VOLUME 4

COMPARTMENT DEFINITION

Contents:

4.1 Summary

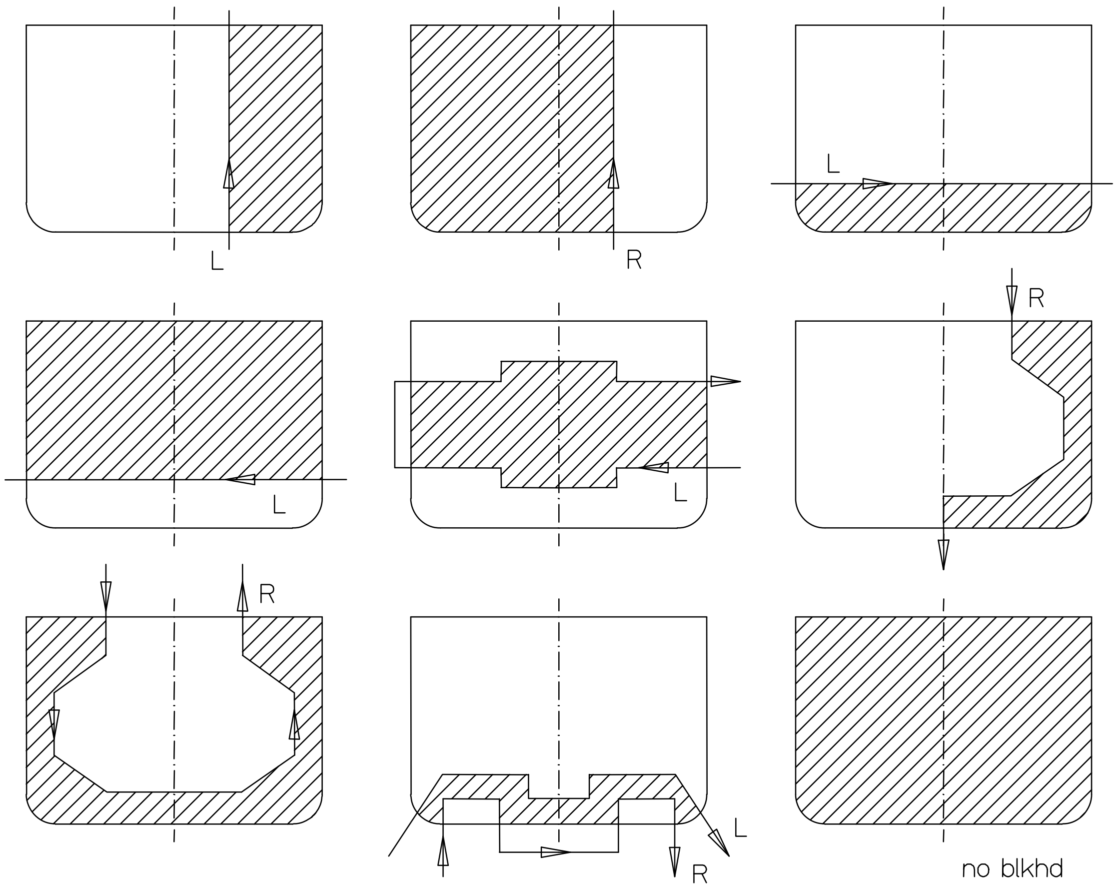
In a naval architecture program package the system for compartment definition is very important - especially in respect of accuracy and flexibility because many other calculations are based on compartment data. These are, for example:

- Capacity tables
- Sounding-ullage tables
- Grain heeling moment calculations
- Loading condition calculations
- Damage stability calculations

The input data are defined on two different types of data sheets, data sheet 6 and data sheet 7 resp. Data sheet 6 is used for description of tables. Data sheet 7 is used for description of individual compartments. Also, on data sheet 7 references to the tables on sheet 6 are made. This system reduces the amount of input data.
Data sheets 6, 6:1 and 6:2 are three different layouts of the same sheet. Data sheet 6:3 is used for definition of circular tanks.
There are 6 different types of data sheet 7, each used for its special purpose. Sheets 7, 7:1a, 7:1b are three different layouts of the same sheet. Sheet 7:2, 7:3 and 7:4 are slightly modified versions of data sheet 7. Data sheet 7:5 is used for description of compartments identical to already described compartments but with position different longitudinally or reflected in CL. Finally, data sheet 7:6 is a special sheet for cylindrical or conic tanks. All data sheets are enclosed.

Data sheet 6

Bulkhead contours:

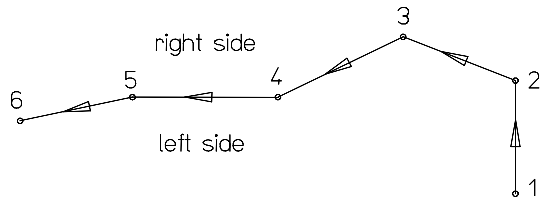


The picture above shows various compartment sections.

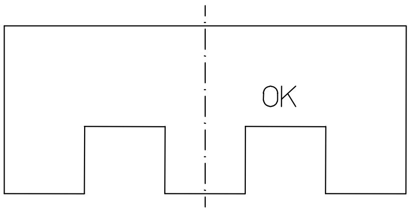
L "Left bulkhead" (stated as polygon)
R "Right bulkhead" (stated as polygon)

The word "bulkhead" is used for all limitation surfaces in the longitudinal direction i.e. real bulkhead but also decks etc.
The compartment section is defined as the area inside the frame section lying:

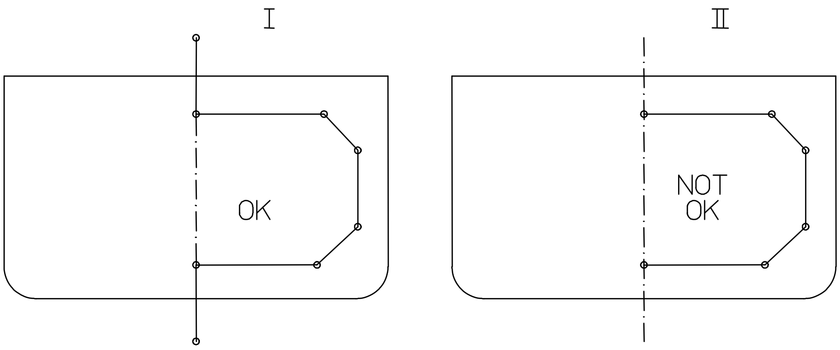
- to the right of the L-polygon
- to the left of the R-polygon



The sequence for the polygon points in input defines the direction on the polygon. When the polygon direction is given, the right and left sides of the polygon are defined.
The polygon points for L and R are stated on sheet 6 as a series of z, y coordinates. The references to these are made on sheet 7.
The program calculating the compartment section is very general and only and very obvious restrictions are the following:
1. The hull frame section must be a closed contour. The contour must not intersect itself.



2. The polygon describing L or R contour must not intersect itself. It must start and end outside the frame section.



Description of data sheet 6 item by item:

30 ***ship no*** is the same number as in hull form
print =1 suppresses the printing of input data. Usually used at rerunning when there is no need for the new list of input data
print1 =1 enables printing of the y and z coordinates for the final contour consisting of bulkhead and frame border for each calculation section
print2 =1 enables printing of the y and z coordinates for the final contour consisting of bulkhead and frame border for each calculated section

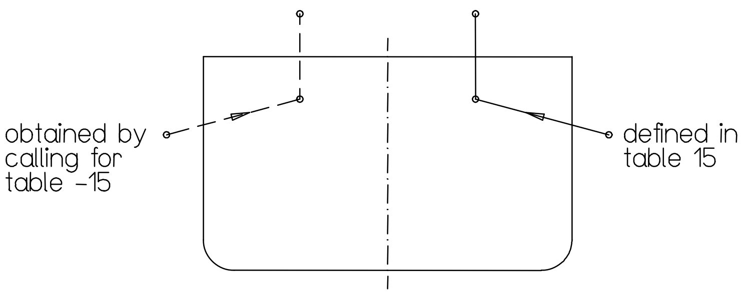
Data stored on sheets 6 and 7 as well as calculated sections, capacities, moments etc. are stored in computer memory. The storage capacity varies with installation but in some cases the following deleting possibility can be used to overcome memory limitations. (Deleted memory space is then made available for the new data).

delt =1 all tables from sheet 6 stored at preceding runs are deleted
delc =1 all compartment data from data sheet 7 stored at preceding runs are deleted
dels =1 all sections calculated in preceding runs are deleted

These deleting options have to be used carefully. The following examples give some guidance.
Example 1
Problem: Number of tables exceeds the limit.
Solution: Split the input data in several sets of sheets 6 and 7. Included will be only those tables on sheet 6 to which the reference is made on sheet 7 in the set in question. By stating ***delt*** =1 in each run, the previously stored tables will be deleted immediately and the space made available for the new run.
Example 2
delc =2 can be used when all previously calculated compartments are not any more relevant for some reason. All other ship related data would be kept, including tables on data sheet 6.
Example 3
If a new run for additional compartments, whose number of sections exceeds the limit, has to be made, and if all the calculations for the previous compartments are finished (programs SOUND, CVOL and VOLLC), ***dels*** =1 can be used to ensure necessary memory for the section in the new runs. Stored volumes, moments etc. for the previous compartments are, however still available for the other programs such as damage stability or loading conditions.

mult; all relevant data on sheets 6 and 7 are multiplied by this factor. For example, it can be used to convert units from feet to metric.
bmult, ***hmult***; these factors are used if only y respectively z coordinates are to be multiplied. This option is used if measures are taken from the drawings that have shrunk.
old; number 1 indicates that input data are stated for the old version of the program. The only modification made by the program here is adding two points outside the frame section in each table.

31 ***table no*** is a positive integer number between 11 and 10000. Tables don't have to be numbered in sequence, but this is recommended.
N.B. Negative number for a table in data sheet 7 only means that the table with the corresponding positive number, reflected about the CL, shall be used.



z coordinate is measured from the BL
y coordinate is measured from the CL, positive to starboard and negative to port

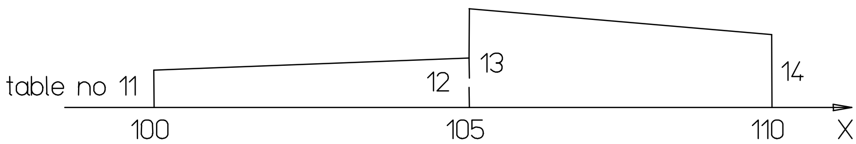
Data sheet 6:3
This sheet was created to avoid the time consuming job to calculate the polygon for circular and elliptic sections.

Data sheet 7
There are six alternative data sheets 7 to describe compartments. The first version, type 1, is described in detail below. The other types require just a few extra comments. The user is recommended to analyze which type or types are most useful for this job. Please note that various data sheets can be used in any mixed order except that data sheet 7:5 must be given after the compartments to which references are made.

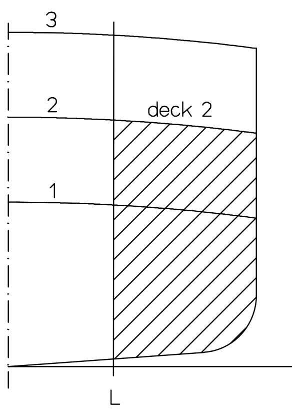
33 ***no of comp*** has to be a positive integer. This number is used in other programs for reference to the compartment in question.

type; this figure is pre-printed on data sheet and indicates to the program which type of data sheet has been used for description of the compartment in question.
add compts; specified compartments will be added or subtracted to the compartment defined below on the data sheet. For example data 3 7 –15 mean that compartments 3 and 7 should be added while compartment 15 should be subtracted from the calculated volume. The referred compartments must be described before the reference to them is made. This option is especially useful in the damage stability calculation. Assume for example that inside a main compartment two circular tanks are placed and they are not damaged. They contain liquids and free surface has to be considered. Capacity tables are also required for the tanks. For this reason they have to be described somehow, preferable on data sheet 7:6. In the damage stability calculation, the whole compartment is described as the flooded space from which the two circular tanks are subtracted.
N.B. This option to add or subtract compartments can be used on sheet 7 types 1, 2, 3 and 6. Maximum 7 compartments can be added or subtracted to the described compartment. Compartments that are added or subtracted cannot be described on sheet 7:5 or 7:6 or contain added or subtracted compartments itself.
name of comp; any text describing the compartment. Comp-no, type, added compartments and text must be stated in one line.

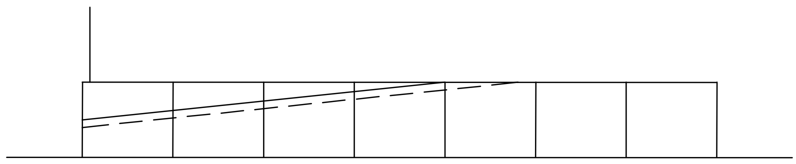
34 ***frame no dx L and R bulkheads***; each pair of lines describes one continuous part of the compartment. In the example below a double bottom tank is described. At frame 100 the tank section is defined by the table no 11. At frame no 105 the section is defined by table any 12. Between these two sections the bulkhead varies linearly.



At frame 105 there is a step, therefore the part between frames 105 and 110 has to be described on two new lines.
N.B. This means that the input data for bulkheads between which the interpolation occurs have to contain the same number of points.
deck no refers to the corresponding number of the deck in the hull form. If we suppose that the deck number is 2, the frame form of the vessel will be limited upwards by the deck number 2define on sheet 2. Normally only one deck is used (generally the main deck). When, for example, the double bottom tank has to be defined, the top of the tank is defined with the longitudinal bulkhead (see example on sheet 7). Deck number, however, must always be given, even if it does not limit the compartment in question.



no of cuts defines how many cuts have to be calculated for the compartment in question. The program uses Simpson's first (1-4-1) rule. Therefore, the number of cuts has to be odd. Choice of the number of cuts depends of the required accuracy. Although the experience shows that only very long compartments require more than five (5) cuts, in case of fore and aft peaks compartments, where the shape of the ship changes rapidly, more cuts are necessary. Of course, accuracy requirement varies with the type of calculation to be preformed.
N.B. If sounding or ullage tables for trimmed condition have to be calculated there is need for about 5-9 sections. Similar definition is required for parallel tanks due to the trim effect when the liquid surface meets the upper or lower tank boundaries.



Calculation of sounding table for a double bottom tank having a tank top parallel to the baseline.

perm; may be entered or left blank. If this factor is left blank the gross-volume of the compartment is considered. It is also possible to give permeability on sheet 7a, 7b and 7c for volume calculations and on sheet 10 for damage stability.
N.B. Permeability must not be given twice because the product of the given permeability will be used.

Data sheet 7 type 2

The only difference with data sheet 7 type 1 is that a part of the compartment is described on one line instead of two lines, which reduces the number of input data compared to type 1. Compartments where the bulkheads vary along the length of the part of the compartment cannot be described on this sheet.

Data sheet 7 type 3

In some cases the shape of a longitudinal bulkhead is specified forward or aft of the compartment. If data sheet 7 type 1 was used and if the bulkhead is not parallel to the longitudinal direction of the ship, the shape of the bulkhead at the aft and fore end of the compartment would have to be calculated manually. If data sheet type 3 is used manual calculation is avoided.

Data sheet 7 type 4

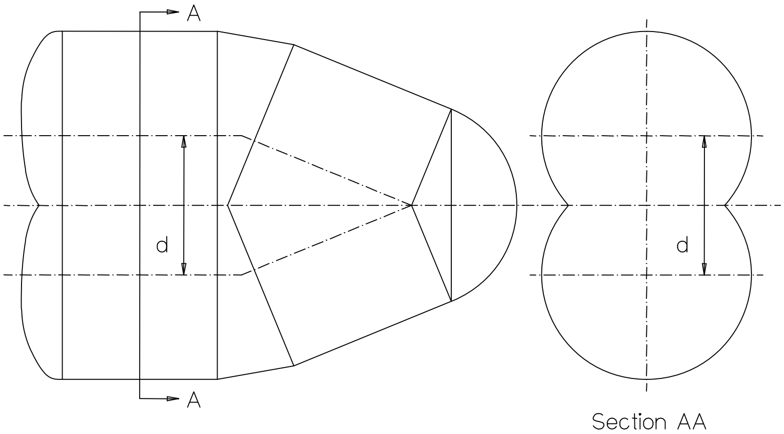
This data sheet is almost identical to data sheet 7 type 2. One compartment is described on each line. This sheet is the most compressed form of compartment description but also implies more restrictions.

Data sheet 7 type 5

In some cases there are more compartments with identical shapes and volumes. Anyway, for the purpose of the identification texts as well as different centers of gravities, they all need to be defined (e.g. as basis for the loading condition or damage stability calculations). It has to be noted that no real calculation is performed for the tanks described on this sheet. It can therefore not be used to describe a compartment that has different capacity than the compartment to which the reference is made (e.g. due to the hull shape in the fore or aft body).

Data sheet 7 type 6

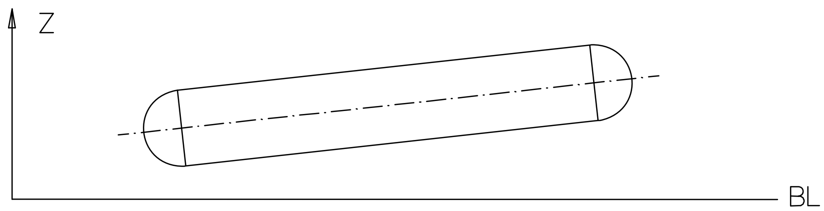
This sheet is specially designed to deal with tank shapes often found in gas carriers. Each two lines define a complete tank. Several pairs of two lines enable description of more complicated tanks. Many complicated shapes of tanks may occur in gas tankers and one particular shape that is taken into consideration is the “twin-tank”.



Value ***d*** is the only additional data, compared to the circular or conic tank, necessary to define the twin tank shape.
For the connecting part between the various geometries some approximation has to be used. The program is written for tanks placed in the longitudinal direction and perpendicular to the longitudinal direction.

Tanks located in the longitudinal direction

In this case program allows some slope to the BL.



The volume is compensated for the slope in the calculation. However, for slopes larges then 1:5, the accuracy is not satisfactory.

<u>**34**</u> ***fr dx y z*** define the coordinates for point P resp P’
d is sed only for twin tanks, see figure. Otherwise d =0.
R1 R2 R3 See the sketches.
There are, of course, geometric restrictions in the relation between R1, R2 and R3:

- R1 > R3
- for semi-sphere state R2 = R1 and R3 =0
- for no end part state R2 = R3 =0

perm same as in standard compartment definition.
SB/P =0; the whole tank is calculated.
SB/P =1; only SB part of the tank is calculated.
SB/P =2; only P part of the tank is calculated.
CS =0; normally.
CS =1 the tank is placed longitudinally with a slope to the longitudinal direction. For example, if a tank has two different ***d*** values of two ends tank section perpendicular to the longitudinal direction is an ellipse. However, in some cases the tanks have such a shape that this section is a circle. In such a case give ***CS*** =1.
CS =-1; the tank is positioned vertically.

Although most of the times two lines are enough to describe the complete tank any number of sets can be entered for each compartment.

Restrictions: Only the following alternatives can be calculated

Tanks positioned longitudinally

Indicated by ***y***1 = ***y2***
Longitudinal slope ≤ 1/5 to have reasonable accuracy.
If ***d*** is stated this refers to the y direction.

Tanks positioned perpendicular to the longitudinal direction

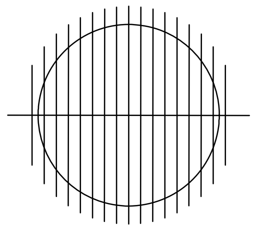
Indicated by ***fr1*** = ***fr2*** ***dx1*** = ***dx2***
a) Vertical ***CS*** =-1; ***y1*** = ***y2***
b) Slope or horizontal ***CS*** = 0
R1, ***R2***, ***R3*** and ***d*** have to have the same value for P and P'.
If ***d*** is stated this refers to the x direction.

Accuracy

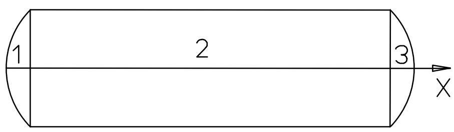
The program works in such a way that it first calculates the transversal sections from the input data and then the standard program calculates the volumes at various levels from these sections. As a consequence of this, the accuracy depends on the number of calculated sections and the number of generated points for each section.
User can increase or decrease accuracy by adding two values ***n***1 and ***n2*** directly after the ***CS*** value in data group **34**.

n1 defines number of the contour points on one section
Default value =24. Max. value =100. Min. value =5.

For a transverse cylinder
n2 defines total number of sections.
Default value =25. No max. value for ***n2***. Min. value =9.



For a longitudinal cylinder
n2 states the number of sections in each of the three parts of the cylinder.
Default value =11. No max. value. Min. value =5.



N.B. This program has been developed for loading conditions and damage stability calculations that means that for complicated shapes the accuracy is usually not satisfactory for making the capacity tables.

Execution and check of input, plotting

Experience shows that description of all compartments for a complicated ship is almost always connected with many mistakes from the user. This fact has been taken in consideration through the development of the programs. As a result, program VOL1 reads input data and performs a logic check.
Those checks are:

- Unique number used for each table and compartment.
- The same number of points in two tables between which the interpolation is performed (sheet 6).
- Correct number of numbers on each data set (when possible to check).
- A number of various other checks.

After running the VOL1 program, the input is listed together with the error messages above. If there are no errors, user can continue with execution of VOL2. Otherwise, any error that occurs has to be corrected and program VOL1 repeated.

N.B. When correcting or adding new compartments, only modified tables and compartments have to be included.

Exception

Compartments referring to the tables that have been modified have t be re-input even if no modification in the definition on sheet 7 has been made.

Description of longitudinal bulkheads

	←				normally blank					→
ship no	print	print1	print2	delt	delc	dels	mult	bmult	hmult	old
30										

print =1	input data are not printed	delts =1	delete all sections saved earlier
print1 =1	bulkhead coordinates printed for all calculated sections	mult	factor for multiplication of all coordinates
print2 =1	as above but including frame sections and the final compartment sections coordinates	bmult	factor for multiplication of breadths
delt =1	delete all tables saved earlier	hmult	factor for multiplication of heights
delc =1	delete all compartments saved earlier	old =1	generates two extra points, one below the first point, one above the last point

Maximum number of tables is 2000. Table numbers must be positive and >10 and ≤ 10000.

	table no	
31		
	z=	y=

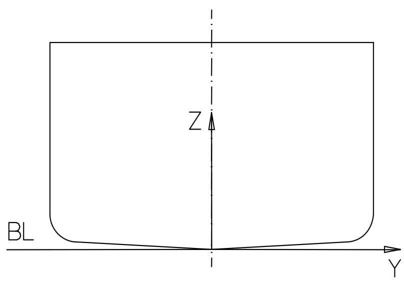
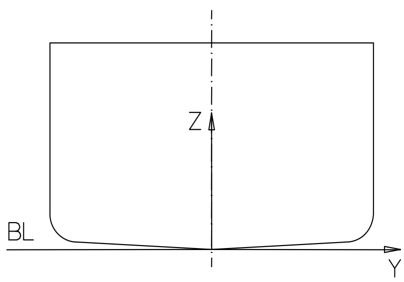
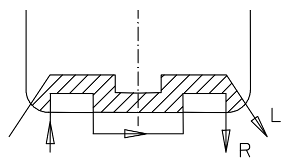


	table no	
31		
	z=	y=



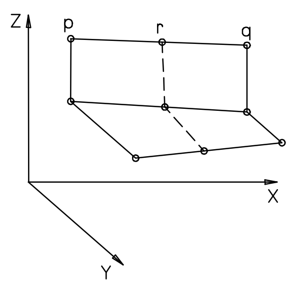
N.B. One complete table is entered on each line. Use ‘c’ for continuation if necessary.
The last table has to be followed by one blank line.

The compartment cross section is defined as the area that lies to the right from the left bulkhead and to the left from the right bulkhead and within the frame cross section (append. not included).



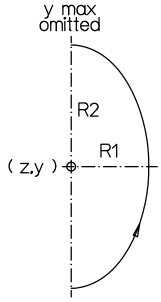
If the bulkhead form is changing longitudinally, more bulkhead forms for more longitudinal positions have to be defined. Sketch shows interpolation of the bulkhead that is between two defined bulkhead forms. Geometrically explanation is that the respective points of the defined bulkheads are connected with the line that is cross-sectioned on the longitudinal position of the wanted bulkhead.

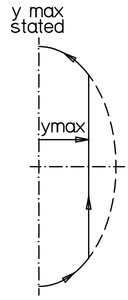
p and q defined bulkhead forms
r interpolated bulkhead form



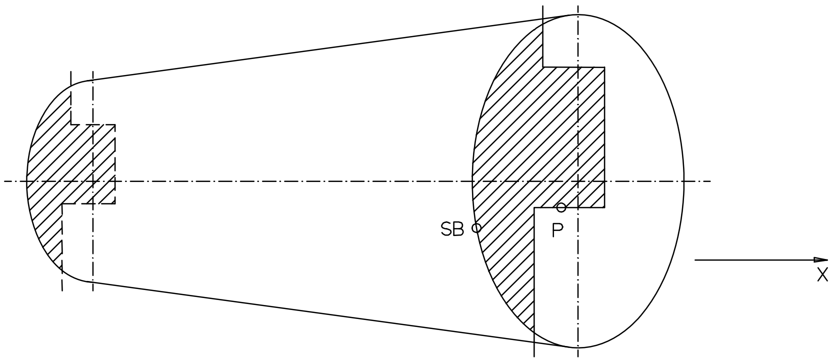
Description of circular or elliptic sections

table no	z	y	R1	R2	npt	SB/P 1/2	ymax (optional)





N.B. A blank line has to be entered between the last table and the first compartment.
Reflection over CL cannot be used for these tables.
Ymax has to be stated for both tables when longitudinal interpolation is used
SB/P has to be the same for both tables when longitudinal interpolation is used



This sheet is used when there is a need for description of compartment sections with circular or elliptic form. Each line describes one table. Decimal 3 or 4 has to be added to the table number;

decimal =3 normally
decimal =4 corresponds to the decimal =1 for the standard tables i.e. compartment not connected with the hull
(z,y) center of the ellipse or circle
npt number of polygon points to be calculated on the ellipse or circle. Accuracy and computer time depend on Npt. Restrictions: $10 \leq Npt \leq 30$.
SB/P Indicates whether SB or P contour has to be generated.
ymax optional; it gives some extra possibilities for description of tanks

Tables described here are stored in memory and can be referred to on data sheet 7 in exactly the same way as other tables described on data sheet 6. For each section that has to be calculated, values z, y, R1, R2, and ymax are interpolated linearly from the two tables referred to.

Example above: Tank is limited by with a conic body and a stepped bulkhead. Semi-circle is described on this sheet and referred to as SB bulkhead on the data sheet 7. Stepped bulkhead is described normally and referred to as P bulkhead on sheet 7.

Description of compartments

	no of comp	type	add compt	name of the compartment
33		1		

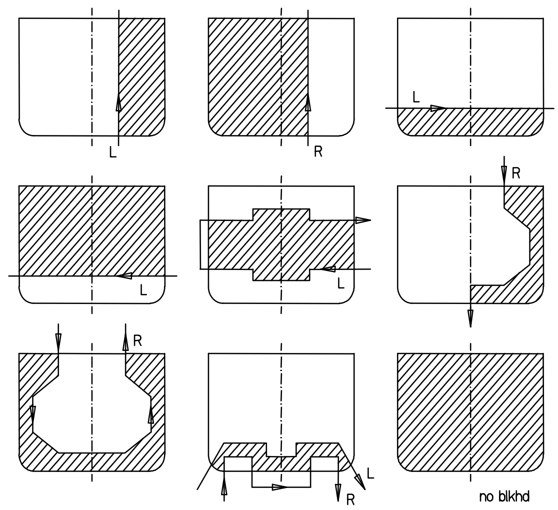
	frame no	dx	L blkd	R blkd	deck no	number of cuts	perm
34					-	-	-
35							
					-	-	-
					-	-	-
					-	-	-
					-	-	-
					-	-	-
					-	-	-
					-	-	-
	one blank line						

<u>frame no and dx</u>
Enter the longitudinal coordinate
Example: Frame no =17, dx =0.42 means 0.42m forward from the frame number 17.
<u>L and R bulkhead</u>
Enter the table numbers that refer to the data on data sheet 6.
<u>deck no</u>
Refers to the deck number given in hull form on data sheet 2.
<u>number of cuts</u>
Has to be 1, 3, 5 etc. Simpson's first rule is used except for 1 cut in which case the calculation is made as for the parallel part. Negative sign means the neg. part of compartment.
<u>perm</u>
This is the factor by which the calculated volumes are multiplied. It can be left blank here and then entered in the data for the sounding table or for the damage stability.

	no of comp	type	add compt	name of the compartment
33		1		

	frame no	dx	L blkd	R blkd	deck no	number of cuts	perm
34					-	-	-
35							
					-	-	-
					-	-	-
					-	-	-
					-	-	-
					-	-	-
					-	-	-
					-	-	-
	one blank line						

<u>Other points</u>
Every couple of two lines describes one continuous part of the compartment. Data given for the different parts are therefore totally independent from each other (maximum is 30 lines)
Tot. number of comp. is 2000.
Tot. number of sections (cuts) for all comp. < 10000



N.B. The very last compartment to be followed by two blank lines.

Description of compartments

This sheet is only an alternative layout to data sheet 7. Therefore, for description see data sheet 7.

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
					-	-	-
	one blank line						

N.B. The very last compartment to be followed by two blank lines.

Description of compartments

This sheet is only an alternative layout to data sheet 7. Therefore, for description see data sheet 7.

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
	one blank line						

	no of comp		type	add compt		name of the comp	
33			1				
	frame	dx	L	R	deck	cuts	perm
34					-	-	-
35							
					-	-	-
	one blank line						

N.B. The very last compartment to be followed by two blank lines.

Description of compartments

	no of comp	type	add compt	name of the comp			
33		2					
	from frame	to frame	L blkd	R blkd	deck no	cuts	perm
34							
35							
	one blank line						

	no of comp	type	add compt	name of the comp			
33		2					
	from frame	to frame	L blkd	R blkd	deck no	cuts	perm
34							
35							
	one blank line						

	no of comp	type	add compt	name of the comp			
33		2					
	from frame	to frame	L blkd	R blkd	deck no	cuts	perm
34							
35							
	one blank line						

	no of comp	type	add compt	name of the comp			
33		2					
	from frame	to frame	L blkd	R blkd	deck no	cuts	perm
34							
35							
	one blank line						

This data sheet (type 2) is simplified data sheet type 1. It can be used when SB and P bulkhead are parallel to the longitudinal direction of the ship i.e. the bulkheads can be described with one table only. In such a case each line on this data sheet describes one part of the compartment.

Description of compartments

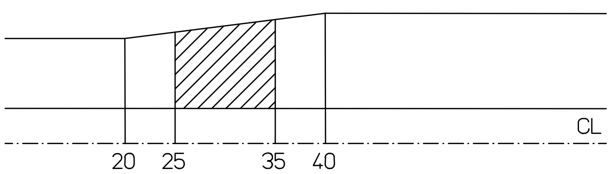
	no of comp	type	add compt	name of the comp
33		3		

	limits fr	L bulkhead fr	L bulkhead tab	R bulkhead fr	R bulkhead tab	deck no	cuts	perm
34						-	-	-
35								
						-	-	-
						-	-	-
						-	-	-
						-	-	-
						-	-	-
	one blank line							

	no of comp	type	add compt	name of the comp
33		3		

	limits fr	L bulkhead fr	L bulkhead tab	R bulkhead fr	R bulkhead tab	deck no	cuts	perm
34						-	-	-
35								
						-	-	-
						-	-	-
						-	-	-
						-	-	-
						-	-	-
	one blank line							

This data sheet (type 3) is used when the coordinates for the longitudinal bulkheads are defined outside the compartment (longitudinally). In the following sketch, compartment that spreads from frame 25 to frame 35 has to be described but the described bulkheads with their coordinates are at frames 20 and 40.



Data sheet 7:4
Type =4

Description of compartments

Each compartment has to be contained on one line.

	no of comp	type	from frame	to frame	L blkd	R blkd	deck no	number of cuts	perm	name of the comp
33		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
		4								
	one blank line									

This data sheet is convenient for use if many simple compartments have to be described. Each line describes one compartment.

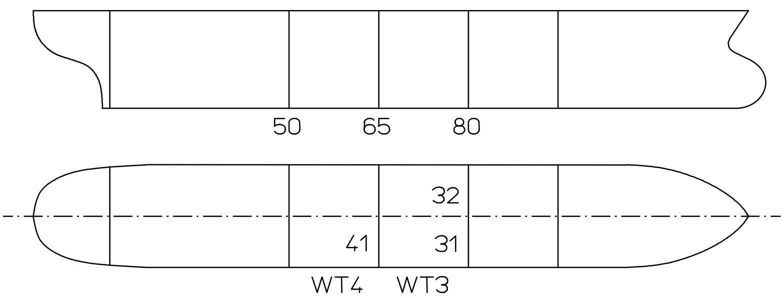
A blank line is allowed but not necessary after each line of compartment description. If there is an error in data, the program skips all data until the next blank line.

Data sheet 7:5
Type =5

Description of compartments

Each compartment has to be contained on one line.
This data sheet is used to describe compartments identical with the compartments already described. Normally, this limits the use of the data sheet to the compartments positioned in the parallel part of the ship.

	no of comp	type	equal comp.	moved		refl. in CL	name of the comp
				from frame	to frame		
33		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
		5					
	one blank line						



Example

31	5	41	50	65	0	Wing tank no 3 SB
32	5	31	0	0	1	Wing tank no 3 P

In this example wing tank 4 is described as compartment no 41 on SB side and has the aft end bulkhead on frame 50.
Wing tank 3 SB is identical with wing tank 4 but with aft end bulkhead on frame 65.
Wing tank 3 P is identical with wing tank 2 SB.

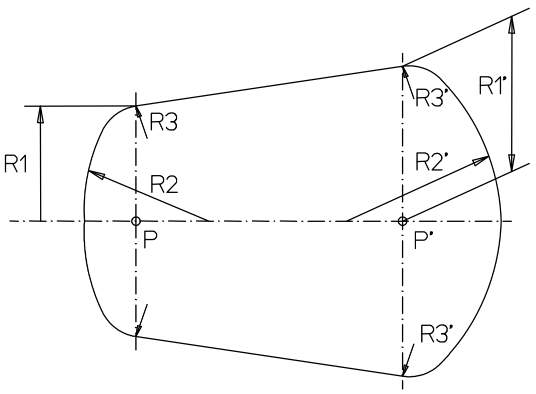
A blank line is allowed but not necessary after each line of compartment description. If there is an error in data, the program skips all data until the next blank line.

Description of compartments with circular or spherical sections

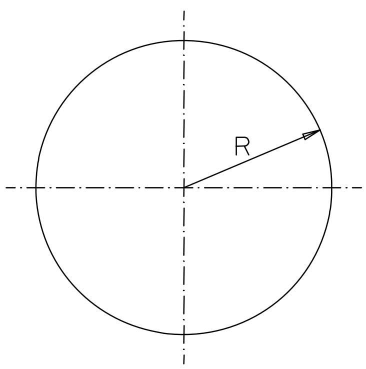
	no of comp	type	add compt	name of the compartment
33		6		

	fr	dx	y	z	d	R1	R2	R3	perm	SB/P	CS
34 for P											
35 for P’											
for P											
for P’											
for P											
for P’											
for P											
for P’											
for P											
for P’											
for P											
for P’											

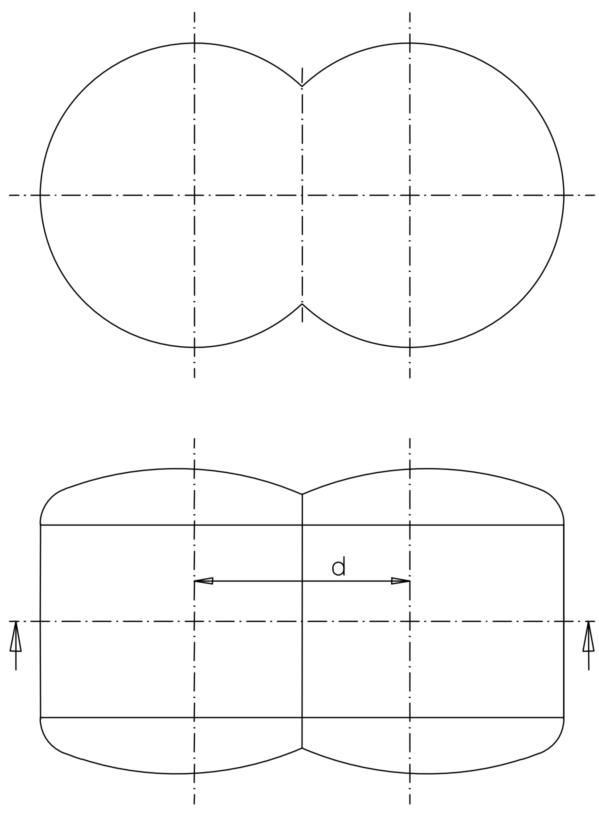
Cylindrical or conic tank



Spherical tank



Twin tank



For the spherical tank, enter R1=R
R2=R
R3=0

4.2 Program CVOL

Program CVOL calculates tables of compartment capacity, center of gravity, moment of inertia etc. for various filling levels. This program can be run at any time after successful completion of programs VOL1 and VOL2. Data sheet cvol follows on the next page.

Volume calculations

	ship no	inp	outp	save	p1
40					

Following data are omitted if inp above =0.

	comp no	perm	distw
40			

Calculation of volumes, centers of gravity etc. for the compartments described on data sheets 6 and 7. Calculated data are printed and/or saved in the computer for the later use of other programs - loading conditions.

ship no	number entered on data sheet 1
inp =0	all compartments saved on disk are calculated
inp =1	only specified compartments are calculated
outp =0	standard printing of capacity tables for many levels
outp =1	printing of full capacities only
outp =-1	most complete printing
save =0	no saving (except for total volume for tonnage
save =1	calculated results are saved on disk
p1 =0	normal print
p1 =1	print of total area for each calculated section
p1 =2	as above but also section coordinates
comp no	refers to numbers given on data sheet 7
perm	has to stated here if it was not given in data sheet 7. (Example: for 2% steel the perm =0.98)
distw	spacing (interval) between calculated waterlines. Total number of waterlines has to be less than 40. It is best to enter distw =0 in which case the computer chooses the suitable number of waterlines

Several examples of various print options

Example 1:

	ship no	inp	outp	save	p1
40	402	0	1		

```
                                  VOLUME  CENTRE OF GRAVITY FROM  INERTIA
NO COMPARTMENT                             LPP/2    BL       CL     MOMENT
 1 CARGO TANK No.1 SB             2673.4   66.35  10.423   5.073   2424.2
 2 CARGO TANK No.1 PS             2673.4   66.35  10.423  -5.073   2424.2
 3 CARGO TANK No.2 SB             4615.8   46.82  10.110   6.778   4935.7
 4 CARGO TANK No.2 PS             4615.8   46.82  10.110  -6.778   4935.7
 5 CARGO TANK No.3 SB             4809.6   24.63  10.052   7.070   5199.5
 6 CARGO TANK No.3 PS             4809.6   24.63  10.052  -7.070   5199.5
```

Example 2:

	ship no	inp	outp	save	p1
40	402	1	0		

Following data are omitted if inp above = 0.

	comp no	perm	distw
40	4		

```
402
CARGO TANK No.2
COMP. NO     4

   LEVEL FROM    VOLUME    CENTRE OF GRAVITY FROM  INERTIA
   BL  BOTTOM      CUBM     LPP/2    BL       CL     MOMENT
2.150   0.000       0.0
2.650   0.500     133.0    46.557   2.400  -6.783   3612.4
3.150   1.000     266.9    46.577   2.651  -6.801   3667.7
3.650   1.500     401.7    46.596   2.902  -6.819   3724.9
4.150   2.000     537.3    46.615   3.154  -6.838   3783.8
4.650   2.500     673.8    46.635   3.407  -6.856   3844.4
5.150   3.000     812.4    46.655   3.662  -6.871   4580.9
5.650   3.500     962.2    46.680   3.932  -6.853   4580.9
```

Example 3:

	ship no	inp	outp	save	p1
40	402	1	-1		

Following data are omitted if inp above = 0.

	comp no	perm	distw
40	4		

```
402
CARGO TANK No.2 PS
COMP. NO     4

   LEVEL FROM     VOLUME   CENTRE OF GRAVITY FROM   AREA    CENTRE OF AREA  MOMENT OF INERTIA
   BL  BOTTOM      CUBM     LPP/2    BL       CL      M2    LPP/2     CL      TRANSV LONGITUD
2.150   0.000       0.0
2.650   0.500     133.0    46.557   2.400  -6.783   268.4   46.577  -6.800   3612.4  11577.8
3.150   1.000     266.9    46.577   2.651  -6.801   270.1   46.616  -6.836   3667.7  11676.0
3.650   1.500     401.7    46.596   2.902  -6.819   271.9   46.654  -6.873   3724.9  11773.3
4.150   2.000     537.3    46.615   3.154  -6.838   273.6   46.692  -6.910   3783.8  11869.8
4.650   2.500     673.8    46.635   3.407  -6.856   275.4   46.729  -6.947   3844.4  11964.9
5.150   3.000     812.4    46.655   3.662  -6.871   301.2   46.818  -6.756   4580.9  12472.6
```

4.3 Program VOLLC

Capacities, centers of gravity etc. for various heeling angles

Program VOLLC calculates capacities and corresponding centers of gravity for various angles of heel. Results are used both in damage and intact stability for calculations of free surfaces in tanks. All calculated values are stored on disc for subsequent access from the other programs. Before running VOLLC, programs STHYD (for stability),VOL1 and VOL2 have to be accomplished. Program VOLLC will use the angles of heel stated in the data sheet sth.

Input data

All input data are in one line as follows:

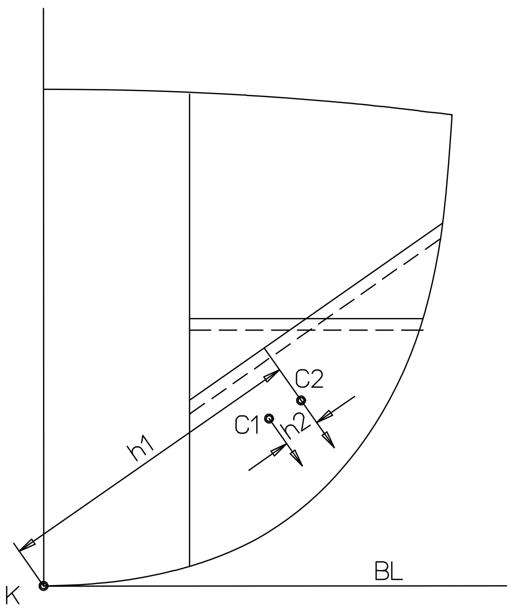
i1	0	0	i2

i1 =1; prints volume and heeling levers for various fillings and angles stated on the sheet sth
i1 =2; prints volume and center of gravity for full tank only
i2 =0; calculates for SB heeling only
i2 =1; calculates both for SB and P heeling

Value ***i2*** =1 is necessary if damage stability calculation will be performed both to SB and P side.

Note: It is not allowed to run some compartments with ***i2*** =0 and others with ***i2*** =1. Therefore, one has to decide form the beginning which ***i2*** value will be used. If ***i2*** =0 has been used instead of ***i2*** =1, all compartments have to be rerun through the VOL1 and VOL2 programs. To reuse the storage, put ***delt***=***delc***=***dels*** =1 in the first line of data sheet 6.

For ***i1*** =2 two arms are printed, h1 and h2. Arm h1 is used to calculate the heeling moment around the keel from flooded water in the damaged compartment. Arm h2 is used to calculate the heeling moment due to the free movement of the liquid.



C1 center of gravity for unheeled liquid
C2 center of gravity for heeled liquid
h1 total lever around the keel
h2 change in the lever due to the free surface

Examples for two print options

Example 1: *i1* =0

```
SEAKING HYDROSTATIC SYSTEM      2001-11-15 TIME 18.03    PAGE   1

 VOLUMES AND MOMENTS FOR COMP NO     1
 CARGO TANK No.1 SB

 THE FIRST LINE FOR EACH LEVEL=VOLUMELEVER AROUND KEEL
 THE SECOND LINE=HEELING LEVER DUE TO TRANSFER OF THE VOLUME
 LONG C.G. FROM LPP/2 FOR FULL COMPT =   66.346
  THE LAST COLUMN = CG ABOVE BL (ANGLE=0)
```

VOLUME	LEVEL	LEVERS AT FOLLOWING ANGLES OF HEEL										
	BL	0.10	5.00	10.00	20.00	30.00	-0.10	-5.00	-10.00	-20.00	-30.00	
400.00	5.06	4.674	5.270	5.856	6.932	7.934	4.648	4.020	3.365	2.011	0.571	3.723
		0.006	0.303	0.619	1.279	2.036	-0.006	-0.299	-0.578	-1.095	-1.603	
600.00	6.24	4.792	5.378	5.933	6.923	7.768	4.768	4.147	3.482	2.096	0.628	4.352
		0.005	0.237	0.470	0.943	1.452	-0.005	-0.236	-0.470	-0.908	-1.335	
800.00	7.40	4.848	5.427	5.981	6.981	7.824	4.823	4.206	3.541	2.113	0.589	4.980
		0.004	0.176	0.354	0.734	1.147	-0.004	-0.177	-0.357	-0.728	-1.109	
1000.00	8.55	4.881	5.477	6.049	7.073	7.951	4.856	4.223	3.542	2.077	0.495	5.578
		0.003	0.140	0.285	0.590	0.946	-0.003	-0.141	-0.285	-0.591	-0.932	
1200.00	9.71	4.904	5.528	6.126	7.197	8.108	4.878	4.217	3.510	1.994	0.361	6.166
		0.002	0.118	0.239	0.492	0.790	-0.002	-0.118	-0.236	-0.493	-0.792	
1400.00	10.87	4.921	5.578	6.210	7.342	8.314	4.893	4.198	3.455	1.879	0.191	6.761
		0.002	0.101	0.203	0.419	0.684	-0.002	-0.101	-0.203	-0.419	-0.678	
1600.00	12.03	4.933	5.628	6.296	7.508	8.571	4.904	4.172	3.390	1.743	-0.007	7.341
		0.002	0.088	0.178	0.375	0.640	-0.002	-0.088	-0.179	-0.368	-0.596	
1800.00	13.19	4.944	5.681	6.395	7.702	8.868	4.913	4.140	3.318	1.594	-0.225	7.931
		0.002	0.080	0.164	0.359	0.634	-0.002	-0.078	-0.158	-0.325	-0.528	
2000.00	14.33	4.960	5.748	6.514	7.924	9.140	4.927	4.107	3.241	1.432	-0.457	8.515
		0.002	0.081	0.167	0.367	0.601	-0.002	-0.076	-0.149	-0.301	-0.481	
2200.00	15.42	4.992	5.832	6.651	8.149	9.363	4.957	4.087	3.169	1.268	-0.677	9.087
		0.002	0.084	0.174	0.366	0.511	-0.002	-0.077	-0.152	-0.298	-0.442	
2673.40	17.90	5.091	5.962	6.806	8.332	9.605	5.055	4.146	3.186	1.203	-0.818	10.423
		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Example 2: *i1* =2

```
SEAKING HYDROSTATIC SYSTEM      2001-11-15 TIME 18.05    PAGE   1
```

COMPT	VOLUME	CG-BL	CG-CL	LCG	
1	2673.40	10.423	5.073	66.346	CARGO TANK No.1 SB
2	2673.40	10.423	-5.073	66.346	CARGO TANK No.1 PS
3	4615.81	10.110	6.778	46.818	CARGO TANK No.2 SB
4	4615.81	10.110	-6.778	46.818	CARGO TANK No.2 PS
5	4809.58	10.052	7.070	24.631	CARGO TANK No.3 SB
6	4809.58	10.052	-7.070	24.631	CARGO TANK No.3 PS
7	4827.60	10.052	7.074	2.261	CARGO TANK No.4 SB
8	4827.60	10.052	-7.074	2.261	CARGO TANK No.4 PS
9	4824.90	10.055	7.077	-20.144	CARGO TANK No.5 SB
10	4824.91	10.055	-7.077	-20.144	CARGO TANK No.5 PS
11	3975.82	10.168	6.956	-40.690	CARGO TANK No.6 SB
12	3975.82	10.168	-6.956	-40.690	CARGO TANK No.6 PS
13	69.23	14.024	-1.910	-51.700	DIRTY SLOP TANK
14	555.21	9.994	-7.510	-51.692	SLOP TANK PS
15	674.94	10.412	6.375	-51.693	SLOP TANK SB
16	129.72	15.156	7.285	-80.600	FRESH WATER TK PS
17	129.72	15.156	-7.285	-80.600	FRESH WATER TK SB
18	68.41	12.467	8.907	-76.830	FEED WATER TK
19	810.41	9.979	11.938	-59.227	H.O. BUNKER TK SB
20	891.05	10.220	-11.972	-59.954	H.O. BUNKER TK PS

4.4 Program SOUND

Sounding and ullage tables

Ship owners sometimes have their particular standards for the layout of the sounding and ullage tables. In order to meet these requirements the program has been written as flexible as possible.
Data sheet sound shows the data necessary for the program SOUND which can be run at any moment after a successful running of programs VOL1 and VOL2.
The shape of the sounding pipe has to be defined by sufficient number of points so that the straight line polygon through these points describes the curve with acceptable accuracy. If the mathematical length of these straight lines is not the same as the length measured on board, the data can be modified by program so that they correspond to each other. In this case enter value ***pl*** in input.
Ullage table is defined as a table that starts with the full volume and then decreases to the lowest volume. Sounding table goes in the opposite direction i.e. starts with the lowest volume and ends with the full volume. If data set **41** starts with the top point, an ullage table is generated and if it starts with the bottom point, the sounding table is generated. Usually, the ullage table has ullage level in the first column and sometimes the corresponding sounding value in the last column. However, it is also possible that the ullage table starts with the sounding in the first and the ullage in the second or last column.

Description of each data set on the data sheet sound:
42 ***nprin*** calls for the standard layout of the sounding and ullage tables as follows:

nprin =1:	Sound (m)	Volume		Ullage (m)	(***nset*** ≤3)	
nprin =2:	Sound (ft)	Volume - 9 trims			(***nset*** =1)	
nprin =3:	Sound (m)	Volume - 3 trims		Ullage (m)	(***nset*** ≤2)	
nprin =4:	Sound (m)	Volume - 4 trims		Ullage (m)	(***nset*** =1)	
nprin =5:	Sound (m),	Volume - 5 trims		Ullage (m)	(***nset*** =1)	
nprin =6:	Sound (m)	Volume - 6 trims		Ullage (m)	(***nset*** =1)	
nprin =7:	Sound (m)	Volume – 7 trims		Ullage (m)	(***nset*** =1)	
nprin =8:	Sound (m)	Volume – 8 trims		Ullage (m)	(***nset*** =1)	
nprin =9:	Sound (m)	cubft	cubm	Ullage (m)	(***nset*** ≤2, ***mult*** =0.028316)	
nprin=10:	Sound (m)	cubft	cubm	us barrels 35cuft/ts	43cuft/ts ullage (m)	39 (***nset*** =1)

nlin, ***nline*** define number of lines that are printed on each page and number of lines before between the blank line. For example, ***nlin*** =40, and ***nline*** =5 print 40 lines on each page with the blank line after each 5th printed line.
nset defines number of sets side by side on the page

Example 1:	***nset*** =1	Sound	Volume – 6 trims					
		cm	0 m	0.5 m	1 m	1.5 m	2 m	2.5 m
Example 1:	***nset*** =2	Sound	Volume		Sound	Volume		
		cm	m^3		cm	m^3		

nblank defines number of blank lines on the top of the page
ntext is the number of text lines stated in the last data on the sheet. These text lines are printed on the top of the page.

mult and ***multd***; normally =1; in the case where hull form is in meters and result requested for trim and spacing in feet and inches, enter ***mult*** =0.3048 and ***multd*** =0.0254 and then specify trim and spacing in feet and inches respectively.

multipliers for volumes are used as shown in the following examples:

Example 1:	***multipl*** =1	m^3 are printed				
Example 2:	***multipl*** =2	1.025 Ton sw are printed				
Example 3:	***multipl***	=35.3147	6.2901	0.82127	0.9055	1.009
		cub ft	US barrels	43 cuft/ts	39 cuft/ts	35 cuft/ts

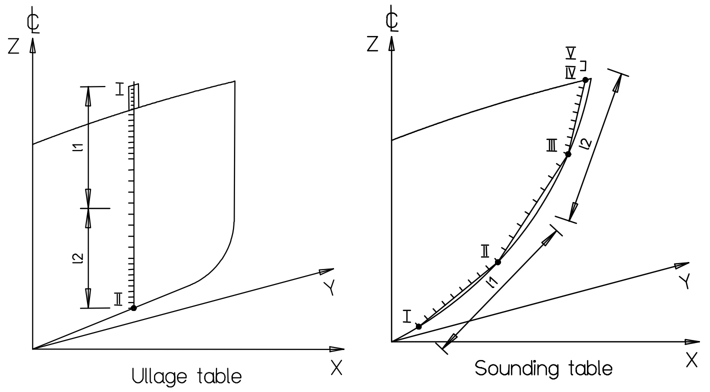
Sounding – ullage tables

	comp no	perm	pl
40			

comp no	refers to data sheet 7
pl	total length of the sounding pipe from the first to the last given point in the table below. Do not give pl if it is not measured on board the ship
perm	has to be given here if it is not given in data sheet 7. For example, for 2% steel volume in the compartment perm =0.98.

Measuring pipe

	fr no	dx	y	z
41				
	one blank line			



Printed table starts at the level of the first stated point. Both lengths, from the first point (l1) as well as from the last point (l2), can be printed in result. If mathematical length of the straight lines through the given points is not the same as the measured length on board (pl), the data are modified by the program so that they correspond to each other.

	nprin	plpp		nlin	nline	nset	nblank	ntext
42			-					

	multt	multd	multipliers for volumes (max 10)					
43								

required trims for sounding/ullage table (values are multiplied by multt)

44								

number of levels with the spacing below.

45								

spacing
(last value is used to the end of the table, values are multiplied by the multd)

46								

Heading text for the sounding/ullage table (max 10 lines)

↑ One blank line if data are the same for the next compartment ↓

nprin	calls for the standard layout of the sounding and ullage tables
plpp	ship length used for trim calc. If blank, the Lpp is used.
nlin	number of printed lines on each page
nline	number of printed lines in each group
nset	number of sets side by side on each page
nblank	number of blank lines at the top of the page

Multipliers for volumes are stated only if capacities are printed in various units.

multt	multiplier for given trim values **44**
multt	multiplier for spacing **45**
ntext	number of textlines below

Example of input file for program SOUND:

```
1
192 0 2 2.15
192 0 2 17.9

8 0 60 10 1 1 0
1 0.01 1
-1 0 1 2
1
10
```

Example of output file for program SOUND:

```
    SEAKING HYDROSTATIC SYSTEM      2001-11-15 TIME 16.46    PAGE   1


 402
 CARGO TANK No.1 SB
 COMP. NO     1



 SOUNDING-PIPE OR ULLAGE-PLUG-DATA
 DX=DIST FORWARD GIVEN FRAME NO
 Y= HALFBREADTHS   Z= DIST FROM BL
 FRAME NO       DX        Y        Z
  192.000    0.000    2.000    2.150
  192.000    0.000    2.000   17.900
 FOLLOWING TABLES M3 *   1.0000
                                                                              PAGE   1

      0.00      1.8      0.1      1.3      2.5     15.8
      0.10     12.2     11.7     11.1     10.6     15.6
      0.20     24.0     23.4     22.9     22.4     15.6
      0.30     35.9     35.4     34.9     34.4     15.4
      0.40     48.0     47.5     46.9     46.5     15.4
      0.50     60.2     59.7     59.2     58.7     15.2
      0.60     72.5     72.0     71.5     71.1     15.1
      0.70     85.0     84.5     84.1     83.6     15.1
      0.80     97.6     97.2     96.7     96.3     14.9
      0.90    110.4    109.9    109.5    109.1     14.9

      1.00    123.3    122.9    122.5    122.0     14.8
      1.10    136.4    135.9    135.5    135.1     14.6
      1.20    149.6    149.2    148.8    148.4     14.6
      1.30    162.9    162.5    162.1    161.8     14.4
      1.40    176.4    176.0    175.6    175.3     14.4
      1.50    190.0    189.7    189.3    189.0     14.2
      1.60    203.8    203.4    203.1    202.8     14.1
      1.70    217.7    217.4    217.0    216.7     14.1
      1.80    231.8    231.4    231.1    230.8     13.9
      1.90    246.0    245.6    245.3    245.1     13.9

      2.00    260.3    260.0    259.7    259.4     13.8
      2.10    274.8    274.5    274.2    274.0     13.6
      2.20    289.4    289.1    288.9    288.6     13.6
      2.30    304.2    303.9    303.7    303.4     13.5
      2.40    319.1    318.9    318.6    318.4     13.4
      2.50    334.2    333.9    333.7    333.5     13.2
      2.60    349.4    349.1    348.9    348.7     13.2
      2.70    364.7    364.5    364.3    364.1     13.1
      2.80    380.2    380.0    379.8    379.7     13.0
      2.90    395.8    395.6    395.5    395.3     12.9
```

4.5 Grain program for IMO A264

Introduction

There are a few programs evaluating the shifting moment for various standard types of ship arrangements e.g. one or more decks, centerline divisions etc. An analysis of various types of ships shows a very large variety in the principal geometry that is almost impossible to cover completely by any number of standards as described above. For this reason and due to the advantage in covering all cases with one and the same program, the input data and calculation method have been chosen completely independently to any standard arrangement. The disadvantages are that the input data may be more extensive and the calculation time longer. However, the advantage of possibility of treatment any section with the same program is more important then the extra input data and computer time.
The program is flexible as follows:

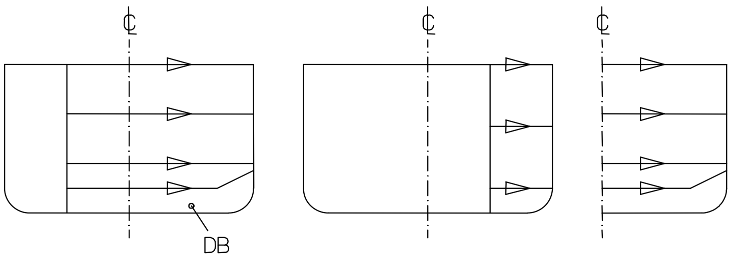
- Any number of decks.
- Any number of hatches side-ways on each deck.
- Any number of hatches longitudinally on each deck.
- Any number of longitudinal bulkheads.
- Any number of girders.
- Any shape of hatches and deck contour.

Description

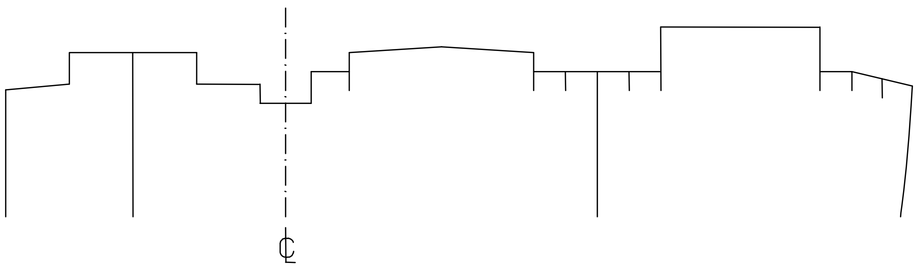
Two data sheets are used, grain1 and grain2. On sheet grain1 all information for a particular section are stated. Sheet grain2 is used for the longitudinal integration. This layout means that the same section on sheet grain1 can be used for more compartments. In order to limit the work for preparing the input data, data sheet grain1a has been added to give an option to modify some data in a given section in order to obtain the relevant section for another part of the ship.

Data sheet grain1

One sheet is given for each different type of section. In the simplest case it means that one sheet is filled in for the section in the way of hatch and another for the section outside the way of hatch. The possibility to refer to the general hull definition for the frame shape helps to avoid describing new sections due to the changes in the half breaths.
The section is described as a polygon from portside to starboard (if section is symmetric then from CL to starboard), starting with the uppermost deck, followed by the other decks in sequence and last followed by the bottom.

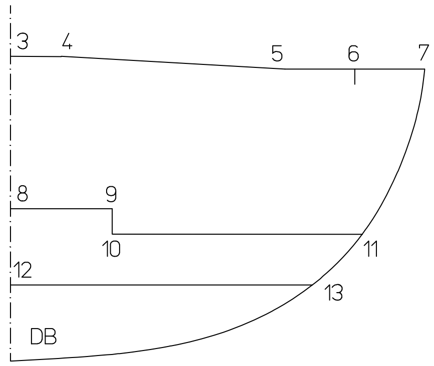


The following sketch is far from a practical design but is intended to show the type of geometry that can be treated:



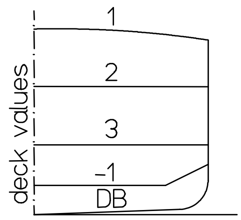
Input data are based on two basic concepts “**points**” and “**elements**”. On each line of the data sheet one point is described. An element can be described with one or more points. **A new element starts in each point where a code number ≠0 is given. An element ends where the next element starts.** The only exception from this rule is when the next point is on a new deck (or on bottom). In this case the element is completed by continuation of the element to the next deck as shown for element 6 in the sketch. An element is identified by the same number as the point number for the point where the element starts.
Example for the sketch
code ≠ 0 for point 3, 6, 8, 10 and 12.
This means that program creates the following elements:

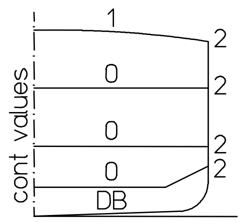
Element	Consisting of points			
3	3	4	5	6
6	6	7	11	
8	8	9	10	
10	10	11	13	
12	12	1		



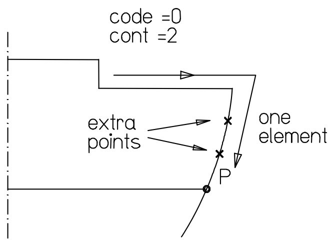
Description of input data

point no entered in sequence. Direction of the sequence of points is from the portside to the starboard. (if section is symmetrical then from the CL to the starboard), starting with the uppermost deck, followed by the other decks and last followed by the bottom.
Y from the CL (positive to the SB side)
Z from the BL
deck has to numbered in sequence 1, 2, 3, etc. starting on the highest deck.
N.B. deck is entered =-1 for points on the bottom.
cont information about the outer contour of the compartment
cont =1 and 3 indicates deck respectively bottom of the compartment
cont =2 (-2) indicates the side of the compartment
cont =0 for the point which doesn’t belong to the outer contour
N.B. it’s important to enter ***cont*** =2 for the points P1 – P4

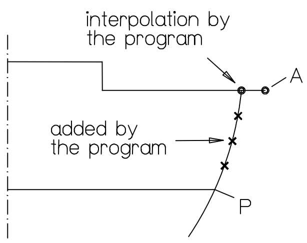




The program builds up the total contour using all points with cont =1, cont =2 and cont =3. This means the straight lines between the given points. If this accuracy is not satisfactory, there is a possibility to give more points on the frame contour. In such a case the points have to follow directly after the deck, before the next deck is defined. For these points, keep the same ***deck*** number and give ***code*** =0. Point P is, however, given on the next deck.
The hull form program has always to be executed before because of the frame spacing etc. However, if the hull geometry has been properly defined through the length of the grain cargo rooms, the program can use this data as follows in further explanation.



State ***cont*** =-2 for the point A at the side of the ship. The program interpolates the intersection between the deck (bottom) and the side of the ship. If that is a deck point, the program automatically adds the extra points on the shipside of the element.



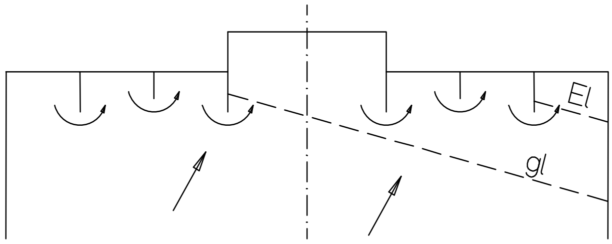
code is the number that enables the program to build up the elements from the given points. It also gives information how to calculate the initial void for each element. Columns A, B and l give further details about the void calculation.

Transfer of excessive void area

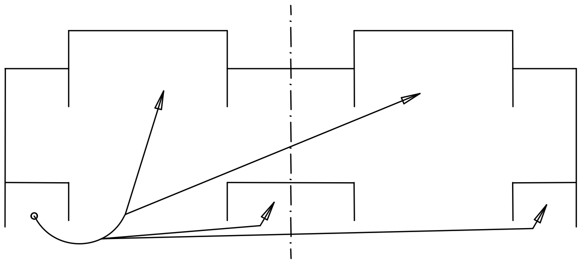
It is assumed that the ship heels to P side which means that the voids transfer to SB side. Assumed angle for full compartment is 15° and for partly filled compartment is 25° in each void.

For a close deck program calculates all transfer automatically. In fact the transfer will take place in the same sequence as the input data described.

However, when the last element 'El' is reached the transferred area may exceed the max area A that can be contained. In such a case the program automatically works backwards in order to find the grain level 'gl'. The user doesn't have to consider that problem except to inform the program how the transfer would take place.



For a twin deck with open hatches (common loading) it's necessary to supply information about the transfer. For the first point on the element (line with the code ≠ 0) number of elements to where the transfer takes place has to be stated. The decimal states the percentage of the total transfer that goes to the element in question (sum of all decimal figures must therefore always be 1). Although stating all these figures may seem as a mere disadvantage, on the other hand it enables user to control the program entirely and interpret the regulations individually.



When compartment is symmetric about the CL, only the SB side is described. For transfer, however, it's necessary to supply information for PS also. The first group of transfer data gives information for the elements on SB side and the next group for the corresponding elements on the PS side. Transfer can take place to the elements both on P and SB side. If transfer takes place to an element on P side, it's indicated with the negative sign before the number. For example, -5.25 means that transfer takes place with 25% to the element on P side corresponding to element 5 on SB side. For better understanding of the transfer data, there are several examples enclosed.

Data sheet grain1a

The purpose of this data sheet is to simplify the description of new sections when there are only some data that are modified. Text on the data sheet gives the guidance.

Data sheet grain2

This sheet describes each individual compartment and performs the calculation by referring relevant sections on sheet grain1.

> ***compt no*** identification
>
> ***volm/perm***; if stated figure is less or equal to 1 (≤ 1), it is interpreted as permeability if stated figure is greater then 1 (> 1), it is interpreted as a volume. Program sets the permeability to be equal to the stated volume divided with the calculated volume. When printing the result, calculated volumes and moments are multiplied by the factor perm. Steel is estimated to 1% permeability. For very complicated compartments, it's not practical and necessary to consider all details in the calculation of the grain heeling moment. In such cases it is recommended to use the normal volume program for the accurate calculation of the capacity and then give these figures as input in the grain calculation.

glow, ***ghigh***; by stating these values the calculations are limited to levels between those values (default values are: ***glow*** =0, ***ghigh*** =ullage point)
gmax should be equal to a point above the highest point in the compartment.
it =0 represents trimmed ends; only a blank line is given for the following table.
it =1 represents untrimmed ends , angle in hatch section =15°
it =2 represents untrimmed ends , angle in hatch section =25°
Reason for the alternatives ***it*** =1 and ***it*** =2 is that regulation defines different angles in the hatch itself and outside the hatch and the program can use only one angle for a particular section. For ***it*** =1 and ***it*** =2 information ***A***, ***B***, ***l*** for void calculation is not necessary except for the hatch (***code*** =2). If the calculation is performed for untrimmed ends, it's likely that it would also have to be performed for trimmed ends. In that case it's more practical to give the data ***A***, ***B***, ***l*** completely.

Longitudinal integration

This table is similar to the data sheet for the normal volume program. For interpolation between two sections, it is necessary that those sections are principally the same, only the values for ***y***, ***z***, ***D***, ***A***, ***B***, ***l*** can vary.

Symmetric and assymmetrc sections

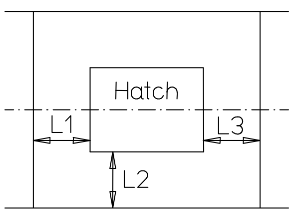
Symbol ***symm*** on the data sheet is defined as follows.

Symmetric section:	Describe only the SB side and give ***symm*** =0
Section only on SB or PS of the CL:	Describe only the SB side for the SB compartment give ***symm*** =1 for the PS compartment give ***symm*** =-1

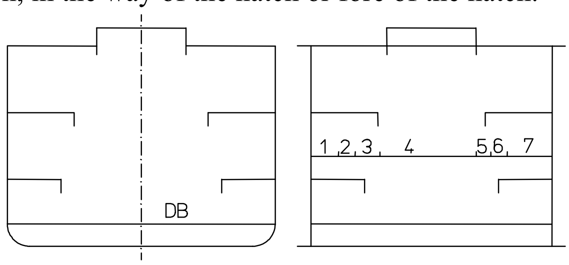
For an unsymmetrical compartment passing CL give the total information from PS to SB for each deck. Give ***symm*** =1 (if compartment has to reflected in CL in relation to its description, give ***symm*** =-1). There is a restriction that the first point cannot be a point on the PS shell plate. Using the symm factor this difficulty can be normally overcome.
Each two line describe one continuous part.

section no refers to the number used on data sheet 1.
no of cuts represents the number of sections to be calculated (1, 3, 5, etc.).
dist used for calculation of void depth (applicable for trimmed ends).

In accordance with the regulation the ***dist*** should be equal to L1, L2 and L3 depending on whether the part of compartment is aft of the hatch, in the way of the hatch or fore of the hatch.



Example 1



Example 2

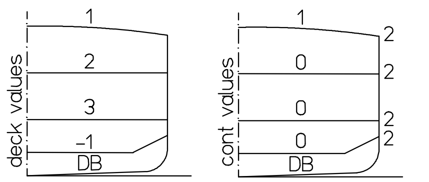
In some cases the data for void calculation have to be given on sheet grain1 instead of here. Column ***l*** on data sheet 1 is used for this purpose. For ***l*** =-1 the program uses the section data for finding the length for the void calculation. Example 2 above shows a case when the length for a void calculation has to be given on data sheet 1 due to various values for the various decks. To perform the calculation for this example fully in accordance to the IMO regulation, it's necessary to describe 7 parts longitudinally. Part1 1 and 7, 2 and 6, 3 and 5 respectively have normally the same section and reference can be made to the same data sheet 1.

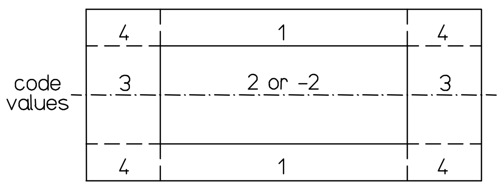
Description of sections

	ship no	print		
10			print =0 print =1	normally omit printing of input data

	section	type		
11		1	section	identification integer number (Note: Describe always the SB side, even if only the PS has to be calculated)

					12						13		14
point no	Y	Z	deck	cont	code	D	for void calc.				Excessive void area transfer to points number		D:0 for voids on portside
							A	B	l				
1										/		/	
2										/		/	
3										/		/	
4										/		/	
5										/		/	
6										/		/	
7										/		/	
8										/		/	
9										/		/	
10										/		/	
11										/		/	
12										/		/	
13										/		/	
14										/		/	
15										/		/	
16										/		/	
17										/		/	
18										/		/	
one blank line ; for the last section two blank lines													





Y Y coordinate of the point
Z Z coordinate of the point
deck =1 for the highest deck
=2 for the next deck etc.
=-1 for the bottom
cont =0 inside compartment
=1 highest deck
=2 side
=3 bottom
cont =-2 hull form data are used
code =0 continuation of an element
code =1 side of hatch; A =depth of girder for void calc.
code =2 hatch; initial void =0.15m + A
code =-2 opening in twin deck (open hatch)
code =3 aft or fore of a hatch. A =depth of hatch end beam
code =4 corner; A =depth to be used for the void calc., either the depth of the hatch end beam or the of the depth of the side girder (normally the lesser depth is used)
D depth of girder in this point if any
Special A values: A =-1 use void depth from previous element
A =-2 use void depth = B

If void area has to be transferred to an element other then next in the sequence, this has to be stated with the number of element and the portion transferred, e.g. 3.5 5.25 9.25 which means 50% to element no 3, 25% to element no 5 and 25% to element no 9. Negative numbers mean transfer to a P side element, e.g. –3.5 means transfer to the element on portside corresponding to element.

Description of sections by modifying already described section

11

section	type	reference to section no

All data has to be filled in; 0 indicates no modification of the corresponding value

15

Δy	Δz	ΔD	ΔA	ΔB	Δl	
y	z	D	A	B	l	points to be modified
one blank line ; for the last section two blank lines						

11

section	type	reference to section no

15

Δy	Δz	ΔD	ΔA	ΔB	Δl	
y	z	D	A	B	l	points to be modified
one blank line ; For the last section two blank lines						

11

section	type	reference to section no

15

Δy	Δz	ΔD	ΔA	ΔB	Δl	
y	z	D	A	B	l	points to be modified
one blank line ; for the last section two blank lines						

section	identification number for the new section								
type =2	if	Δy	Δz	ΔD	ΔA	ΔB	Δl	are stated	
type =3	if	y	z	D	A	B	l	are stated	
reference	to the previously described sections								

In the following table the modification or total values of y, z, D, A, B and l have to be stated.
The point no refers to the first column on sheet grain1.
For example, if all data for the new section are the same except that the sheer on one deck influences the z coordinates for all points on that deck. By stating Δz =the sheer and stating all points belonging to that deck, the correct new section is obtained.

Description of compartments

compt no	type	name of the compartment

vol/perm	step	ullage point

vol/perm   enter total volume or permeability
step   interval for calculated and printed grain levels
ullage point   position above BL for measuring the grain level

glow	ghigh	gmax

glow   lowest grain level to be printed
ghigh   highest grain level to be printed
gmax   highest part of the compartment

it

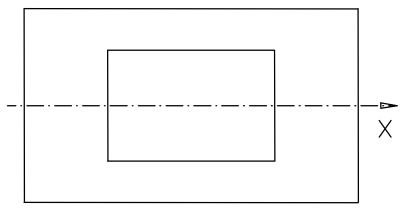
it =0   trimmed ends
it =1   untrimmed ends, angle in the hatch section in 15˚
it =2   untrimmed ends, angle in the hatch section is 25˚

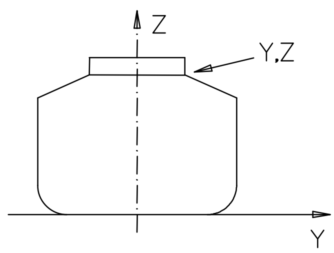
Limits of compartment and hatches
The following data are necessary only for calculation of untrimmed grain. Data are stated for each deck starting with the highest deck. For normal calculation with trimmed ends give only the blank line.

aft end		aft end hatch				fore end hatch				fore end	
fr no	dx	fr no	dx	y	z	fr no	dx	y	z	fr no	dx
one blank line											

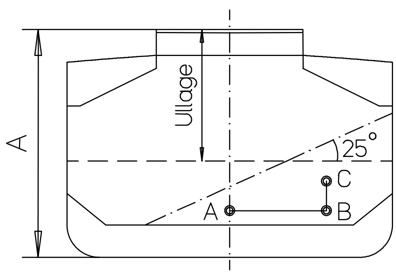
Longitudinal integration

frame no	dx	section	dist	symm	cuts
			-	-	-
			-	-	-
			-	-	-
			-	-	-
			-	-	-
one blank line; for the last section two blank lines					





section   identification number refers to data sheet grain1.
dist   controls the void calculation to data sheet grain1.
symm =0   symmetric section
symm =1   starboard section
symm =-1   portside section
cuts   1, 3, 5, etc.



Execution sequence for grain program

- HULL data sheets 1 to 4
- GRAIN1 data sheets grain1, grain1a, grain2
- GRAIN2 two blank cards

For intermediate results in GRAIN1

In data sheet grain1, enter the following in the first line:

ship no.	print		prpoint	prelem
		6x0		

prpoint =1 point information is printed
prelem =1 element information is printed

For intermediate results in GRAIN2

Instead of the first blank card enter the following:

prarea	prback	prtrans

prarea =1 area instead of volume is printed
prback=2 each step of backing procedure is printed
prtrans =2 each transfer is printed

Instead of the first blank card enter the following:

ITRL	grainlevels
3	

Start with the grain level for the full compartment followed by desired levels in decreasing order.