

TRIM & STABILITY BOOKLET

	Page
1. GENERAL PARTICULARS.....	2
2. GENERAL ARRANGEMENT.....	3
3. ARRANGEMENT OF TANK.....	4
4. CAPACITY TABLE.....	6
5. STABILITY REQUIREMENTS.....	8
6. LOADING SUMMARY TABLE.....	12
7. INTACT STABILITY LOADING CONDITION.....	14
8. APPENDIX	
1) HYDROSTATIC TABLE.....	22
2) CORRECTION TABLE OF DRAFT BY TRIM.....	28
3) CROSS CURVE TABLE (Including Flooding Angle).....	30
4) COMPARTMENT PROPERTIES.....	33
5) PROTECT WIND AREA & LEVER.....	42
6) RESULTS OF INCLINING EXPERIMENT.....	45

3. ARRANGEMENT OF TANK

4. CAPACITY TABLE

TANK CAPACITY TABLE

FUEL OIL ($\rho = 0.880$)							
COMPARTMENT		LOCATION (FR. NO.)	CAPACITY (m3)	WEIGHT 95% FULL (t)	CENTER OF GRAVITY (m)		MAX I (m4)
					MID. G	K G	
FORE F. O. T.	C	17 — 21	10.42	8.71	-3.54	1.62	5.46
AFT F. O. T.	P	1 — 4	3.40	2.84	4.68	1.74	0.73
	S		3.40	2.84	4.68	1.74	0.73
T O T A L		—	17.22	14.39	—		

BALLAST WATER ($\rho = 1.025$)							
COMPARTMENT		LOCATION (FR. NO.)	CAPACITY (m3)	WEIGHT (t)	CENTER OF GRAVITY (m)		MAX I (m4)
					MID. G	K G	
F. P. V. S.	C	21 — 23	13.95	14.30	-5.10	1.46	14.56
B. W. T.	C	1 — 4	3.87	3.97	4.68	1.75	1.00
T O T A L		—	17.82	18.27	—		

VOID SOACE ($\rho = 1.000$)							
COMPARTMENT		LOCATION (FR. NO.)	CAPACITY (m3)	WEIGHT (t)	CENTER OF GRAVITY (m)		MAX I (m4)
					MID. G	K G	
V. S.	P	17 — 21	7.59	7.59	-3.52	1.03	3.60
	S		7.59	7.59	-3.52	1.03	3.60
A. P. V. S.	C	-3 — 1	12.54	12.54	6.46	1.88	26.44
T O T A L		—	27.72	27.72	—		

5. STABILITY REQUIREMENTS

This subsection describes detail of intact stability requirements of the rules which the ship must comply with.

1. GENERAL STABILITY REQUIREMENTS

The stability curves are to comply with the following requirements in Fig.1.1.

- 1) Area A_1 is to be not less than 0.055 m·rad.
- 2) Area A_2 is to be not less than 0.03 m·rad.
- 3) Area $A_1 + A_2$ is to be not less than 0.09 m·rad.
- 4) GoZ is to be at least 0.20m at an angle of heel equal to or greater than 30° .
- 5) θ_{max} is to be not less than 25° .
- 6) GoM is to be not less than 0.15 m.

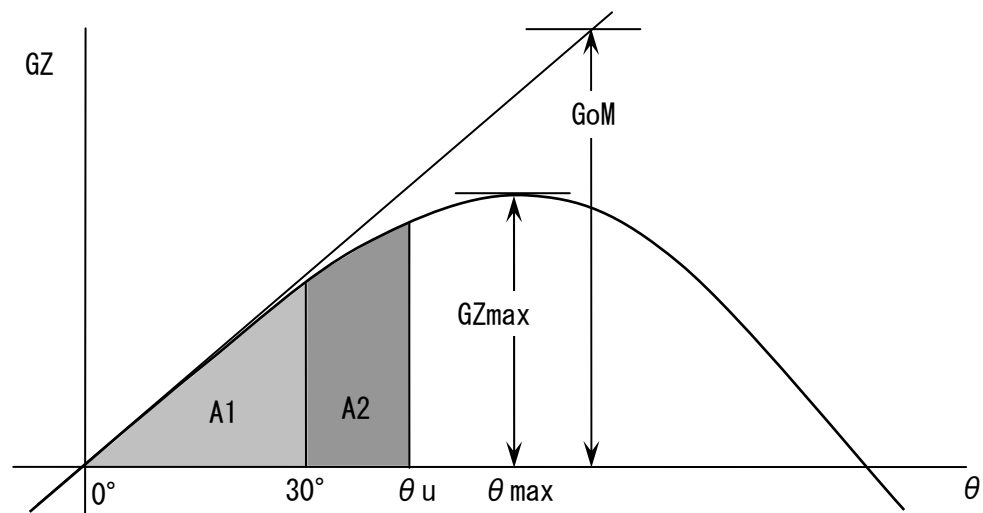


Fig.1.1 Stability Curve (General Stability Requirements)

Where ;

A_1 = Area under stability curve between 0° and 30° (m·rad).

A_2 = Area under stability curve between 30° and θ_u (m·rad).

θ_u = Heeling angle(degree) to be taken of whichever is less,
downflood angle(θ_f) in relevant loading condition or 40° .

GZ_{max} = Maximum righting lever (m)

θ_{max} = Heeling angle at which righting arm reaches maximum(degree).

GoM = Initial metacentric height corrected by free surface effect (m).

2. STABILITY CRITERIA IN WIND AND WAVES

Stability curves and wind-heeling moment lever curves of ships are to comply with the following requirements in Fig.1.2.

- (1) Heeling angle caused by steady wind is to be less than 16° or an angle corresponding to 80% of immersing angle of deck edge whichever is less.
- (2) Area "b" is not to be less than area "a".

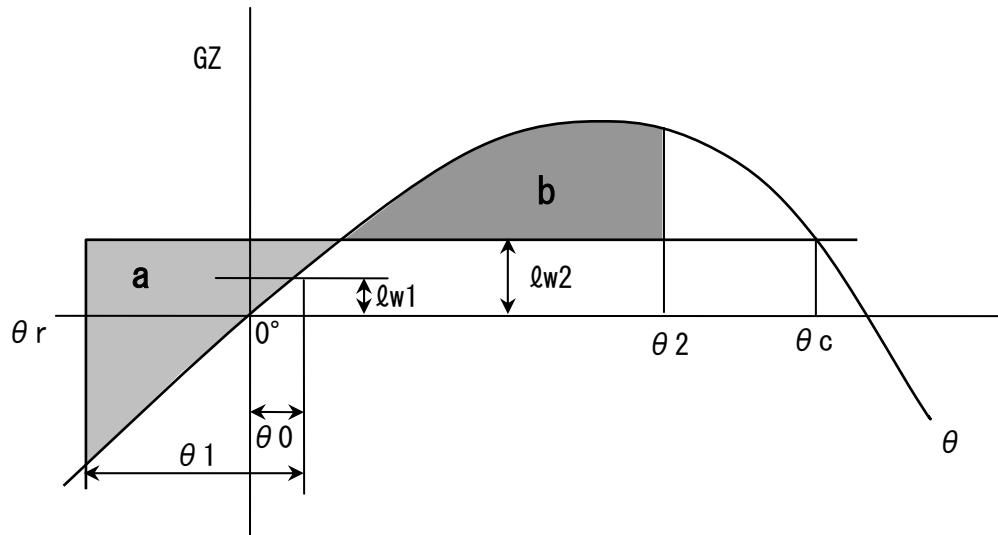


Fig.1.2 Stability and wind-heeling Moment Lever Curve
(Stability Requirements in Wind and Waves)

Where ;

θ_0 = angle of heel under action of steady wind

θ_1 = angle of roll to windward due to wave action

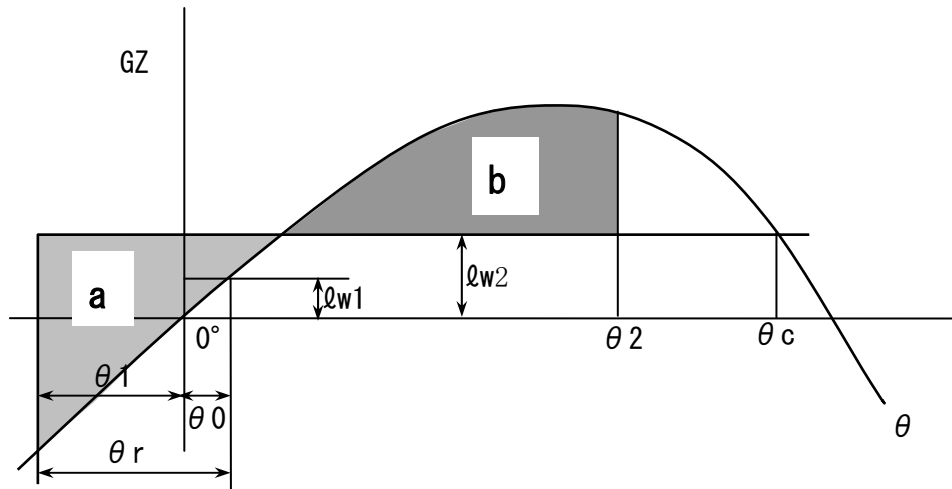
θ_2 = angle of downflooding (θ_f) or 50° or θ_c whichever is less

θ_c = angle of second intercept between wind heeling lever ρw_2 and GoZ curves.

ρw_1 = Wind heeling lever caused by steady wind

ρw_2 = Wind heeling lever caused by gust

Wind heeling lever and angle of roll to windward due to wave action



- 1) The angle in the above figure are defined as follows;

θ_0 = angle of heel under action of steady wind

θ_1 = angle of roll to windward due to wave action

θ_2 = angle of downflooding (θ_f) or 50° or θ_c whichever is less

θ_r = rolling angle

where,

θ_f = downflooding angle

(from "CROSS CURVE TABLE (INC. DOWNFLOODING ANGLE)")

θ_c = angle of second intercept between wind heeling lever l_w2 and GoZ curves

- 2) The wind heeling levers l_w1 and l_w2 should be calculated as follows;

$$l_w1 = P \cdot A \cdot Z / W \quad \text{in m}$$

and

$$l_w2 = 1.5 l_w1 \quad \text{in m}$$

where;

$$P = 0.0514 \text{ (t/m}^2\text{)}$$

A = projected lateral area of the portion of the ship and deck cargo above the water line (m^2)

Z = vertical distance from the center of "A" to the center of the underwater lateral area or approximately to a point at one half the draft (m)

W = displacement (t)

3) The angle of roll (θ_1) should be calculated as follows.

$$\theta_1 = 109 \cdot K \cdot X_1 \cdot X_2 \cdot \sqrt{rs}$$

Where,

X_1 = factor as shown in Table 1

X_2 = factor as shown in Table 2

factor (K) as follows:

K = 1.0 for round-bilged ship having no bilge or bar keels;

K = 0.7 for a ship having sharp bilges ;

K = to be obtained from table 3 for a ship having bilge keels, a bar keel or both.

$$r = 0.73 + 0.6 OG / d$$

with

OG = distance between the center of gravity and the water line

(+) ... if center of gravity is above the waterline

(-) ... if it is below

s = factor as shown in Table 4.

Table 1 factor x_1		Table 2 factor x_2		Table 3 factor k		Table 4 factor s	
B/d	X_1	cb	x_2	$\frac{AK \cdot 100}{L \cdot B}$	K	T	s
≤ 2.4	1.0	≤ 0.45	0.75	0.0	1.0	≤ 6	0.100
2.5	0.98	0.50	0.82	1.0	0.98	7	0.098
2.6	0.96	0.55	0.89	1.5	0.95	8	0.093
2.7	0.95	0.60	0.95	2.0	0.88	12	0.065
2.8	0.93	0.65	0.97	2.5	0.79	14	0.053
2.9	0.91	≥ 0.70	1.00	3.0	0.74	16	0.044
3.0	0.90			3.5	0.72	18	0.038
3.1	0.88			≥ 4.0	0.70	≥ 20	0.035
3.2	0.86						
3.3	0.84						
3.4	0.82						
≥ 3.5	0.80						

(Intermediate values in table 1~4 should be obtained by linear interpolation)

$$\text{Rolling period } T = 2 \cdot C \cdot B / \sqrt{GoM} \text{ (sec.)}$$

Where,

$$C = 0.373 + 0.023 (B/d) - 0.043(L/100)$$

The symbols as follows;

L = length of the ship (m)

B = moulded breadth of the ship (m)

d = mean moulded draft of the ship (m)

cb = block coefficient = $W / 1.025 \cdot L \cdot B \cdot d$

Ak = total overall area of bilge keels (m²)

GoM = metacentric height corrected for free surface effect (m)

6. LOADING SUMMARY TABLE

* * * SUMMARY TABLE * * *

CONDITION NO.		1	2	3		
CONDITION		LIGHT COND	FULL LOAD COND.			
ITEM			DEP.	ARR.		
LIGHT WEIGHT	(t)	60.91	60.91	60.91		
D/W CONSTANTS	(t)	0.00	1.15	1.15		
FUEL OIL	(t)	0.00	14.39	1.43		
BALLAST WATER	(t)	0.00	10.21	13.95		
VOID SPACE	(t)	0.00	0.00	0.00		
DEADWEIGHT	(t)	0.00	25.75	16.53		
DISPLACEMENT	(t)	60.91	86.66	77.44		
DRAFT (m)	EQUIVALENT	1.25	1.61	1.49		
	FORE	0.40	1.51	1.44		
	AFT	2.09	1.69	1.52		
	MEAN	1.25	1.60	1.48		
TRIM	(m)	1.69	0.18	0.08		
MID. F	(m)	0.03	0.87	0.90		
MID. B	(m)	-0.73	-0.30	-0.44		
MID. G	(m)	0.74	-0.13	-0.35		
M. T. C.	(t-m)	0.53	0.83	0.83		
T. P. C.	(t)	0.60	0.74	0.74		
I/D	(%)	115.00	90.00	79.38		
T. KM	(m)	3.34	3.13	3.29		
K G	(m)	1.32	1.38	1.35		
G M	(m)	2.02	1.75	1.94		
GG _o	(m)	0.00	0.24	0.27		
GoM	(m)	2.02	1.51	1.67		
GoM (REQUIRED)	(m)	0.57	1.06	0.93		
JUDGEMENT		Good	Good	Good		
S	AREA 0-30 (m-rad)	0.282	0.183	0.205		
	AREA 30- θ_u (m-rad)	0.172	0.094	0.112		
T	AREA 0- θ_u (m-rad)	0.454	0.278	0.317		
A	MAX GoZ (m)	0.99	0.56	0.66		
B	MAX GoZ ANGLE (deg)	35.8	30.1	31.4		
I	FLOOD. ANGLE (deg)	72.7	59.3	63.8		
L	θ_o (deg)	1.6	1.3	1.5		
I	AREA a (m-rad)	0.113	0.087	0.097		
T	AREA b (m-rad)	0.541	0.310	0.359		
Y	C = b / a -	4.809	3.577	3.696		
SHEARING FORCE (t)	MAX	0	0	0		
	ALLOW.	0	0	0		
BENDING MOMENT (t-m)	MAX	0	0	0		
	ALLOW.	0	0	0		

(-)MARK is FORE, (+)MARK is AFT.

< > shows S.F. after BHD Correction.

(-)MARK is SAGGING, (+)MARK is HOGGING.

7. INTACT STABILITY LOADING CONDITION

CONDITION NAME : LIGHT CONDITION

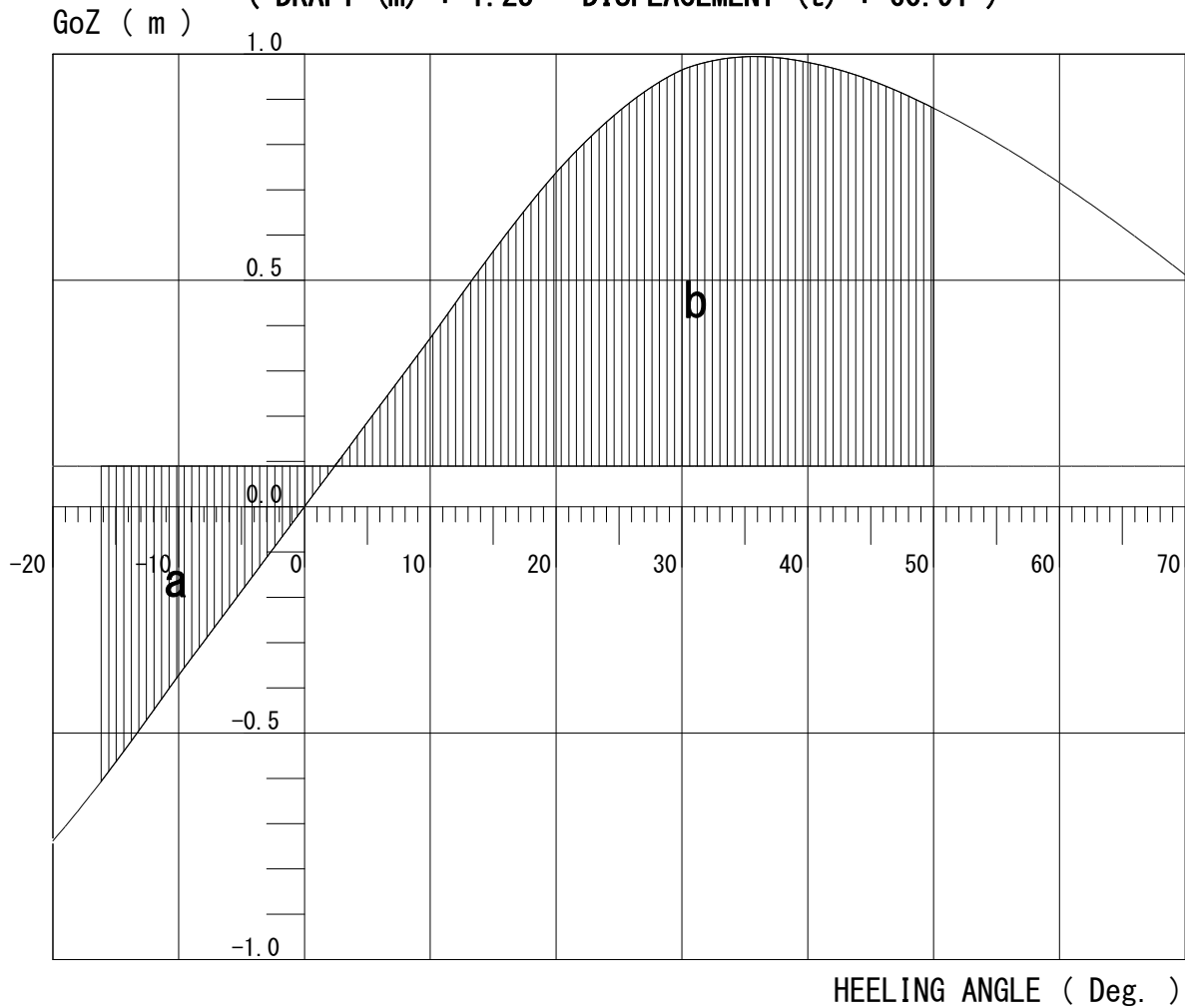
I T E M	(%)	WEIGHT (t)	MID. G (m)	MOMENT (t-m)	K G (m)	MOMENT (t-m)	$\rho * I$ (t-m)
LIGHT WEIGHT		60.91	0.74	45.07	1.32	80.40	0.00
CONSTANTS		0.00	0.00	0.00	0.00	0.00	0.00
CREWS (2P)		0.00	0.00	0.00	0.00	0.00	0.00
D/W CONSTANTS		0.00	0.00	0.00	0.00	0.00	0.00
FORE F. O. T. (C)		0.00	0.00	0.00	0.00	0.00	0.00
AFT F. O. T. (P)		0.00	0.00	0.00	0.00	0.00	0.00
AFT F. O. T. (S)		0.00	0.00	0.00	0.00	0.00	0.00
FUEL OIL		0.00	0.00	0.00	0.00	0.00	0.00
F. P. V. S. (C) (B. W. T)		0.00	0.00	0.00	0.00	0.00	0.00
B. W. T. (C)		0.00	0.00	0.00	0.00	0.00	0.00
BALLAST WATER		0.00	0.00	0.00	0.00	0.00	0.00
V. S. (P)		0.00	0.00	0.00	0.00	0.00	0.00
V. S. (S)		0.00	0.00	0.00	0.00	0.00	0.00
A. P. V. S. (C)		0.00	0.00	0.00	0.00	0.00	0.00
VOID SPACE		0.00	0.00	0.00	0.00	0.00	0.00
T O T A L		60.91	0.74	45.07	1.32	80.40	0.00

* * * * *						S U M M A R Y		* * * * *	
DISPT (t)	60.91	MID. G (m)	0.74	T. KM (m)	3.34				
DRAFT (EQ) (m)	1.25	MID. B (m)	-0.73	K G (m)	1.32				
DRAFT (F) (m)	0.40	B G (m)	1.47	G M (m)	2.02				
DRAFT (A) (m)	2.09	MID. F (m)	0.03	GoG (m)	0.00				
DRAFT (M) (m)	1.25	M. T. C. (t-m)	0.53	GoM (m)	2.02				
TRIM (m)	1.69	T. P. C. (t)	0.60	I/D (%)	115.00				

STABILITY CURVE

COND. NAME : LIGHT CONDITION

(DRAFT (m) : 1.25 DISPLACEMENT (t) : 60.91)



[A749(18) 3.2]		
WIND AREA	(m ²)	42.8
WIND LEVER	(m)	2.30
ROLLING ANGLE (θ_1)	(deg.)	17.76
AREA "a"	(m-rad)	0.113
AREA "b"	(m-rad)	0.541
C (b/a)		4.809
ANGLE θ_o	(deg.)	1.61

[A749(18) 3.1]		
AREA 0° - 30°	(m-rad)	0.282
AREA 30° - θ_u	(m-rad)	0.172
AREA 0° - θ_u	(m-rad)	0.454
MAX. GoZ	(m)	0.99
MAX. GoZ	(deg.)	35.80
GoM		2.02
FLOOD. ANGLE	(deg.)	72.69
GZ at 30°	(m)	0.97

NOTE : θ_u ... 40° or the angle of flooding whichever is less.

CONDITION NAME : FULL LOAD COND. (DEP.)

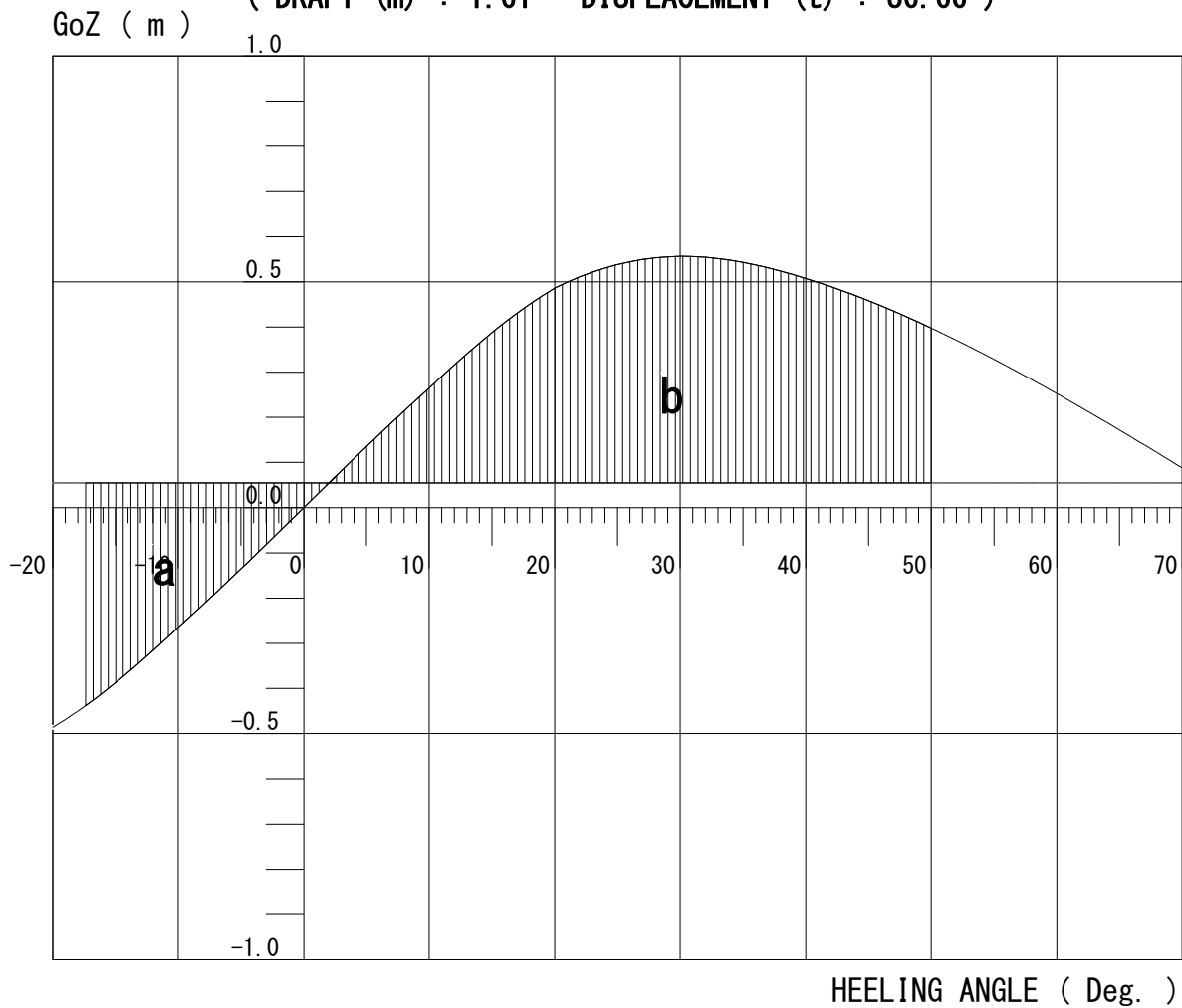
I T E M	(%)	WEIGHT (t)	MID. G (m)	MOMENT (t-m)	K G (m)	MOMENT (t-m)	$\rho * I$ (t-m)
LIGHT WEIGHT		60.91	0.74	45.07	1.32	80.40	0.00
CONSTANTS		1.00	0.00	0.00	1.20	1.20	0.00
CREWS (2P)		0.15	-2.50	-0.38	5.70	0.86	0.00
D/W CONSTANTS		1.15	-0.33	-0.38	1.79	2.06	0.00
FORE F. O. T. (C)	95	8.71	-3.53	-30.75	1.58	13.76	4.80
AFT F. O. T. (P)	95	2.84	4.67	13.26	1.71	4.86	0.64
AFT F. O. T. (S)	95	2.84	4.67	13.26	1.71	4.86	0.64
FUEL OIL		14.39	-0.29	-4.23	1.63	23.48	6.08
F. P. V. S. (C) (B. W. T)	73	10.21	-5.05	-51.56	1.35	13.78	14.56
B. W. T. (C)		0.00	0.00	0.00	0.00	0.00	0.00
BALLAST WATER		10.21	-5.05	-51.56	1.35	13.78	14.56
V. S. (P)		0.00	0.00	0.00	0.00	0.00	0.00
V. S. (S)		0.00	0.00	0.00	0.00	0.00	0.00
A. P. V. S. (C)		0.00	0.00	0.00	0.00	0.00	0.00
VOID SPACE		0.00	0.00	0.00	0.00	0.00	0.00
T O T A L		86.66	-0.13	-11.10	1.38	119.72	20.64

* * * * * S U M M A R Y * * * * *					
DISPT (t)	86.66	MID. G (m)	-0.13	T. KM (m)	3.13
DRAFT (EQ) (m)	1.61	MID. B (m)	-0.30	K G (m)	1.38
DRAFT (F) (m)	1.51	B G (m)	0.17	G M (m)	1.75
DRAFT (A) (m)	1.69	MID. F (m)	0.87	GoG (m)	0.24
DRAFT (M) (m)	1.60	M. T. C. (t-m)	0.83	GoM (m)	1.51
TRIM (m)	0.18	T. P. C. (t)	0.74	I/D (%)	90.00

STABILITY CURVE

COND. NAME : FULL LOAD COND. (DEP.)

(DRAFT (m) : 1.61 DISPLACEMENT (t) : 86.66)



[A749(18) 3.2]		
WIND AREA	(m ²)	38.2
WIND LEVER	(m)	2.31
ROLLING ANGLE (θ_1)	(deg.)	18.72
AREA "a"	(m-rad)	0.087
AREA "b"	(m-rad)	0.310
C (b/a)		3.577
ANGLE θ_o	(deg.)	1.34

[A749(18) 3.1]		
AREA 0° - 30°	(m-rad)	0.183
AREA 30° - θ_u	(m-rad)	0.094
AREA 0° - θ_u	(m-rad)	0.278
MAX. GoZ	(m)	0.56
MAX. GoZ	(deg.)	30.10
GoM		1.51
FLOOD. ANGLE	(deg.)	59.31
GZ at 30°	(m)	0.56

NOTE : θ_u ... 40° or the angle of flooding whichever is less.

8. APPENDIX