

## TRIM & STABILITY BOOKLET

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### 3. ARRANGEMENT OF TANK

## 4. CAPACITY TABLE

## TANK CAPACITY TABLE

FUEL OIL <span style="float: right;">(<math>\rho = 0.880</math>)</span>							
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 <span style="float: right;">(<math>\rho = 1.025</math>)</span>							
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 <span style="float: right;">(<math>\rho = 1.000</math>)</span>							
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)  $\theta_{max}$  is to be not less than 25°.
- 6) GoM is to be not less than 0.15 m.

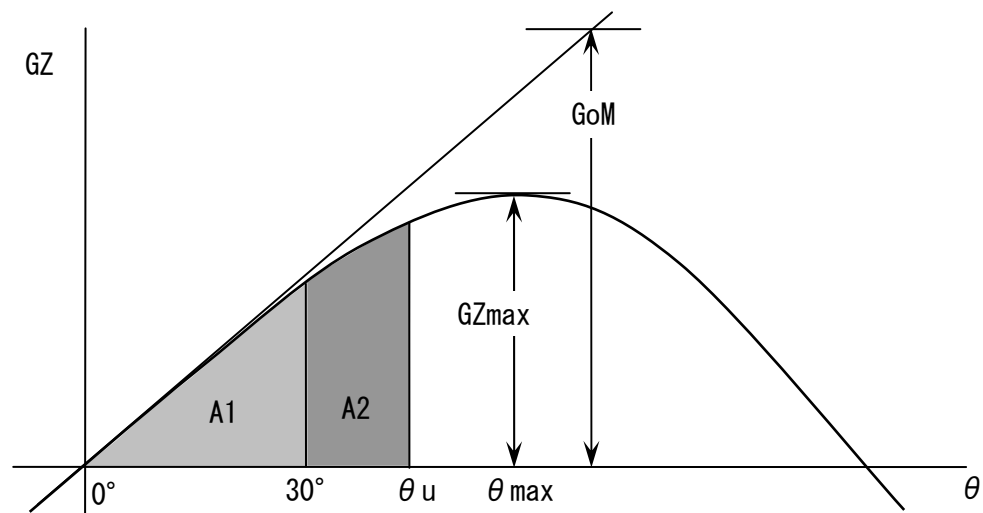


Fig.1.1 Stability Curve (General Stability Requirements)

Where ;

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

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

$\theta_u$  = Heeling angle(degree) to be taken of whichever is less,  
downflood angle( $\theta_f$ ) in relevant loading condition or 40°.

$GZ_{max}$  = Maximum righting lever (m)

$\theta_{max}$  = 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  $16^\circ$  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".

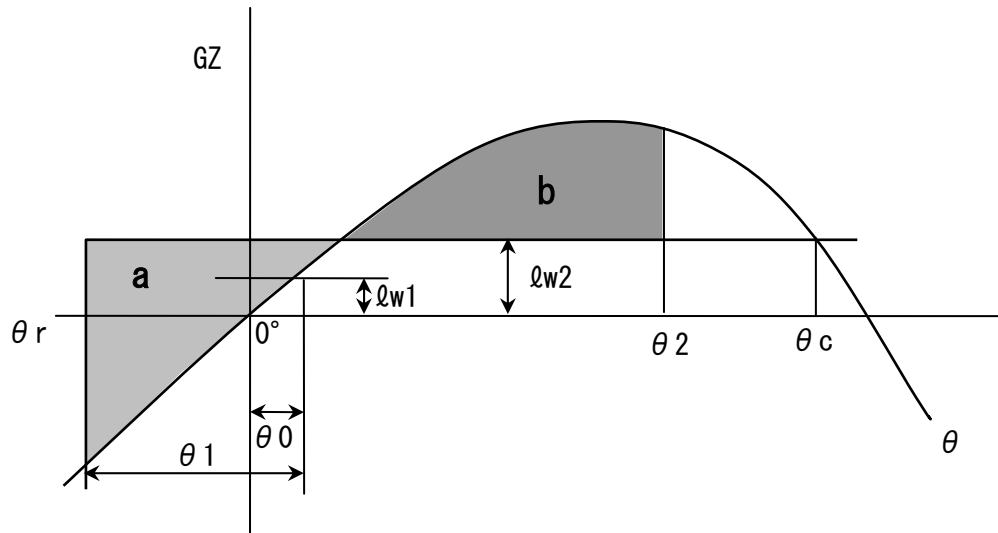


Fig.1.2 Stability and wind-heeling Moment Lever Curve  
(Stability Requirements in Wind and Waves)

Where ;

$\theta_0$  = angle of heel under action of steady wind

$\theta_1$  = angle of roll to windward due to wave action

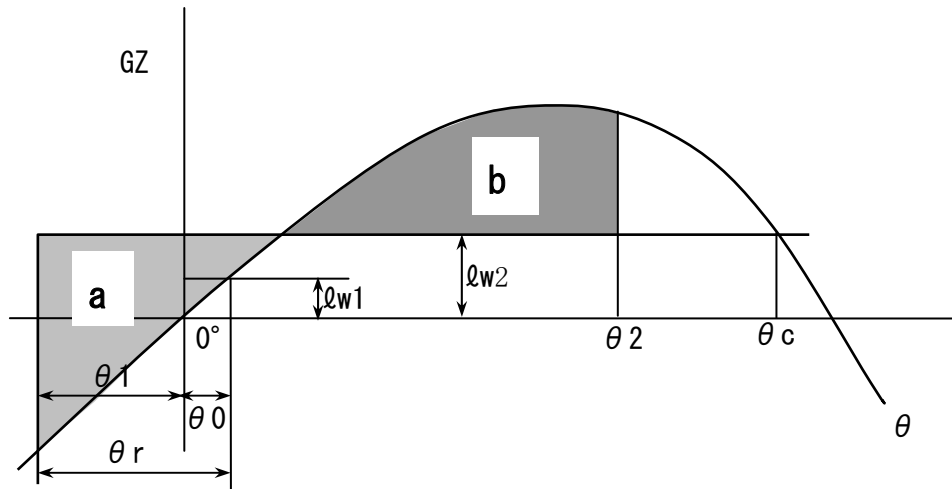
$\theta_2$  = angle of downflooding ( $\theta_f$ ) or  $50^\circ$  or  $\theta_c$  whichever is less

$\theta_c$  = angle of second intercept between wind heeling lever  $\varrho_{w2}$  and  $G_{oZ}$  curves.

$\varrho_{w1}$  = Wind heeling lever caused by steady wind

$\varrho_{w2}$  = 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;

$\theta_0$  = angle of heel under action of steady wind

$\theta_1$  = angle of roll to windward due to wave action

$\theta_2$  = angle of downflooding ( $\theta_f$ ) or  $50^\circ$  or  $\theta_c$  whichever is less

$\theta_r$  = rolling angle

where,

$\theta_f$  = downflooding angle

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

$\theta_c$  = 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 ( $\theta_1$ ) 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
$\leq 2.4$	1.0	$\leq 0.45$	0.75	0.0	1.0	$\leq 6$	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	$\geq 0.70$	1.00	3.0	0.74	16	0.044
3.0	0.90			3.5	0.72	18	0.038
3.1	0.88			$\geq 4.0$	0.70	$\geq 20$	0.035
3.2	0.86						
3.3	0.84						
3.4	0.82						
$\geq 3.5$	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 (m<sup>2</sup>)

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 <sub>o</sub>	(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 T A B I L I T Y	AREA 0-30 (m-rad)	0.282	0.183	0.205		
	AREA 30- $\theta_u$ (m-rad)	0.172	0.094	0.112		
	AREA 0- $\theta_u$ (m-rad)	0.454	0.278	0.317		
	MAX GoZ (m)	0.99	0.56	0.66		
	MAX GoZ ANGLE (deg)	35.8	30.1	31.4		
	FLOOD. ANGLE (deg)	72.7	59.3	63.8		
	$\theta_o$ (deg)	1.6	1.3	1.5		
	AREA a (m-rad)	0.113	0.087	0.097		
	AREA b (m-rad)	0.541	0.310	0.359		
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.

&lt; &gt; shows S.F. after BHD Correction.

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

## 7. INTACT STABILITY LOADING CONDITION

CONDITION NAME : LIGHT CONDITION

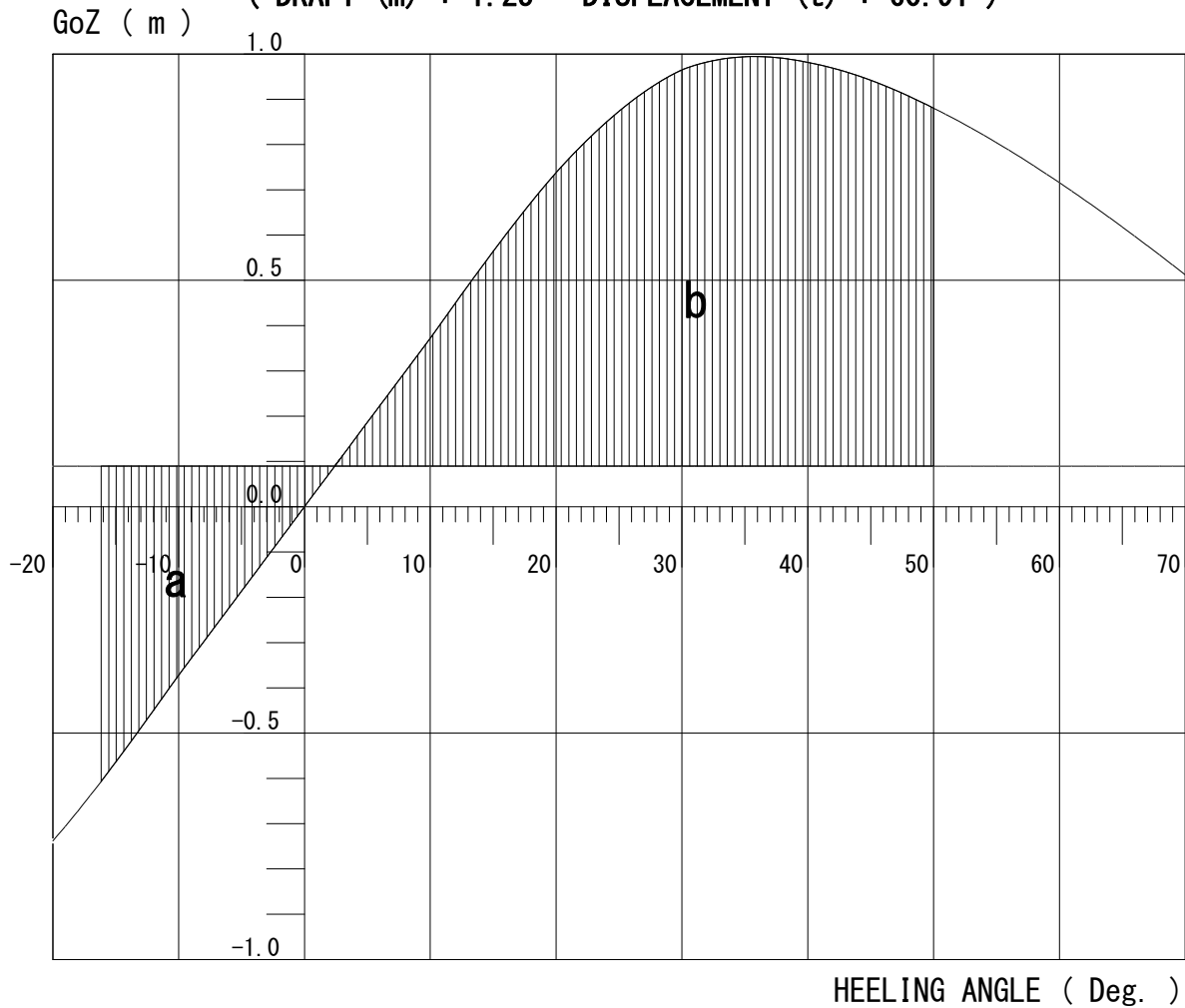
I T E M	(%)	WEIGHT ( t )	MID. G ( m )	MOMENT (t-m)	K G ( m )	MOMENT (t-m)	$\rho * I$ (t-m)
LIGHT WEIGHT		60.91	0.74	45.07	1.32	80.40	0.00
CONSTANTS		0.00	0.00	0.00	0.00	0.00	0.00
CREWS (2P)		0.00	0.00	0.00	0.00	0.00	0.00
D/W CONSTANTS		0.00	0.00	0.00	0.00	0.00	0.00
FORE F. O. T. (C)		0.00	0.00	0.00	0.00	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 <sup>2</sup> )	42.8
WIND LEVER	( m )	2.30
ROLLING ANGLE ( $\theta_1$ )	( deg. )	17.76
AREA "a"	(m-rad)	0.113
AREA "b"	(m-rad)	0.541
C (b/a)		4.809
ANGLE $\theta_o$	( deg. )	1.61

[A749(18) 3.1]		
AREA 0° - 30°	(m-rad)	0.282
AREA 30° - $\theta_u$	(m-rad)	0.172
AREA 0° - $\theta_u$	(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 :  $\theta_u$  ... 40° or the angle of flooding whichever is less.

CONDITION NAME : FULL LOAD COND. (DEP.)

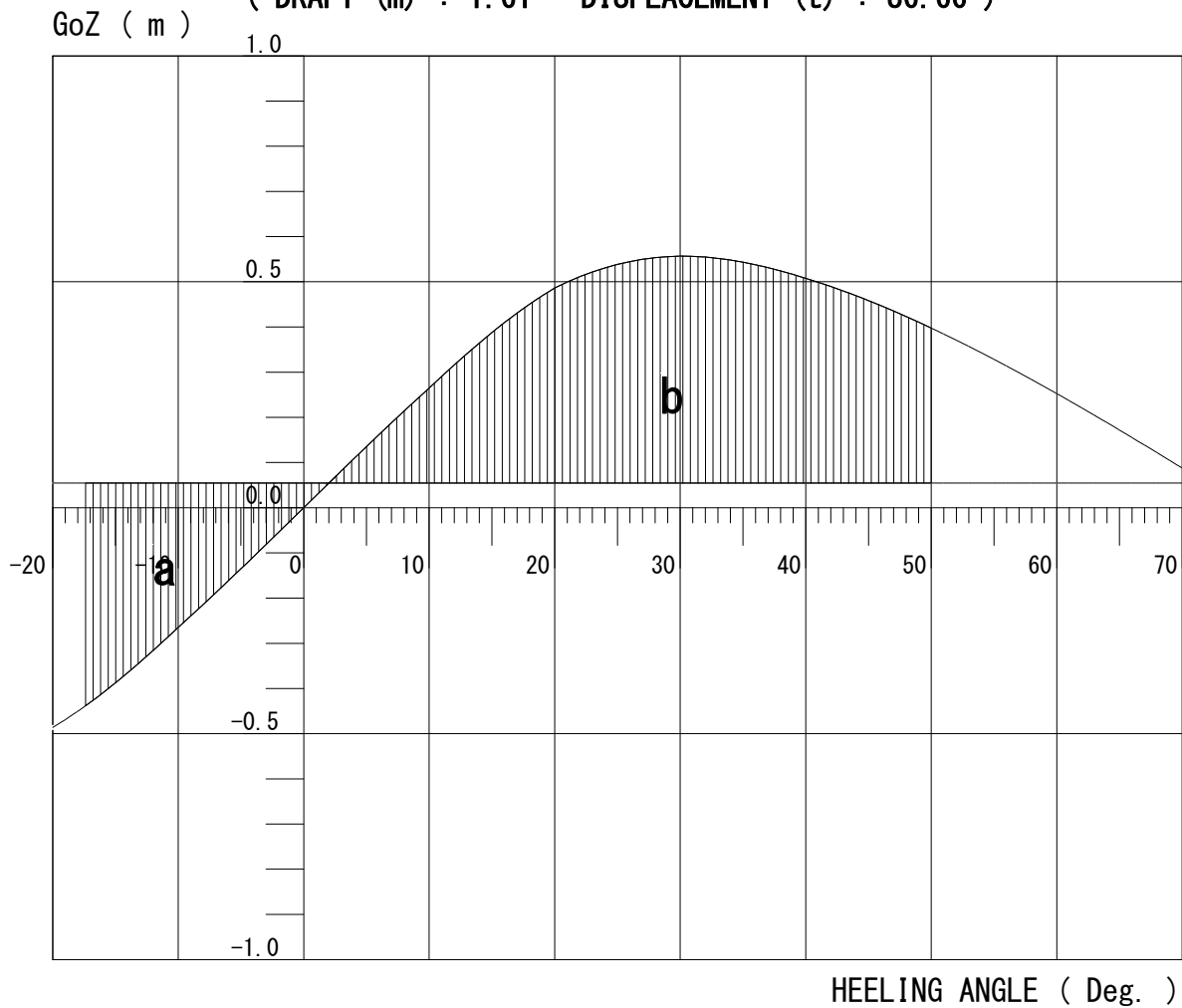
ITEM	(%)	WEIGHT ( t )	MID. G ( m )	MOMENT (t-m)	K G ( m )	MOMENT (t-m)	$\rho * I$ (t-m)
LIGHT WEIGHT		60.91	0.74	45.07	1.32	80.40	0.00
CONSTANTS		1.00	0.00	0.00	1.20	1.20	0.00
CREWS (2P)		0.15	-2.50	-0.38	5.70	0.86	0.00
D/W CONSTANTS		1.15	-0.33	-0.38	1.79	2.06	0.00
FORE F. O. T. (C)	95	8.71	-3.53	-30.75	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 <sup>2</sup> )	38.2
WIND LEVER	( m )	2.31
ROLLING ANGLE ( $\theta_1$ )	( deg. )	18.72
AREA "a"	(m-rad)	0.087
AREA "b"	(m-rad)	0.310
C (b/a)		3.577
ANGLE $\theta_o$	( deg. )	1.34

[A749(18) 3.1]		
AREA 0° - 30°	(m-rad)	0.183
AREA 30° - $\theta_u$	(m-rad)	0.094
AREA 0° - $\theta_u$	(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 :  $\theta_u$  ... 40° or the angle of flooding whichever is less.

## 8. APPENDIX