. The *DRAFT examples in Chapter IV are for a zero heel condition.

The *GROUNDING routine requires substantial computations since it is an excessive trim condition. The running time can typically take from 20 to 40 CPU depending upon shoal location and shoal draft. The time in the above examples was 29.3 CPU.

The *INTACT STABILITY is a lengthy calculation because 64 points were computed for the Cross Curves of Stability (8 displacements with 8 heel angles) and required about 41 CPU. The small heel angles (10^{o} to 30^{o}) require about half the CPU time as the larger heel angles (60^{o} to 80^{o}). With this in mind, care should be exercised in choosing the range of heel angles which are necessary for a particular vessel.

The *COEFFICIENT sub-program is the most costly of all the subprograms in STATIC. This sub-program calculates the added mass and damping of each station at twenty-five specific frequencies. Hydrostatic conditions of the vessel should be checked thoroughly before executing this program, since it is expensive. The time of computation for one station is 10 to 20 CPU for the Frank close fit method. The conformal mapping approach can take from 3 to 30 CPU and is a function of the number of mapping coefficients needed to describe a station adequately. As seen in our example, Station 11 required 3.5 CPU using conformal mapping (3 mapping coefficients) but required 16 CPU using the close fit technique.

The error messages are printed by the program at the time of error and are self-explanatory. The three types of errors that might be incurred while running STATIC are:

1) File
2) Variable name or value
3) Array exceedence

If a file is to be used by STATIC, it must be saved on your user number. An error message will tell you if the program cannot find a file. The most probable reason for this error is a misspelling of the file name. The second problem associated with file manipulation involves an output file. It is not possible to save a file, such as a SPRINGING or MOTION file, if one already exists on the system with the same name.

An error message will occur if a variable name does not match one specified by the program. For instance, *UNITS (LENGHT=M) would produce an error message indicating that LENGHT was not found as a permitted variable name. This is a logical conclusion since the spelling should be LENGTH. Likewise, if *UNITS (LENGTH=METERS) were given, an error message would also result. METER is not a permitted variable value, while M would be the desired value.

Array exceedance is caused by inputting more data than permitted. The following is a list of maximum numbers used by STATIC, and is repeated from Chapter III.

Stations	41
Points per station	29
Weight elements	200
Number of mapping coefficients	9

If any of these numbers are exceeded, an error message will be provided to indicate the problem area.

VI. REFERENCES

1. Hoffman, D. and Zielinski, T.E., "Integrated Seakeeping Analysis (ISA) Computer Program", Hoffman Maritime Consultant, Inc., HMC Report 7660H, Oct. 1976.

2. Aughey, M., "Ship Hull Characteristics Calculations", SNAME Local Section Paper at Hampton Roads, September 1968.

3. Zielinski, T. E., "Further Developments in the Theory of Springing Applied to a Great Lakes Bulk Carrier", Appendices A-F, Webb Institute Report prepared for the U. S. Coast Guard February 1974.

4. Hoffman, D., "Distribution of Wave Cuased Hydrodynamic Pressures and Forces on a Ship Hull", NSMET, publication #92, Norwegian Ship Model Experimental Tank, 1966.

5. Hoffman, D., and Zielinski, T.E., "A New Approach to the Ship Hull Form Characteristics Problem", Metropolitan Section SNAME, January 1974.

6. Van Hooff, R., "Sectional Hydrodynamic Coefficients for Heave, Sway and Roll", Report to American Bureau of Shipping, New York, January 1975.

7. Frank, W., "Oscillation of Cylinders In or Below the Free Surface of Deep Fluids", Hydrodynamic Laboratory Research and Development Report 2375, October 1967.

8. Bedel, J.W. and Lee, C.M., "Numerical Calculation of the Added Mass and Damping Coefficients of Cylinders Oscillating in or Below a Free Surface", Ship Performance Department Research and Development Report 3551, March 1971.

9. Comstock, J.P., ed., <u>Principles of Naval Architecture</u>, SNAME, New York, 1967.

10. Rawson, K.J. and Tupper, E.C., "Basic Ship Theory", Vols. 1 and 2, Longman, New York, 1976.

11. Paulling, J.R., "The Transverse Stability of a Ship in a Longitudinal Seaway", Journal of Ship Research, Vol. 4, No. 4, March 1961.

12. Zielinski, T.E., "The Use of Conformal Mapping in Ship Design", Senior Thesis, Webb Institute Report, June 1972.

13. Lewis, F.M., "The Inertia of Water Surrounding a Vibrating Ship", SNAME Transactions, 1929.

14. Porter, W.R., "Pressure Distribution, Added Mass and Damping Coefficients for Cylinders Oscillating in a Free Surface", University of California, I.E.R. Report Series 82, Issue 16, July 1960.

15. Ursell, F., "On the Bearing Motion of a Circular Cylinder on the Surface of a Fluid", Quarterly Journal of Mechanics and Applied Mathematics 2, 1949.

16. Zielinski, T.E., "Program HYDRO2D - Two Dimensional Hydrodynamic Properties of Ship Sections", Webb Institute Report to the American Bureau of Shipping, November 1976.

17. Wood, P., "Program Input and Control System "PICSY", Internal report at University of California at Berkeley, 1971.

18. Kaplan P., Sargent, T.P., and Cilmi, J., "Theoretical Estimates of Wave Loads on the SL-7 Container Ship in Regular and Irregular Seas", Ship Structure Committee Report SSC-246, 1974. (used for weight description)

APPENDIX A

PROGRAM STATIC (05/79)

DEVELOPED FOR U.S. COAST GUARD BY:

H O F F M A N   M A R I T I M E   C O N S U L T A N T S
GLEN HEAD (516)676-8499 NEW YORK

07/10/79 10.50.30

-LIST OF UNITS AND PHYSICAL CONSTANTS..

LENGTH UNIT	FEET
TIME UNIT	SECOND
FORCE UNIT	L.TONS

-PHYSICAL CONSTANTS..

GRAVITATIONAL ACCELERATION,	G =	32.1740
VISCOSITY OF WATER,	NU =	.1106E-04
DENSITY OF WATER,	RHO =	.8880E-03

Note:

A mistake in the SL-7 offsets will result in slightly different values.

```
*OFFSETS(FILE=MMTSL7,LIST)
```

ORIG.OFFSETS TABLE (FEET) SEA-LAND ? NTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

	STATION 1 21 POINTS X = 0.000			STATION 2 21 POINTS X = 11.006			STATION 3 21 POINTS X = 22.013	
	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	.820	3.035	2	.820	3.180	2	.820	3.324
3	1.640	4.480	3	1.640	4.625	3	1.640	4.769
4	3.281	6.070	4	3.281	6.214	4	3.281	6.359
5	4.921	6.648	5	4.921	6.995	5	4.921	7.082
6	6.562	7.024	6	6.562	7.226	6	6.562	7.515
7	8.202	7.082	7	8.202	7.226	7	8.202	7.573
8	9.842	6.735	8	9.842	6.995	8	9.842	7.284
9	11.483	6.214	9	11.483	6.590	9	11.483	6.937
10	13.123	5.492	10	13.123	5.839	10	13.123	6.301
11	16.404	3.815	11	16.404	4.278	11	16.404	4.654
12	19.685	2.341	12	19.685	2.890	12	19.685	3.324
13	22.966	1.156	13	22.966	1.792	13	22.966	2.283
14	26.247	.289	14	26.247	1.156	14	26.247	1.532
15	29.528	0.000	15	29.528	.867	15	29.528	1.301
16	32.808	0.000	16	32.808	1.098	16	32.808	1.503
17	39.370	1.012	17	39.370	2.023	17	39.370	2.862
18	45.932	2.515	18	45.932	3.613	18	45.932	4.971
19	52.493	4.278	19	52.493	5.839	19	52.493	7.717
20	59.055	6.272	20	59.055	8.382	20	59.055	10.608
21	65.125	8.238	21	65.026	10.897	21	64.993	13.354

	STATION 4 21 POINTS X = 44.025			STATION 5 21 POINTS X = 66.037			STATION 6 21 POINTS X = 88.050	
	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	.820	3.757	2	.820	4.191	2	.820	4.625
3	1.640	5.203	3	1.640	5.578	3	1.640	6.128
4	3.281	6.879	4	3.281	7.399	4	3.281	8.035
5	4.921	7.660	5	4.921	8.527	5	4.921	9.163
6	6.562	8.151	6	6.562	8.671	6	6.562	9.481
7	8.202	8.238	7	8.202	8.902	7	8.202	9.770
8	9.842	8.093	8	9.842	8.816	8	9.842	9.683
9	11.483	7.804	9	11.483	8.527	9	11.483	9.336
10	13.123	7.226	10	13.123	8.093	10	13.123	8.960
11	16.404	5.839	11	16.404	6.648	11	16.404	7.949
12	19.685	4.336	12	19.685	5.347	12	19.685	6.937
13	22.966	3.180	13	22.966	4.393	13	22.966	6.214
14	26.247	2.601	14	26.247	4.133	14	26.247	6.214
15	29.528	2.544	15	29.528	4.336	15	29.528	6.879
16	32.808	3.035	16	32.808	5.000	16	32.808	8.006
17	39.370	5.058	17	39.370	7.602	17	39.370	10.926
18	45.932	7.862	18	45.932	10.984	18	45.932	14.452
19	52.493	11.273	19	52.493	11.909	19	52.493	18.267
20	59.055	14.886	20	59.055	18.788	20	59.055	23.066
21	64.961	18.007	21	64.895	22.545	21	64.797	27.112

ORIG.OFFSETS TABLE (FEET) SEA-LAND 7 CONTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 7 — 21 POINTS — X = 110.062

STATION 8 — 22 POINTS — X = 132.075

STATION 9 — 22 POINTS — X = 176.100

	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	.820	5.145	2	.066	2.890	2	.131	4.336
3	1.640	6.879	3	.820	5.925	3	.820	6.937
4	3.281	8.469	4	1.640	7.226	4	1.640	8.758
5	4.921	9.394	5	3.281	8.960	5	3.281	10.695
6	6.562	9.827	6	4.921	10.059	6	4.921	11.909
7	8.202	10.261	7	6.562	10.666	7	6.562	12.862
8	9.842	10.406	8	8.202	10.752	8	8.202	13.585
9	11.483	10.203	9	9.842	11.273	9	9.842	14.308
10	13.123	10.059	10	11.483	11.330	10	11.483	14.741
11	16.404	9.394	11	13.123	11.273	11	13.123	15.319
12	19.685	8.758	12	16.404	11.128	12	16.404	16.331
13	22.966	8.613	13	19.685	11.041	13	19.685	17.342
14	26.247	9.018	14	22.966	11.330	14	22.966	18.354
15	29.528	9.827	15	26.247	12.140	15	26.247	19.741
16	32.808	11.041	16	29.528	13.151	16	29.528	21.042
17	39.370	14.452	17	32.808	14.597	17	32.808	22.487
18	45.932	18.267	18	39.370	18.094	18	39.370	25.783
19	52.493	22.545	19	45.932	22.112	19	45.932	29.482
20	59.055	27.112	20	52.493	26.303	20	52.493	33.529
21	64.698	31.303	21	59.055	30.927	21	59.055	37.864
			22	64.633	34.974	22	64.534	41.911

ORIG.OFFSETS TABLE (FEET) SEA-LAND 7 CONTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 10
22 POINTS
X = 220.125

STATION 11
22 POINTS
X = 264.150

STATION 12
22 POINTS
X = 308.175

	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	.197	4.336	2	.262	7.226	2	.328	11.562
3	.820	8.960	3	.820	12.284	3	.820	17.198
4	1.640	10.839	4	1.640	14.741	4	1.640	20.233
5	3.281	13.296	5	3.281	18.210	5	3.281	24.424
6	4.921	15.319	6	4.921	20.666	6	4.921	27.025
7	6.562	16.967	7	6.562	22.776	7	6.562	29.338
8	8.202	18.152	8	8.202	24.279	8	8.202	31.216
9	9.842	19.366	9	9.842	25.667	9	9.842	32.806
10	11.483	20.233	10	11.483	26.736	10	11.483	34.107
11	13.123	21.158	11	13.123	27.893	11	13.123	35.465
12	16.404	23.037	12	16.404	30.003	12	16.404	37.489
13	19.685	24.568	13	19.685	31.794	13	19.685	39.136
14	22.966	26.014	14	22.966	33.297	14	22.966	40.408
15	26.247	27.459	15	26.247	34.830	15	26.247	41.622
16	29.528	28.904	16	29.528	36.188	16	29.528	42.720
17	32.808	30.349	17	32.808	37.633	17	32.808	43.790
18	39.370	33.297	18	39.370	40.177	18	39.370	45.697
19	45.932	36.708	19	45.932	42.720	19	45.932	47.605
20	52.493	40.119	20	52.493	45.380	20	52.493	49.224
21	59.055	43.790	21	59.055	45.183	21	59.055	50.871
22	64.370	46.969	22	64.337	50.351	22	64.305	52.027

ORIG.OFFSETS TABLE (FEET) SEA-LAND 7 CONTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 13
22 POINTS
X = 352.200

	HEIGHT Z	H-B Y
1	0.000	0.000
2	.394	19.366
3	.820	23.412
4	1.640	27.314
5	3.281	31.505
6	4.921	33.962
7	6.562	36.564
8	8.202	38.298
9	9.842	39.888
10	11.483	41.044
11	13.123	42.142
12	16.404	43.934
13	19.685	45.235
14	22.966	46.247
15	26.247	47.171
16	29.528	47.836
17	32.808	48.559
18	39.370	49.715
19	45.932	50.640
20	52.493	51.565
21	59.055	52.259
22	64.305	52.548

STATION 14
22 POINTS
X = 396.225

	HEIGHT Z	H-B Y
1	0.000	0.000
2	.591	26.303
3	.820	30.060
4	1.640	33.962
5	3.281	38.298
6	4.921	40.610
7	6.562	42.778
8	8.202	44.310
9	9.842	45.524
10	11.483	46.478
11	13.123	47.345
12	16.404	48.703
13	19.685	49.715
14	22.966	50.351
15	26.247	50.929
16	29.528	51.305
17	32.808	51.594
18	39.370	52.027
19	45.932	52.374
20	52.493	52.605
21	59.055	52.750
22	64.305	52.750

STATION 15
18 POINTS
X = 440.250

	HEIGHT Z	H-B Y
1	0.000	0.000
2	.656	32.662
3	.820	34.685
4	1.640	39.310
5	3.281	43.212
6	4.921	45.380
7	6.562	47.114
8	8.202	48.559
9	9.842	49.571
10	11.483	50.293
11	13.123	50.958
12	16.404	51.912
13	19.685	52.374
14	22.966	52.605
15	26.247	52.663
16	29.528	52.721
17	32.808	52.750
18	64.305	52.750

STATION 16
15 POINTS
X = 484.275

	HEIGHT Z	H-B Y
1	0.000	0.000
2	.656	32.751
3	.820	35.650
4	1.640	40.867
5	3.281	44.635
6	4.921	46.953
7	6.562	48.692
8	8.202	49.910
9	9.842	50.721
10	11.483	51.446
11	13.123	52.025
12	16.404	52.518
13	19.685	52.750
14	22.966	52.750
15	68.242	52.750

STATION 17
15 POINTS
X = 528.300

	HEIGHT Z	H-B Y
1	0.000	0.000
2	.656	32.751
3	.820	33.911
4	1.640	38.548
5	3.281	42.751
6	4.921	45.359
7	6.562	47.185
8	8.202	48.692
9	9.842	49.649
10	11.483	50.489
11	13.123	51.214
12	16.404	52.083
13	19.685	52.605
14	22.966	52.750
15	68.242	52.750

STATION 18
17 POINTS
X = 572.325

	HEIGHT Z	H-B Y
1	0.000	0.000
2	.492	24.636
3	.820	28.694
4	1.640	33.621
5	3.281	38.548
6	4.921	41.504
7	6.562	43.910
8	8.202	45.794
9	9.842	47.243
10	11.483	48.547
11	13.123	49.562
12	16.404	51.011
13	19.685	51.880
14	22.966	52.402
15	26.247	52.692
16	29.528	52.750
17	68.242	52.750

ORIG.OFFSETS TABLE (FEET) SEA-LAND 7 CONTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 19 18 POINTS X = 616.350			STATION 20 21 POINTS X = 660.375			STATION 21 21 POINTS X = 704.400		
	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	.328	15.941	2	0.000	3.188	2	0.000	2.811
3	.820	20.868	3	.820	11.593	3	.820	4.898
4	1.640	26.085	4	1.640	16.028	4	1.640	8.202
5	3.281	31.592	5	3.281	22.317	5	3.281	13.187
6	4.921	35.505	6	4.921	24.201	6	4.921	17.245
7	6.562	38.548	7	6.562	31.302	7	6.562	21.390
8	8.202	41.070	8	8.202	34.229	8	8.202	24.694
9	9.842	42.954	9	9.842	36.867	9	9.842	28.085
10	11.483	44.780	10	11.483	39.041	10	11.483	30.665
11	13.123	46.142	11	13.123	40.925	11	13.123	33.215
12	16.404	48.547	12	16.404	44.113	12	16.404	37.041
13	19.685	50.141	13	19.685	46.634	13	19.685	40.229
14	22.966	51.243	14	22.966	48.402	14	22.966	42.606
15	26.247	51.938	15	26.247	49.707	15	26.247	44.664
16	29.528	52.460	16	29.528	50.750	16	29.528	46.374
17	32.808	52.750	17	32.808	51.620	17	32.808	47.765
18	68.242	52.750	18	39.370	52.199	18	39.370	49.852
			19	45.932	52.750	19	45.932	51.388
			20	52.493	52.750	20	52.493	52.605
			21	68.242	52.750	21	68.242	52.750

STATION 22 22 POINTS X = 748.425			STATION 23 22 POINTS X = 770.437			STATION 24 22 POINTS X = 792.450		
	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	0.000	2.464	2	0.000	2.174	2	0.000	2.029
3	.820	3.246	3	.820	2.609	3	.820	2.174
4	1.640	4.290	4	1.640	3.188	4	1.640	2.522
5	3.281	6.724	5	3.281	4.637	5	3.281	3.333
6	4.921	9.420	6	4.921	6.521	6	4.921	4.347
7	6.562	12.376	7	6.562	8.840	7	6.562	5.797
8	8.202	14.985	8	8.202	10.869	8	8.202	7.275
9	9.842	17.970	9	9.842	13.274	9	9.842	9.014
10	11.483	20.288	10	11.483	15.245	10	11.483	10.666
11	13.123	22.781	11	13.123	17.622	11	13.123	12.550
12	16.404	27.100	12	16.404	21.767	12	16.404	16.694
13	19.685	30.925	13	19.685	25.592	13	19.685	19.825
14	22.966	34.200	14	22.966	28.984	14	22.966	23.477
15	26.247	37.099	15	26.247	32.288	15	26.247	26.810
16	29.528	39.562	16	29.528	35.128	16	29.528	30.259
17	32.808	41.823	17	32.808	37.679	17	32.808	30.375
18	39.370	45.504	18	39.370	42.171	18	39.370	38.432
19	45.932	48.692	19	45.932	45.504	19	45.932	42.925
20	52.493	51.301	20	52.493	48.692	20	52.493	47.069
21	54.626	52.025	21	54.626	51.359	21	54.626	48.344
22	68.242	52.025	22	68.405	52.083	22	68.438	48.344

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USER MANUAL FOR PROGRAM STATIC -- FIRST PART OF COAST GUARD SHI--ETC(U)
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ORIG.OFFSETS TABLE (FEET) SEA-LAND 7 CONTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 25
22 POINTS
X = 814.463

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	1.594
3	.820	1.739
4	1.640	1.971
5	3.281	2.522
6	4.921	3.130
7	6.562	4.000
8	8.202	4.782
9	9.842	5.884
10	11.483	6.956
11	13.123	8.289
12	16.404	11.159
13	19.685	14.318
14	22.966	17.535
15	26.247	21.013
16	29.528	24.491
17	32.808	28.027
18	39.370	33.911
19	45.932	39.273
20	52.493	44.055
21	54.626	45.301
22	68.537	45.301

STATION 26
15 POINTS
X = 836.475

	HEIGHT Z	H-B Y
1	11.024	0.000
2	11.024	3.072
3	11.483	3.623
4	13.123	4.492
5	16.404	6.376
6	19.685	8.840
7	22.966	11.535
8	26.247	14.955
9	29.528	18.549
10	32.808	22.317
11	39.370	29.042
12	45.932	34.780
13	52.493	36.693
14	54.626	41.475
15	68.635	41.475

STATION 27
12 POINTS
X = 858.487

	HEIGHT Z	H-B Y
1	16.404	0.000
2	16.404	2.753
3	19.685	3.739
4	22.966	5.507
5	26.247	8.463
6	29.528	12.028
7	32.808	16.173
8	39.370	23.766
9	45.932	29.998
10	52.463	35.447
11	54.626	37.099
12	68.898	37.099

STATION 28
10 POINTS
X = 869.494

	HEIGHT Z	H-B Y
1	22.966	0.000
2	22.966	2.753
3	26.247	5.507
4	29.528	8.898
5	32.808	12.956
6	39.370	20.607
7	45.932	27.303
8	52.493	33.012
9	54.626	34.780
10	68.898	34.780

STATION 29
9 POINTS
X = 880.500

	HEIGHT Z	H-B Y
1	26.247	0.000
2	26.247	2.058
3	29.528	5.652
4	32.808	9.391
5	39.370	17.390
6	45.932	24.346
7	52.493	30.375
8	54.626	32.085
9	68.898	32.085

STATION 30
7 POINTS
X = 902.513

	HEIGHT Z	H-B Y
1	30.512	0.000
2	32.808	2.840
3	39.370	10.811
4	45.932	18.115
5	52.493	24.781
6	54.626	26.665
7	68.898	26.665

ORIG.OFFSETS TABLE (FEET) SEA-LAND 7 CONTAINERSHIP

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

AFTER PROFILE

	HEIGHT Z	DIST X
1	0.000	814.463
2	11.024	836.475
3	16.404	858.487
4	22.966	869.494
5	26.247	880.500
6	30.512	902.513
7	68.898	902.513

FORWARD PROFILE

	HEIGHT Z	DIST X
1	0.000	0.000
2	68.898	0.000

*DRAFT(DRAFT=20.0)

HYDROSTATICS SEA-LAND 7 CONTAINERSHIP

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	20.0000	4.4549	207.670	2.33082	9.3548	0.0000
11.0063	20.0000	5.5699	219.991	1.97482	9.5234	0.0000
22.0125	20.0000	6.4482	231.954	1.79860	9.6584	0.0000
44.0250	20.0000	8.4492	263.383	1.55863	9.9183	0.0000
66.0375	20.0000	10.5114	291.741	1.38773	10.0563	0.0000
88.0500	20.0000	13.7352	328.002	1.19402	10.2703	0.0000
110.0625	20.0000	17.4881	362.878	1.03750	10.5315	0.0000
132.0750	20.0000	22.1383	407.990	.92146	10.7333	0.0000
176.1000	20.0000	34.8792	542.206	.77726	11.2176	0.0000
220.1250	20.0000	49.4145	733.585	.74228	11.4575	0.0000
264.1500	20.0000	63.8776	971.500	.76044	11.3638	0.0000
308.1750	20.0000	78.5166	1242.447	.79120	11.2144	0.0000
352.2000	20.0000	90.6641	1510.813	.83319	10.9819	0.0000
396.2250	20.0000	99.5523	1730.167	.86897	10.8002	0.0000
440.2500	20.0000	104.7928	1886.066	.89990	10.6641	0.0000
484.2750	20.0000	105.5000	1928.614	.91404	10.6179	0.0000
528.3000	20.0000	105.2380	1886.784	.89644	10.6908	0.0000
572.3250	20.0000	103.8612	1788.635	.86107	10.8770	0.0000
616.3500	20.0000	100.4945	1615.585	.80382	11.1980	0.0000
660.3750	20.0000	93.6085	1351.018	.72163	11.7755	0.0000
704.4000	20.0000	80.9146	1038.220	.64155	12.3606	0.0000
748.4250	20.0000	62.4797	697.122	.55788	12.8934	0.0000
770.4375	20.0000	51.8360	538.484	.51941	13.1321	0.0000
792.4500	20.0000	40.3506	393.031	.48702	13.3202	0.0000
814.4625	20.0000	29.2535	268.595	.45908	13.2896	0.0000
836.4750	20.0000	18.1976	107.619	.65883	16.2240	0.0000
858.4875	20.0000	7.8173	23.709	.84345	18.3020	0.0000
869.4938	20.0000	0.0000	0.000	0.00000	20.0000	0.0000
880.5000	20.0000	0.0000	0.000	0.00000	20.0000	0.0000
902.5125	20.0000	0.0000	0.000	0.00000	20.0000	0.0000

HYDROSTATICS SEA-LAND 7 CONTAINERSHIP

VOLUME (MLD.)	902813.2	FEET **3
DISPLACEMENT (MLD.)	25794.662	L.TONS
BLOCK COEFFICIENT (MLD.)	.489223	
HALF-AREA MIDSHIP SECTION	943.033	FEET **2
MIDSHIP SECTION COEFFICIENT	.899902	
PRISMATIC COEFFICIENT (MLD.),	.543640	
TRIM	0.000	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	11.154	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	464.483	FEET
BM,TRANSVERSE	40.351	FEET
BM,LONGITUDINAL	2037.155	FEET
MOMENT TO ALTER TRIM 0.1 FEET	5967.942	
L.TONS PER 0.1 FEET IMMERSION	160.571	
AREA OF WATERPLANE	56199.912	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.609081	
L.C.F. FROM F.P.	485.146	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-81.874	L.TONS
WETTED SURFACE (MLD.)	74780.118	FEET **2

*DRAFT(TF=25.0,TA=25.0)

HYDROSTATICS SEA-LAND 7 CONTAINERSHIP

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	25.0000	1.2371	221.315	7.15611	10.1345	0.0000
11.0063	25.0000	2.7957	240.054	3.43464	10.5834	0.0000
22.0125	25.0000	3.6349	256.630	2.82404	10.8701	0.0000
44.0250	25.0000	5.6422	297.549	2.10947	11.3428	0.0000
66.0375	25.0000	8.4643	337.905	1.59685	11.7431	0.0000
88.0500	25.0000	12.4288	392.083	1.26185	12.2616	0.0000
110.0625	25.0000	17.7286	449.910	1.01510	12.8474	0.0000
132.0750	25.0000	23.6643	521.539	.88156	13.3010	0.0000
176.1000	25.0000	38.4286	724.784	.75442	14.0698	0.0000
220.1250	25.0000	53.8195	991.670	.73703	14.3406	0.0000
264.1500	25.0000	68.4947	1302.378	.76057	14.2004	0.0000
308.1750	25.0000	82.3212	1644.647	.79914	13.9791	0.0000
352.2000	25.0000	93.6401	1971.733	.84226	13.6776	0.0000
396.2250	25.0000	101.4187	2232.701	.88059	13.4353	0.0000
440.2500	25.0000	105.2827	2411.574	.91623	13.2437	0.0000
484.2750	25.0000	105.5000	2456.114	.93123	13.1698	0.0000
528.3000	25.0000	105.5000	2413.895	.91522	13.2698	0.0000
572.3250	25.0000	105.1638	2311.623	.87925	13.5079	0.0000
616.3500	25.0000	103.3483	2125.938	.82282	13.9140	0.0000
660.3750	25.0000	98.4222	1831.947	.74453	14.5965	0.0000
704.4000	25.0000	87.7633	1460.500	.66565	15.3021	0.0000
748.4250	25.0000	71.9950	1034.001	.57448	16.0425	0.0000
770.4375	25.0000	62.0641	823.393	.53067	16.3995	0.0000
792.4500	25.0000	51.0864	622.209	.48718	16.7375	0.0000
814.4625	25.0000	39.3827	439.705	.44660	16.9216	0.0000
836.4750	25.0000	27.3117	220.060	.57650	19.5161	0.0000
858.4875	25.0000	14.6796	77.766	.61629	21.3996	0.0000
869.4938	25.0000	8.9211	14.674	.80864	24.0632	0.0000
880.5000	25.0000	0.0000	0.000	0.00000	25.0000	0.0000
902.5125	25.0000	0.0000	0.000	0.00000	25.0000	0.0000

HYDROSTATICS SEA-LAND 7 CONTAINERSHIP

VOLUME (MLD.)	1191035.5	FEET **3
DISPLACEMENT (MLD.)	34029.585	L.TONS
BLOCK COEFFICIENT (MLD.)	.513923	
HALF-AREA MIDSHIP SECTION	1205.787	FEET **2
MIDSHIP SECTION COEFFICIENT	.916228	
PRISMATIC COEFFICIENT (MLD.),	.560912	
TRIM	0.000	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	13.905	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	470.498	FEET
BM,TRANSVERSE	33.545	FEET
BM,LONGITUDINAL	1685.981	FEET
MOMENT TO ALTER TRIM 0.1 FEET	6515.985	
L.TONS PER 0.1 FEET IMMERSION	168.859	
AREA OF WATERPLANE	59100.476	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.637536	
L.C.F. FROM F.P.	492.738	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-100.658	L.TONS
WETTED SURFACE (MLD.)	84454.406	FEET **2

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*DRAFT(WT=47760.0000,LCG=478.8632,KG=42.31,TITLE)
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BALANCING OF SHIP SL-7 FULL LOAD EXAMPLE

6 ITERATIONS TO BALANCE SHIP

TRIM (+ BOW UP)	=	.4170	FEET
HEEL (+ ST'BD. DOWN)	=	0.0000	DEGREES
DRAFT FOWARD	=	32.5742	FEET
DRAFT AFT	=	32.9913	FEET
WEIGHT	=	47760.0000	L.TONS
BUOYANCY	=	47760.0009	L.TONS
LCG (FROM F.P.)	=	478.8632	FEET
LCB (FROM F.P.)	=	478.8743	FEET
VCG (FROM B.L.)	=	42.3100	FEET
VCB (FROM B.L.)	=	18.2314	FEET
HCG (FROM C.L.)	=	0.0000	FEET
HCB (FROM C.L.)	=	0.0000	FEET

HYDROSTATICS SL-7 FULL LOAD EXAMPLE

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	32.5742	0.0000	223.395	1.00000	10.2856	0.0000
11.0063	32.5793	2.1645	255.826	3.62781	11.6946	0.0000
22.0125	32.5844	2.9784	278.628	2.87101	12.2759	0.0000
44.0250	32.5946	6.0058	338.200	1.72767	13.4474	0.0000
66.0375	32.6048	9.9183	404.721	1.25152	14.5780	0.0000
88.0500	32.6149	15.8799	496.289	.95823	15.7712	0.0000
110.0625	32.6251	21.9472	598.465	.83581	16.8453	0.0000
132.0750	32.6353	29.0407	720.398	.76011	17.6204	0.0000
176.1000	32.6556	44.8402	1043.108	.71237	18.6032	0.0000
220.1250	32.6760	60.5819	1430.740	.72275	18.8128	0.0000
264.1500	32.6963	75.1676	1855.258	.75487	18.5830	0.0000
308.1750	32.7166	87.5196	2300.360	.80338	18.2315	0.0000
352.2000	32.7370	97.0863	2709.943	.85264	17.8218	0.0000
396.2250	32.7573	103.1786	3027.153	.89565	17.4911	0.0000
440.2500	32.7777	105.4995	3231.401	.93446	17.2134	0.0000
484.2750	32.7980	105.5000	3278.806	.94758	17.1165	0.0000
528.3000	32.8184	105.5000	3238.733	.93542	17.2528	0.0000
572.3250	32.8387	105.5000	3138.135	.90580	17.5673	0.0000
616.3500	32.8591	105.5000	2948.151	.85044	18.1054	0.0000
660.3750	32.8794	103.2517	2628.041	.77412	18.9508	0.0000
704.4000	32.8997	95.5877	2187.151	.69548	19.8548	0.0000
748.4250	32.9201	83.7717	1653.008	.59940	20.9166	0.0000
770.4375	32.9303	75.5241	1371.574	.55149	21.4725	0.0000
792.4500	32.9404	61.0736	1081.683	.53767	21.9837	0.0000
814.4625	32.9506	56.3092	820.037	.44197	22.6211	0.0000
836.4750	32.9608	44.9469	506.557	.51375	25.0536	0.0000
858.4875	32.9709	32.7218	262.508	.48425	27.1063	0.0000
869.4938	32.9760	26.3021	150.434	.57137	29.1270	0.0000
880.5000	32.9811	19.2025	77.926	.60259	30.3446	0.0000
902.5125	32.9913	6.1251	7.603	.50061	32.1647	0.0000

HYDROSTATICS SL-7 FULL LOAD EXAMPLE

VOLUME (MLD.)	1671600.0	FEET **3
DISPLACEMENT (MLD.)	47760.001	L.TONS
BLOCK COEFFICIENT (MLD.)	.549003	
HALF-AREA MIDSHIP SECTION	1615.701	FEET **2
MIDSHIP SECTION COEFFICIENT	.934464	
PRISMATIC COEFFICIENT (MLD.),	.587506	
TRIM	.417	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	18.231	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	478.874	FEET
BM,TRANSVERSE	26.815	FEET
BM,LONGITUDINAL	1456.157	FEET
MOMENT TO ALTER TRIM 0.1 FEET	7898.471	
L.TONS PER 0.1 FEET IMMERSION	182.938	
AREA OF WATERPLANE	64028.258	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.689274	
L.C.F. FROM F.P.	500.766	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-125.731	L.TONS
WETTED SURFACE (MLD.)	99885.068	FEET **2

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*GROUNDING(WTDIST=DWSL7FU,SHOAL LENGTH=5.0,SHOAL LOCATION=50.0,
 SHOAL DRAFT=5.0,KG=42.31,TITLE)
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WEIGHT BLOCK DATA SL-7 FULL LOAD GROUNDING EXAMPLE

WEIGHT TYPE	BLOCK WEIGHT (L.TONS)	BLOCK LCG (FEET)	FWD END BLOCK (FEET)	AFT END BLOCK (FEET)
1	765.20	19.00	-20.00	42.00
1	1847.70	84.32	42.00	115.25
1	1205.70	143.18	115.25	167.75
1	1613.40	185.52	167.75	207.75
1	1943.60	225.50	207.75	247.75
1	2379.20	265.54	247.75	287.75
1	2305.60	305.53	287.75	327.75
1	2610.80	345.53	327.75	367.75
1	3148.70	385.52	367.75	407.75
1	3343.70	425.51	407.75	447.75
1	3299.00	467.99	447.75	492.75
1	3179.20	512.99	492.75	537.75
1	3293.30	550.00	537.75	562.75
1	3039.80	587.50	562.75	612.75
1	2661.30	635.00	612.75	652.75
1	2898.70	674.35	652.75	697.75
1	2116.10	716.10	697.75	737.75
1	1678.30	756.40	737.75	777.75
1	1597.20	795.55	777.75	817.75
1	1244.50	835.50	817.75	852.50
1	897.70	869.50	852.50	880.50
1	691.30	900.50	880.50	920.50

BLOCK TYPE	SUMMARY WEIGHT (L.TONS)	SUMMARY LCG (FEET)
1	47760.00	478.86
TOTAL	47760.00	478.86

BALANCING OF SHIP SL-7 FULL LOAD GROUNDING EXAMPLE

6 ITERATIONS TO BALANCE SHIP

TRIM (+ BOW UP)	=	.4170	FEET
HEEL (+ ST'BD. DOWN)	=	0.0000	DEGREES
DRAFT FOWARD	=	32.5742	FEET
DRAFT AFT	=	32.9913	FEET
WEIGHT	=	47760.0000	L.TONS
BUOYANCY	=	47760.0009	L.TONS
LCG (FROM F.P.)	=	478.8632	FEET
LCB (FROM F.P.)	=	478.8743	FEET
VCG (FROM B.L.)	=	42.3100	FEET
VCB (FROM B.L.)	=	18.2314	FEET
HCG (FROM C.L.)	=	0.0000	FEET
HCB (FROM C.L.)	=	0.0000	FEET

GROUNDING OF SHIP SL-7 FULL LOAD GROUNDING EXAMPLE

SHOAL LOCATION (FROM F.P.)	=	50.0000	FEET
SHOAL WATER DEPTH	=	5.0000	FEET
SHOAL LENGTH	=	5.0000	FEET
DRAFT FORWARD	=	2.4746	FEET
DRAFT AFT	=	48.1818	FEET
TRIM (+ BOW UP)	=	45.7072	FEET
HEEL (+ ST'BD. DOWN)	=	0.0000	DEGREES
EQUIVALENT SHOAL FORCE	=	7798.960	L.TONS
EQUIVALENT WEIGHT	=	39961.040	L.TONS
LCG (FROM F.P.)	=	562.5619	FEET
VCG (FROM B.L.)	=	50.5674	FEET
HCG (FROM C.L.)	=	0.0000	FEET
DISPLACEMENT	=	39961.065	L.TONS
LCB (FROM F.P.)	=	564.2012	FEET
VCB (FROM B.L.)	=	18.1991	FEET
HCB (FROM C.L.)	=	0.0000	FEET

SHEAR FORCE-BENDING MOMENT SL-7 FULL LOAD GROUNDING EXAMPLE

DISTANCE FROM FP (FEET)	WEIGHT FORCE	BUOYANCY FORCE (L.TONS)	SHEAR FORCE	WEIGHT MOMENT	BUOYANCY MOMENT (FEET -L.TONS)	BENDING MOMENT
-20.00	0.	0.	0.0	0.	0.	0.0
42.00	7.652E+02	4.043E+01	724.8	1.760E+04	7.280E+02	16871.6
47.50	8.441E+02	4.880E+01	795.3	2.202E+04	9.730E+02	21047.7
52.50	-6.875E+03	5.722E+01	-6932.0	6.941E+03	1.238E+03	5702.9
115.25	-5.186E+03	2.349E+02	-5420.9	-3.781E+05	9.664E+03	-387745.9
167.75	-3.980E+03	5.227E+02	-4503.1	-6.207E+05	2.882E+04	-649543.7
207.75	-2.367E+03	8.864E+02	-3253.3	-7.441E+05	5.642E+04	-800494.0
247.75	-4.234E+02	1.458E+03	-1881.1	-7.955E+05	1.024E+05	-897913.6
287.75	1.956E+03	2.334E+03	-378.4	-7.596E+05	1.770E+05	-936645.6
327.75	4.261E+03	3.606E+03	655.6	-6.301E+05	2.944E+05	-924547.2
367.75	6.872E+03	5.332E+03	1540.0	-4.017E+05	4.716E+05	-873296.6
407.75	1.002E+04	7.519E+03	2502.3	-5.678E+04	7.271E+05	-783925.4
447.75	1.336E+04	1.013E+04	3234.4	4.184E+05	1.079E+06	-660363.2
492.75	1.666E+04	1.346E+04	3208.3	1.102E+06	1.608E+06	-506622.2
537.75	1.984E+04	1.707E+04	2776.9	1.930E+06	2.294E+06	-363864.5
562.75	2.314E+04	1.916E+04	3976.5	2.468E+06	2.747E+06	-278511.5
612.75	2.618E+04	2.346E+04	2719.1	3.702E+06	3.812E+06	-110029.4
652.75	2.884E+04	2.688E+04	1954.7	4.796E+06	4.819E+06	-22860.5
697.75	3.174E+04	3.055E+04	1189.9	6.161E+06	6.112E+06	49330.0
737.75	3.385E+04	3.348E+04	375.4	7.477E+06	7.394E+06	82802.8
777.75	3.553E+04	3.597E+04	-442.9	8.867E+06	8.785E+06	82049.7
817.75	3.713E+04	3.792E+04	-792.9	1.032E+07	1.026E+07	59015.1
852.50	3.837E+04	3.910E+04	-724.3	1.163E+07	1.160E+07	30701.9
880.50	3.927E+04	3.969E+04	-418.4	1.272E+07	1.271E+07	11310.7
920.50	3.996E+04	4.007E+04	-104.5	1.430E+07	1.430E+07	-1292.4

HYDROSTATICS SL-7 FULL LOAD GROUNDING EXAMPLE

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	2.4746	10.5772	16.802	.64193	1.5455	0.0000
11.0063	3.0320	11.9466	23.757	.65587	1.8670	0.0000
22.0125	3.5894	12.9897	31.586	.67744	2.1870	0.0000
44.0250	4.7042	15.1127	50.798	.71453	2.8087	0.0000
66.0375	5.8191	17.2116	74.247	.74132	3.4393	0.0000
88.0500	6.9339	19.0922	101.722	.76839	4.0388	0.0000
110.0625	8.0487	20.4409	129.904	.78958	4.5960	0.0000
132.0750	9.1635	22.1145	165.478	.81659	5.1256	0.0000
176.1000	11.3931	29.4347	264.977	.79014	6.4061	0.0000
220.1250	13.6227	42.8875	438.159	.74996	7.7974	0.0000
264.1500	15.8523	59.2952	715.762	.76148	9.0099	0.0000
308.1750	18.0820	76.6623	1093.569	.78889	10.1483	0.0000
352.2000	20.3116	90.8562	1539.092	.83400	11.1505	0.0000
396.2250	22.5412	100.5374	1984.400	.87564	12.1419	0.0000
440.2500	24.7708	105.2746	2387.445	.91552	13.1261	0.0000
484.2750	27.0004	105.5000	2667.159	.93632	14.1850	0.0000
528.3000	29.2300	105.5000	2860.165	.92749	15.4301	0.0000
572.3250	31.4597	105.5000	2992.646	.90167	16.8584	0.0000
616.3500	33.6893	105.5000	3035.741	.85412	18.5431	0.0000
660.3750	35.9189	103.7888	2942.692	.78935	20.6028	0.0000
704.4000	38.1485	98.9262	2697.632	.71481	22.8228	0.0000
748.4250	40.3781	91.9878	2308.908	.62163	25.4025	0.0000
770.4375	41.4929	86.4987	2067.665	.57610	26.8044	0.0000
792.4500	42.6078	81.2976	1781.167	.51421	28.2766	0.0000
814.4625	43.7226	74.9348	1529.136	.46672	30.0270	0.0000
836.4750	44.8374	67.6461	1180.431	.51606	33.1843	0.0000
858.4875	45.9522	60.0298	873.299	.49234	36.1865	0.0000
869.4938	46.5096	55.6105	712.498	.54419	38.1314	0.0000
880.5000	47.0670	50.7783	580.694	.54927	39.6283	0.0000
902.5125	48.1818	40.8011	372.560	.51676	42.2118	0.0000

HYDROSTATICS SL-7 FULL LOAD GROUNDING EXAMPLE

VOLUME (MLD.)	1398637.3	FEET **3
DISPLACEMENT (MLD.)	39961.065	L.TONS
BLOCK COEFFICIENT (MLD.)	.609133	
HALF-AREA MIDSHIP SECTION	1193.722	FEET **2
MIDSHIP SECTION COEFFICIENT	.915524	
PRISMATIC COEFFICIENT (MLD.),	.665338	
TRIM	45.707	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	18.199	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	564.201	FEET
BM,TRANSVERSE	32.087	FEET
BM,LONGITUDINAL	1951.388	FEET
MOMENT TO ALTER TRIM 0.1 FEET	8856.278	
L.TONS PER 0.1 FEET IMMERSION	186.313	
AREA OF WATERPLANE	65209.507	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.703490	
L.C.F. FROM F.P.	527.047	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-183.662	L.TONS
WETTED SURFACE (MLD.)	87031.130	FEET **2

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*INTACTSTABILITY(DISP1=15000,DISP2=50000,DISPINC=5000,KG=30.,
TITLE)
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INTACT STABILITY SL-7 INTACT STABILITY EXAMPLE

HEEL = 10.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	8.101	9.537	5.590	-2.7861E-04
20000.0	9.828	8.118	4.492	-1.7236E-04
25000.0	11.502	7.112	3.792	-1.1270E-04
30000.0	13.133	6.355	3.330	-7.4874E-05
35000.0	14.726	5.763	3.024	-4.9823E-05
40000.0	16.286	5.283	2.822	-3.1656E-05
45000.0	17.814	4.893	2.703	-1.6550E-05
50000.0	19.314	4.574	2.649	-5.4137E-06

HEEL = 20.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	10.253	17.666	9.847	-3.6677E-04
20000.0	11.794	15.498	8.337	-2.4663E-04
25000.0	13.304	13.853	7.307	-1.6931E-04
30000.0	14.795	12.560	6.602	-1.1574E-04
35000.0	16.272	11.518	6.128	-7.5709E-05
40000.0	17.734	10.666	5.827	-4.6191E-05
45000.0	19.178	9.957	5.655	-2.3642E-05
50000.0	20.605	9.361	5.583	-5.8796E-06

INTACT STABILITY SL-7 INTACT STABILITY EXAMPLE

HEEL = 30.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	CENTER OF BUOYANCY FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	13.120	23.849	12.214	-3.1785E-04
20000.0	14.596	21.537	10.950	-2.0073E-04
25000.0	16.045	19.750	10.126	-1.3260E-04
30000.0	17.472	18.306	9.590	-8.5536E-05
35000.0	18.878	17.102	9.249	-5.2131E-05
40000.0	20.264	16.078	9.055	-2.6525E-05
45000.0	21.627	15.188	8.967	-9.5441E-06
50000.0	22.967	14.404	8.958	5.5012E-06

HEEL = 40.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	CENTER OF BUOYANCY FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	16.789	29.085	13.788	-2.3957E-04
20000.0	18.230	26.720	12.903	-1.2486E-04
25000.0	19.676	24.926	12.458	-5.8241E-05
30000.0	21.104	23.484	12.272	-1.9274E-05
35000.0	22.497	22.264	12.232	3.3706E-06
40000.0	23.844	21.188	12.274	1.0961E-05
45000.0	25.091	20.144	12.276	-1.3631E-05
50000.0	26.200	19.048	12.149	-3.6887E-05

INTACT STABILITY SL-7 INTACT STABILITY EXAMPLE

HEEL = 50.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	CENTER OF BUOYANCY FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	21.520	33.811	15.237	1.0154E-05
20000.0	23.216	31.683	15.169	-1.4586E-05
25000.0	24.635	29.869	15.089	-1.1028E-05
30000.0	25.821	28.205	14.929	-5.1676E-05
35000.0	26.783	26.577	14.619	-6.6011E-05
40000.0	27.617	24.995	14.241	-8.1972E-05
45000.0	28.365	23.450	13.821	-8.2776E-05
50000.0	29.071	21.949	13.397	-8.5519E-05

HEEL = 60.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	CENTER OF BUOYANCY FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	27.080	37.701	16.322	1.9520E-04
20000.0	28.833	35.655	16.817	1.5126E-05
25000.0	29.764	33.498	16.544	-1.0495E-04
30000.0	30.284	31.354	15.923	-1.4521E-04
35000.0	30.626	29.289	15.187	-1.4519E-04
40000.0	30.944	27.341	14.488	-1.3586E-04
45000.0	31.251	25.484	13.825	-1.3010E-04
50000.0	31.561	23.705	13.204	-1.1881E-04

INTACT STABILITY SL-7 INTACT STABILITY EXAMPLE

HEEL = 70.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	CENTER OF BUOYANCY FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	32.311	40.164	15.909	6.7890E-05
20000.0	33.213	37.718	15.920	-4.6611E-05
25000.0	33.707	35.362	15.578	-8.3496E-05
30000.0	33.950	33.085	15.027	-1.2669E-04
35000.0	34.002	30.878	14.321	-1.5189E-04
40000.0	33.949	28.751	13.544	-1.5551E-04
45000.0	33.889	26.722	12.794	-1.4297E-04
50000.0	33.867	24.786	12.111	-1.2897E-04

HEEL = 80.00 DEGREES

CENTER OF GRAVITY FROM B.L.= 30.00 FEET ; FROM C.L.= 0.00 FEET

DISPLACEMENT (L.TONS)	CENTER OF BUOYANCY FROM B.L. (FEET)	CENTER OF BUOYANCY FROM C.L. (FEET)	GZ RIGHTING ARM (FEET)	TANGENT TO CROSS CURVE (FEET /L.TONS)
15000.0	36.780	41.374	13.862	-4.8910E-05
20000.0	36.919	38.722	13.537	-7.8287E-05
25000.0	36.930	36.234	13.117	-9.0242E-05
30000.0	36.875	33.878	12.654	-9.5399E-05
35000.0	36.759	31.628	12.149	-1.0204E-04
40000.0	36.578	29.465	11.595	-1.1953E-04
45000.0	36.323	27.380	10.981	-1.2294E-04
50000.0	36.066	25.378	10.381	-1.1532E-04

*DRAFT(WTDIST=DWSL7BA,KG=40.26,WAVE=1,TITLE)

WEIGHT BLOCK DATA SL-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS

WEIGHT TYPE	BLOCK WEIGHT (L.TONS)	BLOCK LCG (FEET)	FWD END BLOCK (FEET)	AFT END BLOCK (FEET)
1	777.40	19.00	-20.00	42.00
1	1859.90	84.32	42.00	115.25
1	1217.90	143.18	115.25	167.75
1	1151.80	185.52	167.75	207.75
1	1379.20	225.50	207.75	247.75
1	1844.30	265.54	247.75	287.75
1	1990.60	305.53	287.75	327.75
1	2429.00	345.53	327.75	367.75
1	2547.50	385.52	367.75	407.75
1	2707.60	425.51	407.75	447.75
1	2714.90	467.99	447.75	492.75
1	2697.90	512.99	492.75	537.75
1	3284.90	550.00	537.75	562.75
1	3031.40	587.50	562.75	612.75
1	2726.30	635.00	612.75	652.75
1	2757.40	674.35	652.75	697.75
1	1631.30	716.10	697.75	737.75
1	1217.70	756.40	737.75	777.75
1	982.50	795.55	777.75	817.75
1	901.20	835.50	817.75	852.50
1	889.30	869.50	852.50	880.50
1	682.90	900.50	880.50	920.50

BLOCK TYPE	SUMMARY WEIGHT (L.TONS)	SUMMARY LCG (FEET)
1	41422.90	477.68
TOTAL	41422.90	477.68

BALANCING OF SHIP SL-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS

WAVE CHARACTERISTICS

SINUSOIDAL WAVE

CREST (FROM F.P.)(FEET)	0.00
WAVE LENGTH (FEET)	880.50
HEIGHT (CREST TO TROUGH)	44.0250
WAVE HEADING (BOW=0 DEGREES)	0.00

6 ITERATIONS TO BALANCE SHIP

TRIM (+ BOW UP)	=	-18.5919	FEET
HEEL (+ ST'BD. DOWN)	=	0.0000	DEGREES
DRAFT FOWARD	=	44.1528	FEET
DRAFT AFT	=	25.5610	FEET
WEIGHT	=	41422.9000	L.TONS
BUOYANCY	=	41422.9002	L.TONS
LCG (FROM F.P.)	=	477.6818	FEET
LCB (FROM F.P.)	=	477.2854	FEET
VCG (FROM B.L.)	=	40.2600	FEET
VCB (FROM B.L.)	=	21.0202	FEET
HCG (FROM C.L.)	=	0.0000	FEET
HCB (FROM C.L.)	=	0.0000	FEET

BALANCING OF SH.. S..-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS

STATION FROM F.P.	MEAN WATERLINE	WAVE ELEVATION	DRAFT FROM B.L.
0.000	44.1528	22.0078	66.1607
11.006	43.9261	21.9344	65.8605
22.013	43.6994	21.7258	65.4251
44.025	43.2459	20.9093	64.1552
66.037	42.7925	19.5793	62.3718
88.050	42.3390	17.7691	60.1081
110.062	41.8855	15.5237	57.4092
132.075	41.4321	12.8985	54.3305
176.100	40.5252	6.7743	47.2995
220.125	39.6182	-.0073	39.6109
264.150	38.7113	-6.7882	31.9231
308.175	37.8044	-12.9103	24.8941
352.200	36.8975	-17.7778	19.1197
396.225	35.9905	-20.9139	15.0767
440.250	35.0836	-22.0079	13.0758
484.275	34.1767	-20.9467	13.2300
528.300	33.2698	-17.8282	15.4415
572.325	32.3629	-12.9543	19.4086
616.350	31.4559	-6.8021	24.6538
660.375	30.5490	.0221	30.5711
704.400	29.6421	6.8441	36.4862
748.425	28.7352	12.9899	41.7251
770.437	28.2817	15.6156	43.8974
792.450	27.8283	17.8541	45.6823
814.463	27.3748	19.6502	47.0250
836.475	26.9213	20.9601	47.8815
858.487	26.4679	21.7522	48.2201
869.494	26.2411	21.9477	48.1889
880.500	26.0144	22.0077	48.0221
902.513	25.5610	21.7211	47.2820

SHEAR FORCE-BENDING MOMENT SL-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS

DISTANCE FROM FP (FEET)	WEIGHT FORCE	BUOYANCY FORCE (L.TONS)	SHEAR FORCE	WEIGHT MOMENT	BUOYANCY MOMENT (FEET -L.TONS)	BENDING MOMENT
-20.00	0.	0.	0.0	0.	0.	0.0
42.00	7.774E+02	8.191E+02	-41.7	1.788E+04	1.516E+04	2718.7
115.25	2.637E+03	3.372E+03	-735.1	1.324E+05	1.606E+05	-28228.4
167.75	3.855E+03	5.852E+03	-1996.8	3.007E+05	4.011E+05	-100357.7
207.75	5.007E+03	7.935E+03	-2928.0	4.805E+05	6.766E+05	-196015.9
247.75	6.386E+03	1.005E+04	-3667.3	7.115E+05	1.036E+06	-324959.7
287.75	8.230E+03	1.209E+04	-3857.1	1.008E+06	1.480E+06	-471810.3
327.75	1.022E+04	1.396E+04	-3736.9	1.381E+06	2.001E+06	-619896.7
367.75	1.265E+04	1.562E+04	-2974.0	1.844E+06	2.594E+06	-749407.2
407.75	1.520E+04	1.710E+04	-1901.1	2.407E+06	3.249E+06	-841798.0
447.75	1.791E+04	1.846E+04	-558.5	3.075E+06	3.960E+06	-885166.0
492.75	2.062E+04	2.001E+04	608.9	3.948E+06	4.826E+06	-877601.0
537.75	2.332E+04	2.175E+04	1568.1	4.943E+06	5.764E+06	-821514.3
562.75	2.660E+04	2.287E+04	3736.2	5.567E+06	6.322E+06	-754121.8
612.75	2.963E+04	2.551E+04	4123.0	6.974E+06	7.529E+06	-554452.4
652.75	3.236E+04	2.803E+04	4334.9	8.208E+06	8.598E+06	-390371.8
697.75	3.512E+04	3.116E+04	3957.3	9.729E+06	9.929E+06	-200535.8
737.75	3.675E+04	3.402E+04	2725.3	1.117E+07	1.123E+07	-64468.4
777.75	3.797E+04	3.673E+04	1239.3	1.266E+07	1.265E+07	15480.2
817.75	3.895E+04	3.899E+04	-44.4	1.421E+07	1.417E+07	39796.7
852.50	3.985E+04	4.041E+04	-560.7	1.557E+07	1.555E+07	27182.8
880.50	4.074E+04	4.111E+04	-372.1	1.670E+07	1.669E+07	10529.9
920.50	4.142E+04	4.151E+04	-84.4	1.834E+07	1.834E+07	-993.1

HYDROSTATICS SL-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS

WAVE CHARACTERISTICS

SINUSOIDAL WAVE

CREST (FROM F.P.)(FEET) 0.00
WAVE LENGTH (FEET) 880.50
HEIGHT (CREST TO TROUGH) 44.0250
WAVE HEADING (BOW=0 DEGREES) 0.00

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	66.1607	0.0000	455.036	1.00000	33.1927	0.0000
11.0063	65.8605	0.0000	584.240	1.00000	35.5853	0.0000
22.0125	65.4251	0.0000	705.129	1.00000	37.4101	0.0000
44.0250	64.1552	35.1631	939.247	.41635	38.4499	0.0000
66.0375	62.3718	41.8434	1093.302	.41891	37.3076	0.0000
88.0500	60.1081	47.6153	1323.513	.46243	36.3746	0.0000
110.0625	57.4092	51.9332	1488.593	.49929	34.7062	0.0000
132.0750	54.3305	55.1950	1618.241	.53963	32.5902	0.0000
176.1000	47.2995	60.6513	1809.434	.63073	27.8044	0.0000
220.1250	39.6109	66.8454	1871.982	.70699	22.9102	0.0000
264.1500	31.9231	74.4864	1798.446	.75634	18.1492	0.0000
308.1750	24.8941	82.2428	1638.261	.80018	13.9363	0.0000
352.2000	19.1197	90.0216	1434.038	.83317	10.5217	0.0000
396.2250	15.0767	96.3074	1249.403	.86047	8.1981	0.0000
440.2500	13.0758	101.8772	1169.043	.87758	7.0501	0.0000
484.2750	13.2300	104.0828	1216.928	.88374	7.1095	0.0000
528.3000	15.4415	103.6565	1408.098	.87972	8.3024	0.0000
572.3250	19.4086	103.6145	1725.649	.85810	10.5551	0.0000
616.3500	24.6538	103.2015	2090.196	.82152	13.7274	0.0000
660.3750	30.5711	102.0533	2393.314	.76712	17.6966	0.0000
704.4000	36.4862	97.8689	2538.161	.71080	21.9106	0.0000
748.4250	41.7251	93.2967	2438.483	.62641	26.2354	0.0000
770.4375	43.8974	88.9414	2283.067	.58476	28.3065	0.0000
792.4500	45.6823	85.5076	2041.489	.52263	30.3046	0.0000
814.4625	47.0250	80.1389	1788.365	.47455	32.2570	0.0000
836.4750	47.8815	70.6972	1394.009	.53497	35.2064	0.0000
858.4875	48.2201	63.8138	1014.420	.49964	37.7052	0.0000
869.4938	48.1889	58.5331	808.518	.54764	39.2271	0.0000
880.5000	48.0221	52.5334	629.781	.54473	40.2453	0.0000
902.5125	47.2820	38.9729	335.873	.39676	41.6095	0.0000

HYDROSTATICS SL-7 BALLAST-L/20 WAVE TROUGH AMIDSHIPS

VOLUME (MLD.)	1449801.5	FEET **3
DISPLACEMENT (MLD.)	41422.900	L.TONS
BLOCK COEFFICIENT (MLD.)	.460678	
HALF-AREA MIDSHIP SECTION	584.522	FEET **2
MIDSHIP SECTION COEFFICIENT	.327076	
PRISMATIC COEFFICIENT (MLD.),	1.408473	
TRIM	-18.592	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	21.020	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	477.285	FEET
BM,TRANSVERSE	32.536	FEET
BM,LONGITUDINAL	2442.681	FEET
MOMENT TO ALTER TRIM 0.1 FEET	11491.531	
L.TONS PER 0.1 FEET IMMERSION	203.421	
AREA OF WATERPLANE	71197.454	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.793703	
L.C.F. FROM F.P.	497.118	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-131.382	L.TONS
WETTED SURFACE (MLD.)	108160.717	FEET **2

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*DRAFT(WTDIST=DWSL7FU,KG=42.31,TITLE,EQUALSTATION=21,
POINTS=19,LIST)
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WEIGHT BLOCK DATA SL-7 - NORMAL FULL LOAD DEPARTURE

WEIGHT TYPE	BLOCK WEIGHT (L.TONS)	BLOCK LCG (FEET)	FWD END BLOCK (FEET)	AFT END BLOCK (FEET)
1	765.20	19.00	-20.00	42.00
1	1847.70	84.32	42.00	115.25
1	1205.70	143.18	115.25	167.75
1	1613.40	185.52	167.75	207.75
1	1943.60	225.50	207.75	247.75
1	2379.20	265.54	247.75	287.75
1	2305.60	305.53	287.75	327.75
1	2610.80	345.53	327.75	367.75
1	3148.70	385.52	367.75	407.75
1	3343.70	425.51	407.75	447.75
1	3299.00	467.99	447.75	492.75
1	3179.20	512.99	492.75	537.75
1	3293.30	550.00	537.75	562.75
1	3039.80	587.50	562.75	612.75
1	2661.30	635.00	612.75	652.75
1	2898.70	674.35	652.75	697.75
1	2116.10	716.10	697.75	737.75
1	1678.30	756.40	737.75	777.75
1	1597.20	795.55	777.75	817.75
1	1244.50	835.50	817.75	852.50
1	897.70	869.50	852.50	880.50
1	691.30	900.50	880.50	920.50

BLOCK TYPE	SUMMARY WEIGHT (L.TONS)	SUMMARY LCG (FEET)
1	47760.00	478.86
TOTAL	47760.00	478.86

BALANCING OF SHIP SL-7 - NORMAL FULL LOAD DEPARTURE

6 ITERATIONS TO BALANCE SHIP

TRIM (+ BOW UP)	=	.4170	FEET
HEEL (+ ST'BD. DOWN)	=	0.0000	DEGREES
DRAFT FOWARD	=	32.5742	FEET
DRAFT AFT	=	32.9913	FEET
WEIGHT	=	47760.0000	L.TONS
BUOYANCY	=	47760.0009	L.TONS
LCG (FROM F.P.)	=	478.8632	FEET
LCB (FROM F.P.)	=	478.8743	FEET
VCG (FROM B.L.)	=	42.3100	FEET
VCB (FROM B.L.)	=	18.2314	FEET
HCG (FROM C.L.)	=	0.0000	FEET
HCB (FROM C.L.)	=	0.0000	FEET

SHEAR FORCE-BENDING MOMENT SL-7 - NORMAL FULL LOAD DEPARTURE

DISTANCE FROM FP (FEET)	WEIGHT FORCE	BUOYANCY FORCE (L.TONS)	SHEAR FORCE	WEIGHT MOMENT	BUOYANCY MOMENT (FEET -L.TONS)	BENDING MOMENT
-20.00	0.	0.	0.0	0.	0.	0.0
42.00	7.652E+02	3.340E+02	431.2	1.760E+04	6.573E+03	11026.7
115.25	2.613E+03	1.306E+03	1307.3	1.308E+05	6.285E+04	67950.8
167.75	3.819E+03	2.497E+03	1321.4	2.976E+05	1.603E+05	137305.2
207.75	5.432E+03	3.808E+03	1623.9	4.862E+05	2.851E+05	201125.6
247.75	7.376E+03	5.529E+03	1846.4	7.467E+05	4.704E+05	276344.3
287.75	9.755E+03	7.693E+03	2061.8	1.095E+06	7.333E+05	361279.6
327.75	1.206E+04	1.031E+04	1747.6	1.536E+06	1.092E+06	444065.9
367.75	1.467E+04	1.336E+04	1315.8	2.076E+06	1.564E+06	512438.9
407.75	1.782E+04	1.674E+04	1079.4	2.733E+06	2.165E+06	568383.4
447.75	2.116E+04	2.036E+04	799.2	3.520E+06	2.906E+06	614102.3
492.75	2.446E+04	2.456E+04	-96.0	4.555E+06	3.917E+06	637573.8
537.75	2.764E+04	2.874E+04	-1094.4	5.734E+06	5.116E+06	617744.9
562.75	3.094E+04	3.101E+04	-78.6	6.467E+06	5.863E+06	603821.2
612.75	3.397E+04	3.540E+04	-1424.0	8.091E+06	7.525E+06	565789.0
652.75	3.664E+04	3.863E+04	-1995.1	9.497E+06	9.006E+06	490320.0
697.75	3.953E+04	4.182E+04	-2281.4	1.121E+07	1.082E+07	394579.5
737.75	4.165E+04	4.413E+04	-2478.3	1.284E+07	1.254E+07	301052.0
777.75	4.333E+04	4.588E+04	-2551.4	1.454E+07	1.434E+07	200788.0
817.75	4.493E+04	4.705E+04	-2121.8	1.631E+07	1.620E+07	108959.6
852.50	4.617E+04	4.758E+04	-1410.8	1.789E+07	1.785E+07	45830.1
880.50	4.707E+04	4.773E+04	-664.4	1.920E+07	1.918E+07	13610.5
920.50	4.776E+04	4.776E+04	-2.0	2.109E+07	2.109E+07	-24.4

HYDROSTATICS SL-7 - NORMAL FULL LOAD DEPARTURE

STATION FROM F.P.	MEAN DRAFT (FEET)	BEAM (FEET)	AREA (FEET **2)	S.A. COEF.	VCB (FEET)	HCB (FEET)
0.0000	32.5742	0.0000	222.324	1.00000	10.3399	0.0000
44.0250	32.5946	6.0058	337.029	1.72169	13.5029	0.0000
88.0500	32.6149	15.8799	495.892	.95747	15.7963	0.0000
132.0750	32.6353	29.0407	719.110	.75875	17.6561	0.0000
176.1000	32.6556	44.8402	1042.186	.71174	18.6209	0.0000
220.1250	32.6760	60.5819	1429.338	.72204	18.8262	0.0000
264.1500	32.6963	75.1676	1853.956	.75434	18.5905	0.0000
308.1750	32.7166	87.5196	2298.444	.80271	18.2403	0.0000
352.2000	32.7370	97.0863	2706.108	.85143	17.8344	0.0000
396.2250	32.7573	103.1786	3023.046	.89443	17.5044	0.0000
440.2500	32.7777	105.4995	3226.899	.93316	17.2270	0.0000
484.2750	32.7980	105.5000	3273.375	.94601	17.1344	0.0000
528.3000	32.8184	105.5000	3235.228	.93441	17.2624	0.0000
572.3250	32.8387	105.5000	3134.283	.90469	17.5758	0.0000
616.3500	32.8591	105.5000	2944.349	.84934	18.1117	0.0000
660.3750	32.8794	103.2517	2625.787	.77346	18.9552	0.0000
704.4000	32.8997	95.5877	2185.048	.69481	19.8611	0.0000
748.4250	32.9201	83.7717	1651.807	.59896	20.9230	0.0000
792.4500	32.9404	61.0736	1080.407	.53704	21.9932	0.0000
836.4750	32.9608	44.9469	506.188	.51337	25.0663	0.0000
880.5000	32.9811	19.2025	77.919	.60254	30.3453	0.0000

VOLUME (MLD.)	1670224.0	FEET **3
DISPLACEMENT (MLD.)	47720.685	L.TONS
BLOCK COEFFICIENT (MLD.)	.548551	
HALF-AREA MIDSHIP SECTION	1613.449	FEET **2
MIDSHIP SECTION COEFFICIENT	.933162	
PRISMATIC COEFFICIENT (MLD.),	.587841	
TRIM	.417	FEET
HEEL	0.000	DEGREES
VCB (FROM B.L.)	18.240	FEET
HCB (FROM C.L.)	0.000	FEET
LCB (FROM F.P.)	478.373	FEET
BM,TRANSVERSE	26.813	FEET
BM,LONGITUDINAL	1456.486	FEET
MOMENT TO ALTER TRIM 0.1 FEET	7893.755	
L.TONS PER 0.1 FEET IMMERSION	182.368	
AREA OF WATERPLANE	63828.925	FEET **2
WATERPLANE COEFFICIENT (MLD.)	.687128	
L.C.F. FROM F.P.	496.493	FEET
CHANGE IN DISPL. FOR 1 FEET TRIM AFT	-116.490	L.TONS
WETTED SURFACE (MLD.)	99185.360	FEET **2

WET OFFSETS TABLE (FEET) SL-7 - NORMAL FULL LOAD DEPARTURE

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 1 — 19 POINTS — X = 0.000
STATION 2 — 20 POINTS — X = 44.025
STATION 3 — 20 POINTS — X = 88.050

	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	-3.047	0.000	1	0.000	0.000	1	0.000	0.000
2	-4.973	.170	2	0.000	3.003	2	0.000	7.940
3	-6.882	.435	3	-2.112	2.687	3	-2.069	7.229
4	-8.751	.930	4	-4.237	2.564	4	-4.176	6.659
5	-10.592	1.512	5	-6.372	2.606	5	-6.319	6.224
6	-12.411	2.168	6	-8.475	2.976	6	-8.506	6.214
7	-14.189	2.925	7	-10.538	3.500	7	-10.669	6.439
8	-15.952	3.717	8	-12.552	4.210	8	-12.805	6.909
9	-17.679	4.586	9	-14.506	5.067	9	-14.898	7.544
10	-19.401	5.466	10	-16.451	5.949	10	-16.988	8.188
11	-21.172	6.240	11	-18.418	6.781	11	-19.079	8.833
12	-23.022	6.796	12	-20.407	7.556	12	-21.203	9.351
13	-24.925	7.062	13	-22.479	8.045	13	-23.355	9.714
14	-26.837	6.835	14	-24.604	8.227	14	-25.523	9.574
15	-28.687	6.284	15	-26.708	7.949	15	-27.673	9.167
16	-30.220	5.172	16	-28.692	7.175	16	-29.448	7.902
17	-31.397	3.664	17	-30.325	5.845	17	-30.875	6.244
18	-32.070	1.866	18	-31.565	4.127	18	-31.851	4.308
19	-32.574	.000	19	-32.139	2.086	19	-32.233	2.154
			20	-32.595	.000	20	-32.615	.000

STATION 4 — 20 POINTS — X = 132.075
STATION 5 — 20 POINTS — X = 176.100
STATION 6 — 20 POINTS — X = 220.125

	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	0.000	14.520	2	0.000	22.420	2	0.000	30.291
3	-2.053	13.616	3	-2.203	21.450	3	-2.458	29.208
4	-4.150	12.830	4	-4.426	20.527	4	-4.915	28.126
5	-6.294	12.169	5	-6.662	19.635	5	-7.373	27.043
6	-8.471	11.626	6	-8.879	18.697	6	-9.831	25.961
7	-10.674	11.242	7	-11.149	17.904	7	-12.289	24.878
8	-12.909	11.045	8	-13.450	17.195	8	-14.729	23.757
9	-15.151	11.100	9	-15.750	16.485	9	-17.125	22.548
10	-17.393	11.179	10	-18.051	15.776	10	-19.455	21.214
11	-19.634	11.277	11	-20.341	15.034	11	-21.803	19.910
12	-21.876	11.305	12	-22.647	14.351	12	-24.055	18.461
13	-24.057	10.872	13	-24.859	13.406	13	-26.214	16.867
14	-26.267	10.594	14	-27.009	12.331	14	-28.071	14.929
15	-28.296	9.669	15	-28.995	10.976	15	-29.719	12.811
16	-30.021	8.256	16	-30.625	9.219	16	-31.161	10.551
17	-31.435	6.527	17	-31.756	7.113	17	-31.983	8.019
18	-32.185	4.439	18	-32.402	4.797	18	-32.341	5.357
19	-32.584	2.243	19	-32.583	2.406	19	-32.554	2.683
20	-32.635	.000	20	-32.656	.000	20	-32.676	.000

WET OFFSETS TABLE (FEET) SL-7 - NORMAL FULL LOAD DEPARTURE

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 7 / 20 POINTS / X = 264.150 — STATION 8 / 20 POINTS / X = 308.175 — STATION 9 / 20 POINTS / X = 352.200

	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	0.000	37.584	2	0.000	43.760	2	0.000	48.543
3	-2.776	36.361	3	-3.229	42.707	3	-3.656	47.746
4	-5.574	35.192	4	-6.450	41.629	4	-7.308	46.941
5	-8.339	33.947	5	-9.636	40.450	5	-10.901	45.898
6	-11.092	32.674	6	-12.803	39.225	6	-14.438	44.685
7	-13.820	31.353	7	-15.848	37.722	7	-17.828	43.117
8	-16.474	29.885	8	-18.761	35.978	8	-21.032	41.192
9	-19.025	28.245	9	-21.460	33.927	9	-23.949	38.866
10	-21.527	26.532	10	-24.017	31.698	10	-26.462	36.108
11	-23.961	24.731	11	-26.277	29.166	11	-28.485	32.960
12	-26.202	22.690	12	-28.207	26.373	12	-30.182	29.650
13	-28.036	20.276	13	-29.834	23.406	13	-31.350	26.107
14	-29.650	17.714	14	-31.072	20.244	14	-32.020	22.430
15	-30.947	14.972	15	-31.917	16.958	15	-32.357	18.705
16	-31.897	12.098	16	-32.213	13.574	16	-32.433	14.964
17	-32.229	9.083	17	-32.428	10.186	17	-32.509	11.223
18	-32.476	6.062	18	-32.524	6.790	18	-32.585	7.482
19	-32.586	3.031	19	-32.620	3.395	19	-32.661	3.741
20	-32.696	.000	20	-32.717	.000	20	-32.737	.000

STATION 10 / 20 POINTS / X = 396.225 — STATION 11 / 20 POINTS / X = 440.250 — STATION 12 / 20 POINTS / X = 484.275

	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	0.000	51.589	2	0.000	52.750	2	0.000	52.750
3	-4.010	51.215	3	-4.235	52.704	3	-4.300	52.750
4	-7.998	50.667	4	-8.470	52.629	4	-8.601	52.750
5	-11.957	49.931	5	-12.699	52.402	5	-12.901	52.750
6	-15.835	48.863	6	-16.880	51.765	6	-17.185	52.399
7	-19.573	47.370	7	-20.902	50.452	7	-21.354	51.428
8	-23.082	45.400	8	-24.645	48.498	8	-25.174	49.481
9	-26.159	42.812	9	-27.688	45.558	9	-28.216	46.474
10	-28.565	39.583	10	-29.990	42.040	10	-30.334	42.758
11	-30.344	36.005	11	-31.360	38.055	11	-31.505	38.656
12	-31.496	32.159	12	-32.023	33.875	12	-32.049	34.394
13	-32.052	28.181	13	-32.182	29.643	13	-32.195	30.097
14	-32.215	24.158	14	-32.267	25.409	14	-32.281	25.798
15	-32.305	20.131	15	-32.352	21.174	15	-32.367	21.498
16	-32.396	16.105	16	-32.437	16.939	16	-32.453	17.198
17	-32.486	12.079	17	-32.522	12.704	17	-32.540	12.899
18	-32.577	8.053	18	-32.608	8.470	18	-32.626	8.599
19	-32.667	4.026	19	-32.693	4.235	19	-32.712	4.300
20	-32.757	.000	20	-32.778	.000	20	-32.798	.000

WET OFFSETS TABLE (FEET) SL-7 - NORMAL FULL LOAD DEPARTURE

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

STATION 13
20 POINTS
X = 528.300

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	52.750
3	-4.239	52.750
4	-8.478	52.750
5	-12.714	52.624
6	-16.895	51.956
7	-20.923	50.672
8	-24.650	48.661
9	-27.631	45.655
10	-29.814	42.043
11	-31.263	38.068
12	-32.001	33.894
13	-32.224	29.667
14	-32.309	25.429
15	-32.394	21.191
16	-32.479	16.952
17	-32.564	12.714
18	-32.649	8.476
19	-32.733	4.238
20	-32.818	.000

STATION 14
20 POINTS
X = 572.325

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	52.750
3	-4.116	52.736
4	-8.226	52.548
5	-12.305	52.015
6	-16.302	51.046
7	-20.049	49.355
8	-23.359	46.923
9	-26.220	43.975
10	-28.460	40.527
11	-30.143	36.789
12	-31.326	32.855
13	-32.002	28.794
14	-32.342	24.693
15	-32.428	20.577
16	-32.510	16.462
17	-32.592	12.346
18	-32.674	8.231
19	-32.757	4.115
20	-32.839	.000

STATION 15
20 POINTS
X = 616.350

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	52.750
3	-3.919	52.367
4	-7.799	51.687
5	-11.598	50.670
6	-15.223	49.146
7	-18.527	47.028
8	-21.582	44.550
9	-24.194	41.601
10	-26.405	38.348
11	-28.212	34.851
12	-29.694	31.203
13	-30.819	27.427
14	-31.613	23.577
15	-32.158	19.676
16	-32.535	15.755
17	-32.616	11.816
18	-32.697	7.878
19	-32.778	3.939
20	-32.859	.000

STATION 16
20 POINTS
X = 660.375

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	51.626
3	-3.596	50.672
4	-7.130	49.509
5	-10.553	48.058
6	-13.766	46.195
7	-16.694	43.900
8	-19.363	41.307
9	-21.803	38.502
10	-23.921	35.446
11	-25.797	32.232
12	-26.915	28.715
13	-27.753	25.089
14	-29.678	22.015
15	-30.617	18.413
16	-31.467	14.793
17	-32.105	11.127
18	-32.466	7.423
19	-32.828	3.719
20	-32.879	.000

STATION 17
20 POINTS
X = 704.400

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	47.794
3	-3.122	46.480
4	-6.136	44.933
5	-9.029	43.173
6	-11.813	41.245
7	-14.403	39.075
8	-16.801	36.684
9	-19.007	34.112
10	-20.970	31.360
11	-22.791	28.503
12	-24.317	25.481
13	-25.815	22.443
14	-27.152	19.333
15	-28.407	16.186
16	-29.667	13.041
17	-30.726	9.823
18	-31.665	6.570
19	-32.689	3.348
20	-32.900	.000

STATION 18
20 POINTS
X = 748.425

	HEIGHT Z	H-B Y
1	0.000	0.000
2	0.000	41.886
3	-2.495	40.181
4	-4.938	38.402
5	-7.312	36.535
6	-9.577	34.534
7	-11.736	32.421
8	-13.824	30.239
9	-15.791	27.944
10	-17.671	25.579
11	-19.499	23.173
12	-21.188	20.667
13	-22.921	18.191
14	-24.402	15.559
15	-25.978	12.981
16	-27.478	10.358
17	-29.012	7.755
18	-30.654	5.218
19	-32.516	2.849
20	-32.920	.000

WET OFFSETS TABLE (FEET) SL-7 - NORMAL FULL LOAD DEPARTURE

LENGTH = 880.500 BEAM = 105.500 DEPTH = 64.305

	STATION 19 20 POINTS X = 792.450			STATION 20 20 POINTS X = 836.475			STATION 21 20 POINTS X = 880.500	
	HEIGHT Z	H-B Y		HEIGHT Z	H-B Y		HEIGHT Z	H-B Y
1	0.000	0.000	1	0.000	0.000	1	0.000	0.000
2	0.000	30.537	2	0.000	22.473	2	0.000	9.601
3	-2.521	30.290	3	-1.198	21.116	3	-.439	9.087
4	-4.589	29.022	4	-2.388	19.750	4	-.885	8.579
5	-6.380	27.139	5	-3.581	18.388	5	-1.331	8.071
6	-8.198	25.282	6	-4.802	17.050	6	-1.777	7.562
7	-10.019	23.427	7	-6.023	15.713	7	-2.223	7.054
8	-11.756	21.494	8	-7.258	14.389	8	-2.669	6.546
9	-13.513	19.579	9	-8.512	13.082	9	-3.115	6.038
10	-15.393	17.785	10	-9.765	11.775	10	-3.563	5.532
11	-17.169	15.895	11	-11.138	10.596	11	-4.019	5.032
12	-18.782	13.857	12	-12.537	9.447	12	-4.475	4.533
13	-20.429	11.847	13	-13.960	8.327	13	-4.931	4.034
14	-22.185	9.933	14	-15.408	7.239	14	-5.387	3.534
15	-23.992	8.066	15	-16.881	6.190	15	-5.842	3.035
16	-25.862	6.263	16	-18.452	5.288	16	-6.298	2.535
17	-27.805	4.537	17	-20.026	4.393	17	-6.734	2.028
18	-30.004	3.163	18	-21.585	3.494	18	-6.734	1.352
19	-32.379	2.128	19	-21.937	1.811	19	-6.734	.676
20	-32.940	.000	20	-21.937	.000	20	-6.734	.000

-LONGITUDINAL LIMITS OF WETTED HULL..

WATERLINE -- FWD =	32.574	WATERLINE -- AFT =	32.991
WET HULL -- FWD =	0.000	WET HULL -- AFT =	902.513

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*COEFFICIENT(FIRSTSTATION=1,LASTSTATION=1)
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SL-7 - NORMAL FULL LOAD DEPARTURE STATION 1

FRANK CLOSE FIT -19 POINTS DRAFT = 32.574 FEET

ENDPOINTS OF SEGMENTS H-BRDTH	HEIGHT	LENGTH	SEGMENT MIDPOINTS H-BRDTH	HEIGHT	SINE	COSINE	MOMENT
.000	-32.574	1.933	.933	-32.322	.2609	.9654	-7.532
1.866	-32.070	1.919	2.765	-31.734	.3505	.9366	-8.533
3.664	-31.397	1.914	4.418	-30.808	.6153	.7883	-15.474
5.172	-30.220	1.894	5.728	-29.453	.8096	.5870	-20.484
6.284	-28.687	1.930	6.559	-27.762	.9584	.2855	-24.733
6.835	-26.837	1.925	6.948	-25.881	.9930	.1180	-24.880
7.062	-24.925	1.922	6.929	-23.974	.9904	-.1384	-24.702
6.796	-23.022	1.932	6.518	-22.097	.9577	-.2879	-23.038
6.240	-21.172	1.933	5.853	-20.286	.9164	-.4003	-20.933
5.466	-19.401	1.933	5.026	-18.540	.8905	-.4550	-18.796
4.586	-17.679	1.933	4.152	-16.816	.8933	-.4495	-16.887
3.717	-15.952	1.933	3.321	-15.071	.9122	-.4098	-15.108
2.925	-14.189	1.932	2.547	-13.300	.9201	-.3916	-13.235
2.168	-12.411	1.933	1.840	-11.502	.9405	-.3397	-11.443
1.512	-10.592	1.931	1.221	-9.672	.9535	-.3014	-9.590
.930	-8.751	1.933	.682	-7.816	.9668	-.2555	-7.731
.435	-6.882	1.927	.303	-5.927	.9904	-.1379	-5.912
.170	-4.973	1.933	.085	-4.010	.9961	-.0877	-4.002
0.000	-3.047						

FREQ. PARAM.	A' 33	N' Z	M S	N S	M S.R	N S.R	I R	N R
.00	INFINITY	0.000	.730	0.000	13.09	0.00	249.2	0.0
.01	.134	-.000	.731	.000	13.11	.00	249.2	.0
.03	.135	-.000	.738	.000	13.22	.00	251.3	.0
.06	.135	.000	.748	.001	13.41	.01	254.6	.3
.10	.137	.000	.762	.003	13.66	.05	259.2	1.0
.15	.138	.001	.780	.007	13.98	.14	264.9	2.6
.21	.140	.001	.800	.017	14.33	.32	271.1	5.9
.28	.141	.003	.820	.034	14.67	.62	277.0	11.6
.36	.142	.005	.835	.060	14.93	1.11	281.3	20.5
.45	.143	.008	.842	.098	15.03	1.79	282.5	33.0
.55	.142	.011	.837	.147	14.88	2.67	279.2	48.8
.67	.140	.016	.813	.208	14.41	3.76	269.8	68.2
.82	.137	.021	.765	.279	13.50	5.00	252.6	89.8
1.01	.132	.027	.693	.349	12.17	6.17	228.1	109.5
1.25	.125	.032	.608	.400	10.64	6.97	200.5	121.8
1.55	.118	.035	.527	.422	9.21	7.21	175.6	123.3
1.95	.111	.034	.458	.411	8.06	6.83	156.5	113.7
2.45	.107	.029	.413	.373	7.38	5.93	146.2	96.2
3.05	.105	.022	.392	.320	7.11	4.92	143.4	75.9
3.80	.106	.014	.386	.259	7.13	3.79	145.5	55.5
4.70	.107	.008	.392	.200	7.32	2.77	150.2	38.4
5.80	.110	.004	.404	.148	7.59	1.93	155.7	25.1
7.10	.112	.002	.418	.107	7.87	1.31	160.9	16.0
8.70	.113	.001	.432	.073	8.12	.85	165.3	9.9
10.70	.117	0.000	.499	0.000	9.17	0.00	181.6	0.0

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*COEFFICIENT(FIRSTSTATION=11,LASTSTATION=11,LIST)
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MAPPING STATION 11 SL-7 - NORMAL FULL LOAD DEPARTURE

VALUES PRINTED ARE FOR 8 ITERATIONS
3 MAPPING COEFFICIENTS

A(0) = 47.0731651
A(1) = -10.1726039
A(3) = -4.3511423

	ORIGINAL WETTED OFFSETS		MAPPED WETTED OFFSETS		MAPPED ANGLE
POINT	H-BRDTH	HEIGHT	H-BRDTH	HEIGHT	THETA
1	.0000	-32.7777	.0000	-32.5494	0.0000
2	2.1174	-32.7351	2.1060	-32.5504	.0300
3	4.2348	-32.6926	4.2200	-32.5533	.0601
4	6.3522	-32.6501	6.3346	-32.5578	.0904
5	8.4696	-32.6075	8.4602	-32.5632	.1211
6	10.5870	-32.5650	10.5908	-32.5686	.1521
7	12.7043	-32.5224	12.7272	-32.5727	.1836
8	14.8217	-32.4799	14.8649	-32.5740	.2155
9	16.9391	-32.4374	17.0087	-32.5701	.2482
10	19.0565	-32.3948	19.1540	-32.5585	.2815
11	21.1739	-32.3523	21.2953	-32.5358	.3155
12	23.2913	-32.3097	23.4282	-32.4978	.3504
13	25.4087	-32.2672	25.5459	-32.4397	.3861
14	27.5261	-32.2247	27.6394	-32.3556	.4227
15	29.6435	-32.1821	29.6973	-32.2390	.4602
16	31.7590	-32.1026	31.7379	-32.0798	.4991
17	33.8745	-32.0232	33.7156	-31.8715	.5387
18	35.9647	-31.6915	35.8296	-31.5712	.5837
19	38.0549	-31.3598	37.8442	-31.1850	.6297
20	39.0511	-31.0173	38.9342	-30.9234	.6501
21	40.0472	-30.6747	39.9865	-30.6272	.6829
22	41.0434	-30.3322	40.9941	-30.2955	.7098
23	42.0395	-29.9896	41.9529	-29.9276	.7367
24	43.7987	-28.8386	43.9607	-28.9429	.7986
25	45.5579	-27.6876	45.6902	-27.7663	.8596
26	47.0279	-26.1662	47.2571	-26.2925	.9241
27	48.4980	-24.6447	48.5217	-24.6566	.9857
28	49.4752	-22.7734	49.5694	-22.8155	1.0468
29	50.4523	-20.9021	50.3902	-20.8760	1.1045
30	51.1084	-18.8910	51.0322	-18.8633	1.1594
31	51.7646	-16.8799	51.5321	-16.8046	1.2116
32	52.0833	-14.7892	51.9161	-14.7429	1.2608
33	52.4020	-12.6986	52.2150	-12.6546	1.3084
34	52.5156	-10.5845	52.4430	-10.5710	1.3540
35	52.6291	-8.4703	52.6160	-8.4687	1.3987
36	52.6664	-6.3528	52.7421	-6.3623	1.4423
37	52.7037	-4.2354	52.8281	-4.2470	1.4855
38	52.7267	-2.1177	52.8782	-2.1241	1.5282
39	52.7497	0.0000	52.8946	-.0000	1.5708

AVERAGE ERROR = .41483 PERCENT OF DRAFT
STD. DEV. ERROR = .22431 PERCENT OF DRAFT

SL-7 - NORMAL FULL LOAD DEPARTURE STATION 11
CONFORMAL MAPPING - 3 COEFFICIENTS DRAFT = 32.778 FEET

ENDPOINTS OF SEGMENTS			SEGMENT MIDPOINTS				
H-BRDTH	HEIGHT	LENGTH	H-BRDTH	HEIGHT	SINE	COSINE	MOMENT
.000	-32.778	4.236	2.117	-32.735	.0201	.9998	1.459
4.235	-32.693	4.236	6.352	-32.650	.0201	.9998	5.695
8.470	-32.608	4.236	10.587	-32.565	.0201	.9998	9.931
12.704	-32.522	4.236	14.822	-32.480	.0201	.9998	14.166
16.939	-32.437	4.236	19.057	-32.395	.0201	.9998	18.402
21.174	-32.352	4.236	23.291	-32.310	.0201	.9998	22.638
25.409	-32.267	4.236	27.526	-32.225	.0201	.9998	26.873
29.643	-32.182	4.234	31.759	-32.103	.0375	.9993	30.531
33.875	-32.023	4.233	35.965	-31.691	.1567	.9876	30.553
38.055	-31.360	2.107	39.051	-31.017	.3252	.9457	26.843
40.047	-30.675	2.107	41.043	-30.332	.3252	.9457	28.949
42.040	-29.990	4.205	43.799	-28.839	.5475	.8368	20.862
45.558	-27.688	4.231	47.028	-26.166	.7192	.6949	13.860
48.498	-24.645	4.222	49.475	-22.773	.8864	.4629	2.714
50.452	-20.902	4.231	51.108	-18.891	.9507	.3102	-2.107
51.765	-16.880	4.230	52.083	-14.789	.9886	.1507	-6.771
52.402	-12.699	4.234	52.516	-10.584	.9986	.0536	-7.752
52.629	-8.470	4.236	52.666	-6.353	.9998	.0176	-5.424
52.704	-4.235	4.236	52.727	-2.118	.9999	.0109	-1.545
52.750	0.000						

FREQ. PARAM.	A'_{33}	N'_Z	M_S	N_S	$M_{S.R}$	$N_{S.R}$	I_R	N_R
.00	INFINITY	0.000	1.978	0.000	-17.06	0.00	829.2	0.0
.01	11.980	.893	2.014	.000	-17.40	-.00	832.7	.0
.03	8.441	1.362	2.103	.004	-18.23	-.05	841.0	.6
.06	6.426	1.670	2.243	.022	-19.51	-.25	853.3	3.0
.10	5.144	1.850	2.420	.077	-20.97	-.87	865.7	9.9
.15	4.296	1.927	2.578	.207	-21.93	-2.22	870.3	23.9
.21	3.733	1.922	2.616	.436	-21.39	-4.42	857.7	45.0
.28	3.369	1.849	2.444	.744	-18.72	-7.06	824.9	67.1
.36	3.153	1.726	2.076	1.051	-14.50	-9.23	781.7	81.3
.45	3.047	1.565	1.627	1.278	-10.13	-10.29	743.3	83.0
.55	3.026	1.383	1.212	1.403	-6.67	-10.25	718.1	74.9
.67	3.072	1.176	.858	1.445	-4.25	-9.38	705.3	60.8
.82	3.179	.949	.579	1.419	-2.88	-7.92	703.4	44.0
1.01	3.340	.717	.379	1.340	-2.48	-6.13	709.2	27.8
1.25	3.535	.501	.255	1.222	-2.81	-4.28	719.1	14.7
1.55	3.737	.324	.192	1.082	-3.61	-2.61	729.6	6.0
1.95	3.937	.184	.177	.917	-4.65	-1.13	739.4	1.4
2.45	4.104	.096	.198	.755	-5.67	-.15	746.0	.0
3.05	4.231	.047	.240	.606	-6.51	.38	750.2	.2
3.80	4.329	.021	.292	.474	-7.16	.60	752.8	.8
4.70	4.400	.009	.346	.364	-7.62	.60	754.4	1.0
5.80	4.454	.004	.397	.276	-7.92	.51	755.7	.9
7.10	4.493	.002	.442	.209	-8.11	.39	756.6	.7
8.70	4.525	.001	.481	.155	-8.24	.27	757.4	.5
10.70	4.549	.000	.514	.115	-8.34	.18	758.1	.3

```
*COEFFICIENT(FIRSTSTATION=11,LASTSTATION=11,FRANK)
```

SL-7 - NORMAL FULL LOAD DEPARTURE STATION 11
FRANK CLOSE FIT -20 POINTS DRAFT = 32.778 FEET

ENDPOINTS OF SEGMENTS			SEGMENT MIDPOINTS				
H-BRDTH	HEIGHT	LENGTH	H-BRDTH	HEIGHT	SINE	COSINE	MOMENT
.000	-32.778	4.236	2.117	-32.735	.0201	.9998	1.459
4.235	-32.693	4.236	6.352	-32.650	.0201	.9998	5.695
8.470	-32.608	4.236	10.587	-32.565	.0201	.9998	9.931
12.704	-32.522	4.236	14.822	-32.480	.0201	.9998	14.166
16.939	-32.437	4.236	19.057	-32.395	.0201	.9998	18.402
21.174	-32.352	4.236	23.291	-32.310	.0201	.9998	22.638
25.409	-32.267	4.236	27.526	-32.225	.0201	.9998	26.873
29.643	-32.182	4.234	31.759	-32.103	.0375	.9993	30.531
33.875	-32.023	4.233	35.965	-31.691	.1567	.9876	30.553
38.055	-31.360	4.214	40.047	-30.675	.3252	.9457	27.896
42.040	-29.990	4.205	43.799	-28.839	.5475	.8368	20.862
45.558	-27.688	4.231	47.028	-26.166	.7192	.6949	13.860
48.498	-24.645	4.222	49.475	-22.773	.8864	.4629	2.714
50.452	-20.902	4.231	51.108	-18.891	.9507	.3102	-2.107
51.765	-16.880	4.230	52.083	-14.789	.9886	.1507	-6.771
52.402	-12.699	4.234	52.516	-10.584	.9986	.0536	-7.752
52.629	-8.470	4.236	52.666	-6.353	.9998	.0176	-5.424
52.704	-4.235	4.236	52.727	-2.118	.9999	.0109	-1.545
52.750	0.000	52.750	26.375	0.000	0.0000	-1.0000	-26.375
0.000	0.000						

FREQ. PARAM.	A' 33	N' Z	M S	N S	M S.R	N S.R	I R	N R
.00	INFINITY	0.000	2.034	0.000	-17.19	0.00	851.9	0.0
.01	12.004	.878	2.039	.000	-17.50	-.00	846.1	.0
.03	8.497	1.347	2.128	.004	-18.32	-.05	854.0	.5
.06	6.487	1.655	2.270	.022	-19.57	-.25	865.5	2.9
.10	5.206	1.836	2.448	.078	-20.98	-.87	876.8	9.6
.15	4.357	1.913	2.606	.209	-21.87	-2.20	880.2	23.0
.21	3.791	1.907	2.643	.439	-21.26	-4.37	867.0	43.0
.28	3.426	1.834	2.470	.749	-18.55	-6.94	834.8	63.5
.36	3.209	1.709	2.101	1.056	-14.34	-9.02	793.3	76.0
.45	3.103	1.546	1.651	1.285	-10.03	-9.99	757.1	76.5
.55	3.083	1.361	1.234	1.412	-6.63	-9.87	733.9	67.8
.67	3.130	1.151	.877	1.456	-4.27	-8.93	723.0	53.6
.82	3.241	.920	.594	1.431	-2.97	-7.39	722.3	37.2
1.01	3.406	.684	.392	1.350	-2.63	-5.53	728.9	21.9
1.25	3.606	.465	.264	1.231	-3.02	-3.62	739.1	10.1
1.55	3.815	.286	.200	1.087	-3.87	-1.91	749.4	3.0
1.95	4.022	.147	.184	.921	-4.98	-.47	758.3	.1
2.45	4.228	.032	.205	.754	-6.06	.49	764.1	.4
3.05	4.300	.040	.247	.602	-6.94	1.01	767.3	1.9
3.80	4.404	.012	.286	.438	-7.63	1.67	768.6	4.3
4.70	4.479	.003	.361	.367	-8.06	.92	770.2	3.0
5.80	4.523	-.002	.411	.276	-8.35	.83	771.1	2.7
7.10	4.564	-.000	.503	-.091	-8.34	-.16	770.7	1.6
8.70	4.590	-.004	.398	.091	-8.90	.21	771.0	1.9
10.70	4.714	0.000	.672	0.000	-8.95	0.00	775.4	0.0

APPENDIX B

JOB CONTROL FILES

TABLE 1

File COMSTAT

```
00100 JOB,CM10000,L15,T30.
00110 ACCOUNT,U707008,TED.
00120 GET,STATIC.
00130 RFL,100000.
00140 UNIFORE(-BATCH,LN=STATCOM,I=STATIC)
00150 PUT,LGO=STATBIN.
00160 LGO.
00170 PUT,OUTPUT=RESULTO.
00180 PUT,STATCOM.
00190 PUT,DAYO.
00200 DFD,DAYO,R.
00210 EXIT.
00215 NOEXIT.
00220 PUT,OUTPUT=RESULTO.
00230 PUT,DAYO.
00240 DFD,DAYO,R.
00250 EOR.
00260 $D2SL7
00270 EOF.
```

TABLE 2

File RUNSTAT

```
00100 JOB,CM10000,L15,T400.
00110 ACCOUNT,U707008,TED.
00120 GET,LGO=STATBIN.
00130 RFL,100000.
00140 LGO.
00150 PUT,OUTPUT=RESULTO.
00160 PUT,DAYO.
00170 DFD,DAYO,R.
00180 EXIT.
00190 NOEXIT.
00200 PUT,OUTPUT=RESULTO.
00210 PUT,DAYO.
00220 DFD,DAYO,R.
00230 EOR.
00240 $D2SL7
00250 EOF.
```

DATE
ILME