VOLUME 2

HULL DEFINITION

Contents:

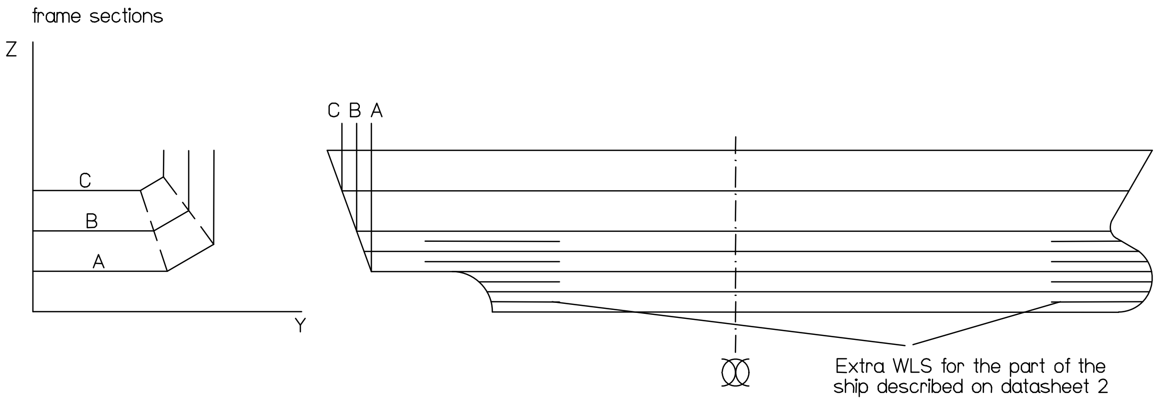
2.1 Summary 2

2.2 Data sheet description 2

2.3 Practical guide through hull form definition 17

2.1 Summary

HULL74 is the program for definition of hull geometry, based on parabolic and double parabolic interpolations. Hull geometry represents an important basis for most of the calculations performed by the SEAKING package. The hull form data are described only once after what they are available to all subsequent calculations.



Since the various calculations which require hull form geometry are all based on a longitudinal integration
using Simpson's first rule, the hull form has to be described in such a way as to enable the derivation of frame section at any longitudinal station. For this reason, it's most efficient to describe the geometry by sufficient number of longitudinal curves that will enable the accurate interpolationof transverse sections.
The longitudinal curves that can be described are:
CL contour (data sheet 1)
Knuckles (data sheet 2)
Deck edge (data sheet 2)
Other space curves (data sheet 2)
WLS (data sheet 4)
In order to fill the data sheets properly, it's necessary to know the interpolation procedure. Therefore, the description of data sheets is directly followed with the description of interpolation procedure named ˝frame˝.

2.2 Data sheet description

The enclosed sheets 1, 1a, 1b, 2, 3 and 4 are used to form the input. Up to some extent, the sheets are self-explanatory. Bolded, underlined numbers on the left side of the sheet represent the dataset number. The following descriptions refer to these numbers.

Data sheet 1

<u>1</u> ***ship no*** is a number chosen by the user to identify the ship. Most following data sheets start with the ship number, which enables the program to check whether the data are given for the right ship.
alt Normally the hull form data are read only once, at the beginning of the calculation. All required disc files are at the same time automatically cleared. In special cases it can, however, be of interest to be able to read in a new hull form without deleting the calculation already made. (See example in the description of sheet sth).
alt =0 deletes all previously performed calculation
alt =1 suppresses the deletion of the calculation already made

alt =2 has the same effect as Alt =1 and is used when only the ship number and name are to be changed. (Mostly for calculations of sister ships to obtain a clean printout with the new name and number). Only three lines are stated.
sp In some calculations there is no need to describe a hull form at all. The only hull form data required in this case are the principal particulars and the frame spacing. In these cases Sp =1. Dataset 4 as a last line.
mult All length units in hull form data are multiplied by this factor. For example, if all calculations have to be made in metric units but the hull form data are in feet, this factor is 0.3048. The following factors, bmult, hmult are used if only breadths or heights have to be corrected. These factors are normally used to compensate for the stretch of the drawings used. Note that in this case all breadths or heights respectively will be converted.
plot =0 no plotting of result will be made
plot =1 stores all output results on a special file to enable result plotting. When iplot =1 any result can be plotted at any stage after the requested result has been calculated.

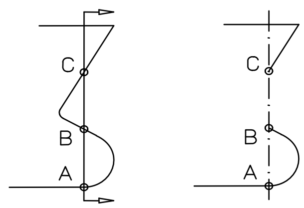
2 ***Lpp, Bmould***, (moulded length and breadth) are used for the calculation of coefficients in hydrostatics (if breadth exceeds Bmould/2 it is reduced to Bmould/2). Lpp is also used as a reference length for trim if not otherwise stated. Distance from frame 0 to Lpp/2 is required to set the frame position in relation to the coordinate system. Using this length and the table of frame spacing, program is able to calculate the longitudinal position of any frame.
max of y-z is required by some plotting programs to enable the choice of an appropriate scale.
keel plate thickness is used when draught from underside of keel is requested. In the calculation procedure, draught is always calculated to baseline, but when result is requested from underside keel, this value is added.
shell plate thickness is given as a mean value. Wetted surface multiplied with this value for shell plate thickness is added to the molded displacement volume. Shell plate is also included in the stability calculation.

3, **4** Table of frame spacing. In the following example the frame spacing is 0.6 abaft frame 9, 0.65 between frames 9 and 112, and 0.6 forward of frame 112. Even if the vessel has constant frame spacing, an arbitrary frame no has still to be stated together with that constant frame spacing both abaft and forward of that frame.

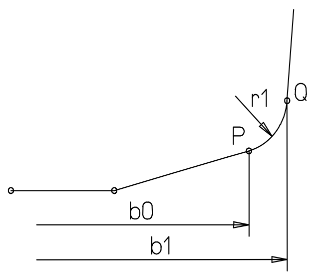
3	Fr112	9	112	
4	Sp	0.6	0.65	0.6

5 Ship contour on CL is used in the calculation for two different purposes:

1. To give the ship length at different WLS (used in calculations of coefficients based on the real length, if requested in hydrostatic data).
2. To give points such as A, B, C (see the sketch) at interpolated frame sections.



The CL contour is divided in three parts, 1, 2, and 3, as shown in the sketch on data sheet 1. (Number of each part is stated in the first column of the table.)
For part 1 z coordinate has to be decreasing.
For part 2 x coordinate has to be increasing.
For part 3 z coordinate has to be increasing.
Type =1 is explained on the data sheet.
The definition can, however, be further extended by stating b0, b1, r1 in accordance with the sketch.
r1 is radius of the section in question.
b1 is end of the radius arc.



The center of r1 is calculated from the requirement that the circle should be tangent to the bottom in point P, i.e. the slope of bottom; value of b0 and r1 define the center of r1. Point Q is defined by the value of b1.

5 *__midship section__*. These data are explained on the data sheet and discussed above.
6 ***napp*** is total number of appendages described on data sheet 1a. If no appendages, give napp =0.
norder is 0 (or blank space) if data sheet 1b is skipped.
norder is 1 if data sheet 1b is stated.

Sequence of input sheets

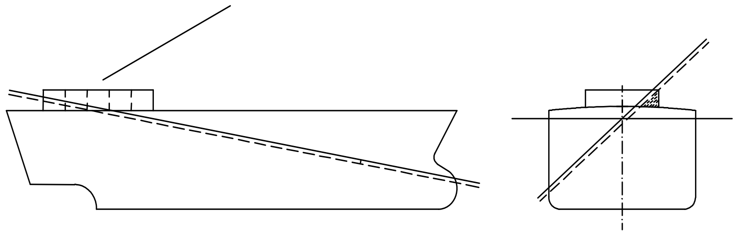
The following sequence has to be respected:

- Sheet 1
- Sheet 1a as many as stated for ***napp*** (see above)
- Sheet 1b if ***norder*** =1 (see above)
- Sheet 2 as many as necessary
- 1 blank line
- Sheet 3
- 1 blank line
- Sheet 4 (as many as necessary for the same set of WLS)
- 2 blank lines
- next sheet 4 (as many as necessary for the same set of WLS)
- 2 blank lines
- etc.
- last sheet 4 (as many as necessary for the same set of WLS)
- 3 blank lines

Data sheet 1a

The number of appendages is unlimited but only one appendage can be described on each sheet. Only the starboard side of an appendage is defined. Asymmetrical appendage cannot be considered. If an appendage has a constant section, only one section needs to be defined. Nevertheless, the calculation for more sections may be required (for example if appendage is partly above and partly below the water surface when the ship is in trimmed position).

Example of a box described as an appendage. As a prism, only one section needs to be given in the input. In spite of that, 5 sections are calculated to have good accuracy in the longitudinal integration. (It's better to describe it as a camber.)



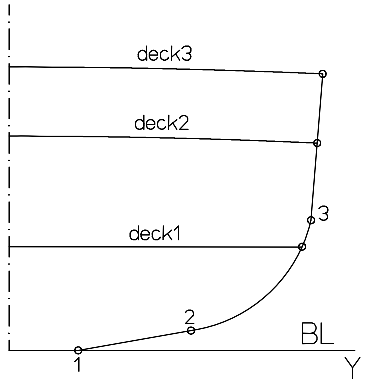
Appendages defined in data sheet 1a are included in hydrostatic data, intact stability, etc. but omitted in the calculation of compartments. There are, however, other possibilities to include appendages in compartments (see description on data sheet 6 and 7).
The effective factor indicates whether the appendage has to be added (+1) or subtracted (-1) and is especially useful in special cases when an appendage is only partly effective. For example timber load on deck is correctly handled with permeability less than 1.
N.B. In this version of program package appendages are not considered in the programs for the floodable length and the longitudinal strength part of the loading condition calculation.

Data sheet 1b

This sheet is stated only if ***norder*** =1 in dataset 6. Data sheet 1b is self explanatory.

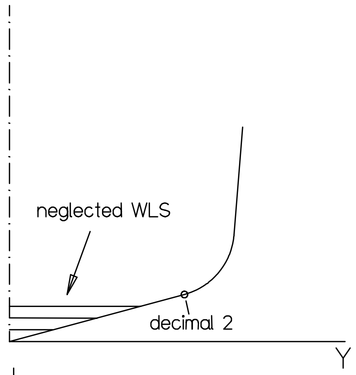
Data sheet 2

Deck sheers and knuckle lines are defined on this sheet. The figure shows a cross section with three decks and three knuckles. (Word knuckle is not quite relevant. For example, point 2 in the sketch is not a real knuckle but a point of change between a straight line and a curve). The numbers of decks and knuckles are to be regarded only as identification numbers. All decks have to be defined before knuckles. The program distinguishes decks from knuckles because the decks are additionally described with radius and camber number stated in seventh and eight column (i.e. decks are defined with eight columns while knuckles are defined with six). Neither decks nor knuckle lines have to extend to the full length of the vessel.

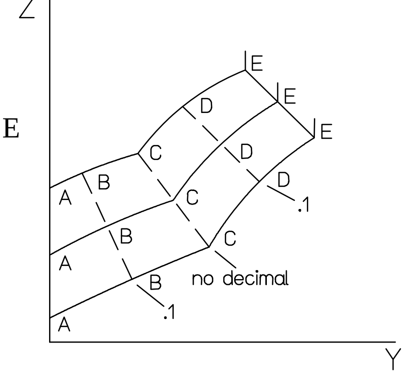


Decimals .1 and .2

Decimal .1 in the first column of data sheet 2 will be interpreted by the program as an extra point on the continuous part of the frame, not a knuckle. This option is used to describe extra WLS in a part of the ship; sometimes this is more convenient than using extra WLS in data sheet 4. Decimal .2 indicates that any WLS given between previous knuckle and the knuckle (or deck) in question is skipped in calculation - the frame is taken with a straight line between the knuckles, independent of stated WLS.



Note that instead of WL any space curve can be described on data sheet 2. Hull form shown in the sketch can normally be described by knuckles and WLS on data sheet 4. Simpler and more accurate description would be by describing curve A on CL data, curves C and E as knuckle curves on data sheet 2 and finally curve B and D on data sheet 2 but adding the decimal .1 to the numbers in question. The program will now fit frame-curves from A to C and from C to E.



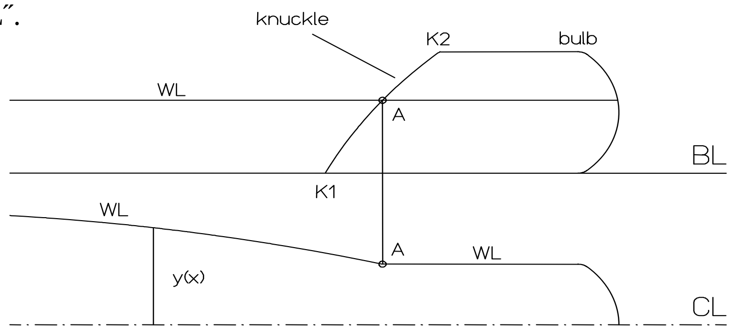
Note

Curves defined on sheet 2 with decimal .1 program treats as normal WLS on data sheet 4 given on sheet 2. Therefore, the same restriction applies regarding the spacing (along the frame) between these points as for normal WLS (see data sheet 4).

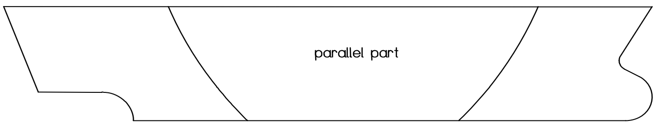
Sequence of data on sheet 2

- Give all the decks before the knuckles.
- Before numbering the knuckles consult data sheet 1b.
- Intersections between knuckles and WLS
- When interpolating the WLS in the longitudinal direction an intersection with a knuckle is considered as a knuckle ″on the WL″.

Example
In the sketch the knuckle curve k1-k2 is described on data sheet 2. When interpolating the WL, point A is used to obtain a better fit.

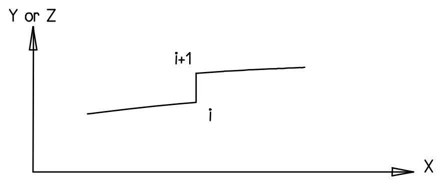


This possibility can also be used for describing the parallel part of the ship.
(Useful to give but not always available).

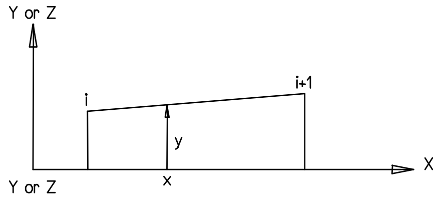


Data sheets 2 and 4 contain interpolation codes which define the way of interpolation of the deck corners, knuckles or half-breadths. Usually this code is left blank except for the parallel parts where it should be set equal to 1. In that case, the program selects best interpolation procedure. There are, however, certain exceptions, when the interpolation code has to be stated. For example, if a vessel consists of flat surfaces only the deck corners and knuckle lines have to be given and the interpolation code is set to 1, which produces straight-line interpolation.

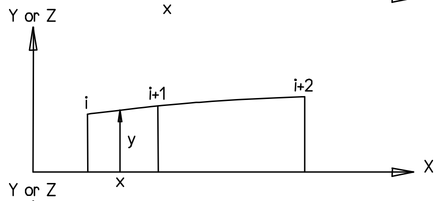
Five different values can be stated for the interpolation code:
int =0 The interval is a step $x_i = x_{i+1}$. It is also used when a user leaves to the computer to choose the interpolation code.



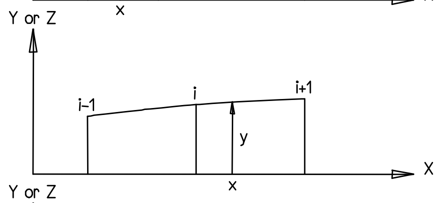
int =1 Straight-line interpolation, which means straight line between i and i+1.



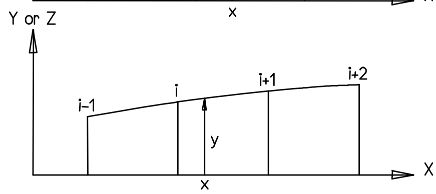
int =2 Parabolic interpolation. A point forward from the interval is used to calculate the coefficients of the parabola $y = ax^2 + bx + c$.



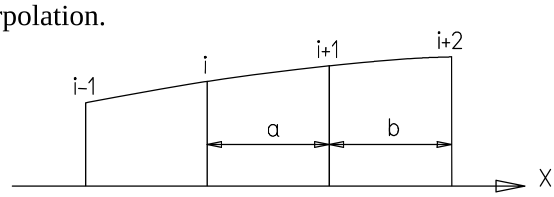
int =-2 Parabolic interpolation. A point afterward of the interval is used to calculate the coefficients of $y = ax^2 + bx + c$.



int =3 Double parabolic interpolation.
Define theta $=(x-x_i)/(x_{i+1}-x_i)$
y1(x) is a parabola through the points i-1, i, i+1
y2(x) is a parabola through the points i, i+1, i+2
y(x) is interpolated value for the interval i, i+1
y(x) =y1(x)*(1-theta)+y2(x)*theta



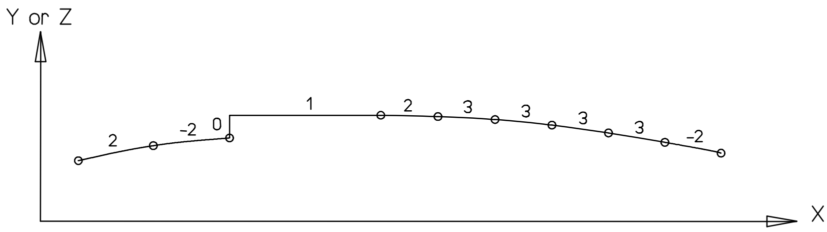
This interpolation implies that the mid-point of the interval, y(x) becomes the average value of the two possible parabolic interpolations, whilst towards the ends of the interval there occurs a gradual change tending towards only one parabolic interpolation. This method of interpolation results in a significantly closer approximation to curve than using only the straightforward parabolic interpolation avoiding at the same time the danger of oscillations which arise in higher degree polynomials.
If the interpolation code is left blank in the input, the values of interpolation code used by the program are as follows:
The spacing ratio between points i, i+1, and i+2 is considered good if 0.5<a/b<2, otherwise is bad.
Note that if ***int*** =0, the program will choose a smooth interpolation.



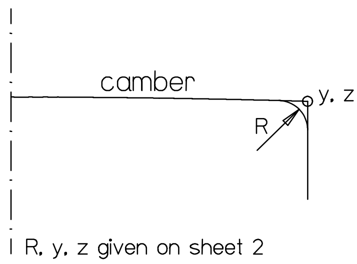
Interpolation code for interval i, i+1, if the following conditions are fulfilled

0	$x_{i+1}=x_i$
1	ratio i-1, i, i+1 bad and i, i+1, i+2 bad
2	ratio i-1, i, i+1 bad and i, i+1, i+2 good
-2	ratio i-1, i, i+1 good and i, i+1, i+2 bad
3	ratio i-1, i, i+1 good and i, i+1, i+2 good

Example

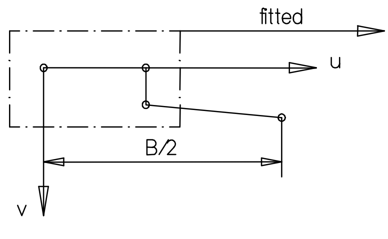


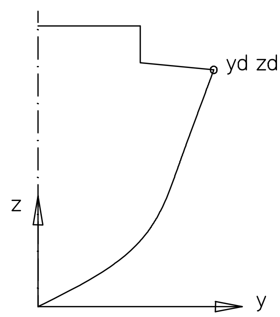
Last two columns on data sheet 2 are only filled to describe the deck line. Camber numbers refer to data sheet 3. The radius is related to the frame section as the very last step. Coordinates of the circle center are found automatically by the program.



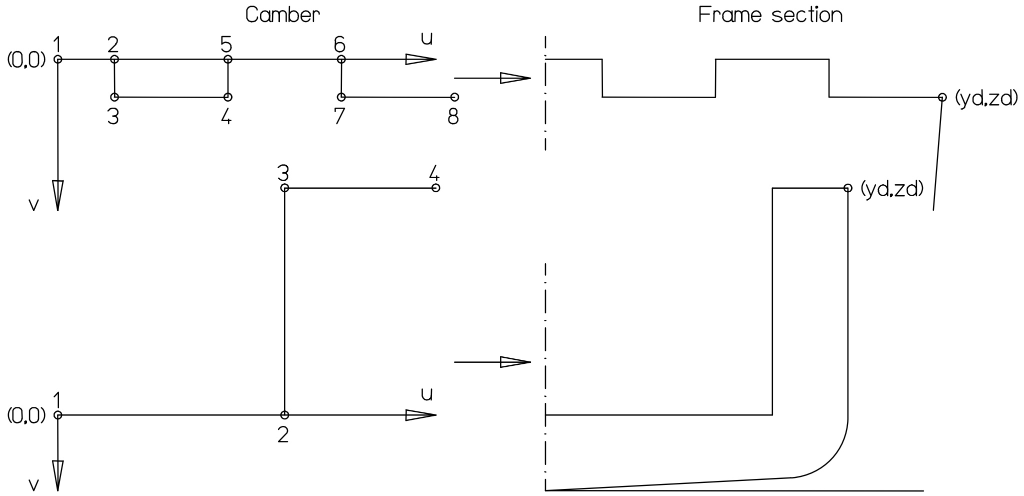
Data sheet 3

Although this data sheet is normally used to describe camber, it can also include hatches or houses on the curve (as an alternative to defining as an appendage). The number in first column is camber number and has to be repeated for each line that describes that camber. Cambers have to be numbered in order 1, 2, 3 etc. Number in second column in the horizontal coordinate from the CL or, in the case of parabolic camber, the number of points to be used in the calculation (minimum 3, normally 5-10). Column three represents the round of beam for parabolic camber or, in other cases, the vertical distance of the various data points below an upper datum line.
N.B. The coordinate axes u and v refer to camber only. Transformation to y, z coordinate system is made after calculation of the deck edge yd, zd see the sketch. (See also description of the procedure ″frame″)





The fourth column, headed ″H″, is used when the line of the hatch differs from the deck sheer line. The height from the base line to the top of the hatch, H, is given in the first line of the camber in question. When that height is stated, the program makes necessary modification to the vertical height of the coaming above the deck at the hatch side. Note that camber must always be given for the maximum half-breadth of the ship. The program selects appropriate part of the camber from the data sheet 3 when the half breadth to the deck edge is less than the maximum half breadth.
When different decks have the same camber, the camber needs to be defined only once. In contrary, one deck can have different camber forms. Therefore, on data sheet 2, in column 8, different numbers can be used for the same deck. Where there is a change in camber form, the number of points has to be the same for two cambers. Camber form at locations between the changes is obtained by straight-line interpolation. (See the sketch in the middle of the data sheet 3). If there is a sudden discontinuity in longitudinal direction, the number of points for two neighboring cambers doesn't have to be the same, but the location of change has to be defined twice on data sheet 2 - once for each camber.
Because of the fact that former limitation of increasing z coordinates for the frame section no longer exists, the description can be done as shown below



Data sheet 4

Arbitrary number of half breadths can be defined for arbitrary number of sections. The number of sections and half breadths depends, of course, on the required accuracy. To achieve very high accuracy in displacement (for example in deadweight estimation) it's justifiable to use as many as 40 sections and 20 waterlines. On the other hand, in the calculation of damage stability, 20 sections and 8 waterlines might be enough. The simplest way to determine suitable number of sections and waterlines would be to make some comparative calculations. Interpolation of the half breadths for a cross section between specified sections is carried out in exactly the same manner as for y and z coordinates on data sheet 2.
The data sheet is rather self explaining. Symbol ″/″after ***frame no***, ***dx***, and ***int***[1] indicates a new dataset according to the free format system. If neither ***dx*** nor ***int*** is stated (which is normally the case), the typing would be: ***frame*** / ***y1 y2*** etc. If all the numbers cannot be contained on one line, type C and continue on the next line. If many waterlines have the same half breadth of B/2, use the multiplier option in typing. For example, 5*13.745 instead of 13.745 repeated 5 times.
If more frames than can be fitted on one page are stated, continue on another page but skip first two lines. Sometimes it's useful to use different WLS for fore and aft body. In that case fill one data sheet 4 for aft body and another for fore body with first two lines stated on each data sheet 4. It's even possible to add third page with intermediate WLS, for example for the bulbous part of the ship. Although there is no restriction in number on data sheet 4, the total number of data for hull form is limited and varies for different computers. Maximum available and really used storage is printed upon the start of the program.

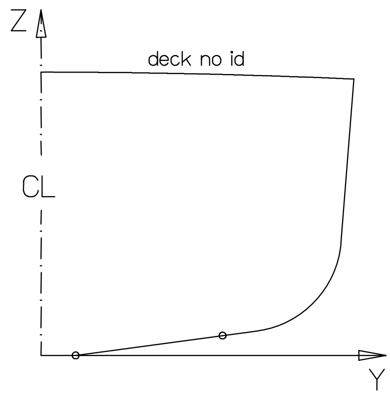
[1] int has the same meaning as on the sheet 2

Description of the procedure 'Frame'

Possibility to determine the geometrical cross section form for the vessel at any arbitrary longitudinal position is of great importance.

Given: x = longitudinal coordinate
id = deck number

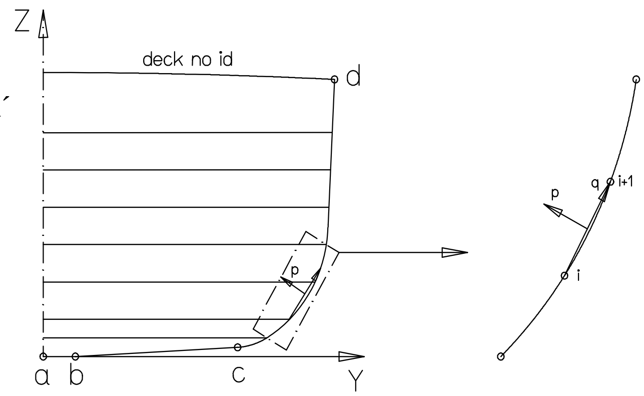
Required: y and z coordinates for the cross section from CL at bottom to CL at deck level



<u>The calculation sequence</u>

1. Interpolate all half breadths from data sheet 4 for the longitudinal coordinate x. See page 9 for the interpolation method.

2. From the data on data sheet 2, interpolate the coordinates for all knuckle points and the actual corner of the deck for the given value of x (points ´b´, ´c´, and ´d´ in sketch).



3. From the data sheet 1 the ship contour on CL is calculated by the straight-line interpolation (point ´a´ in the sketch). From here on, this point is also considered to be a knuckle.

4. Now, it's verified whether input half breadths exist between knuckle points. If there are no half breadths between two consecutive knuckle points, the shape of the section is a straight line between these two points (that is ´a´-´b´, ´b´-´c´, see sketch) In the sketch there are 6 half breadths between the knuckle point ´a´ and the deck corner ´d´. The points that are described by these half breadths must be given at reasonable spacing such that the ratio of the interval between any three consecutive points, other than knuckle points, is not less than 1:2 or more than 2:1. For this reason the lowest waterline is usually chosen on a level of about 30-40 % of the second waterline's distance from the baseline. No special care is required with regard to the interval between the knuckle points (or deck corners) and half breadths. Curve between the points ´c´ and ´d´ is calculated with ´c´ and ´d´ coordinates and 6 half breadths. In interpolation method of the frame (see the sketch), when calculating the section form for the (i, i+1) interval, a coordinate transformation to the (p, q) system is done first. P axes passes through the points i and i+1. The section form between i and i+1 is calculated from a parabolic function whose second derivative is selected equal to the average value of the second derivative for the parabolas through i-1, i, i+1 and i, i+1, i+2.

5. Interpolate the form of the camber for the deck at the longitudinal coordinate x from data on sheet 3.

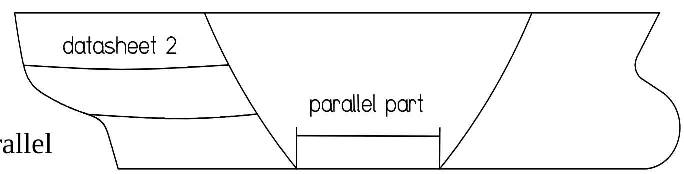
6. With help of the coordinates for the deck edge (´d´) and the camber form, the deck is fitted to complete the section.

A few final general notes

If a parallel part has been given in dataset 4, the following items 1 and 2 are applied:

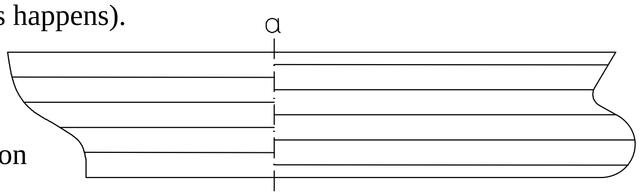
1. If a knuckle or space curves are given on data sheet 2, they may not extend over parallel part.

2. If data sheet 4 is extended over the parallel part, data on this sheet are neglected in the parallel part of the ship.

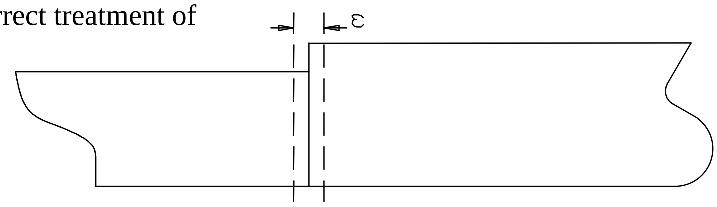


3. Check that number of data stated in dataset 5 does not exceed the maximum values stated o the data sheet (present version of the program crashes if this happens).

4. If different parts of the ship are described for different WLS or space curves, there could be problems if a calculation section is requested exactly on the limit between the two systems (section in the sketch).



Note, however, when calculating the so-called ˝calculation parts˝ in sth or voll, the end sections are moved for a small distance to ensure the correct treatment of any discontinuity. This also avoids above-mentioned problems, if the calculation parts end exactly at the section where the system of hull definition is changed.



← normally blank →

	ship no	alt		sp	mult	bmult	hmult	plot
1			0					
	one blank line							

If stated mult, bmult and/or hmult:
a) all coord. are mult. with mult
b) breadths are mult. with bmult
c) heights are mult. with hmult

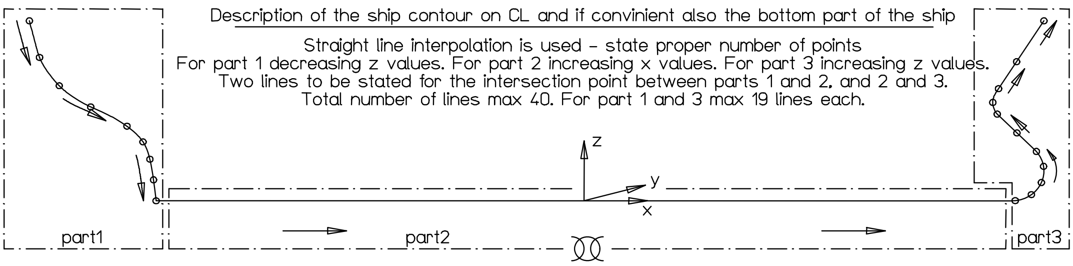
ship name (text)

alt =see user's guide
sp =1 only three following lines are stated
(used if the hull form is not needed for the calc.)
plot =1 plotting information created on disc

		Lpp	Bmoulded	Dmoulded	dist from frame 0 to Lpp/2	max of y and z	keelplate thickness	shellplate thickness
2	1							

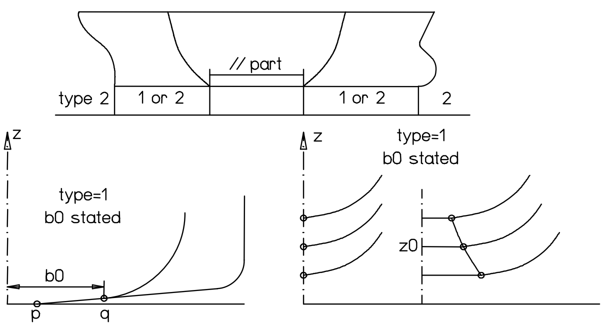
state frames (Fr) at which the frame spacing changes

3	Fr													
4	Sp													



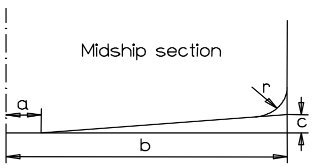
	part no	frame no	dx	type =1 / type =2	b_0 / z_0
5					
	one blank line				

Part no 1, 2, or 3, see the sketch above.
Type =1 is used for the // part (Note: state b_0 =b, see figure).
Type =2 is used for the frames ending above (or below) BL.
For frames outside the // part but landing on BL type 1 or 2 may be used.
If type 1 is used point p and q are calculated from the data b_0, a, b and c.
If type 2 is used, points p and q have to be described on data sheet 2.
Snce the Interpolation between data given on data sheet 1 is made linearly use type =2 when point q has to be described as a longitudinal curve.



midship section or a blank line

		a	b	c	r
5	1				



	napp	norder
6		

napp =number of given data sheet 1a (0 if no appendices
norder =0 if data sheet 1b is skipped
norder =1 if data sheet 1b is stated

	app.no	from		to		no of sections stated below, 1, 2, or 3	no of sections for calculation - must be odd: 1, 3, 5 etc.	effective factor
		frame	dx	frame	dx			
7								

Effective factor=1 if the appendage has to be added.
Effective factor=-1 if the appendage has to be subtracted.
Effective factor=0.5, for example, addition 50% of volume and moment (timber on deck load).

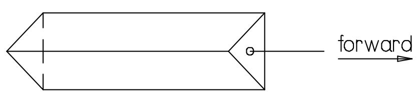
N.B. Each section has to be described on one line (if it doesn't fit on one card use ˝C˝ in accordance with the free format system).

	y	z	y	z	y	z	y	z	y	z	(C)	
9												first section

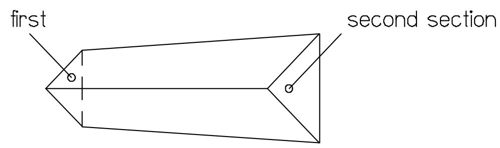
	y	z	y	z	y	z	y	z	y	z	(C)	
9												second section

	y	z	y	z	y	z	y	z	y	z	(C)	
9												third section

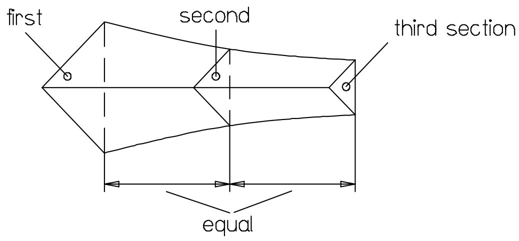
If one section is defined calculation is made for prismatic formed appendage with parallel sides.

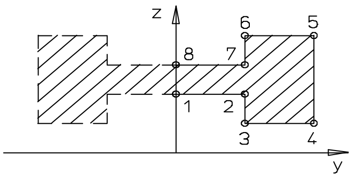


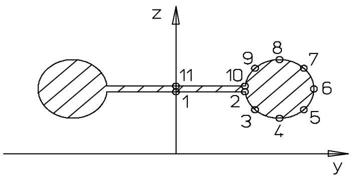
If two sections are defined calculation is made for appendage which has straight-line sides.



If three sections are defined calculation is made for appendage with generatrices in form of parabolic curves.



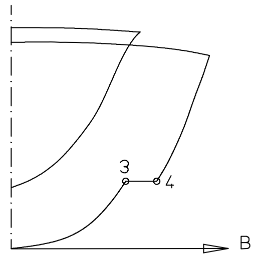




First and last point on CL.
No other restrictions.

Sorting of input lines (curves) at section calculation
(This sheet is omitted if norder =0 in data set 6 on data sheet 1)

Points on the frame section are interpolated from the data on sheets 2 and 4. Purpose of the following data is to define in which sequence if the stated points have to be used in building the frame section for complicated shapes.



In cases when two z coordinates are equal or almost equal it is recommended to give this sheet to avoid any possible mistakes (for example, code =1, order of lines =3 4 in the sketch)

The following data are given:

code	order of lines
step1	step2

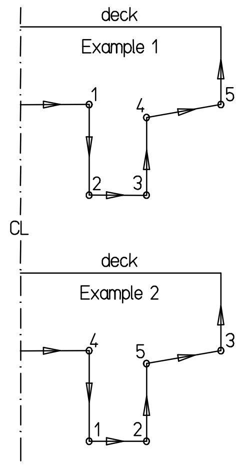
Sorting of calculated points for the frame contour is done in two steps, 1 and 2.

Step1 is controlled with the code value, as follows:
- code =1 sort all lines in increasing z coordinate sequence
- code =2 sort all lines in increasing y coordinate sequence
- code =3 no sorting in first step

Step2 is controlled with the ″order of lines″ data.

If sorting performed in step 1 is enough these data are left blank.
If certain line numbers are stated, the program will sort these lines in given order. Primarily, those numbers refer to the knuckle numbers as stated on data sheet 2, but can also be WLS stated in data sheet 4, in which case their number is added to hundred (100) [1)] (to avoid mixing WLS with the knuckles). For example, WL number 5 on data sheet 4 is referred to as 105.

<u>Example 1</u>
The points are already stated in correct sequence on data sheet 2. The only input is code =3.



<u>Example 2</u>
For some reason input on data sheet 2 has been given in sequence shown in the sketch and can therefore not be used as in the previous example. Give one of the following alternatives:

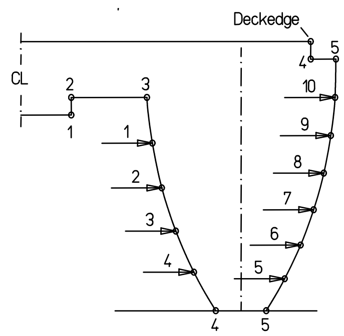
code	order of lines				
1	4	1	2		
2	4	1	2	5	
3	4	1	2	5	3

Code =1 represents increasing z coordinates. This is correct with exception of line 4, which is before line 1. Code 2 represents increasing y coordinates. It's stated to avoid danger of mixing lines 1 and 2. Also, lines 1 and 4, 2 and 5, which have the same y coordinate are stated to avoid any risk.

<u>Example 3</u>
Assume that knuckles 1 2 ... 7 are stated on data sheet 2 and WLS 1 2 ... 10 on data sheet 4. The sorting information should be:

code	order of lines
3	1 2 3 101 102 103 104 4 5 105 106 107 108 109 110 6 7

Note: Beginning of the frame is CL contour stated on data sheet 1 (dataset 5) and the end of the frame is deck edge (except for the camber). These data are therefore not included in the sorting procedure.



[1)] If several sets of data sheet 4 are stated e.g. one for aft body, another for the fore body etc., references are made by adding 100 to the first set, 200 to the next etc

10

	coords. of deck edge and knuckle line					(omitted if knuckle line)	
						straight line interpolation	
no	frame no	dx	half breadth y	height above BL z	int. code	radius	camb. no
one blank line							

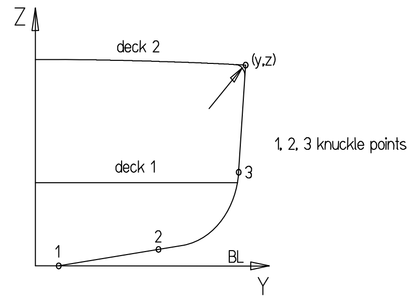
No Number of deck or knuckle.
N.B. All decks have to be stated before knuckles.

Options with the decimals added to number no.:

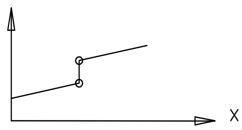
.1 indicates that the knuckle should be treated as an extra WL instead of a real knuckle

.2 indicates that any WL stated between the previous and this knuckle (or deck) should be omitted in the calculation (i.e. straight line between the two knuckles).

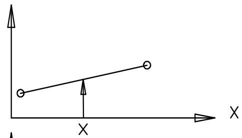
For the rounded deck corner, edge is completed with the radius (automatically fitted by the program).



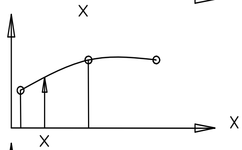
int = interpolation code (refers to preceding interval) Refers only to coord. for deck edge and knuckle-lines (for camber, straight-line interpolation is always applied, see sheet 3). This factor defines the model of interpolation between stated points. Normally, this factor is left blank leaving program to calculate in accordance to the rules stated in the description. For straight lines however (e.g. parallel part) int. must be stated 1 to ensure that a curve is not fitted.
Discontinuities are steps in deck-edge or camber.
For discont. frame no. and dx have to be stated twice.



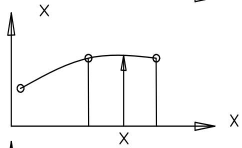
int =0 step in deck edge or camber.



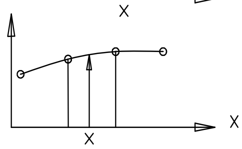
int =1 straight line int.



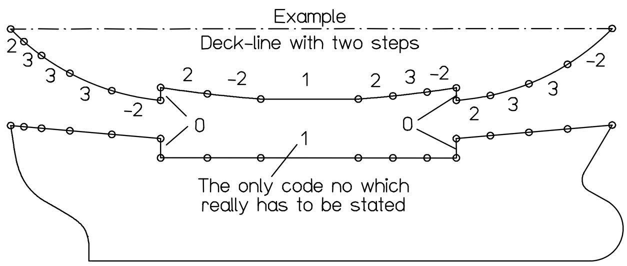
int =2 parabolic int. with the point forward of theinterval.



int =-2 parabolic int. with the point abaft the interval



int =3 double parabolic int. with one point abaft and one forward from the interval.



(normally blank)

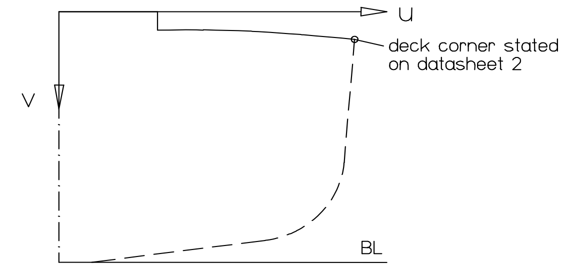
	camber no	u	v	H
11				
	one blank line			

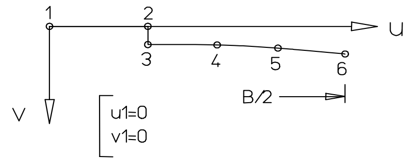
If data sheet 4 is skipped, one extra blank card is placed here.

If camber is parabolic only one line needs to be stated with values for $v=v_0$; ″u″ in this case is the number of points that has to be used of this parabolic camber form. Minimum is 3, but normally 5 to 10 is stated.

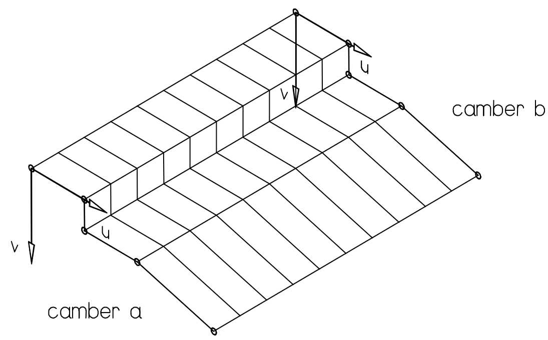
Cambers

The cambers are numbered 1, 2, 3 etc.



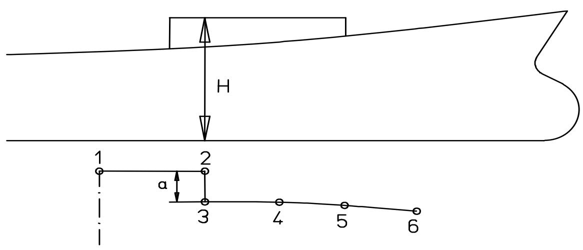


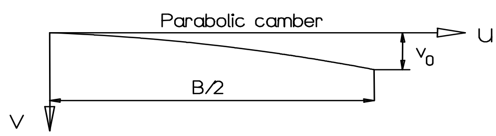
Interpolation between two different cambers (a and b) is made straight line in accordance with the following figure. Number of points of definition for the two following cambers must be equal.



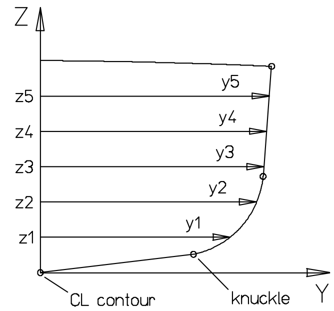
The ″H″ column is used when the top of the hatch is defined in relation to the baseline. If H is stated the program makes the necessary modification of the vertical distance ″a″ between the 2nd and 3rd points in the camber form.

The straight-line interpolation also works on the H value, which means that a hatch with a constant slope can also be described. Value H is stated in the first line for the camber in question.





Data sheet 4



Description of waterlines

The first two lines (˝type˝ and ˝z values˝) are stated only once. All the WLS below the highest point stated on data sheet 1 (ship contour on CL ...) are neglected at the calculation of the section in question.

Spacing requirement 0.5<a/b<2 (does not apply on knuckles and deck edge).

	type
12	1

	z1	z2	z3	z4	z5	z6	z7	z8	z9	z10	z11	z12
13												

14				**15**											
Frame	dx	int		y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11	y12
			/												
			/												
			/												
			/												
			/												
			/												
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			/												
			/												

Data have to typed line by line.

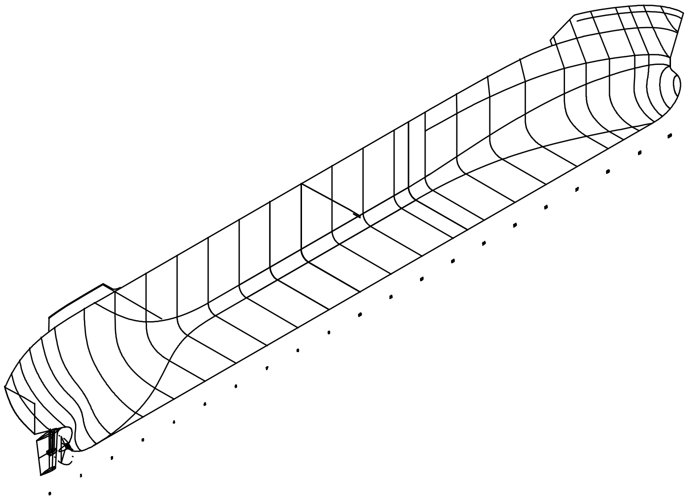
Each complete dataset on data sheet 4 has to be followed with two blank lines.

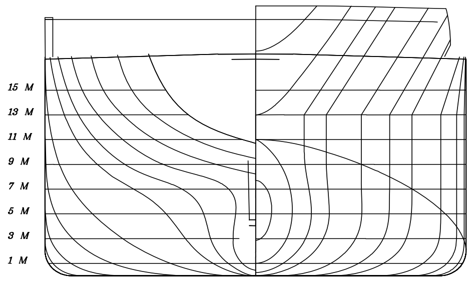
The last data on the data sheet 4 has to be followed with three blank lines.

2.3 Practical guide through the hull form definition

Following examples try to show to the user how to define some usual hull forms. Each of the following forms can be defined in many different ways, depending on the user's approach or requested accuracy. Only one way of definition will be shown here to make examples as simple as possible.

2.3.1 Ship with parallel part and traditional amidships section






```
$* SHIP NUMBER
402 0 0 0 1 1 1 1

402
$* MAIN DIMENSIONS
1   169.000   32.200   17.500   84.500   21.000   0.016
0.014
$* FRAME SPACING
   12   240
  0.600   0.800   0.600
$* SHIPCONTOUR
1  0    -4.200   2    18.060
1  0    -4.200   2    10.700
1  0     4.267   2     8.196
1  0     5.040   2     7.771
1  0     5.581   2     7.228
1  0     5.847   2     6.694
1  0     5.950   2     6.000
1  0     5.841   2     5.287
1  0     5.490   2     4.538
1  0     4.938   2     3.885
1  0     4.432   2     3.450
1  0     5.605   2     2.110
1  0     6.517   2     1.380
1  0     7.553   2     0.810
1  0     8.863   2     0.353
1  0    10.375   2     0.078
1  0    11.841   2     0.000
2  0    11.840   2     0.000
2  0   164.080   2     0.000
3  0   164.080   2     0.000
3  0   165.990   2     0.108
3  0   167.504   2     0.410
3  0   168.705   2     0.856
3  0   169.771   2     1.477
3  0   170.608   2     2.212
3  0   171.235   2     3.059
3  0   171.640   2     4.000
3  0   171.820   2     5.000
3  0   171.770   2     6.000
3  0   171.470   2     7.000
3  0   170.930   2     8.000
3  0   170.180   2     9.000
3  0   169.299   2    10.112
3  0   169.033   2    10.719
3  0   169.000   2    13.000
3  0   172.600   2    21.784

$* MIDSHIP SECTION
1     0.   16.100   0.000   2.000
$* APPENDAGES, ORDER
  1   0
$ rudder blade
  1   0   -3.152   0   1.699   3   3   1.000
 0.000  0.200  0.213  0.200  0.408  8.900  0.000  8.900
 0.000  0.200  0.353  0.200  0.527  8.900  0.000  8.900
 0.000  0.200  0.396  0.200  0.569  8.900  0.000  8.900
```

```
$* DECKS
$ weather deck, camber1
  1 0    -4.200     0.000    17.900    1   0   1
  1 0    -4.200     2.880    17.900    1   0   1
  1 0    -4.200     8.134    17.741    2   0   1
  1 0    -2.100     9.346    17.704    0   0   1
  1 0    -1.050     9.937    17.686    0   0   1
  1 0     0.000    10.509    17.669    0   0   1
  1 0     1.050    11.057    17.653    0   0   1
  1 0     2.100    11.576    17.637    0   0   1
  1 0     3.150    12.064    17.622    0   0   1
  1 0     4.200    12.520    17.608    0   0   1
$ weather deck, camber6
  1 0     4.200    12.520    17.608    2   0   6
  1 0     4.600    12.685    17.603    0   0   6
  1 0     5.000    12.847    17.598    0   0   6
  1 0     5.400    13.003    17.594    0   0   6
$ weather deck, camber3
  1 0     5.400    13.003    17.594    2   0   3
  1 0     6.000    13.230    17.587    0   0   3
  1 0     6.600    13.446    17.580    0   0   3
  1 0     7.200    13.653    17.574    0   0   3
$ weather deck, camber4
  1 0     7.200    13.653    17.574    2   0   4
  1 0     9.120    14.246    17.556    0   0   4
  1 0    11.040    14.737    17.541    0   0   4
  1 0    12.960    15.135    17.529    0   0   4
  1 0    14.880    15.448    17.520    0   0   4
  1 0    16.800    15.686    17.513    0   0   4
$ weather deck, camber5
  1 0    16.800    15.686    17.513    2   0   5
  1 0    19.088    15.886    17.506    0   0   5
  1 0    21.377    16.008    17.503    0   0   5
  1 0    23.665    16.073    17.501    0   0   5
  1 0    25.953    16.096    17.500    0   0   5
  1 0    28.242    16.100    17.500    1   0   5
  1 0    30.400    16.100    17.500    0   0   5
$ weather deck, camber1
  1 0    30.400    16.100    17.500    1   0   1
  1 0   118.300    16.100    17.500    2   0   1
  1 0   122.550    16.088    17.500    0   0   1
  1 0   126.800    16.053    17.501    0   0   1
  1 0   131.050    15.992    17.503    0   0   1
  1 0   135.300    15.908    17.506    0   0   1
  1 0   139.550    15.785    17.510    0   0   1
  1 0   143.800    15.527    17.517    0   0   1
  1 0   148.050    15.018    17.533    0   0   1
  1 0   152.300    14.119    17.560    0   0   1
  1 0   156.550    12.699    17.603    0   0   1
  1 0   160.800    10.727    17.663    0   0   1
```

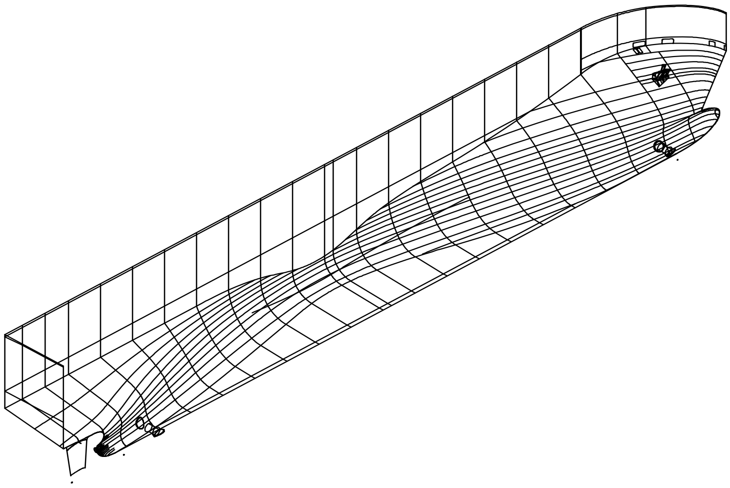
```
$ forecastle deck
  1 0   160.800    12.438    20.532    2   0   2
  1 0   162.708    11.336    20.557    0   0   2
  1 0   164.616    10.118    20.585    0   0   2
  1 0   166.525     8.772    20.615    0   0   2
  1 0   168.433     7.149    20.652    0   0   2
  1 0   170.341     5.000    20.700    2   0   2
  1 0   171.067     3.860    20.700    0   0   2
  1 0   171.430     3.145    20.700    0   0   2
  1 0   171.793     2.219    20.700    0   0   2
  1 0   172.156     0.000    20.700    0   0   2
$* KNUCKLES
$ even bottom
 1.0 0    11.841     0.000     0.000    0
 1.0 0    18.149     0.470     0.000    0
 1.0 0    24.456     1.786     0.000    0
 1.0 0    29.187     3.279     0.000    0
 1.0 0    35.495     6.062     0.000    0
 1.0 0    41.803     9.523     0.000    0
 1.0 0    48.111    12.457     0.000    0
 1.0 0    54.419    13.878     0.000    0
 1.0 0   113.760    14.100     0.000    0
 1.0 0   120.469    13.950     0.000    0
 1.0 0   127.179    13.375     0.000    0
 1.0 0   133.888    12.215     0.000    0
 1.0 0   140.597    10.428     0.000    0
 1.0 0   147.307     7.985     0.000    0
 1.0 0   154.016     4.996     0.000    0
 1.0 0   160.725     1.702     0.000    0
 1.0 0   164.080     0.000     0.000    0
$ lower fore knuckle
 2.0 0   118.300    16.100     2.113    2
 2.0 0   127.595    15.918     2.919    0
 2.0 0   136.890    15.196     4.216    0
 2.0 0   146.185    13.645     5.800    0
 2.0 0   155.480    10.630     7.792    0
 2.0 0   164.775     5.400     9.995    2
 2.0 0   166.465     4.088    10.397    0
 2.0 0   168.155     2.363    10.794    0
 2.0 0   169.000     0.000    11.000    0
$ upper fore knuckle
 3.2 0   118.300    16.100    13.000    0
 3.2 0   123.370    16.051    13.000    0
 3.2 0   128.440    15.879    13.000    0
 3.2 0   133.510    15.538    13.000    0
 3.2 0   138.580    14.985    13.000    0
 3.2 0   143.650    14.170    13.000    0
 3.2 0   148.720    13.017    13.000    0
 3.2 0   153.790    11.337    13.000    0
 3.2 0   158.860     9.004    13.000    0
 3.2 0   163.930     6.008    13.000    0
 3.2 0   169.000     0.000    13.000    0
```

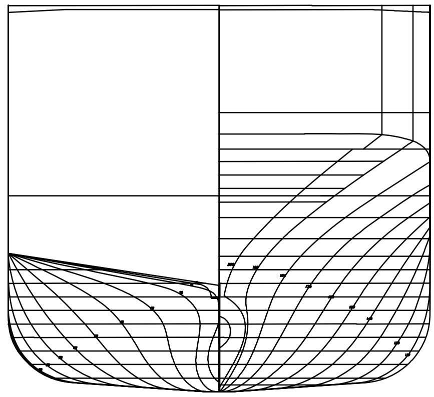
$* CAMBER
1 0.000 0.000
1 2.880 0.000
1 16.100 0.400
2 0.000 0.000
2 5.000 0.000
2 16.100 0.200
3 0.000 0.000
3 8.300 0.000
3 8.300 2.964
3 16.100 3.200
4 0.000 0.000
4 9.960 0.000
4 9.960 3.014
4 16.100 3.200
5 0.000 0.000
5 11.620 0.000
5 11.620 3.064
5 16.100 3.200
6 0.000 0.000
6 4.980 0.000
6 4.980 2.864
6 16.100 3.200

$* WATER LINES
1
0.250 0.500 0.750 1.000 1.500 2.000 3.000 4.000 5.000 6.000 7.000 8.000 9.000 10.000 11.000 13.000 15.000 17.000
0 -4.200 0
0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.970 5.142 6.856 7.859
0 0.000 0
0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.982 4.640 7.803 9.467 10.301
0 4.200 0
0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 2.954 5.782 7.680 10.193 11.581 12.359
0 8.800 0
0.000 0.551 0.944 1.201 1.528 1.717 1.865 1.817 1.703 1.774 2.348 4.335 7.316 9.112 10.368 12.209 13.338 14.010
0 12.800 0
1.006 1.491 1.872 2.184 2.672 3.028 3.481 3.769 4.057 4.579 5.752 8.089 10.011 11.307 12.253 13.577 14.432 14.993
0 16.800 0
1.664 2.299 2.798 3.221 3.919 4.473 5.305 6.013 6.777 7.803 9.260 10.817 12.055 12.960 13.638 14.592 15.206 15.606
0 25.600 0
4.128 5.120 5.923 6.618 7.794 8.764 10.308 11.555 12.600 13.458 14.139 14.657 15.052 15.356 15.587 15.886 16.035
16.091
0 33.600 0
7.989 9.248 10.158 10.866 11.940 12.752 13.929 14.723 15.263 15.621 15.843 15.963 16.024 16.061 16.087 16.100 16.100
16.100
0 42.400 0
12.458 13.223 13.751 14.160 14.766 15.193 15.714 15.976 16.080 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 50.400 0
14.475 14.930 15.242 15.475 15.790 15.977 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 67.200 0

15.067 15.423 15.661 15.832 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 109.600 0
15.067 15.422 15.660 15.831 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 118.400 0
15.066 15.409 15.636 15.803 16.012 16.096 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 126.400 0
14.645 15.050 15.322 15.521 15.775 15.907 15.966 15.966 15.966 15.966 15.966 15.966 15.966 15.966 15.966 15.966 16.007
16.047
0 144.000 0
11.149 11.846 12.335 12.711 13.250 13.613 13.982 14.079 14.100 14.102 14.102 14.102 14.102 14.102 14.102 14.102 14.725
15.349
0 152.000 0
7.966 8.787 9.384 9.846 10.518 10.982 11.561 11.837 11.953 11.996 12.005 12.005 12.005 12.005 12.005 12.005 12.967
13.930
0 156.800 0
5.759 6.585 7.188 7.662 8.374 8.883 9.543 9.867 9.992 10.024 10.028 10.028 10.028 10.028 10.028 10.028 11.145 12.262
0 160.800 0
3.768 4.570 5.152 5.613 6.317 6.833 7.518 7.866 7.981 7.983 7.965 7.953 7.949 7.949 7.949 7.949 9.141 10.333
0 164.800 0
1.677 2.399 2.933 3.363 4.025 4.512 5.155 5.504 5.622 5.596 5.513 5.441 5.396 5.381 5.381 5.381 6.597 7.814
0 167.200 0
0.000 0.909 1.471 1.893 2.530 2.995 3.606 3.934 4.049 4.004 3.864 3.688 3.531 3.444 3.432 3.433 4.697 5.957
0 168.800 0
0.000 0.000 0.000 0.559 1.421 1.916 2.515 2.825 2.946 2.921 2.769 2.497 2.100 1.560 1.164 1.164 2.936 4.358
0 169.600 0
0.000 0.000 0.000 0.000 0.593 1.289 1.962 2.272 2.395 2.386 2.221 1.892 1.291 0.000 0.000 0.000 1.372 3.272
0 171.200 0
0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.931 1.132 1.093 0.772 0.000 0.000 0.000 0.000 0.000 0.000 0.000

2.3.2 Ship with the knuckled form





```
$* SHIP NUMBER
419 0 0 0 1 1 1 1

419
$* MAIN DIMENSIONS
1   165.000   31.100   28.000   82.500   0   0.016   0.012
$* FRAME SPACING
   -4    19    192
  0.750   0.600   0.850   0.600
$* SHIPCONTOUR
1  0    -4.641   2    28.500
1  0    -4.641   2     7.850
1  0     3.890   2     7.532
1  0     4.765   2     7.346
1  0     5.481   2     6.985
1  0     5.932   2     6.543
1  0     6.124   2     6.088
1  0     6.106   2     5.506
1  0     5.849   2     4.914
1  0     5.431   2     4.472
1  0     4.368   2     3.826
1  0     4.201   2     3.491
1  0     4.234   2     2.906
1  0     4.554   2     2.068
1  0     5.030   2     1.413
1  0     5.668   2     0.874
1  0     6.506   2     0.442
1  0     7.584   2     0.153
1  0     9.032   2     0.002
1  0     9.185   2     0.000
2  0     9.185   2     0.000
2  0   158.016   2     0.000
3  0   158.016   2     0.000
3  0   161.053   2     0.092
3  0   163.256   2     0.355
3  0   165.187   2     0.782
3  0   166.547   2     1.254
3  0   167.715   2     1.892
3  0   168.776   2     2.690
3  0   169.280   2     3.291
3  0   169.542   2     3.909
3  0   169.601   2     4.619
3  0   169.455   2     5.208
3  0   169.095   2     5.710
3  0   168.492   2     6.150
3  0   167.403   2     6.618
3  0   165.988   2     6.968
3  0   165.000   2     7.089
3  0   165.036   2     7.890
3  0   171.367   2    19.025
3  0   171.367   2    28.500

$* MIDSHIP SECTION
1     1.000   15.550   1.000   5.100
$* APPENDAGES,ORDER
   5   0
$ bowthruster
   1   0   154.076   0   156.024   3   3   -0.900
  0.000  2.599  1.612  2.599  1.612  2.601  0.000  2.601
  0.000  1.626  1.051  1.626  1.883  3.574  0.000  3.574
  0.000  2.599  1.472  2.599  1.472  2.601  0.000  2.601
$ sternthrust
   2   0   17.226   0   19.174   3   3   -0.900
  0.000  1.624  2.344  1.624  2.344  1.626  0.000  1.626
  0.000  0.651  1.843  0.651  2.798  2.599  0.000  2.599
  0.000  1.624  2.689  1.624  2.689  1.626  0.000  1.626
```

```
$ rudder
   3    0    -3.208    0     1.379    3    5    1.0
  0.000  0.2    0.001  0.2    0.001  6.900  0.000  6.900
  0.000  0.2    0.374  0.2    0.374  6.900  0.000  6.900
  0.000  0.2    0.001  0.2    0.001  6.900  0.000  6.900
$ ramp1
   4    0    -4.641    0    -1.840    2    5    -1.000
 0.000  7.850  -5.250  8.641 -15.550 10.195 -15.550 28.000 C
-11.340 28.200 -5.250 28.200  -5.250  8.642  0.000  7.851
 0.000  7.850  -5.250  8.576 -15.550 10.195 -15.550 28.000 C
-11.340 28.200  -5.250 28.200  -5.250  8.577  0.000  7.851
$ ramp2
   5    0    -1.840    0     4.600    2    5    -1.000
  0.000  7.850  -5.250  8.576 -15.550 10.195 -15.550 28.000 C
 -11.340 28.200 -5.250 28.200  -5.250  8.577  0.000  7.851
  0.000  7.400 -15.549 10.195 -15.550 10.195 -15.550 28.000 C
 -15.549 28.000 -15.548 28.000 -15.548 10.196  0.000  7.401
$ DECKS
$ upper deck
   1 0    -4.641     0.000     28.200   1    0.000    1
   1 0    -4.641    11.340    28.200   1    0.000    1
   1 0    -4.641    15.550    28.000   1    0.000    1
   1 0    33.607    15.550    28.000   1    0.000    1
   1 0    71.855    15.550    28.000   1    0.000    1
   1 0   110.102    15.550    28.000   1    0.000    1
   1 0   148.350    15.550    28.000   1    0.000    1
   1 0   152.228    15.290    28.012   0    0.000    1
   1 0   156.036    14.510    28.049   0    0.000    1
   1 0   159.695    13.203    28.112   0    0.000    1
   1 0   163.104    11.340    28.200   0    0.000    1
   1 0   165.959     9.106    28.200   0    0.000    1
   1 0   168.500     6.519    28.200   0    0.000    1
   1 0   170.458     3.475    28.200   0    0.000    1
   1 0   171.367     0.000    28.200   0    0.000    1
$* KNUCKLES
$ parallel keel
 1.2 0     9.185     0.020     0.000    2
 1.2 0    10.329     0.083     0.000    0
 1.2 0    11.472     0.150     0.000    0
 1.2 0    12.616     0.221     0.000    0
 1.2 0    13.759     0.303     0.000    0
 1.2 0    14.903     0.396     0.000    0
 1.2 0    16.047     0.503     0.000    0
 1.2 0    17.190     0.620     0.000    0
 1.2 0    18.334     0.744     0.000    0
 1.2 0    19.477     0.871     0.000    0
 1.2 0    20.621     1.000     0.000    1
1.2 0   132.146     1.000     0.000    1
$ even bottom
 2.2 0    20.621     1.000     0.000    2
 2.2 0    31.773     2.586     0.109    0
 2.2 0    42.926     4.604     0.248    0
 2.2 0    54.078     6.851     0.402    0
 2.2 0    65.231     9.218     0.565    0
 2.2 0    76.383    10.935     0.683    0
 2.2 0    87.536    10.345     0.642    0
 2.2 0    98.688     8.114     0.489    0
 2.2 0   109.841     5.241     0.291    0
 2.2 0   120.993     2.768     0.121    0
 2.2 0   132.146     1.000     0.000    0
$ bow6
 3.0 0    82.365    15.550     6.000    2
 3.0 0    91.002    15.143     6.000    0
 3.0 0    99.639    14.066     6.000    0
 3.0 0   108.276    12.630     6.000    0
 3.0 0   116.913    10.953     6.000    0
 3.0 0   125.550     9.054     6.000    0
 3.0 0   134.188     6.975     6.000    0
 3.0 0   142.825     4.846     6.000    0
 3.0 0   151.462     2.956     6.000    0
 3.0 0   160.099     1.673     6.000    0
 3.0 0   168.736     0.053     6.000    0
$ stern7
 4.0 0     5.460     0.015     7.000    2
 4.0 0    11.832     2.392     7.000    0
 4.0 0    18.203     5.148     7.000    0
 4.0 0    24.574     7.755     7.000    0
4.0 0    30.946     9.898     7.000    0
 4.0 0    37.317    11.735     7.000    0
 4.0 0    43.689    13.190     7.000    0
 4.0 0    50.060    14.269     7.000    0
 4.0 0    56.432    15.008     7.000    0
 4.0 0    62.803    15.415     7.000    0
 4.0 0    69.175    15.550     7.000    0
$ bow7
 5.0 0    85.852    15.550     7.000    2
 5.0 0    93.846    15.156     7.000    0
 5.0 0   101.840    14.172     7.000    0
 5.0 0   109.834    12.912     7.000    0
 5.0 0   117.829    11.393     7.000    0
 5.0 0   125.823     9.635     7.000    0
 5.0 0   133.817     7.683     7.000    0
 5.0 0   141.811     5.634     7.000    0
 5.0 0   149.806     3.617     7.000    0
 5.0 0   157.800     1.730     7.000    0
5.0 0   165.794     0.050     7.000    0
$ stern8
12.0 0    -4.641     1.013     8.000    2
12.0 0     2.402     2.375     8.000    0
12.0 0     9.445     4.142     8.000    0
12.0 0    16.488     6.875     8.000    0
12.0 0    23.530     9.427     8.000    0
12.0 0    30.573    11.385     8.000    0
12.0 0    37.616    12.936     8.000    0
```

```
12.0 0   44.658   14.089    8.000   0
12.0 0   51.701   14.907    8.000   0
12.0 0   58.744   15.399    8.000   0
12.0 0   65.787   15.550    8.000   0
$ bow8
13.0 0   88.557   15.550    8.000   2
13.0 0   96.209   15.185    8.000   0
13.0 0  103.862   14.332    8.000   0
13.0 0  111.515   13.205    8.000   0
13.0 0  119.168   11.780    8.000   0
13.0 0  126.820   10.091    8.000   0
13.0 0  134.473    8.191    8.000   0
13.0 0  142.126    6.177    8.000   0
13.0 0  149.779    4.101    8.000   0
13.0 0  157.431    2.095    8.000   0
13.0 0  165.084    0.000    8.000   0
$ stern9
14.0 0   -4.641    7.637    9.000   2
14.0 0    1.988    8.327    9.000   0
14.0 0    8.617    9.181    9.000   0
14.0 0   15.246   10.456    9.000   0
14.0 0   21.876   11.744    9.000   0
14.0 0   28.505   12.905    9.000   0
14.0 0   35.134   13.834    9.000   0
14.0 0   41.763   14.526    9.000   0
14.0 0   48.392   15.040    9.000   0
14.0 0   55.021   15.406    9.000   0
14.0 0   61.650   15.550    9.000   0
$ bow9
15.0 0   91.346   15.550    9.000   2
15.0 0   98.776   15.193    9.000   0
15.0 0  106.207   14.509    9.000   0
15.0 0  113.637   13.472    9.000   0
15.0 0  121.068   12.119    9.000   0
15.0 0  128.498   10.448    9.000   0
15.0 0  135.928    8.577    9.000   0
15.0 0  143.359    6.570    9.000   0
15.0 0  150.789    4.463    9.000   0
15.0 0  158.220    2.352    9.000   0
15.0 0  165.650    0.000    9.000   0
$ bow10
16.0 0   95.061   15.550   10.000   2
16.0 0  102.177   15.253   10.000   0
16.0 0  109.293   14.652   10.000   0
16.0 0  116.409   13.727   10.000   0
16.0 0  123.525   12.443   10.000   0
16.0 0  130.641   10.791   10.000   0
16.0 0  137.757    8.968   10.000   0
16.0 0  144.873    7.006   10.000   0
16.0 0  151.989    4.909   10.000   0
16.0 0  159.105    2.761   10.000   0
16.0 0  166.221    0.000   10.000   0
$ bow11.3
17.0 0  103.730   15.550   11.300   2
17.0 0  110.053   15.211   11.300   0
17.0 0  116.376   14.701   11.300   0
17.0 0  122.699   13.843   11.300   0
17.0 0  129.023   12.527   11.300   0
17.0 0  135.346   10.968   11.300   0
17.0 0  141.669    9.279   11.300   0
17.0 0  147.992    7.440   11.300   0
17.0 0  154.315    5.451   11.300   0
17.0 0  160.639    3.419   11.300   0
17.0 0  166.962    0.000   11.300   0
$ bow12.85
18.0 0  122.307   15.550   12.850   2
18.0 0  126.861   14.877   12.850   0
18.0 0  131.415   13.931   12.850   0
18.0 0  135.969   12.849   12.850   0
18.0 0  140.523   11.645   12.850   0
18.0 0  145.076   10.306   12.850   0
18.0 0  149.630    8.862   12.850   0
18.0 0  154.184    7.330   12.850   0
18.0 0  158.738    5.701   12.850   0
18.0 0  163.292    4.007   12.850   0
18.0 0  167.846    0.000   12.850   0
$ port side knuckle
19.0 0   -4.641   15.550   10.195   2
19.0 0    5.559   15.550   10.195   0
19.0 0   15.758   15.550   10.195   0
19.0 0   25.957   15.550   10.195   0
19.0 0   36.157   15.550   10.195   0
19.0 0   46.356   15.550   10.195   0
19.0 0   56.556   15.550    9.786   0
19.0 0   66.755   15.550    7.721   0
19.0 0   76.954   15.550    5.550   0
19.0 0   87.154   15.550    7.478   0
19.0 0   97.353   15.550   10.447   0
19.0 0  107.552   15.550   11.650   0
19.0 0  117.752   15.550   12.419   0
19.0 0  127.951   15.550   13.500   0
19.0 0  138.151   15.550   14.983   0
19.0 0  148.350   15.550   16.982   2
19.0 0  151.419   15.387   17.636   0
19.0 0  154.488   14.893   18.185   0
19.0 0  157.557   14.040   18.581   0
19.0 0  160.626   12.766   18.864   0
19.0 0  163.695   10.933   19.031   0
19.0 0  166.764    8.358   19.025   0
19.0 0  168.298    6.757   19.026   0
19.0 0  169.833    4.632   19.025   0
19.0 0  171.367    0.000   19.025   0
```

```
$* CAMBER
 1     0.000    0.000
 1    11.340    0.000
 1    15.550    0.200

$* WATERLINES
1
  0.750  1.000  1.500  2.000  3.000  4.000  5.000
0  -4.641  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0  -3.900  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0  -3.150  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0  -1.800  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0  -0.600  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0   0.600  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0   1.800  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0   2.400  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0   3.600  0
  0.000  0.000  0.000  0.000  0.000  0.000  0.000
0   4.800  0
  0.000  0.000  0.000  0.240  0.553  0.000  0.000
0   5.400  0
  0.000  0.000  0.357  0.589  0.664  0.350  0.000
0   6.188  0
  0.216  0.448  0.720  0.841  0.792  0.479  0.114
0   7.219  0
  0.639  0.803  0.985  1.047  0.950  0.644  0.315
0   8.250  0
  0.845  0.982  1.152  1.212  1.099  0.806  0.518
0  10.200  0
  1.091  1.219  1.388  1.460  1.362  1.113  0.922
0  12.375  0
  1.314  1.460  1.647  1.729  1.690  1.526  1.437
0  16.500  0
  1.805  1.987  2.259  2.430  2.558  2.553  2.657
0  20.750  0
  2.433  2.658  3.005  3.257  3.592  3.828  4.136
0  24.750  0
  3.108  3.378  3.802  4.127  4.630  5.070  5.571
```

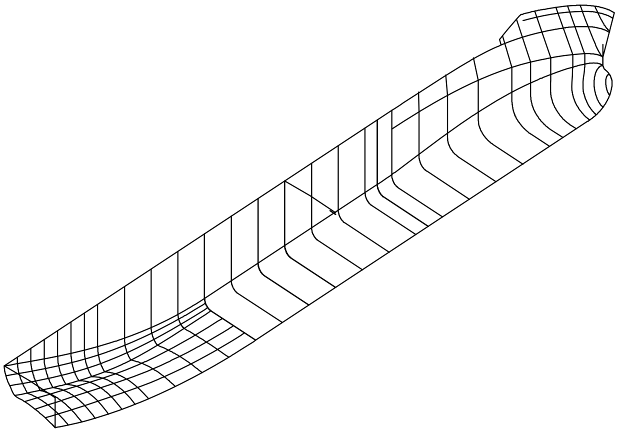

```
0  24.750  0
  3.108  3.378  3.802  4.127  4.630  5.070  5.571
```

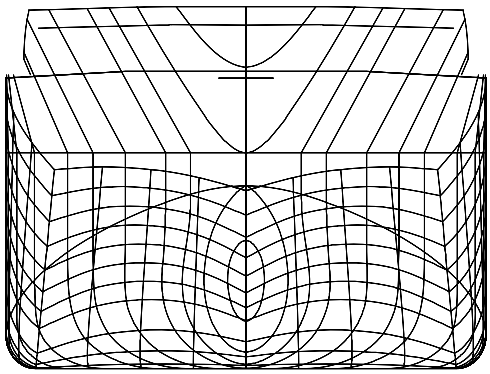

```
0  29.250  0
  3.930  4.258  4.780  5.191  5.850  6.459  7.150
0  33.000  0
  4.635  5.013  5.619  6.105  6.895  7.615  8.410
0  37.750  0
  5.532  5.973  6.685  7.265  8.218  9.053  9.906
0  41.250  0
  6.191  6.678  7.463  8.104  9.161 10.062 10.925
0  46.250  0
  7.128  7.682  8.560  9.273 10.430 11.383 12.221
0  49.500  0
  7.739  8.337  9.270 10.014 11.196 12.143 12.940
0  57.750  0
  9.245  9.968 11.007 11.773 12.884 13.693 14.314
0  66.000  0
 10.535 11.376 12.453 13.176 14.127 14.730 15.134
0  74.250  0
 11.365 12.257 13.284 13.932 14.789 15.262 15.493
0  90.750  0
 10.674 11.401 12.332 12.973 13.836 14.420 14.852
0  99.000  0
  9.329  9.951 10.836 11.486 12.426 13.121 13.687
0 107.250  0
  7.711  8.280  9.146  9.811 10.819 11.594 12.241
0 115.500  0
  6.046  6.570  7.399  8.059  9.094  9.913 10.610
0 123.750  0
  4.461  4.909  5.657  6.280  7.296  8.117  8.820
0 132.000  0
  3.079  3.429  4.049  4.587  5.489  6.238  6.895
0 140.250  0
  1.939  2.235  2.734  3.147  3.822  4.392  4.932
0 148.500  0
  1.078  1.308  1.693  2.010  2.503  2.885  3.218
0 156.750  0
  0.589  0.744  1.022  1.280  1.725  2.016  2.113
0 160.875  0
  0.430  0.569  0.839  1.099  1.561  1.861  1.915
0 162.938  0
  0.310  0.459  0.746  1.023  1.520  1.847  1.914
0 165.000  0
  0.063  0.232  0.562  0.884  1.463  1.844  1.907
0 167.062  0
  0.000  0.000  0.000  0.494  1.264  1.731  1.761
0 169.125  0
  0.000  0.000  0.000  0.000  0.000  0.870  0.841
```

General remark

As shown through the input file, knuckles were more suitable to describe the major part of the form. The waterlines were used only in the very low part of the form (1 to 5 meters) and primarily to backup the accuracy of knuckles in this part of the form.

2.3.3 Ship with complicated aft - tunnel aft





$* SHIP NUMBER
402 0 0 0 1 1 1 1

402
$* MAIN DIMENSIONS
1 169.000 32.200 17.500 84.500 0.000 0.016
0.014
$* FRAME SPACING
12 240
0.600 0.800 0.600
$* SHIPCONTOUR
1 0 -4.200 2 17.900
1 0 -4.200 2 10.700
1 0 1.698 2 8.681
1 0 7.096 2 7.046
1 0 13.119 2 5.448
1 0 19.106 2 4.082
1 0 25.413 2 2.871
1 0 31.625 2 1.896
1 0 37.786 2 1.135
1 0 44.555 2 0.527
1 0 51.246 2 0.154
1 0 57.649 2 0.006
1 0 59.150 2 0.000
2 0 59.150 2 0.000
2 0 164.080 2 0.000
3 0 164.080 2 0.000
3 0 165.990 2 0.108
3 0 167.504 2 0.410
3 0 168.705 2 0.856
3 0 169.771 2 1.477
3 0 170.608 2 2.212
3 0 171.235 2 3.059
3 0 171.640 2 4.000
3 0 171.820 2 5.000
3 0 171.770 2 6.000
3 0 171.470 2 7.000
3 0 170.930 2 8.000
3 0 170.180 2 9.000
3 0 169.299 2 10.112
3 0 169.033 2 10.719
3 0 169.000 2 13.000
3 0 172.600 2 21.784

$* MIDSHIP SECTION
1 0. 16.100 0.000 2.000
$$* APPENDAGES,ORDER
1 1
$ rudder blade
1 0 -3.152 0 1.699 3 3 1.000
0.000 0.200 0.213 0.200 0.408 8.900 0.000 8.900
0.000 0.200 0.353 0.200 0.527 8.900 0.000 8.900
0.000 0.200 0.396 0.200 0.569 8.900 0.000 8.900
$ the following index 3 is stated in accordance to the data sheet 1b
3
$* DECKS
$ weather deck, camber1
1 0 -4.200 0.000 17.900 1 0 1
1 0 -4.200 8.070 17.900 1 0 1
1 0 -4.200 16.100 17.500 1 0 1
1 0 4.200 16.100 17.500 0 0 1
$ weather deck, camber6
1 0 4.200 16.100 17.500 2 0 6
1 0 5.400 16.100 17.500 0 0 6
$ weather deck, camber3
1 0 5.400 16.100 17.500 2 0 3
1 0 7.200 16.100 17.500 0 0 3
$ weather deck, camber4
1 0 7.200 16.100 17.500 2 0 4
1 0 16.800 16.100 17.500 0 0 4
$ weather deck, camber5
1 0 16.800 16.100 17.500 2 0 5
1 0 30.400 16.100 17.500 0 0 5

```
$ weather deck, camber1
 1 0   30.400   16.100   17.500   1  0  1
 1 0  118.300   16.100   17.500   2  0  1
 1 0  122.550   16.088   17.500   0  0  1
 1 0  126.800   16.053   17.501   0  0  1
 1 0  131.050   15.992   17.503   0  0  1
 1 0  135.300   15.908   17.506   0  0  1
 1 0  139.550   15.785   17.510   0  0  1
 1 0  143.800   15.527   17.517   0  0  1
 1 0  148.050   15.018   17.533   0  0  1
 1 0  152.300   14.119   17.560   0  0  1
 1 0  156.550   12.699   17.603   0  0  1
 1 0  160.800   10.727   17.663   0  0  1
$ forcastle deck, camber2
 1 0  160.800   12.438   20.532   2  0  2
 1 0  162.708   11.336   20.557   0  0  2
 1 0  164.616   10.118   20.585   0  0  2
 1 0  166.525    8.772   20.615   0  0  2
 1 0  168.433    7.149   20.652   0  0  2
 1 0  170.341    5.000   20.700   2  0  2
 1 0  170.704    4.466   20.700   0  0  2
 1 0  171.067    3.860   20.700   0  0  2
 1 0  171.430    3.145   20.700   0  0  2
 1 0  171.793    2.219   20.700   0  0  2
 1 0  172.156    0.000   20.700   0  0  2
$* KNUCKLES
$ even bottom line
 1.0 0   59.150   14.100    0.000   0
 1.0 0  113.760   14.100    0.000   0
 1.0 0  115.437   14.092    0.000   0
 1.0 0  117.115   14.066    0.000   0
 1.0 0  118.792   14.020    0.000   0
 1.0 0  120.469   13.950    0.000   0
 1.0 0  122.147   13.854    0.000   0
 1.0 0  123.824   13.728    0.000   0
 1.0 0  125.501   13.570    0.000   0
 1.0 0  127.179   13.375    0.000   0
 1.0 0  128.856   13.143    0.000   0
 1.0 0  130.533   12.872    0.000   0
 1.0 0  132.211   12.563    0.000   0
 1.0 0  133.888   12.215    0.000   0
 1.0 0  135.565   11.828    0.000   0
 1.0 0  137.243   11.402    0.000   0
 1.0 0  138.920   10.935    0.000   0
 1.0 0  140.597   10.428    0.000   0
 1.0 0  142.275    9.880    0.000   0
 1.0 0  143.952    9.289    0.000   0
 1.0 0  145.629    8.656    0.000   0
 1.0 0  147.307    7.985    0.000   0
 1.0 0  148.984    7.278    0.000   0
 1.0 0  150.661    6.542    0.000   0
 1.0 0  152.339    5.779    0.000   0
 1.0 0  154.016    4.996    0.000   0
 1.0 0  155.693    4.194    0.000   0
 1.0 0  157.371    3.375    0.000   0
 1.0 0  159.048    2.544    0.000   0
 1.0 0  160.725    1.702    0.000   0
 1.0 0  162.403    0.853    0.000   0
 1.0 0  164.080    0.000    0.000   0
$ tunnel knuckle1
 2.0 0   -4.200    3.152   11.499   2
 2.0 0    2.135    3.221    9.732   0
 2.0 0    8.470    3.285    8.055   0
 2.0 0   14.805    3.345    6.441   0
 2.0 0   21.140    3.403    4.886   0
 2.0 0   27.475    3.456    3.407   0
 2.0 0   33.810    3.494    2.204   0
 2.0 0   40.145    3.518    1.281   0
 2.0 0   46.480    3.529    0.580   0
 2.0 0   52.815    3.526    0.148   0
 2.0 0   59.150    3.508    0.000   0
$ tunnel knuckle2
 3.0 0   -4.200    6.368   11.982   2
 3.0 0    2.135    6.494   10.297   0
 3.0 0    8.470    6.620    8.607   0
 3.0 0   14.805    6.747    6.922   0
 3.0 0   21.140    6.872    5.246   0
 3.0 0   27.475    6.991    3.609   0
 3.0 0   33.810    7.068    2.293   0
 3.0 0   40.145    7.099    1.317   0
 3.0 0   46.480    7.098    0.591   0
 3.0 0   52.815    7.057    0.150   0
 3.0 0   59.150    6.979    0.000   0
$ tunnel knuckle3
 4.0 0   -4.200    9.615   12.145   2
 4.0 0    2.135    9.806   10.263   0
 4.0 0    8.470    9.996    8.385   0
 4.0 0   14.805   10.179    6.548   0
 4.0 0   21.140   10.353    4.780   0
 4.0 0   27.475   10.508    3.129   0
 4.0 0   33.810   10.604    1.863   0
 4.0 0   40.145   10.639    1.001   0
 4.0 0   46.480   10.630    0.428   0
 4.0 0   52.815   10.583    0.105   0
 4.0 0   59.150   10.502    0.000   0
```

```
$ tunnel knuckle4
 5.0 0    -4.200    12.863    11.986   2
 5.0 0     2.135    13.107     9.621   0
 5.0 0     8.470    13.342     7.348   0
 5.0 0    14.805    13.557     5.259   0
 5.0 0    21.140    13.745     3.441   0
 5.0 0    27.475    13.896     1.973   0
 5.0 0    33.810    14.004     0.930   0
 5.0 0    40.145    14.063     0.358   0
 5.0 0    46.480    14.090     0.100   0
 5.0 0    52.815    14.099     0.012   0
 5.0 0    59.150    14.100     0.000   0
$ tunnel knuckle5
 6.0 0    -4.200    14.351    13.587   2
 6.0 0     2.135    14.560    11.166   0
 6.0 0     8.470    14.758     8.836   0
 6.0 0    14.805    14.933     6.688   0
 6.0 0    21.140    15.075     4.805   0
6.0 0    33.810    15.230     2.098   0
 6.0 0    40.145    15.244     1.266   0
 6.0 0    46.480    15.223     0.715   0
 6.0 0    52.815    15.173     0.396   0
 6.0 0    59.150    15.100     0.268   0
$ tunel knuckle6
 7.0 0    -4.200    15.567    15.399   2
 7.0 0     2.135    15.643    13.028   0
 7.0 0     8.470    15.715    10.729   0
 7.0 0    14.805    15.780     8.572   0
 7.0 0    21.140    15.833     6.624   0
 7.0 0    27.475    15.872     4.943   0
 7.0 0    33.810    15.895     3.570   0
 7.0 0    40.145    15.902     2.497   0
 7.0 0    46.480    15.894     1.716   0
 7.0 0    52.815    15.870     1.218   0
 7.0 0    59.150    15.832     1.000   0
$ tunnel knuckle7
 8.0 0    -4.200    16.100    17.500   2
 8.0 0     2.135    16.100    15.149   0
 8.0 0     8.470    16.100    12.848   0
 8.0 0    14.805    16.100    10.648   0
 8.0 0    21.140    16.100     8.599   0
8.0 0    33.810    16.100     5.140   0
 8.0 0    40.145    16.100     3.822   0
 8.0 0    46.480    16.100     2.833   0
 8.0 0    52.815    16.100     2.214   0
 8.0 0    59.150    16.100     2.000   0

$* CAMBER
 1     0.000     0.000
 1     2.880     0.000
 1    16.100     0.400
 2     0.000     0.000
 2     5.000     0.000
 2    16.100     0.200
 3     0.000     0.000
 3     8.300     0.000
 3     8.300     2.964
 3    16.100     3.200
 4     0.000     0.000
 4     9.960     0.000
 4     9.960     3.014
 4    16.100     3.200
 5     0.000     0.000
 5    11.620     0.000
 5    11.620     3.064
 5    16.100     3.200
 6     0.000     0.000
 6     4.980     0.000
 6     4.980     2.864
 6    16.100     3.200
```

$* WATER LINES
1
0.250 0.500 0.750 1.000 1.500 2.000 3.000 4.000 5.000 6.000 7.000 8.000 9.000 10.000 11.000 13.000 15.000 17.000
0 59.150 0
15.067 15.423 15.661 15.832 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 67.200 0
15.067 15.423 15.661 15.832 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 84.000 0
15.067 15.422 15.661 15.832 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 92.800 0
15.067 15.422 15.661 15.832 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 101.600 0
15.067 15.422 15.660 15.831 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 109.600 0
15.067 15.422 15.660 15.831 16.035 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 118.400 0
15.066 15.409 15.636 15.803 16.012 16.096 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100 16.100
16.100
0 126.400 0
14.645 15.050 15.322 15.521 15.775 15.907 15.966 15.966 15.966 15.966 15.966 15.966 15.966 15.966 15.966 15.966 16.007
16.047
0 144.000 0
11.149 11.846 12.335 12.711 13.250 13.613 13.982 14.079 14.100 14.102 14.102 14.102 14.102 14.102 14.102 14.102 14.725
15.349
0 152.000 0
7.966 8.787 9.384 9.846 10.518 10.982 11.561 11.837 11.953 11.996 12.005 12.005 12.005 12.005 12.005 12.005 12.967
13.930
0 156.800 0
5.759 6.585 7.188 7.662 8.374 8.883 9.543 9.867 9.992 10.024 10.028 10.028 10.028 10.028 10.028 10.028 11.145 12.262
0 160.800 0
3.768 4.570 5.152 5.613 6.317 6.833 7.518 7.866 7.981 7.983 7.965 7.953 7.949 7.949 7.949 7.949 9.141 10.333
0 164.800 0
1.677 2.399 2.933 3.363 4.025 4.512 5.155 5.504 5.622 5.596 5.513 5.441 5.396 5.381 5.381 5.381 6.597 7.814
0 167.200 0
0.000 0.909 1.471 1.893 2.530 2.995 3.606 3.934 4.049 4.004 3.864 3.688 3.531 3.444 3.432 3.433 4.697 5.957
0 168.800 0
0.000 0.000 0.000 0.559 1.421 1.916 2.515 2.825 2.946 2.921 2.769 2.497 2.100 1.560 1.164 1.164 2.936 4.358
0 169.600 0
0.000 0.000 0.000 0.000 0.593 1.289 1.962 2.272 2.395 2.386 2.221 1.892 1.291 0.000 0.000 0.000 1.372 3.272
0 171.200 0
0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.931 1.132 1.093 0.772 0.000 0.000 0.000 0.000 0.000 0.000 0.000

Some general remarks

Although this hull form has tunnel shaped aft, the input file doesn´t differ very much from the normall form. Difference is in index ˝3˝ stated after the appendage description. This index is stated in accordance to the explanations from the data sheet 1b. Besides this, the only other difference is in bigger usage of knuckles to define the aft tunnel then the water lines.