

VOLUME 2

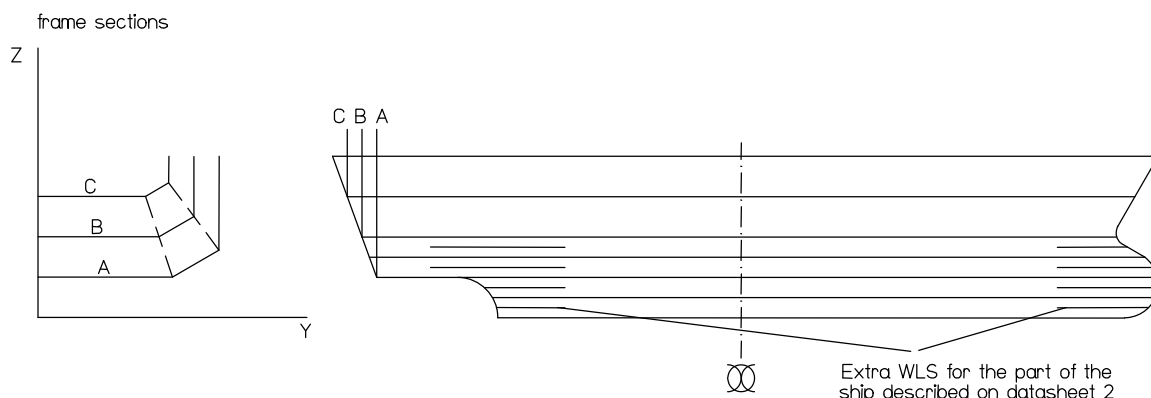
HULL DEFINITION

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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 interpolation of 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

1 *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.

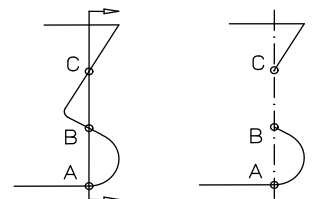
shell plate thickness is given as a mean value. Wetted surface multiplied with this value for shell plate thickness is added to the molded displacement volume. Shell plate is also included in the stability calculation.

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:

- To give the ship length at different WLS (used in calculations of coefficients based on the real length, if requested in hydrostatic data).
- 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.

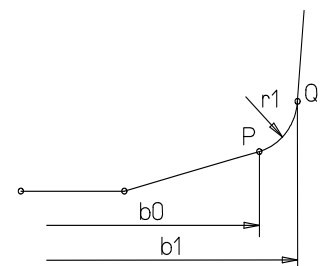
Type =1 is explained on the data sheet.

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

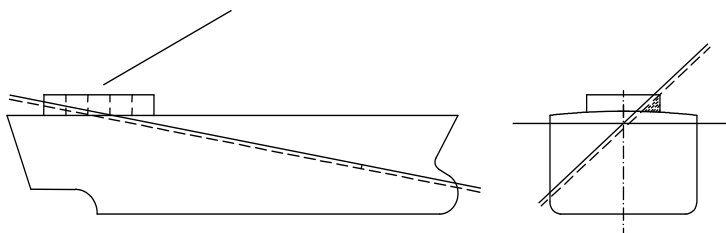
The following sequence has to be respected:

- 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.

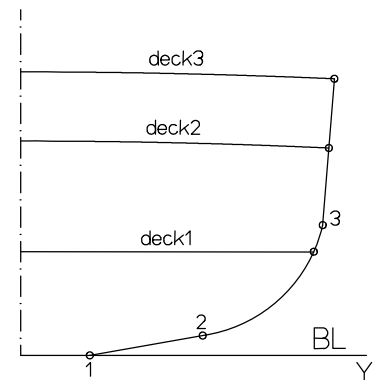
N.B. In this version of program package appendages are not considered in the programs for the floodable length and the longitudinal strength part of the loading condition calculation.

Data sheet 1b

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

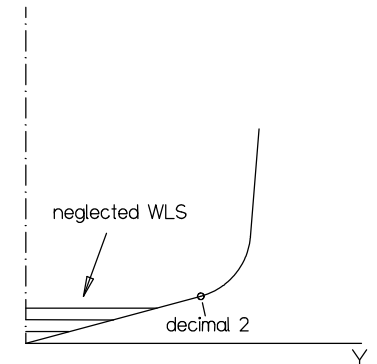
Data sheet 2

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.

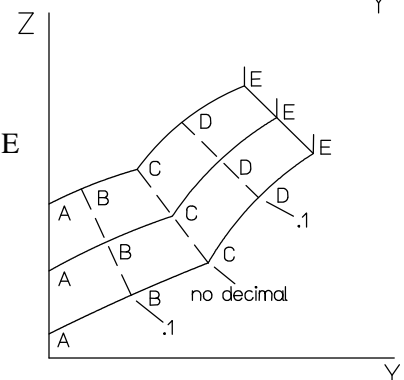


Decimals .1 and .2

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

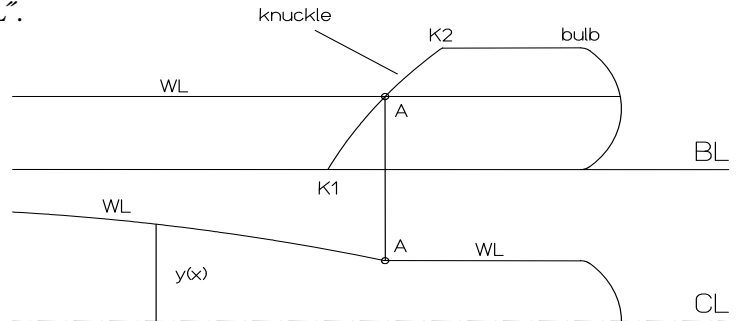
Curves defined on sheet 2 with decimal .1 program treats as normal WLS on data sheet 4 given on sheet 2. Therefore, the same restriction applies regarding the spacing (along the frame) between these points as for normal WLS (see data sheet 4).

Sequence of data on sheet 2

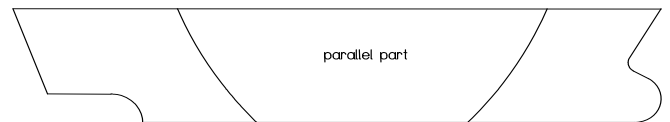
- Give all the decks before the knuckles.
- Before numbering the knuckles consult data sheet 1b.
- Intersections between knuckles and WLS
- When interpolating the WLS in the longitudinal direction an intersection with a knuckle is considered as a knuckle "on the WL".

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.



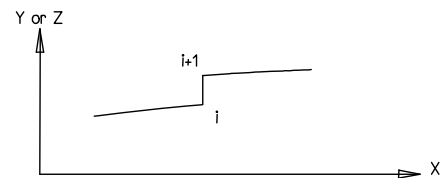
This possibility can also be used for describing the parallel part of the ship. (Useful to give but not always available).



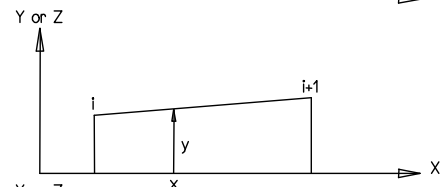
Data sheets 2 and 4 contain interpolation codes which define the way of interpolation of the deck corners, knuckles or half-breadths. Usually this code is left blank except for the parallel parts where it should be set equal to 1. In that case, the program selects best interpolation procedure. There 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:

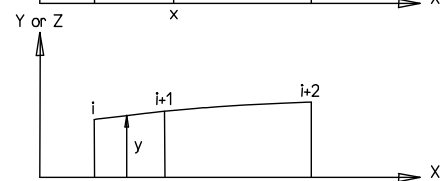
int =0 The interval is a step $x_i=x_{i+1}$. It is also used when a user leaves to the computer to choose the interpolation code.



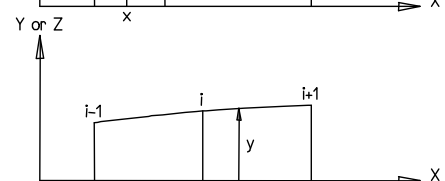
int =1 Straight-line interpolation, which means straight line between i and i+1.



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.

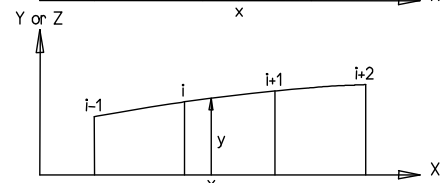
Define $\theta = (x - x_i) / (x_{i+1} - x_i)$

$y_1(x)$ is a parabola through the points i-1, i, i+1

$y_2(x)$ is a parabola through the points i, i+1, i+2

$y(x)$ is interpolated value for the interval i, i+1

$y(x) = y_1(x) * (1 - \theta) + y_2(x) * \theta$

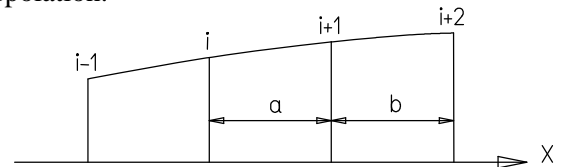


This interpolation implies that the mid-point of the interval, $y(x)$ becomes the average value of the two possible parabolic interpolations, whilst towards the ends of the interval there occurs a gradual change tending towards only one parabolic interpolation. This method of interpolation results in 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.

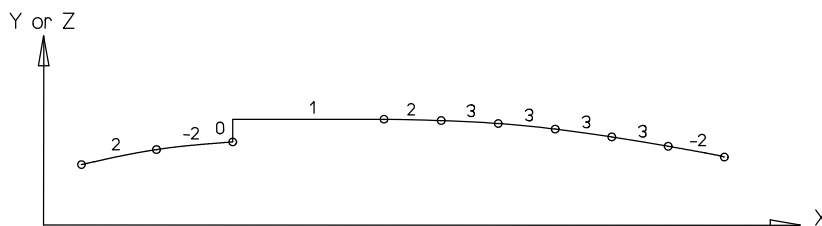
Note that if $int = 0$, the program will choose a smooth interpolation.



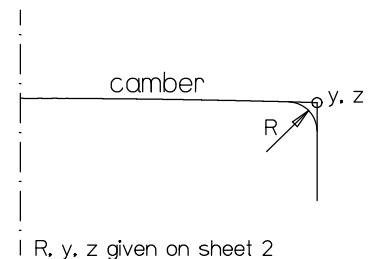
Interpolation code for interval $i, i+1$, if the following conditions are fulfilled

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



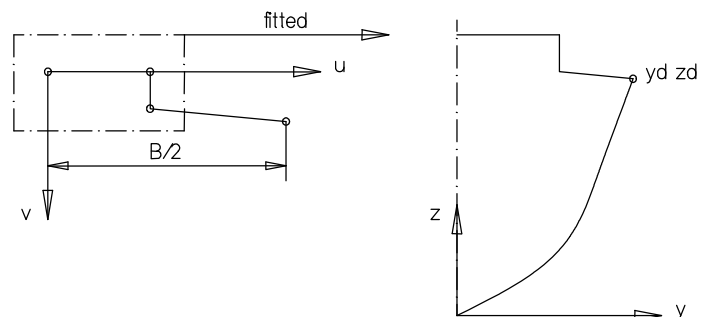
Last two columns on data sheet 2 are only filled to describe the deck line. Camber numbers refer to data sheet 3. The radius is related to the frame section as the very last step. Coordinates of the circle center are found automatically by the program.



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.

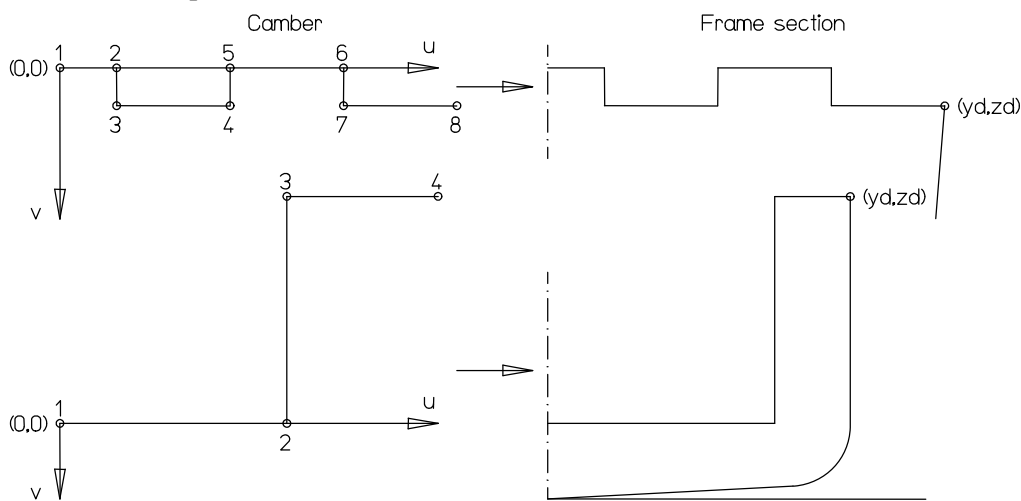
N.B. The coordinate axes u and v refer to camber only. Transformation to y, z coordinate system is made after calculation of the deck edge y_d, z_d see the sketch. (See also description of the procedure "frame")



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.

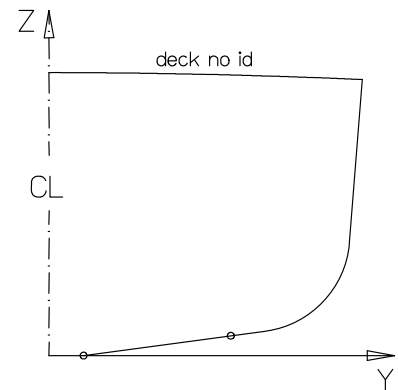
¹ int has the same meaning as on the sheet 2

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



The calculation sequence

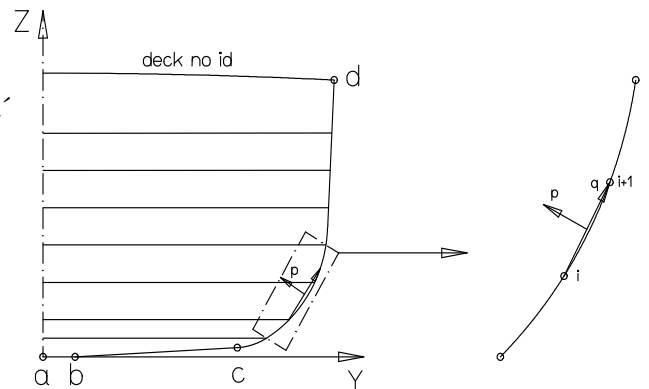
1. Interpolate all half breadths from data sheet 4 for the longitudinal coordinate x . See page 9 for the interpolation method.

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 $i, i+1, i+2$.



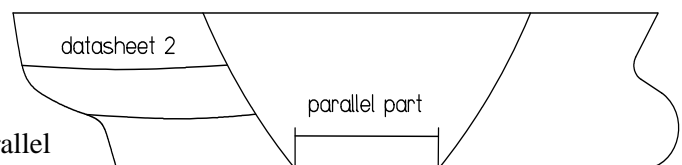
5. Interpolate the form of the camber for the deck at the longitudinal coordinate x from data on sheet 3.

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

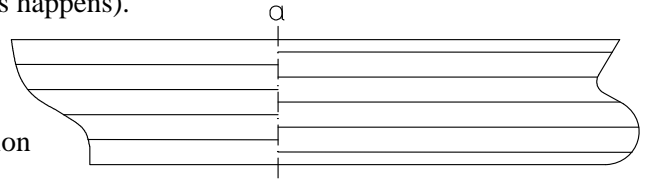
If a parallel part has been given in dataset 4, the following items 1 and 2 are applied:

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.

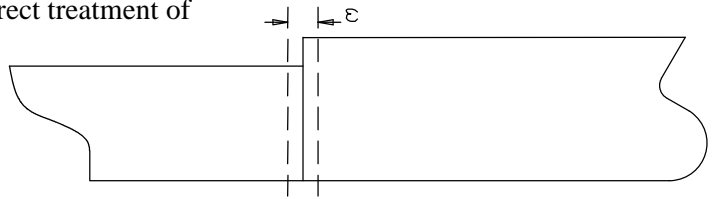


3. Check that number of data stated in dataset 5 does not exceed the maximum values stated o the data sheet (present version of the program crashes if this happens).

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.



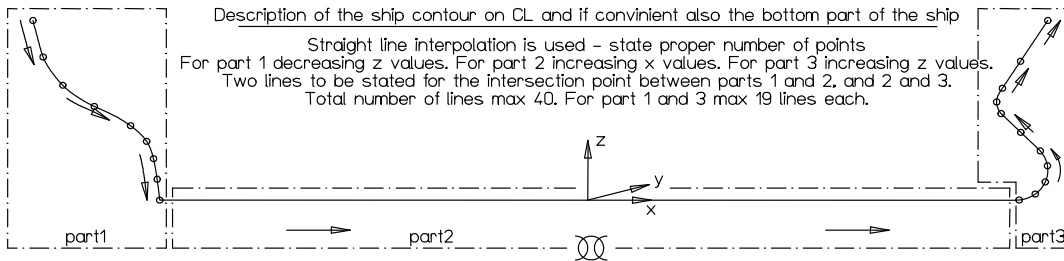
	←	normally blank					→
	ship no	alt	sp	mult	bmult	hmult	plot
1			0				
one blank line							

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)							

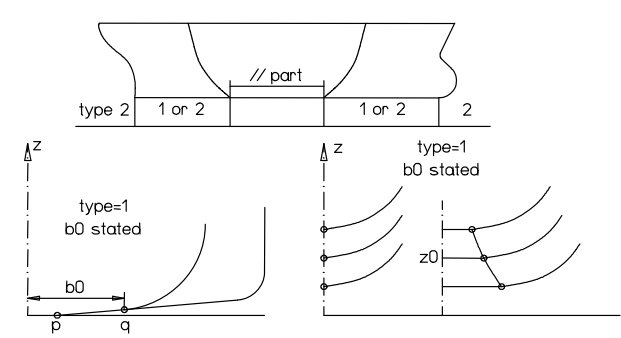
alt =see user's guide
 sp =1 only three following lines are stated
 (used if the hull form is not needed for the calc.)
 plot =1 plotting information created on disc

	Lpp	Bmoulded	Dmoulded	dist from frame	max of y and z	keelplate thickness	shellplate thickness
	0 to Lpp/2						
2	1						
state frames (Fr) at which the frame spacing changes							
3	Fr						
4	Sp						

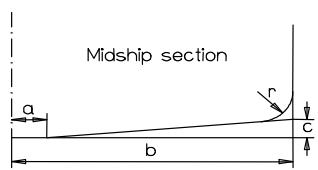


	part no	frame no	dx	type =1	b ₀
				type =2	z ₀
5					
one blank line					

Part no 1, 2, or 3, see the sketch above.
 Type =1 is used for the // part (Note: state b₀ =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 b₀, a, b and c.
 If type 2 is used, points p and q have to be described on data sheet 2.
 Since 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

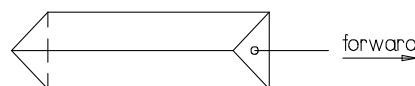
y z y z y z y z y z (C)

9											second section

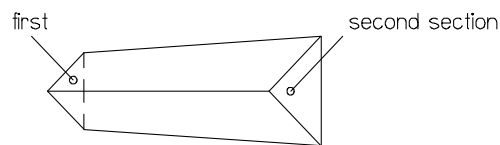
y z y z y z y z y z (C)

9											third section

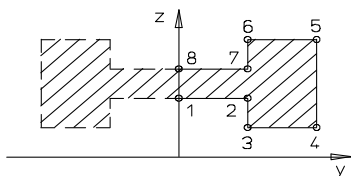
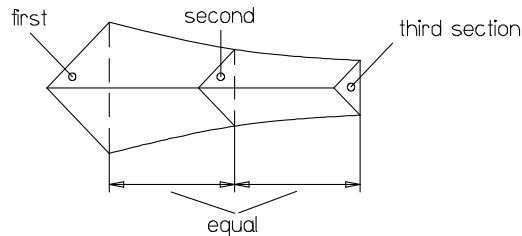
If one section is defined calculation is made for prismatic formed appendage with parallel sides.



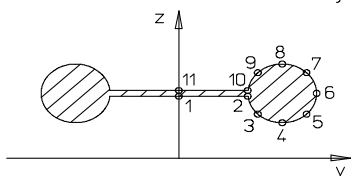
If two sections are defined calculation is made for appendage which has straight-line sides.



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.



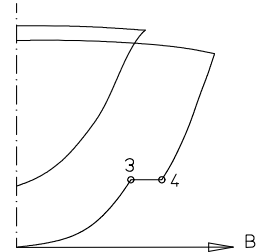
Sorting of input lines (curves) at section calculation
 (This sheet is omitted if norder =0 in data set 6 on data sheet 1)

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.

Example 1

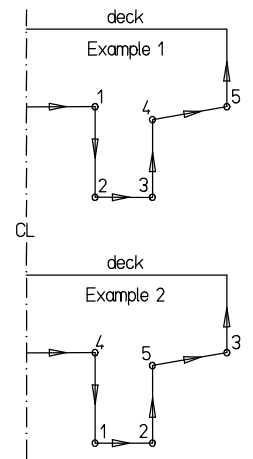
The points are already stated in correct sequence on data sheet 2. The only input is code =3.

Example 2

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.



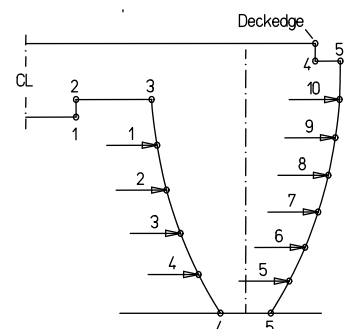
Example 3

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.

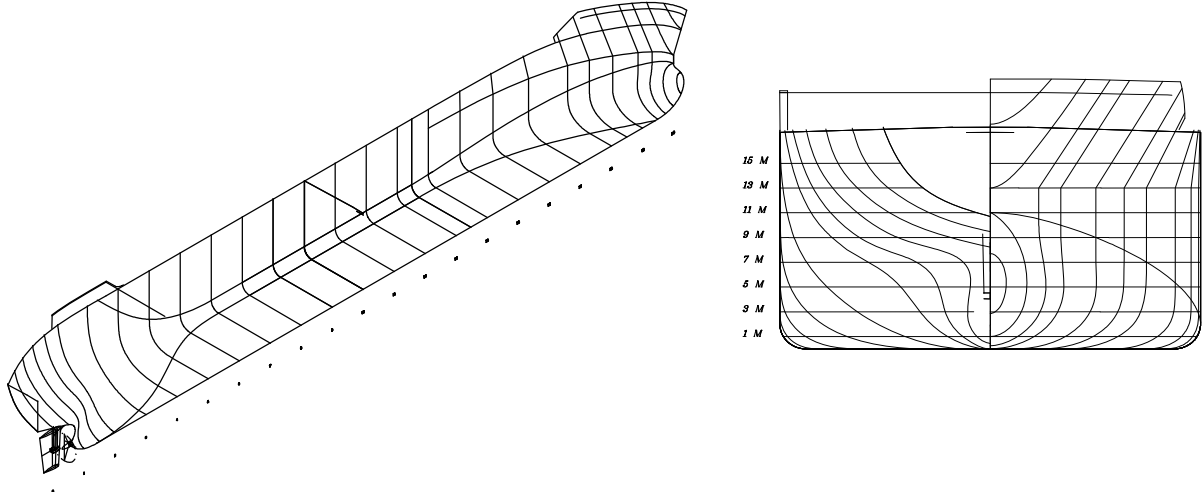
¹⁾ If several sets of data sheet 4 are stated e.g. one for aft body, another for the fore body etc., references are made by adding 100 to the first set, 200 to the next etc



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				
10	-4.200	0.000	17.900	1 0 1
10	-4.200	2.880	17.900	1 0 1
10	-4.200	8.134	17.741	2 0 1
10	-2.100	9.346	17.704	0 0 1
10	-1.050	9.937	17.686	0 0 1
10	0.000	10.509	17.669	0 0 1
10	1.050	11.057	17.653	0 0 1
10	2.100	11.576	17.637	0 0 1
10	3.150	12.064	17.622	0 0 1
10	4.200	12.520	17.608	0 0 1
\$ weather deck, camber6				
10	4.200	12.520	17.608	2 0 6
10	4.600	12.685	17.603	0 0 6
10	5.000	12.847	17.598	0 0 6
10	5.400	13.003	17.594	0 0 6
\$ weather deck, camber3				
10	5.400	13.003	17.594	2 0 3
10	6.000	13.230	17.587	0 0 3
10	6.600	13.446	17.580	0 0 3
10	7.200	13.653	17.574	0 0 3
\$ weather deck, camber4				
10	7.200	13.653	17.574	2 0 4
10	9.120	14.246	17.556	0 0 4
10	11.040	14.737	17.541	0 0 4
10	12.960	15.135	17.529	0 0 4
10	14.880	15.448	17.520	0 0 4
10	16.800	15.686	17.513	0 0 4
\$ weather deck, camber5				
10	16.800	15.686	17.513	2 0 5
10	19.088	15.886	17.506	0 0 5
10	21.377	16.008	17.503	0 0 5
10	23.665	16.073	17.501	0 0 5
10	25.953	16.096	17.500	0 0 5
10	28.242	16.100	17.500	1 0 5
10	30.400	16.100	17.500	0 0 5
\$ weather deck, camber1				
10	30.400	16.100	17.500	1 0 1
10	118.300	16.100	17.500	2 0 1
10	122.550	16.088	17.500	0 0 1
10	126.800	16.053	17.501	0 0 1
10	131.050	15.992	17.503	0 0 1
10	135.300	15.908	17.506	0 0 1
10	139.550	15.785	17.510	0 0 1
10	143.800	15.527	17.517	0 0 1
10	148.050	15.018	17.533	0 0 1
10	152.300	14.119	17.560	0 0 1
10	156.550	12.699	17.603	0 0 1
10	160.800	10.727	17.663	0 0 1

\$ forecastle deck

10	160.800	12.438	20.532	2 0 2
10	162.708	11.336	20.557	0 0 2
10	164.616	10.118	20.585	0 0 2
10	166.525	8.772	20.615	0 0 2
10	168.433	7.149	20.652	0 0 2
10	170.341	5.000	20.700	2 0 2
10	171.067	3.860	20.700	0 0 2
10	171.430	3.145	20.700	0 0 2
10	171.793	2.219	20.700	0 0 2
10	172.156	0.000	20.700	0 0 2

\$* KNUCKLES

\$ even bottom

1.00	11.841	0.000	0.000	0
1.00	18.149	0.470	0.000	0
1.00	24.456	1.786	0.000	0
1.00	29.187	3.279	0.000	0
1.00	35.495	6.062	0.000	0
1.00	41.803	9.523	0.000	0
1.00	48.111	12.457	0.000	0
1.00	54.419	13.878	0.000	0
1.00	113.760	14.100	0.000	0
1.00	120.469	13.950	0.000	0
1.00	127.179	13.375	0.000	0
1.00	133.888	12.215	0.000	0
1.00	140.597	10.428	0.000	0
1.00	147.307	7.985	0.000	0
1.00	154.016	4.996	0.000	0
1.00	160.725	1.702	0.000	0
1.00	164.080	0.000	0.000	0

\$ lower fore knuckle

2.00	118.300	16.100	2.113	2
2.00	127.595	15.918	2.919	0
2.00	136.890	15.196	4.216	0
2.00	146.185	13.645	5.800	0
2.00	155.480	10.630	7.792	0
2.00	164.775	5.400	9.995	2
2.00	166.465	4.088	10.397	0
2.00	168.155	2.363	10.794	0
2.00	169.000	0.000	11.000	0

\$ upper fore knuckle

3.20	118.300	16.100	13.000	0
3.20	123.370	16.051	13.000	0
3.20	128.440	15.879	13.000	0
3.20	133.510	15.538	13.000	0
3.20	138.580	14.985	13.000	0
3.20	143.650	14.170	13.000	0
3.20	148.720	13.017	13.000	0
3.20	153.790	11.337	13.000	0
3.20	158.860	9.004	13.000	0
3.20	163.930	6.008	13.000	0
3.20	169.000	0.000	13.000	0

\$* CAMBER

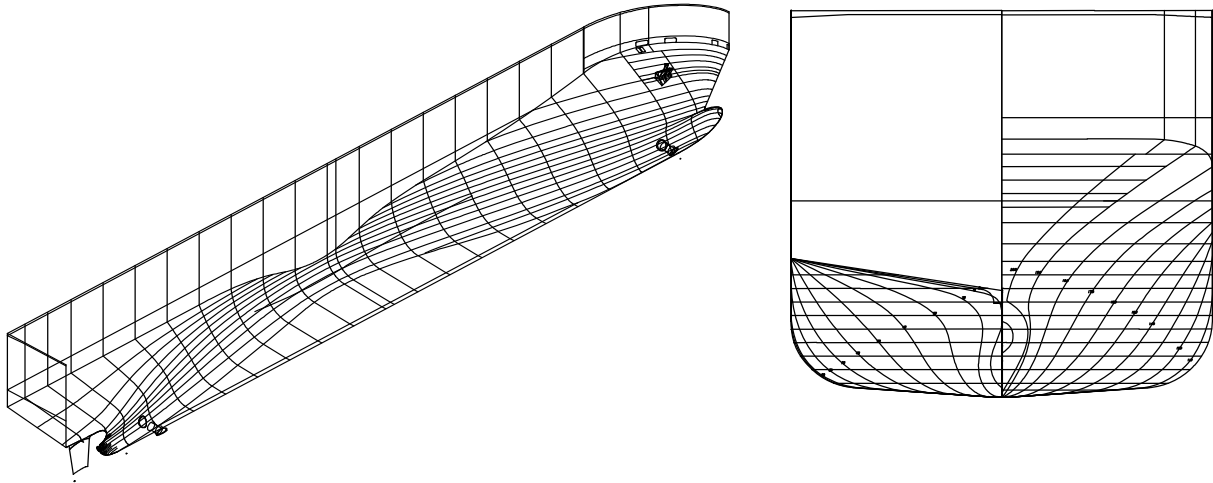
1	0.000	0.000
1	2.880	0.000
1	16.100	0.400
2	0.000	0.000
2	5.000	0.000
2	16.100	0.200
3	0.000	0.000
3	8.300	0.000
3	8.300	2.964
3	16.100	3.200
4	0.000	0.000
4	9.960	0.000
4	9.960	3.014
4	16.100	3.200
5	0.000	0.000
5	11.620	0.000
5	11.620	3.064
5	16.100	3.200
6	0.000	0.000
6	4.980	0.000
6	4.980	2.864
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	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	0.000	0.970	5.142	6.856	7.859	
0	0.000	0																		
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	1.982	4.640	7.803	9.467	10.301	
0	4.200	0																		
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	2.954	5.782	7.680	10.193	11.581	12.359
0	8.800	0																		
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																		
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																		
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																		
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			
0	16.091	0																		
0	33.600	0																		
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			
0	16.100	0																		
0	42.400	0																		
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	16.100	0																		
0	50.400	0																		
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	16.100	0																		
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
 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
 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
 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	2.2 0	54.078	6.851	0.402	0
3 0 -3.208 0 1.379 3 5 1.0	2.2 0	65.231	9.218	0.565	0
0.000 0.2 0.001 0.2 0.001 6.900 0.000 6.900	2.2 0	76.383	10.935	0.683	0
0.000 0.2 0.374 0.2 0.374 6.900 0.000 6.900	2.2 0	87.536	10.345	0.642	0
0.000 0.2 0.001 0.2 0.001 6.900 0.000 6.900	2.2 0	98.688	8.114	0.489	0
\$ ramp1	2.2 0	109.841	5.241	0.291	0
4 0 -4.641 0 -1.840 2 5 -1.000	2.2 0	120.993	2.768	0.121	0
0.000 7.850 -5.250 8.641 -15.550 10.195 -15.550 28.000 C	2.2 0	132.146	1.000	0.000	0
-11.340 28.200 -5.250 28.200 -5.250 8.642 0.000 7.851	\$ bow6				
0.000 7.850 -5.250 8.576 -15.550 10.195 -15.550 28.000 C	3.0 0	82.365	15.550	6.000	2
-11.340 28.200 -5.250 28.200 -5.250 8.577 0.000 7.851	3.0 0	91.002	15.143	6.000	0
\$ ramp2	3.0 0	99.639	14.066	6.000	0
5 0 -1.840 0 4.600 2 5 -1.000	3.0 0	108.276	12.630	6.000	0
0.000 7.850 -5.250 8.576 -15.550 10.195 -15.550 28.000 C	3.0 0	116.913	10.953	6.000	0
-11.340 28.200 -5.250 28.200 -5.250 8.577 0.000 7.851	3.0 0	125.550	9.054	6.000	0
0.000 7.400 -15.549 10.195 -15.550 10.195 -15.550 28.000 C	3.0 0	134.188	6.975	6.000	0
-15.549 28.000 -15.548 28.000 -15.548 10.196 0.000 7.401	3.0 0	142.825	4.846	6.000	0
\$ DECKS	3.0 0	151.462	2.956	6.000	0
\$ upper deck	3.0 0	160.099	1.673	6.000	0
1 0 -4.641 0.000 28.200 1 0.000 1	3.0 0	168.736	0.053	6.000	0
1 0 -4.641 11.340 28.200 1 0.000 1	\$ stern7				
1 0 -4.641 15.550 28.000 1 0.000 1	4.0 0	5.460	0.015	7.000	2
1 0 33.607 15.550 28.000 1 0.000 1	4.0 0	11.832	2.392	7.000	0
1 0 71.855 15.550 28.000 1 0.000 1	4.0 0	18.203	5.148	7.000	0
1 0 110.102 15.550 28.000 1 0.000 1	4.0 0	24.574	7.755	7.000	0
1 0 148.350 15.550 28.000 1 0.000 1	4.0 0	30.946	9.898	7.000	0
1 0 152.228 15.290 28.012 0 0.000 1	4.0 0	37.317	11.735	7.000	0
1 0 156.036 14.510 28.049 0 0.000 1	4.0 0	43.689	13.190	7.000	0
1 0 159.695 13.203 28.112 0 0.000 1	4.0 0	50.060	14.269	7.000	0
1 0 163.104 11.340 28.200 0 0.000 1	4.0 0	56.432	15.008	7.000	0
1 0 165.959 9.106 28.200 0 0.000 1	4.0 0	62.803	15.415	7.000	0
1 0 168.500 6.519 28.200 0 0.000 1	4.0 0	69.175	15.550	7.000	0
1 0 170.458 3.475 28.200 0 0.000 1	\$ bow7				
1 0 171.367 0.000 28.200 0 0.000 1	5.0 0	85.852	15.550	7.000	2
\$* KNUCKLES	5.0 0	93.846	15.156	7.000	0
\$ parallel keel	5.0 0	101.840	14.172	7.000	0
1.2 0 9.185 0.020 0.000 2	5.0 0	109.834	12.912	7.000	0
1.2 0 10.329 0.083 0.000 0	5.0 0	117.829	11.393	7.000	0
1.2 0 11.472 0.150 0.000 0	5.0 0	125.823	9.635	7.000	0
1.2 0 12.616 0.221 0.000 0	5.0 0	133.817	7.683	7.000	0
1.2 0 13.759 0.303 0.000 0	5.0 0	141.811	5.634	7.000	0
1.2 0 14.903 0.396 0.000 0	5.0 0	149.806	3.617	7.000	0
1.2 0 16.047 0.503 0.000 0	5.0 0	157.800	1.730	7.000	0
1.2 0 17.190 0.620 0.000 0	5.0 0	165.794	0.050	7.000	0
1.2 0 18.334 0.744 0.000 0	\$ stern8				
1.2 0 19.477 0.871 0.000 0	12.0 0	-4.641	1.013	8.000	2
1.2 0 20.621 1.000 0.000 1	12.0 0	2.402	2.375	8.000	0
1.2 0 132.146 1.000 0.000 1	12.0 0	9.445	4.142	8.000	0
\$ even bottom	12.0 0	16.488	6.875	8.000	0
2.2 0 20.621 1.000 0.000 2	12.0 0	23.530	9.427	8.000	0
2.2 0 31.773 2.586 0.109 0	12.0 0	30.573	11.385	8.000	0
2.2 0 42.926 4.604 0.248 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

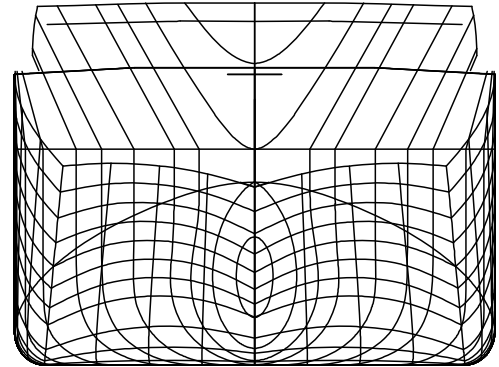
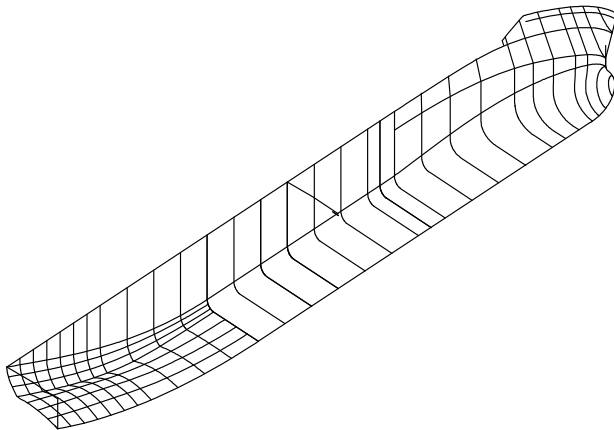
\$ bow11.3				
17.0 0	103.730	15.550	11.300	2
17.0 0	110.053	15.211	11.300	0
17.0 0	116.376	14.701	11.300	0
17.0 0	122.699	13.843	11.300	0
17.0 0	129.023	12.527	11.300	0
17.0 0	135.346	10.968	11.300	0
17.0 0	141.669	9.279	11.300	0
17.0 0	147.992	7.440	11.300	0
17.0 0	154.315	5.451	11.300	0
17.0 0	160.639	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

								0	24.750	0
\$* CAMBER								3.108	3.378	3.802 4.127 4.630 5.070 5.571
1	0.000	0.000						0	29.250	0
1	11.340	0.000						3.930	4.258	4.780 5.191 5.850 6.459 7.150
1	15.550	0.200						0	33.000	0
								4.635	5.013	5.619 6.105 6.895 7.615 8.410
\$* WATERLINES								0	37.750	0
1								5.532	5.973	6.685 7.265 8.218 9.053 9.906
	0.750	1.000	1.500	2.000	3.000	4.000	5.000	0	41.250	0
0	-4.641	0						6.191	6.678	7.463 8.104 9.161 10.062 10.925
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	46.250	0
0	-3.900	0						7.128	7.682	8.560 9.273 10.430 11.383 12.221
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	49.500	0
0	-3.150	0						7.739	8.337	9.270 10.014 11.196 12.143 12.940
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	57.750	0
0	-1.800	0						9.245	9.968	11.007 11.773 12.884 13.693 14.314
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	66.000	0
0	-0.600	0						10.535	11.376	12.453 13.176 14.127 14.730 15.134
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	74.250	0
0	0.600	0						11.365	12.257	13.284 13.932 14.789 15.262 15.493
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	90.750	0
0	1.800	0						10.674	11.401	12.332 12.973 13.836 14.420 14.852
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	99.000	0
0	2.400	0						9.329	9.951	10.836 11.486 12.426 13.121 13.687
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	107.250	0
0	3.600	0						7.711	8.280	9.146 9.811 10.819 11.594 12.241
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	115.500	0
0	4.800	0						6.046	6.570	7.399 8.059 9.094 9.913 10.610
	0.000	0.000	0.000	0.240	0.553	0.000	0.000	0	123.750	0
0	5.400	0						4.461	4.909	5.657 6.280 7.296 8.117 8.820
	0.000	0.000	0.357	0.589	0.664	0.350	0.000	0	132.000	0
0	6.188	0						3.079	3.429	4.049 4.587 5.489 6.238 6.895
	0.216	0.448	0.720	0.841	0.792	0.479	0.114	0	140.250	0
0	7.219	0						1.939	2.235	2.734 3.147 3.822 4.392 4.932
	0.639	0.803	0.985	1.047	0.950	0.644	0.315	0	148.500	0
0	8.250	0						1.078	1.308	1.693 2.010 2.503 2.885 3.218
	0.845	0.982	1.152	1.212	1.099	0.806	0.518	0	156.750	0
0	10.200	0						0.589	0.744	1.022 1.280 1.725 2.016 2.113
	1.091	1.219	1.388	1.460	1.362	1.113	0.922	0	160.875	0
0	12.375	0						0.430	0.569	0.839 1.099 1.561 1.861 1.915
	1.314	1.460	1.647	1.729	1.690	1.526	1.437	0	162.938	0
0	16.500	0						0.310	0.459	0.746 1.023 1.520 1.847 1.914
	1.805	1.987	2.259	2.430	2.558	2.553	2.657	0	165.000	0
0	20.750	0						0.063	0.232	0.562 0.884 1.463 1.844 1.907
	2.433	2.658	3.005	3.257	3.592	3.828	4.136	0	167.062	0
0	24.750	0						0.000	0.000	0.000 0.494 1.264 1.731 1.761
	3.108	3.378	3.802	4.127	4.630	5.070	5.571	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 0	154.016	4.996	0.000	0
1 0 30.400 16.100 17.500 1 0 1	1.0 0	155.693	4.194	0.000	0
1 0 118.300 16.100 17.500 2 0 1	1.0 0	157.371	3.375	0.000	0
1 0 122.550 16.088 17.500 0 0 1	1.0 0	159.048	2.544	0.000	0
1 0 126.800 16.053 17.501 0 0 1	1.0 0	160.725	1.702	0.000	0
1 0 131.050 15.992 17.503 0 0 1	1.0 0	162.403	0.853	0.000	0
1 0 135.300 15.908 17.506 0 0 1	1.0 0	164.080	0.000	0.000	0
1 0 139.550 15.785 17.510 0 0 1					
1 0 143.800 15.527 17.517 0 0 1	\$ tunnel knuckle1	2.0 0	-4.200	3.152	11.499 2
1 0 148.050 15.018 17.533 0 0 1	2.0 0	2.135	3.221	9.732	0
1 0 152.300 14.119 17.560 0 0 1	2.0 0	8.470	3.285	8.055	0
1 0 156.550 12.699 17.603 0 0 1	2.0 0	14.805	3.345	6.441	0
1 0 160.800 10.727 17.663 0 0 1	2.0 0	21.140	3.403	4.886	0
\$ forcastle deck, camber2	2.0 0	27.475	3.456	3.407	0
1 0 160.800 12.438 20.532 2 0 2	2.0 0	33.810	3.494	2.204	0
1 0 162.708 11.336 20.557 0 0 2	2.0 0	40.145	3.518	1.281	0
1 0 164.616 10.118 20.585 0 0 2	2.0 0	46.480	3.529	0.580	0
1 0 166.525 8.772 20.615 0 0 2	2.0 0	52.815	3.526	0.148	0
1 0 168.433 7.149 20.652 0 0 2	2.0 0	59.150	3.508	0.000	0
1 0 170.341 5.000 20.700 2 0 2	\$ tunnel knuckle2	3.0 0	-4.200	6.368	11.982 2
1 0 170.704 4.466 20.700 0 0 2	3.0 0	2.135	6.494	10.297	0
1 0 171.067 3.860 20.700 0 0 2	3.0 0	8.470	6.620	8.607	0
1 0 171.430 3.145 20.700 0 0 2	3.0 0	14.805	6.747	6.922	0
1 0 171.793 2.219 20.700 0 0 2	3.0 0	21.140	6.872	5.246	0
1 0 172.156 0.000 20.700 0 0 2	3.0 0	27.475	6.991	3.609	0
\$* KNUCKLES	3.0 0	33.810	7.068	2.293	0
\$ even bottom line	3.0 0	40.145	7.099	1.317	0
1.0 0 59.150 14.100 0.000 0	3.0 0	46.480	7.098	0.591	0
1.0 0 113.760 14.100 0.000 0	3.0 0	52.815	7.057	0.150	0
1.0 0 115.437 14.092 0.000 0	3.0 0	59.150	6.979	0.000	0
1.0 0 117.115 14.066 0.000 0	\$ tunnel knuckle3	4.0 0	-4.200	9.615	12.145 2
1.0 0 118.792 14.020 0.000 0	4.0 0	2.135	9.806	10.263	0
1.0 0 120.469 13.950 0.000 0	4.0 0	8.470	9.996	8.385	0
1.0 0 122.147 13.854 0.000 0	4.0 0	14.805	10.179	6.548	0
1.0 0 123.824 13.728 0.000 0	4.0 0	21.140	10.353	4.780	0
1.0 0 125.501 13.570 0.000 0	4.0 0	27.475	10.508	3.129	0
1.0 0 127.179 13.375 0.000 0	4.0 0	33.810	10.604	1.863	0
1.0 0 128.856 13.143 0.000 0	4.0 0	40.145	10.639	1.001	0
1.0 0 130.533 12.872 0.000 0	4.0 0	46.480	10.630	0.428	0
1.0 0 132.211 12.563 0.000 0	4.0 0	52.815	10.583	0.105	0
1.0 0 133.888 12.215 0.000 0	4.0 0	59.150	10.502	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					

\$ tunnel knuckle4					2	0.000	0.000
5.0 0	-4.200	12.863	11.986	2	5.000	0.000	
5.0 0	2.135	13.107	9.621	0	2	16.100	0.200
5.0 0	8.470	13.342	7.348	0	3	0.000	0.000
5.0 0	14.805	13.557	5.259	0	3	8.300	0.000
5.0 0	21.140	13.745	3.441	0	3	8.300	2.964
5.0 0	27.475	13.896	1.973	0	3	16.100	3.200
5.0 0	33.810	14.004	0.930	0	4	0.000	0.000
5.0 0	40.145	14.063	0.358	0	4	9.960	0.000
5.0 0	46.480	14.090	0.100	0	4	9.960	3.014
5.0 0	52.815	14.099	0.012	0	4	16.100	3.200
5.0 0	59.150	14.100	0.000	0	5	0.000	0.000
\$ tunnel knuckle5					5	11.620	0.000
6.0 0	-4.200	14.351	13.587	2	5	11.620	3.064
6.0 0	2.135	14.560	11.166	0	5	16.100	3.200
6.0 0	8.470	14.758	8.836	0	6	0.000	0.000
6.0 0	14.805	14.933	6.688	0	6	4.980	0.000
6.0 0	21.140	15.075	4.805	0	6	4.980	2.864
6.0 0	33.810	15.230	2.098	0	6	16.100	3.200
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					

\$* 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 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 14.102 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 12.005 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 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 normal 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.