

GRAIN LOADING

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I . INTENT

This booklet of "GRAIN LOADING CALCULATION" has been prepared complying with chapter VI "Carriage of cargoes" of SOLAS 1974 and "International Grain Code (Res.MSC.23(59))".

NOTICE ON GRAIN LOADING

1. The term grain includes wheat, maize(corn), oats, rye, barley, rice, pulses, seeds and processed forms thereof whose behavior is similar to that of grain in it's natural state.
2. The "Filled of the compartment" has two categories shown as below.
 - i) "Filled in Trimmed"
The bulk grain shall be trimmed so as to fill all the spaces under the deck and hatch covers to the maximum extend as possible.
 - ii) "Filled in Untrimmed"
The bulk grain shall be not proceed to feed throughout the feeder hole at all.

The bulk grain shall be filled to the maximum extent possible in way of the hatch opening but may be at its natural angle of repose outside the periphery of the hatch opening.
3. The grain surface of the partly filled shall be performed to level to minimize the effect of the shifting.
4. After loading the master of the ship ensure that the ship will be upright before proceeding to sea.

III. S Y M B O L S

SYMBOL	DEFINITION	UNIT
t, kt, Mt	Weight unit 1000 kg	-
df	Draft at fore draft mark	m
da	Draft at aft draft mark	m
dF	Draft at F.P.	m
dA	Draft at A.P.	m
dMID	Draft at midship, mean of P and S	m
dm	Mean draft, $(dF + dA) / 2$	m
T	Trim, $dA - dF$	m
δd	Deflection of hull, $dMID - dm$	m
Δo	Displacement corresponding to dm ($\rho = 1.025$)	t
$\delta \Delta i$	Displacement corrections by trim, deflection, etc.	t
Δ	Actual displacement or total weight of ship	t
dCF, DRAFT (EQ)	Corresponding draft or draft at LCF	m
MID.G, MID. G, LCG	Center of gravity from midship, (-) for forward	m
MID.B, MID. B, LCB	Center of buoyancy from midship, (-) for forward	m
MID.F, MID. F, LCF	Center of floatation from midship, (-) for forward	m
BG	Distance MID.G - MID.B	m
CR. G, CG	Center of gravity off center line of ship	m
KG, VCG	Center of gravity above base line	m
KM, TKM	Transverse metacenter above base line	m
GM	Metacentric height, $KM - KG$	m
GGo, GoG	Apparent rise of KG	m
GoM	Apparent metacentric height, $GM - GGo$	m
KGo	Apparent VCG, $KG + GGo$	m
ρ	Specific gravity of liquid	t/ m ³
I	Moment of inertia of freesurface in tank	m ⁴
G'Z	Righting lever on assumed KG (= 0.000 m)	m
GoZ	Righting lever with KGo, $GoZ = G'Z - KGo \cdot \sin \theta$	m
θ	Heel angle	deg.
θf	Downflooding angle	deg.
TPC	Tons per 1 cm immersion	t
MTC	Moment to change trim 1 cm	t-m
Lpp	Length between perpendicular (163.60 m)	m
WPA	Water plane area	m ²
WSA	Wetted surface area	m ²
MID.A	Midship sectional area	m ²
Cb	Block coefficient	-
Cp	Prismatic coefficient	-
Cw	Water plane area coefficient	-
Cm	Midship Sectional area coefficient	-

Note :

" No sigh" and " Minus (-) sigh" of LCG(MID.G), LCB(MID.B), and LCF(MID.F) show aft and fore from midship respectivery.

IV. HOLD & TANK CAPACITY TABLE

TANK CAPACITY TABLE

TANK IN ENGINE ROOM		($\rho = 1.000$)				
COMPARTMENT	LOCATION (FR. NO.)	CAPACITY (m ³)	WEIGHT (t)	MID. G (m)	K G (m)	
F. O. SERVICE TK.	29 — 33	13.4	13.4	59.19	12.61	
F. O. SETTL. TK.	29 — 33	13.4	13.4	59.19	12.61	
L. S. F. O. SERVICE TK.	29 — 33	10.7	10.7	59.19	12.61	
L. S. F. O. SETTL. TK.	29 — 33	10.7	10.7	59.19	12.61	
NO. 1 D. O. SERVICE TK	31 — 33	6.9	6.9	58.52	12.42	
NO. 2 D. O. SERVICE TK	29 — 31	6.9	6.9	59.82	12.42	
L. O. STORAGE TK.	28 — 31	13.6	13.6	60.27	12.42	
L. O. SETTL. TANK	24 — 28	13.6	13.6	63.07	12.42	
NO. 1 CYL. OIL STR. TK	13 — 15	20.3	20.3	72.82	12.47	
NO. 2 CYL. OIL STR. TK	15 — 17	10.6	10.6	71.22	12.47	
F. O. DRAIN TK.	26 — 27	1.1	1.1	62.77	2.55	
F. O. SLUDGE TK.	28 — 29	1.0	1.0	61.07	2.53	
G/E LO SETTL TK.	23 — 24	1.8	1.8	65.20	12.27	
G/E L. O. PURI. TK.	21 — 23	1.8	1.8	66.25	12.27	
G/E L. O. STORAGE TK.	21 — 24	4.6	4.6	65.72	12.30	
L. O. DRAIN TK.	26 — 27	0.8	0.8	62.85	2.62	
L. O. SLUDGE TK.	27 — 28	0.8	0.8	62.10	2.62	
T O T A L	—	132.0	132.0	—	—	

V. CURVES OF HEELING MOMENT, VOLUME AND KG

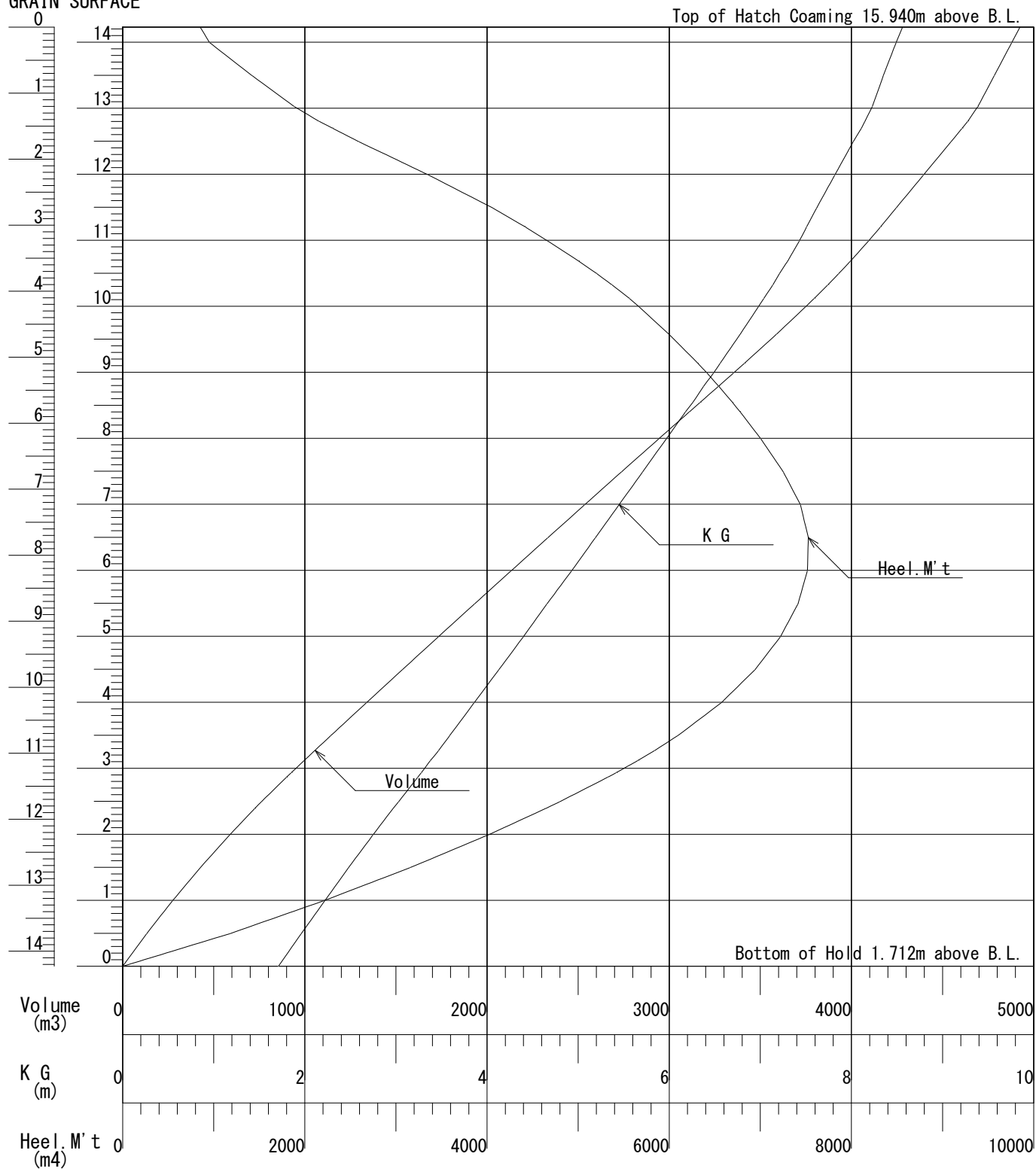
HEELING MOMENT DIAGRAM

< HEEL. M' T = 1.12 × TRANS HEELING MOMENT >

NO. 1 CARGO HOLD

FILLED COMPARTMENT		
Volume	(m ³)	4924.60
K G	(m)	8.56
Heel. M' t	(m ⁴)	392.0

DISTANCE OF
GRAIN SURFACE



HEELING MOMENT TABLE
 < HEEL. M' T = 1.12 × TRANS HEELING MOMENT >
NO. 1 CARGO HOLD

DEPH (m)	VOLUME (m ³)	K (m)	HEEL M' T (m ⁴)
0.00	0.03	1.71	0.4
0.20	52.35	1.81	494.5
0.40	106.08	1.91	963.4
0.60	161.23	2.01	1407.3
0.80	217.78	2.12	1826.1
1.00	275.75	2.22	2220.1
1.20	335.50	2.33	2608.6
1.40	396.86	2.43	2983.3
1.60	459.84	2.54	3344.6
1.80	524.44	2.64	3693.1
2.00	590.65	2.75	4028.4
2.20	658.46	2.86	4349.1
2.40	728.05	2.97	4656.6
2.60	800.62	3.09	4954.7
2.80	874.94	3.20	5237.5
3.00	951.11	3.31	5503.8
3.20	1028.14	3.43	5756.0
3.40	1105.91	3.54	5988.1
3.60	1183.82	3.65	6205.4
3.80	1262.06	3.75	6400.7
4.00	1340.59	3.86	6577.1
4.20	1419.28	3.97	6737.4
4.40	1498.19	4.08	6880.4
4.60	1577.28	4.19	7008.3
4.80	1656.53	4.29	7123.2
5.00	1735.97	4.40	7223.8
5.20	1815.54	4.51	7310.8
5.40	1895.27	4.61	7383.9
5.60	1975.14	4.72	7442.9
5.80	2055.16	4.82	7487.4
6.00	2135.33	4.93	7517.6
6.20	2215.64	5.04	7532.3
6.40	2296.10	5.14	7532.1
6.60	2376.72	5.24	7516.5
6.80	2457.50	5.35	7485.0
7.00	2538.44	5.45	7437.8
7.20	2619.57	5.56	7373.9
7.40	2700.87	5.66	7293.7
7.60	2782.36	5.76	7202.9
7.80	2864.06	5.87	7106.3
8.00	2945.95	5.97	7000.7
8.20	3028.04	6.08	6892.2
8.40	3110.34	6.18	6778.2
8.60	3192.97	6.29	6658.9
8.80	3275.44	6.38	6535.5
9.00	3357.34	6.49	6406.6
9.20	3438.25	6.59	6268.0
9.40	3518.03	6.69	6123.7
9.60	3597.67	6.79	5977.7
9.80	3674.53	6.89	5820.1

DEPH (m)	VOLUME (m ³)	K (m)	HEEL M' T (m ⁴)
10.00	3751.34	6.98	5662.3
10.20	3825.32	7.08	5487.4
10.40	3897.20	7.17	5296.8
10.60	3966.26	7.26	5095.3
10.80	4032.45	7.35	4876.3
11.00	4097.39	7.43	4653.6
11.20	4158.80	7.51	4420.7
11.40	4218.84	7.58	4172.4
11.60	4278.78	7.66	3915.2
11.80	4338.73	7.74	3636.6
12.00	4398.70	7.82	3340.8
12.20	4458.66	7.90	3043.6
12.40	4518.62	7.98	2738.1
12.60	4578.55	8.07	2440.1
12.80	4637.75	8.15	2159.3
13.00	4687.31	8.22	1915.7
13.20	4727.27	8.27	1711.2
13.40	4765.66	8.33	1513.3
13.60	4804.04	8.38	1319.0
13.80	4842.44	8.43	1131.8
14.00	4880.84	8.49	951.1
14.23	4924.50	8.56	852.5
14.23	4924.60	8.56	392.0

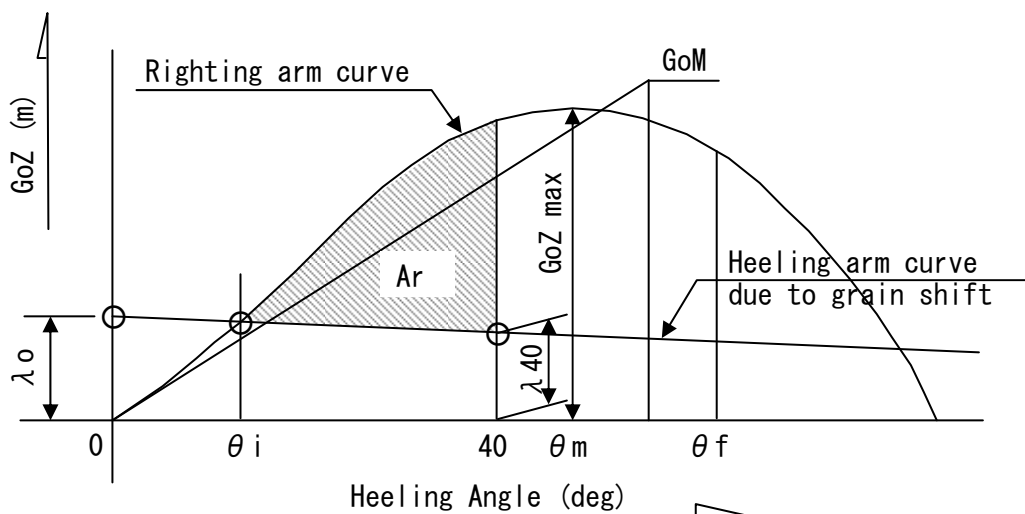
VI. ALLOWABLE HEELING MOMENT

EXPLANATION OF ALLOWABLE HEELING MOMENT

This table shows the allowable maximum heeling moment due to shift of grain which satisfy following conditions.

- 1) The angle of heel due to the shift of grain (θ_i) shall be not greater than 12 degrees. or the angle at which the deck edge is immersed, whichever is the lesser.
- 2) The net or residual area (A_r) between the heeling arm curve and righting arm curve up to angle of heel of maximum difference between the ordinates of the two curves (θ_m), or 40 degrees or the angle of flooding (θ_f), whichever is the least, shall be not less than 0.075 meterradians.
- 3) The initial metacentric height after correction for the free surface effects of liquids in tanks (GoM) shall be not less than 0.30 meters.

Statical stability curve



ALLOWABLE HEELING MOMENT

The allowable heeling moment shows the maximum to be sufficient to comply with the "International Grain Code".

HOW TO USE

The allowable heeling moment on the condition is calculation as follows.

[EXAMPLE]

SHIP'S CONDITION : 11-1 GRAIN LOAD COND. (DEP) TRIM

DISPLACEMENT (T)	36855.0
K M (m)	11.32
K G (m)	8.24
GGo (m)	0.20
KGo (m)	8.44
GoM (m)	2.88

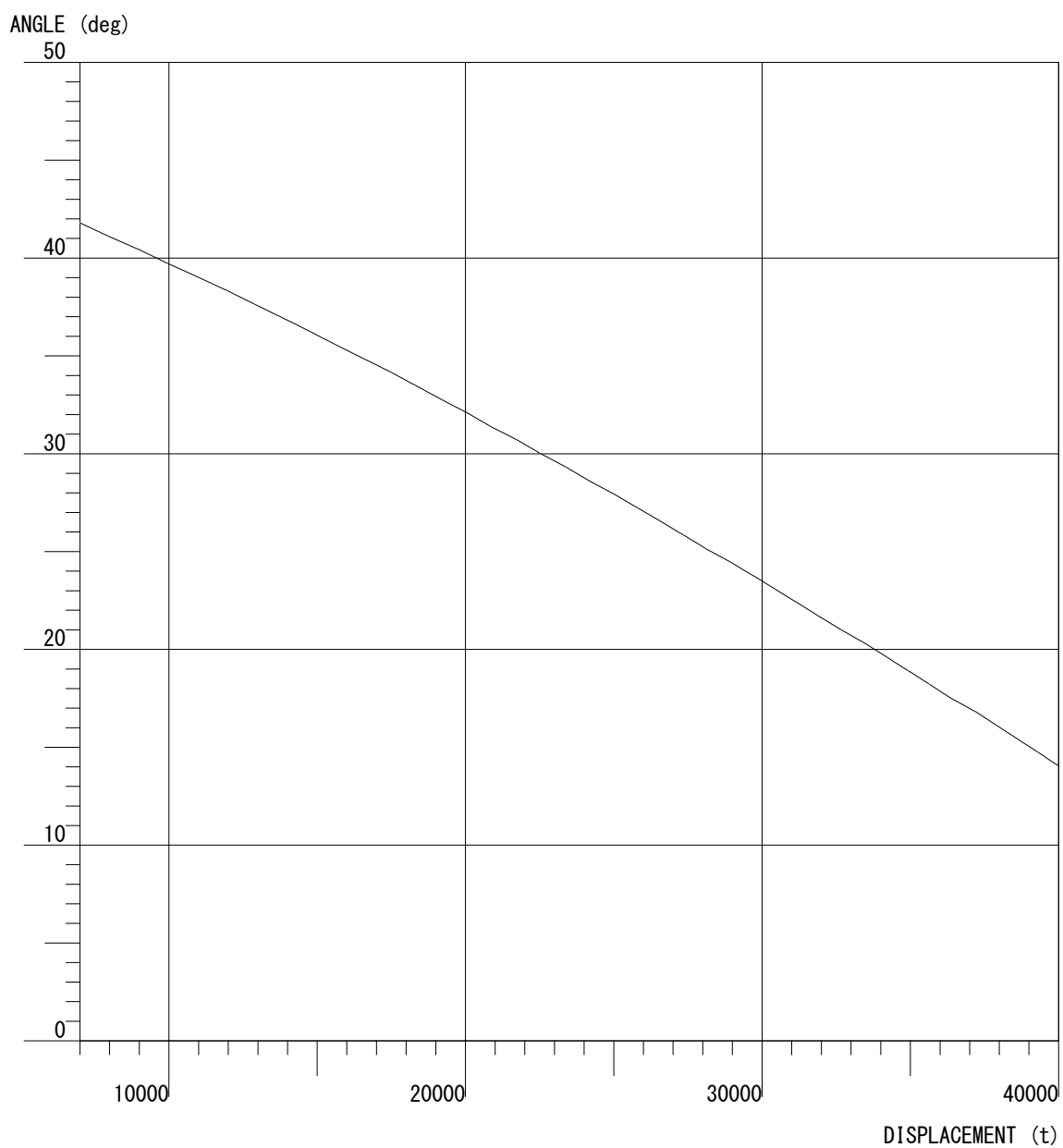
DISPT. (t)	KGo	KGo	KGo
	8.40 m	8.50 m	8.44 m
36500.0	24531.0	23723.0	24207.8
37000.0	24865.0	24047.0	24537.8
36855.0	24768.1	23953.0	24442.1

ALLOWABLE HEELING MOMENT (T-M) 24442

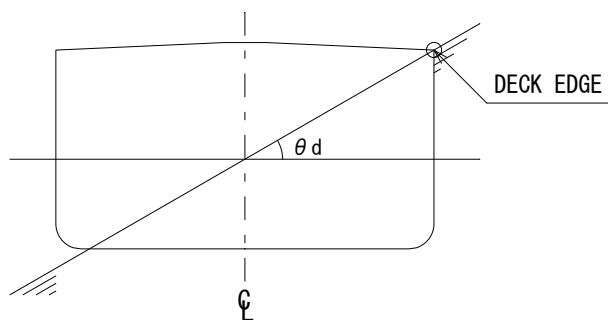
***** ALLOWABLE HEELING MOMENT *****

KGo (m) Dispt. (t)	8. 00	8. 10	8. 20	8. 30	8. 40	8. 50	8. 60	8. 70	8. 80	8. 90
7000	26536	26381	26226	26071	25917	25762	25607	25452	25297	25142
7500	26795	26629	26463	26298	26132	25966	25800	25634	25468	25302
8000	26919	26742	26565	26389	26212	26035	25858	25681	25504	25327
8500	26936	26748	26560	26372	26184	25996	25808	25620	25432	25244
9000	26871	26672	26473	26274	26075	25876	25677	25478	25278	25079
9500	26743	26533	26323	26113	25903	25693	25483	25273	25063	24852
10000	26571	26350	26129	25908	25687	25466	25244	25023	24802	24581
10500	26372	26139	25907	25675	25443	25211	24978	24746	24514	24282
11000	26162	25919	25676	25433	25189	24946	24703	24459	24216	23973
11500	25950	25696	25441	25187	24933	24678	24424	24170	23915	23661
12000	25715	25450	25184	24919	24654	24388	24123	23857	23592	23327
12500	25474	25197	24921	24645	24368	24092	23815	23539	23262	22986
13000	25241	24954	24666	24379	24091	23804	23516	23229	22941	22654
13500	25003	24704	24406	24107	23809	23510	23212	22913	22614	22316
14000	24761	24452	24142	23833	23523	23213	22904	22594	22284	21975
14500	24530	24210	23889	23568	23247	22927	22606	22285	21965	21644
15000	24305	23973	23641	23310	22978	22646	22314	21983	21651	21319
15500	24085	23742	23399	23056	22713	22371	22028	21685	21342	20999
16000	23875	23521	23167	22813	22459	22105	21751	21398	21044	20690
16500	23677	23312	22947	22582	22217	21852	21488	21123	20758	20393
17000	23493	23117	22742	22366	21990	21614	21238	20862	20486	20110
17500	23321	22934	22547	22160	21773	21386	20999	20612	20225	19838
18000	23162	22764	22366	21968	21569	21171	20773	20375	19977	19579
18500	23022	22613	22203	21794	21385	20976	20567	20158	19748	19339
19000	22895	22475	22054	21634	21214	20794	20374	19953	19533	19113
19500	22779	22348	21917	21485	21054	20623	20191	19760	19329	18898
20000	22684	22242	21799	21357	20915	20472	20030	19588	19145	18703
20500	22606	22152	21699	21246	20792	20339	19885	19432	18979	18525
21000	22537	22072	21608	21143	20679	20215	19750	19286	18821	18357
21500	22488	22012	21537	21061	20586	20110	19635	19159	18684	18208
22000	22459	21972	21486	20999	20513	20026	19539	19053	18566	18080
22500	22438	21941	21443	20945	20448	19950	19452	18955	18457	17960
23000	22433	21925	21416	20907	20399	19890	19381	18873	18364	17855
23500	22449	21929	21409	20890	20370	19850	19331	18811	18291	17771
24000	22476	21945	21415	20884	20353	19822	19291	18761	18230	17699
24500	22517	21975	21433	20891	20350	19808	19266	18724	18182	17640
25000	22578	22025	21472	20919	20366	19813	19260	18707	18154	17602
25500	22651	22087	21523	20959	20395	19831	19267	18703	18139	17575
26000	22736	22161	21586	21011	20435	19860	19285	18710	18135	17560
26500	22838	22252	21666	21079	20493	19907	19321	18735	18149	17563
27000	22955	22358	21760	21163	20566	19969	19372	18775	18178	17580
27500	23084	22476	21868	21260	20651	20043	19435	18827	18218	17610
28000	23230	22611	21992	21373	20753	20134	19515	18896	18276	17657
28500	23393	22762	22132	21502	20872	20241	19611	18981	18350	17720
29000	23566	22925	22283	21642	21001	20359	19718	19076	18435	17794
29500	23755	23102	22450	21797	21145	20492	19840	19188	18535	17883
30000	23959	23296	22632	21969	21305	20642	19978	19315	18651	17988
30500	24174	23500	22825	22151	21476	20802	20127	19452	18778	18103
31000	24402	23716	23031	22345	21660	20974	20288	19603	18917	18231
31500	24645	23948	23252	22555	21858	21162	20465	19768	19072	18375

CURVE OF DECK EDGE IMMERSION ANGLE



DECK EDGE IMMERSION ANGLE (θ_d)



VII. GRAIN LOADING STABILITY CALCULATION

TRIM CALCULATION

Refer to "TRIM CALCULATION SHEET" on next page.

- 1) Put the weight and MID.G of cargo, fuel oil, fresh water or ballast water in each tank and provisions, etc. into the column of "WEIGHT" and "MID.G" respectively. MID.G of tanks can be obtained from "TANK CAPACITY TABLE" and "TANK PROPERTIES".
- 2) Sum up the above-mentioned weights to make the deadweight, then add the light weight. The total makes the displacement (W).
- 3) Multiply the "WEIGHT" by "MID.G" and put them into the column of "MOMENT".
- 4) Devide the total of "MOMENT" by the displacement. Results shows the MID.G of this loading condition.
- 5) Get trim(T) and drafts as below :

$$\text{Trim} = \frac{\text{Trimming moment}}{\text{MTC} \times 100} = \frac{W \times (\text{MID.G} - \text{MID.B})}{\text{MTC} \times 100} \dots\dots\dots \text{in m}$$

$$dF = dCF - \text{Trim} \times \frac{\text{LPP} / 2 + \text{MID.F}}{\text{LPP}} \dots\dots\dots \text{in m}$$

$$dA = dF + \text{Trim} \dots\dots\dots \text{in m}$$

$$dm = \frac{dF + dA}{2} \dots\dots\dots \text{in m}$$

MID.B, dCF, MID.F and MTC are to correspond to the displacement (W) on the "HYDROSTATIC TABLE"

Reference ; Propeller immersion (I/D)

$$\frac{I}{D} = \frac{dA - \text{Shaft Cr.H}}{\text{Propeller Dia.}} = \frac{dA - 3.160}{6.000} \times 100 \dots\dots \text{in \%}$$

STABILITY CALCULATION

Refer to "TRIM CALCULATION SHEET" and on next page.

Metacentric height (GM), GGo, KG (TRIM CALCULATION SHEET).

- 1) Put the height of vertical center of gravity above base line of each loading weight into the column of "KG" in m.
KG of tanks can be obtained from "TANK PROPERTIES".
- 2) Multiply the "WEIGHT" by "KG" and put them into the column of "MOMENT".
- 3) Divide the total of "MOMENT" by the displacement. Result shows the vertical center of gravity above base line (KG) of this loading condition.
- 4) Tanks where free surface effect is to be taken account ;
For tanks which are partly filled, the effect due to the free surface on the stability is to be given as the function of the volume or the depth of the liquid.

For tanks which may be consumed or discharged during navigation or may be transferred to and from other tanks, the expected maximum moment of free surface is to be considered.

- 5) Put the products of moment of inertia of free surface about longitudinal axis of each tank and specific gravity of liquid into the column of " $\rho * I$ ".
"I" can be obtained from "TANK PROPERTIES".
- 6) Rise of apparent vertical center of gravity due to effect of free surface can be given as follows :

$$GGo = \frac{\text{total}(\rho \times I)}{W} \dots\dots\dots \text{in m}$$

- 7) Ship's metacentric height (GM) can be given as follows :

$$GM = KM - KG \dots\dots\dots \text{in m}$$

$$\text{and } GoM = GM - GGo \dots\dots\dots \text{in m}$$

Where, "KM" is that which corresponds to the displacement in "HYDROSTATIC TABLE".

GoZ CALCULATION FOR STABILITY CURVE

Statical stability curves (righting arm vs. heeling angle) can be obtained by the following procedure :

- 1) Calculate the "KGo".

$$KGo = KG + GGo \dots\dots\dots \text{ in m}$$

- 2) Read "G'Z" in meter from "GROSS CURVE TABLE" for each heeling angle (θ) at the displacement (W).

- 3) Calculate the actual righting arm (GoZ) for each heeling angle (θ).

$$GoZ = G'Z - KGo \times \sin \theta \dots\dots\dots \text{ in m}$$

	10 °	12 °	20 °	30 °	40 °	50 °	60 °	75 °	90 °
Sin θ	0.1736	0.2079	0.3420	0.5000	0.6427	0.7660	0.8660	0.9659	1.0000

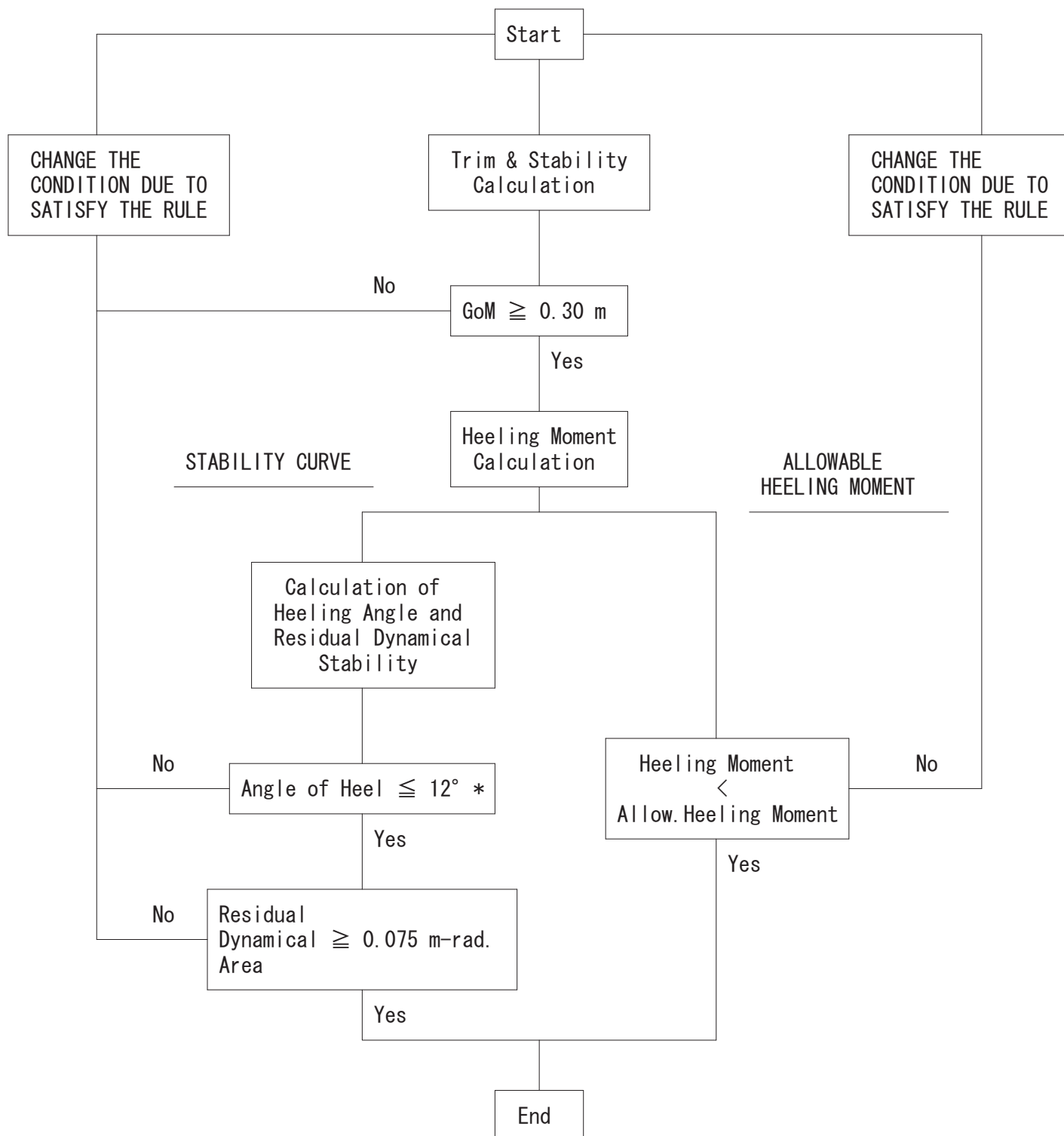
- 4) Plot GoZ against θ and connect these points by a fair curve to make a statical stability curve.

At negative heeling angle, GoZ calculated above should be plotted in negative direction of ordinate.

Usually the curve at small angles will be straight line which, if extended, would pass through a point, the ordinate of which equals the initial GoM and abscissa of which is 57.3 degrees.

JUDGEMENT OF GRAIN HEELING MOMENT

【 FLOW CHART 】



* Check the deck edge immersion angle to be more than 12° .

MINIMUM REQUIRED GoM CURVES

In order to avoid complicated calculation for checking stability according to the stability criteria, required GoM vs. draft has been computed and drawn in chart as shown on next page.

This chart indicates limiting GoM to comply with requirements of all relevant intact and damage stability criteria.

When the ship's actual GoM locates in sufficient stability area i.e. GoM is not less than the required minimum, the ship complies with the said criteria in this condition.

By using the required GoM chart, the ship operator can easily check the stability whether it complies with the criteria or not.

Procedure for checking stability with required GoM chart.

- 1) Calculate the displacement, draft and GoM in accordance with method described in section I-3-3 "TRIM CALCULATION" and I-3-4 "STABILITY CALCULATION".
GoM includes correction for free surface of liquid in tanks.
In operation of ballasting/deballasting, the maximum free surface of the subject tank(s) must be taken into consideration.
- 2) Read the required GoM at this draft in the chart.
- 3) If the calculated GoM is less than required GoM, the condition does not comply with stability requirement.
Then loading arrangement must be changed so as to achieve at least the minimum required GoM.

Permissible Trim Range

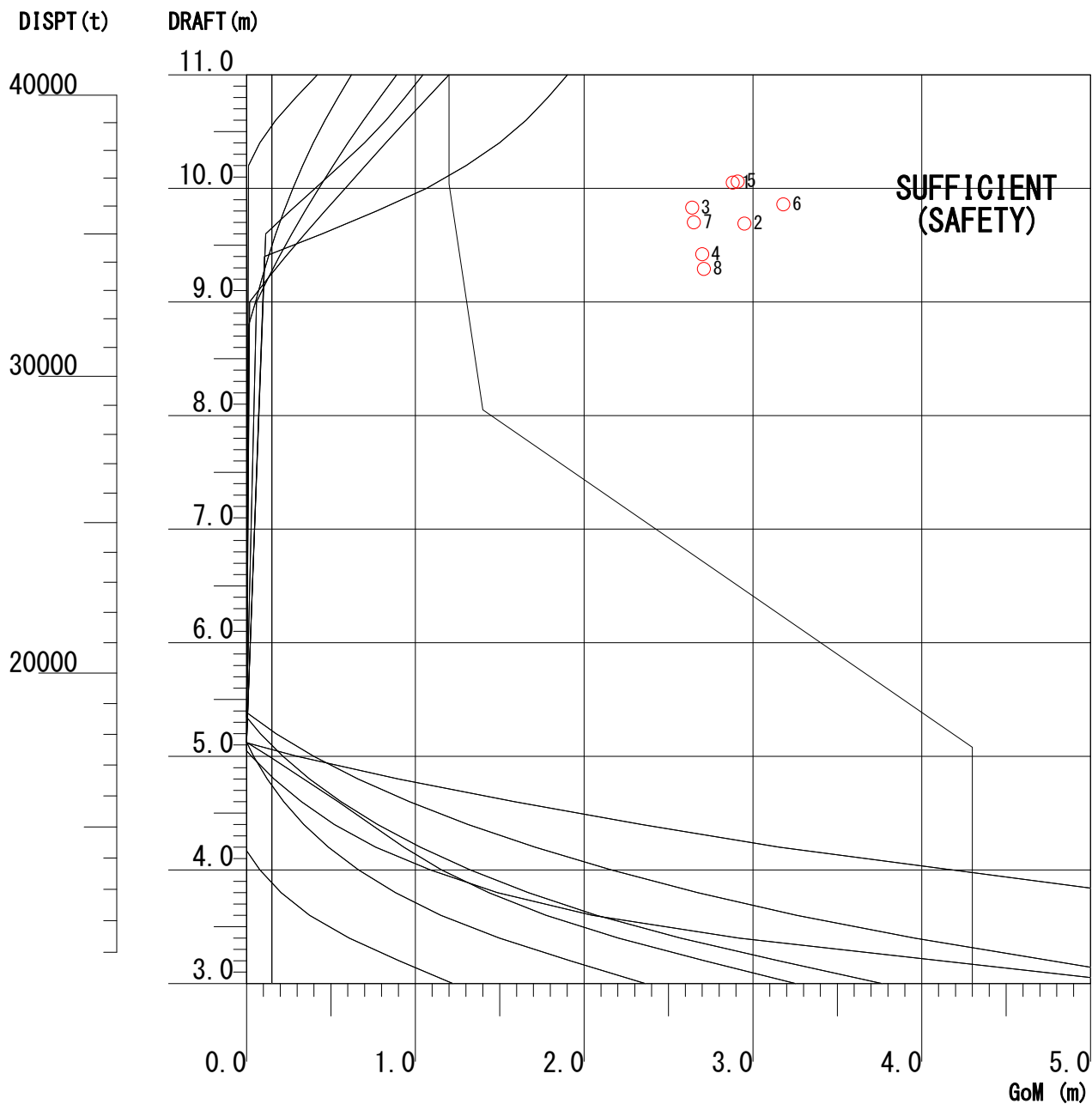
The permissible trim range is a result of damage stability requirement set by SOLAS 2009, Chapter II-1, Part B-1, Reg. 5-1.

The vessel has a permissible operational trim range as below. These shall be used in conjunction with limit GM curves.

Permissible Trim (m)	Normal Freeboard			Timber Freeboard		
	Light Draft	Partial Draft	Summer Draft	Light Draft	Partial Draft	Summer Draft
	5.090	8.057	10.035	5.090	8.204	10.280
By bow	–	0.82	0.82	–	0.82	0.82
By stern	1.46 – 3.16	2.45	2.45	1.46 – 3.16	2.45	2.45

The permissible trim shall be linearly varied between the partial draught and light service draught. Please note the drafts in above table are moulded.

MINIMUM REQUIRED GoM CURVE (INTACT and DAMAGE)



Area under curve up to 30 to be not less than 0.055 m-rad.
 Area under curve up to θ_f to be not less than 0.090 m-rad.
 Area between 30 and of to be not less than 0.030 m-rad.
 GZ to be at least 0.20 m in height at angle not less than 30°
 Max. GZ to occur not less than 25°
 Initial GoM to be not less than 0.15 m.
 Area (b) to be not less than Area (a).
 Heeling angle due to wind not less than θ_0 .
 Dry Cargo Damage

Where

θ_f : flooding Angle or 40. Whichever is less.

θ_0 : 80% of the angle of deck edge immersion or 16.
 whichever is less.

- (1) 11-1 GRAIN LOAD. COND. (DEP) TRIM
- (2) 11-2 GRAIN LOAD. COND. (ARR) TRIM
- (3) 14-1 GRAIN LOAD. COND. (DEP) TRIM
- (4) 14-2 GRAIN LOAD. COND. (ARR) TRIM
- (5) 11-1 GRAIN LOAD. COND. (DEP)
- (6) 11-2 GRAIN LOAD. COND. (ARR)
- (7) 14-1 GRAIN LOAD. COND. (DEP)
- (8) 14-2 GRAIN LOAD. COND. (ARR)

MINIMUM REQUIRED GoM TABLE

DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)
3.00	10.015	4.00	4.300	5.00	4.300	6.00	3.402	7.00	2.425
3.02	9.875	4.02	4.300	5.02	4.300	6.02	3.382	7.02	2.406
3.04	9.736	4.04	4.300	5.04	4.300	6.04	3.363	7.04	2.386
3.06	9.596	4.06	4.300	5.06	4.300	6.06	3.343	7.06	2.367
3.08	9.457	4.08	4.300	5.08	4.300	6.08	3.324	7.08	2.347
3.10	9.317	4.10	4.300	5.10	4.280	6.10	3.304	7.10	2.328
3.12	9.178	4.12	4.300	5.12	4.261	6.12	3.285	7.12	2.308
3.14	9.040	4.14	4.300	5.14	4.241	6.14	3.265	7.14	2.289
3.16	8.901	4.16	4.300	5.16	4.222	6.16	3.245	7.16	2.269
3.18	8.763	4.18	4.300	5.18	4.202	6.18	3.226	7.18	2.249
3.20	8.626	4.20	4.300	5.20	4.183	6.20	3.206	7.20	2.230
3.22	8.489	4.22	4.300	5.22	4.163	6.22	3.187	7.22	2.210
3.24	8.352	4.24	4.300	5.24	4.144	6.24	3.167	7.24	2.191
3.26	8.216	4.26	4.300	5.26	4.124	6.26	3.148	7.26	2.171
3.28	8.081	4.28	4.300	5.28	4.105	6.28	3.128	7.28	2.152
3.30	7.947	4.30	4.300	5.30	4.085	6.30	3.109	7.30	2.132
3.32	7.812	4.32	4.300	5.32	4.066	6.32	3.089	7.32	2.113
3.34	7.680	4.34	4.300	5.34	4.046	6.34	3.070	7.34	2.093
3.36	7.547	4.36	4.300	5.36	4.027	6.36	3.050	7.36	2.074
3.38	7.416	4.38	4.300	5.38	4.007	6.38	3.031	7.38	2.054
3.40	7.286	4.40	4.300	5.40	3.988	6.40	3.011	7.40	2.035
3.42	7.156	4.42	4.300	5.42	3.968	6.42	2.992	7.42	2.015
3.44	7.028	4.44	4.300	5.44	3.948	6.44	2.972	7.44	1.996
3.46	6.900	4.46	4.300	5.46	3.929	6.46	2.953	7.46	1.976
3.48	6.773	4.48	4.300	5.48	3.909	6.48	2.933	7.48	1.957
3.50	6.654	4.50	4.300	5.50	3.890	6.50	2.913	7.50	1.937
3.52	6.534	4.52	4.300	5.52	3.870	6.52	2.894	7.52	1.918
3.54	6.416	4.54	4.300	5.54	3.851	6.54	2.874	7.54	1.898
3.56	6.302	4.56	4.300	5.56	3.831	6.56	2.855	7.56	1.878
3.58	6.188	4.58	4.300	5.58	3.812	6.58	2.835	7.58	1.859
3.60	6.076	4.60	4.300	5.60	3.792	6.60	2.816	7.60	1.839
3.62	5.965	4.62	4.300	5.62	3.773	6.62	2.796	7.62	1.820
3.64	5.854	4.64	4.300	5.64	3.753	6.64	2.777	7.64	1.800
3.66	5.746	4.66	4.300	5.66	3.734	6.66	2.757	7.66	1.781
3.68	5.638	4.68	4.300	5.68	3.714	6.68	2.738	7.68	1.761
3.70	5.531	4.70	4.300	5.70	3.695	6.70	2.718	7.70	1.742
3.72	5.426	4.72	4.300	5.72	3.675	6.72	2.699	7.72	1.722
3.74	5.320	4.74	4.300	5.74	3.656	6.74	2.679	7.74	1.703
3.76	5.217	4.76	4.300	5.76	3.636	6.76	2.660	7.76	1.683
3.78	5.115	4.78	4.300	5.78	3.617	6.78	2.640	7.78	1.664
3.80	5.012	4.80	4.300	5.80	3.597	6.80	2.621	7.80	1.644
3.82	4.912	4.82	4.300	5.82	3.577	6.82	2.601	7.82	1.625
3.84	4.813	4.84	4.300	5.84	3.558	6.84	2.581	7.84	1.605
3.86	4.714	4.86	4.300	5.86	3.538	6.86	2.562	7.86	1.586
3.88	4.616	4.88	4.300	5.88	3.519	6.88	2.542	7.88	1.566
3.90	4.519	4.90	4.300	5.90	3.499	6.90	2.523	7.90	1.546
3.92	4.440	4.92	4.300	5.92	3.480	6.92	2.503	7.92	1.527
3.94	4.370	4.94	4.300	5.94	3.460	6.94	2.484	7.94	1.507
3.96	4.300	4.96	4.300	5.96	3.441	6.96	2.464	7.96	1.488
3.98	4.300	4.98	4.300	5.98	3.421	6.98	2.445	7.98	1.468
4.00	4.300	5.00	4.300	6.00	3.402	7.00	2.425	8.00	1.449

MINIMUM REQUIRED GoM TABLE

DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)	DRAFT (m)	REQUIRED GoM (m)
8.00	1.449	9.00	1.305	10.00	1.204	11.00	1.902		
8.02	1.431	9.02	1.303	10.02	1.202				
8.04	1.417	9.04	1.301	10.04	1.200				
8.06	1.403	9.06	1.298	10.06	1.200				
8.08	1.397	9.08	1.296	10.08	1.200				
8.10	1.395	9.10	1.294	10.10	1.205				
8.12	1.393	9.12	1.292	10.12	1.221				
8.14	1.391	9.14	1.290	10.14	1.238				
8.16	1.389	9.16	1.288	10.16	1.258				
8.18	1.387	9.18	1.286	10.18	1.280				
8.20	1.385	9.20	1.284	10.20	1.302				
8.22	1.383	9.22	1.282	10.22	1.323				
8.24	1.381	9.24	1.280	10.24	1.344				
8.26	1.379	9.26	1.278	10.26	1.364				
8.28	1.377	9.28	1.276	10.28	1.384				
8.30	1.375	9.30	1.274	10.30	1.404				
8.32	1.373	9.32	1.272	10.32	1.424				
8.34	1.371	9.34	1.270	10.34	1.443				
8.36	1.369	9.36	1.268	10.36	1.462				
8.38	1.367	9.38	1.266	10.38	1.480				
8.40	1.365	9.40	1.264	10.40	1.498				
8.42	1.363	9.42	1.262	10.42	1.516				
8.44	1.361	9.44	1.260	10.44	1.533				
8.46	1.359	9.46	1.258	10.46	1.550				
8.48	1.357	9.48	1.256	10.48	1.566				
8.50	1.355	9.50	1.254	10.50	1.583				
8.52	1.353	9.52	1.252	10.52	1.599				
8.54	1.351	9.54	1.250	10.54	1.613				
8.56	1.349	9.56	1.248	10.56	1.628				
8.58	1.347	9.58	1.246	10.58	1.642				
8.60	1.345	9.60	1.244	10.60	1.656				
8.62	1.343	9.62	1.242	10.62	1.670				
8.64	1.341	9.64	1.240	10.64	1.684				
8.66	1.339	9.66	1.238	10.66	1.697				
8.68	1.337	9.68	1.236	10.68	1.710				
8.70	1.335	9.70	1.234	10.70	1.723				
8.72	1.333	9.72	1.232	10.72	1.736				
8.74	1.331	9.74	1.230	10.74	1.749				
8.76	1.329	9.76	1.228	10.76	1.761				
8.78	1.327	9.78	1.226	10.78	1.773				
8.80	1.325	9.80	1.224	10.80	1.785				
8.82	1.323	9.82	1.222	10.82	1.797				
8.84	1.321	9.84	1.220	10.84	1.809				
8.86	1.319	9.86	1.218	10.86	1.821				
8.88	1.317	9.88	1.216	10.88	1.833				
8.90	1.315	9.90	1.214	10.90	1.844				
8.92	1.313	9.92	1.212	10.92	1.856				
8.94	1.311	9.94	1.210	10.94	1.867				
8.96	1.309	9.96	1.208	10.96	1.879				
8.98	1.307	9.98	1.206	10.98	1.890				
9.00	1.305	10.00	1.204	11.00	1.902				

SAMPLE & BLANK SHEET

CONDITION NAME : 11-1 GRAIN LOAD COND. (DEP) TRIM
S.F.=42.0 ft3/LT

ITEM	(%)	WEIGHT (t)	MID. G (m)	MOMENT (t-m)	K G (m)	MOMENT (t-m)	G*I (t-m)
LIGHT WEIGHT		7777	7.40	57550	9.73	75670	0
CONSTANTS		175	46.31	8104	10.06	1761	
COLLAPS. STANCHON		64	-5.50	-352	14.80	947	
SECURING FITTINGS		0	0.00	0	0.00	0	
CONSTANTS		239	32.44	7752	11.33	2708	0
PROVISIONS		6	71.80	431	15.70	94	0
F. W. T. (P)	100	119	49.69	5913	12.61	1501	0
F. W. T. (S)	100	119	49.69	5913	12.61	1501	0
DRINK W. T. (S)	100	49	55.39	2714	12.65	620	0
DIST. W. T. (P)	101	49	55.39	2714	12.65	620	0
FRESH WATER TOTAL		336	51.35	17254	12.63	4242	0
NO. 3 U.W.F.O.T. (P)	96	228	-12.61	-2875	12.83	2925	73
NO. 3 U.W.F.O.T. (S)	96	228	-12.61	-2875	12.83	2925	73
NO. 4 U.W.F.O.T. (P)	96	228	15.53	3541	12.83	2925	73
NO. 4 U.W.F.O.T. (S)	96	228	15.53	3541	12.83	2925	73
NO. 4 F.O.T. (C)	96	275	15.53	4271	0.81	223	584
NO. 5 F.O.T. (C)	96	234	42.04	9837	0.82	192	438
FUEL OIL TOTAL		1421	10.87	15440	8.53	12115	1314
NO. 1 D.O.T. (P)	96	47	61.64	2897	1.07	50	40
NO. 1 D.O.T. (S)	97	44	61.69	2714	1.09	48	36
NO. 2 D.O.T. (C)	98	27	74.79	2019	12.34	333	35
DIESEL OIL		118	64.66	7630	3.65	431	111
NO. 1 CARGO HOLD	59	2499	-63.28	-158137	5.96	14894	
NO. 2 CARGO HOLD	100	7414	-40.71	-301824	8.29	61462	
NO. 3 CARGO HOLD	100	7868	-12.61	-99215	8.21	64596	
NO. 4 CARGO HOLD	28	2160	15.90	34344	3.71	8014	
NO. 5 CARGO HOLD	100	7017	43.22	303275	8.48	59504	
CARGO TOTAL		26958	-8.22	-221557	7.73	208470	0
NO. 1 HATCH & DECK	0	0	0.00	0	0.00	0	0
NO. 2 HATCH & DECK	0	0	0.00	0	0.00	0	0
NO. 3 HATCH & DECK	0	0	0.00	0	0.00	0	0
NO. 4 HATCH & DECK	0	0	0.00	0	0.00	0	0
NO. 5 HATCH & DECK	0	0	0.00	0	0.00	0	0
LUMBER TOTAL		0	0.00	0	0.00	0	0
F. P. T.	0	0	0.00	0	0.00	0	0
NO. 1 UPP. W. T. (P)	0	0	0.00	0	0.00	0	0
NO. 1 UPP. W. T. (S)	0	0	0.00	0	0.00	0	0
NO. 2 UPP. W. T. (P)	0	0	0.00	0	0.00	0	0
NO. 2 UPP. W. T. (S)	0	0	0.00	0	0.00	0	0
NO. 3 UPP. W. T. (P)	0	0	0.00	0	0.00	0	0
NO. 3 UPP. W. T. (S)	0	0	0.00	0	0.00	0	0
NO. 4 UPP. W. T. (P)	0	0	0.00	0	0.00	0	0
NO. 4 UPP. W. T. (S)	0	0	0.00	0	0.00	0	0
NO. 5 UPP. W. T. (P)	0	0	0.00	0	0.00	0	0
NO. 5 UPP. W. T. (S)	0	0	0.00	0	0.00	0	0
NO. 1 W. B. T. (P)	0	0	0.00	0	0.00	0	0
NO. 1 W. B. T. (S)	0	0	0.00	0	0.00	0	0
NO. 2 W. B. T. (P)	0	0	0.00	0	0.00	0	0
NO. 2 W. B. T. (S)	0	0	0.00	0	0.00	0	0
NO. 3 W. B. T. (P)	0	0	0.00	0	0.00	0	0
NO. 3 W. B. T. (S)	0	0	0.00	0	0.00	0	0
NO. 4 W. B. T. (P)	0	0	0.00	0	0.00	0	0
NO. 4 W. B. T. (S)	0	0	0.00	0	0.00	0	0
NO. 5 W. B. T. (P)	0	0	0.00	0	0.00	0	0
NO. 5 W. B. T. (S)	0	0	0.00	0	0.00	0	0
A. P. T.	0	0	77.62	0	6.07	0	6020
NO. 3 CARGO HOLD (W.B)	0	0	0.00	0	0.00	0	0
WATER BALLAST TOTAL		0	0.00	0	0.00	0	6020
T O T A L		36855	-3.13	-115500	8.24	303730	7445

* * * * *						S U M M A R Y		* * * * *	
DISPT (t)	36855	MID. G (m)	-3.13	T. KM (m)	11.31				
DRAFT (EQ) (m)	10.05	MID. B (m)	-3.51	K G (m)	8.24				
DRAFT (F) (m)	9.90	B G (m)	0.38	G M (m)	3.07				
DRAFT (A) (m)	10.20	MID. F (m)	1.91	GoG (m)	0.20				
DRAFT (M) (m)	10.05	M. T. C. (t-m)	462.69	GoM (m)	2.87				
TRIM (m)	0.30	T. P. C. (t)	40.67	I/D (%)	117.33				

JUDGEMENT OF GRAIN LOADING

COND. NAME : 11-1 GRAIN LOAD. COND. (DEP) TRIM					
DISPLACEMENT (t) (W)			36855		
GoM (m) (> 0.30 m)			2.87		
GRAIN HEELING MOMENT					
ITEM	%	VOL. HEEL MOMENT (m**4)	STOWAGE FACTOR (SF)	* HEELING MOMENT (t-m) (Wh)	
NO. 1 CARGO HOLD	59.4	7034	42.000	6009	
NO. 2 CARGO HOLD	100.0	542	42.000	463	
NO. 3 CARGO HOLD	100.0	567	42.000	484	
NO. 4 CARGO HOLD	28.2	18180	42.000	15531	
NO. 5 CARGO HOLD	100.0	536	42.000	458	
ACTUAL HEELING MOMENT (t-m) (ΣWh)			22945		
ALLOWABLE HEELING MOMENT (t-m)			24442		
HEELING ARM (m)	0° (λo) ($\Sigma Mh / W$)		0.623		
	40° ($\lambda 40$) ($\lambda o \times 0.8$)		0.498		
HEELING ANGLE (θ) (deg.) (< 12 deg.)			11.34		
FLOODING ANGLE (θf) or MAX DIFF. CURVES or 40 (deg.)			40.00		
RESIDUAL DYN. STABILITY					
	NO	ANGLE	GoZ	S	S. GoZ
	1	11.34	0.000	1	0.000
	2	18.51	0.439	4	1.756
	3	25.67	0.725	2	1.450
	4	32.84	0.910	4	3.640
	5	40.00	1.031	1	1.031
TOTAL				7.877	
RESIDUAL DYN. AREA $= 1/12 \times 28.66 \times 7.877 / 57.3$ $= 0.3283 (> 0.075 \text{ m-rad})$					

* HEELING MOMENT (Wh) = VOL. HEEL MOMENT x 35.88 / STOWAGE FACTOR (SF)

CONDITION NAME :

ITEM	(%)	WEIGHT (t)	MID. G (m)	MOMENT (t-m)	K G (m)	MOMENT (t-m)	Q*J (t-m)
LIGHT WEIGHT		7777	7.40	57550	9.73	75670	0
CONSTANTS	0	175	44.87	7852	10.06	1761	76
COLLAPS. STANCHON	0	64	-5.50	-352	14.80	947	0
SECURING FITTINGS							
CONSTANTS		239	31.38	7500	11.33	2708	0
PROVISIONS							
F. W. T. (P)							
F. W. T. (S)							
DRINK W. T. (S)							
DIST. W. T. (P)							
FRESH WATER TOTAL							
NO. 3 U. W. F. O. T. (P)							
NO. 3 U. W. F. O. T. (S)							
NO. 4 U. W. F. O. T. (P)							
NO. 4 U. W. F. O. T. (S)							
NO. 4 F. O. T. (C)							
NO. 5 F. O. T. (C)							
FUEL OIL TOTAL							
NO. 1 D. O. T. (P)							
NO. 1 D. O. T. (S)							
NO. 2 D. O. T. (C)							
DIESEL OIL							
NO. 1 CARGO HOLD							
NO. 2 CARGO HOLD							
NO. 3 CARGO HOLD							
NO. 4 CARGO HOLD							
NO. 5 CARGO HOLD							
CARGO TOTAL							
NO. 1 HATCH & DECK							
NO. 2 HATCH & DECK							
NO. 3 HATCH & DECK							
NO. 4 HATCH & DECK							
NO. 5 HATCH & DECK							
LUMBER TOTAL							
F. P. T.							
NO. 1 UPP. W. T. (P)							
NO. 1 UPP. W. T. (S)							
NO. 2 UPP. W. T. (P)							
NO. 2 UPP. W. T. (S)							
NO. 3 UPP. W. T. (P)							
NO. 3 UPP. W. T. (S)							
NO. 4 UPP. W. T. (P)							
NO. 4 UPP. W. T. (S)							
NO. 5 UPP. W. T. (P)							
NO. 5 UPP. W. T. (S)							
NO. 1 W. B. T. (P)							
NO. 1 W. B. T. (S)							
NO. 2 W. B. T. (P)							
NO. 2 W. B. T. (S)							
NO. 3 W. B. T. (P)							
NO. 3 W. B. T. (S)							
NO. 4 W. B. T. (P)							
NO. 4 W. B. T. (S)							
NO. 5 W. B. T. (P)							
NO. 5 W. B. T. (S)							
A. P. T.							
NO. 3 CARGO HOLD (W. B)							
WATER BALLAST TOTAL							
TOTAL							

***** SUMMARY *****					
DISPT (t)		MID. G (m)		T. KM (m)	
DRAFT (EQ) (m)		MID. B (m)		K G (m)	
DRAFT (F) (m)		B G (m)		G M (m)	
DRAFT (A) (m)		MID. F (m)		GoG (m)	
DRAFT (M) (m)		M. T. C. (t-m)		GoM (m)	
TRIM (m)		T. P. C. (t)		I/D (%)	

JUDGEMENT OF GRAIN LOADING

COND. NAME :					
DISPLACEMENT (t) (W)					
GoM (m) (> 0.30 m)					
GRAIN HEELING MOMENT					
ITEM	%	VOL. HEEL MOMENT (m**4)	STOWAGE FACTOR (SF)	* HEELING MOMENT (t-m) (Wh)	
NO. 1 CARGO HOLD					
NO. 2 CARGO HOLD					
NO. 3 CARGO HOLD					
NO. 4 CARGO HOLD					
NO. 5 CARGO HOLD					
ACTUAL HEELING MOMENT (t-m) (ΣWh)					
ALLOWABLE HEELING MOMENT (t-m)					
HEELING ARM (m)	0° (λ_0) ($\Sigma Mh / W$)				
	40° (λ_{40}) ($\lambda_0 \times 0.8$)				
HEELING ANGLE (θ) (deg.) (< 12 deg.)					
FLOODING ANGLE (θ_f) or MAX DIFF. CURVES or 40 (deg.)					
RESIDUAL DYN. STABILITY					
	NO	ANGLE	GoZ	S	S. GoZ
	1			1	
	2			4	
	3			2	
	4			4	
	5			1	
	TOTAL				
RESIDUAL DYN. AREA = $1/12 \times \quad \times \quad / 57.3$ = $(> 0.075 \text{ m-rad})$					

* HEELING MOMENT (Wh) = VOL. HEEL MOMENT x 35.88 / STOWAGE FACTOR (SF)

VIII. SUMMARY OF GRAIN LOADING CONDITION

The stability of standard grain loading condition is ensured to be safe at any stage of voyage to comply with the stability criteria required by international grain code (IMO Res. MSC.23(59)) and IMO Res. A749(19) 3.1 & 3.2, Dry cargo damage which are shown below.

IMO Res. MSC.23(59)

The allowable Heeling moment is to be calculated to comply with it.

Then the actual heeling moment on the condition is to be less than the allowable.

ACTUAL HEELING MOMENT < ALLOWABLE HEELING MOMENT

IMO Res. A749(18) 3.1 & 3.2, DRY CARGO DAMAGE

GoM(ALLOWABLE) mean the sufficient stability to satisfy the above,
then calculated GoM must be more than it.

GoM > GoM(ALLOWABLE)

A749(18)3.1

Area 0° ~ 30°	>	0.055 m-rad
Area 30° ~ θF°	>	0.030 m-rad
Area 0° ~ θF°	>	0.090 m-rad
Maximum GoZ	>	0.20 m
Angle of Maximum GoZ	>	25°
GoM	>	0.15 m

A749(18)3.2

θ_o	<	16° or 0.8 * Deck Edge Angle
C (Area b/Area a)	>	1.00

IX. TRIMMED CONDITION

* * * SUMMARY TABLE * * *

CONDITION NO.		11-1	11-2	12-1	12-2	13-1	13-2
CONDITION		GRAIN LOAD. COND. (TRIMMED)					
		S. F. = 42 ft ³ /LT		S. F. = 45 ft ³ /LT		S. F. = 50 ft ³ /LT	
ITEM		DEP.	ARR.	DEP.	ARR.	DEP.	ARR.
LIGHT WEIGHT	(t)	7777	7777	7777	7777	7777	7777
CONSTANTS	(t)	239	239	239	239	239	239
PROVISIONS	(t)	6	6	6	6	6	6
FRESH WATER TOTAL	(t)	336	34	336	34	336	34
FUEL OIL TOTAL	(t)	1421	129	1421	129	1421	129
DIESEL OIL	(t)	118	6	118	6	118	6
CARGO TOTAL	(t)	26958	26958	26958	26958	26958	26958
LUMBER TOTAL	(t)	0	0	0	0	0	0
WATER BALLAST TOTAL	(t)	0	208	0	212	0	335
DEADWEIGHT	(t)	29078	27580	29078	27584	29078	27707
DISPLACEMENT	(t)	36855	35357	36855	35361	36855	35484
DRAFT (m)	EQUIVALENT	10.05	9.69	10.05	9.69	10.05	9.72
	FORE	9.90	9.69	9.90	9.69	10.00	9.72
	AFT	10.20	9.69	10.19	9.69	10.09	9.72
	MEAN	10.05	9.69	10.05	9.69	10.05	9.72
TRIM	(m)	0.30	0.00	0.29	0.00	0.09	0.00
MID. F	(m)	1.91	1.57	1.91	1.57	1.91	1.60
MID. B	(m)	-3.51	-3.74	-3.51	-3.74	-3.51	-3.72
MID. G	(m)	-3.13	-3.74	-3.15	-3.74	-3.40	-3.72
M. T. C.	(t-m)	462.7	454.4	462.7	454.5	462.7	455.2
T. P. C.	(t)	40.7	40.4	40.7	40.4	40.7	40.4
I/D	(%)	117.33	108.83	117.17	108.83	115.50	109.33
T. KM	(m)	11.31	11.31	11.31	11.31	11.31	11.31
K G	(m)	8.24	8.18	8.24	8.18	8.45	8.41
G M	(m)	3.07	3.13	3.07	3.13	2.86	2.90
GG _o	(m)	0.20	0.18	0.20	0.18	0.20	0.18
GoM	(m)	2.87	2.95	2.87	2.95	2.66	2.72
GoM (ALLOWABLE)	(m)	1.20	1.24	1.20	1.24	1.20	1.23
JUDGEMENT		Good	Good	Good	Good	Good	Good
S T A B I L I T Y	AREA 0-30 (m-rad)	0.401	0.425	0.401	0.425	0.373	0.393
	AREA 30- θ_u (m-rad)	0.255	0.286	0.255	0.286	0.234	0.261
	AREA 0- θ_u (m-rad)	0.656	0.710	0.656	0.710	0.607	0.654
	MAX GoZ (m)	1.53	1.72	1.53	1.72	1.39	1.56
	MAX GoZ ANGLE (deg)	40.8	41.4	40.8	41.4	40.0	40.3
	FLOOD. ANGLE (deg)	66.5	69.0	66.5	69.0	66.5	68.8
	$\theta_o \leq 16$ (deg)	0.4	0.4	0.4	0.4	0.4	0.4
	C = b / a -	4.229	4.522	4.229	4.521	4.269	4.562
	RES. DYNAMICAL (m-rad)	0.3225	0.3632	0.3401	0.3814	0.4282	0.4680
	ANGLE OF HEEL (deg)	11.34	11.48	10.72	10.85	6.39	6.48
ACTUAL HEEL. M' T (t-m)	22945	22945	21546	21546	11479	11479	
ALLOW. HEEL. M' T (t-m)	24442	24124	24442	24126	22730	22396	
SHEARING FORCE (KN)	MAX	-19387	-20903	-13205	-14736	5614	8319
	ALLOW.	-31000	-31000	-31000	-31000	32000	32000
BENDING MOMENT (KN-m)	MAX	344592	491646	258020	406636	165054	341309
	ALLOW.	823000	823000	823000	823000	823000	823000

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

< > shows S.F. after BHD Correction.

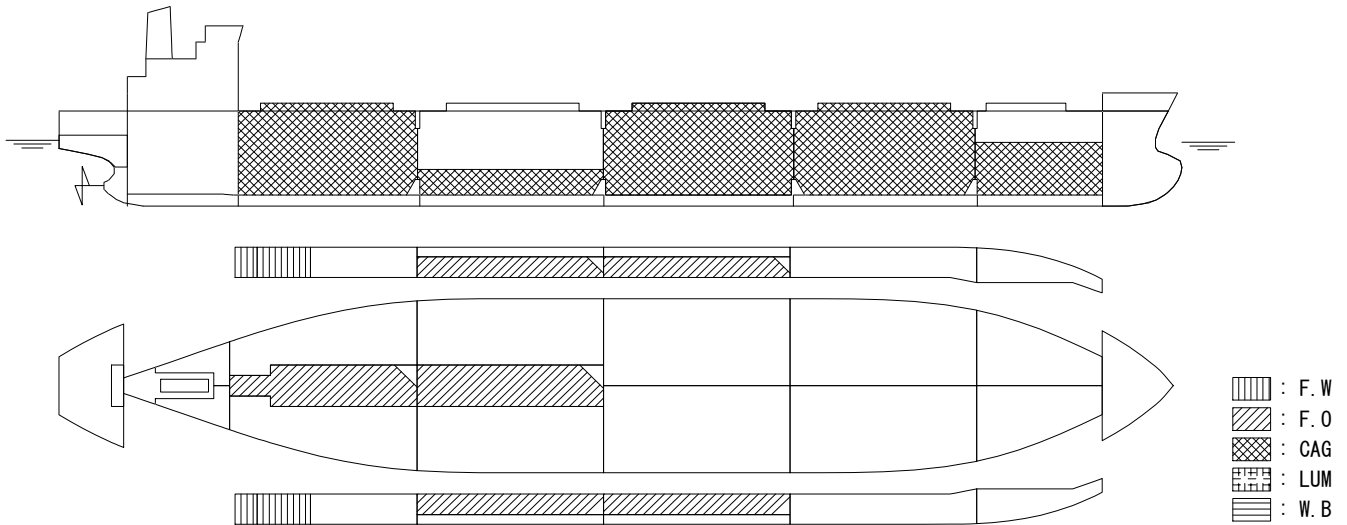
(-)MARK is SAGGING, (+)MARK is HOGGING.

※ shows the Rate for Ship Length (Lumber/Fore End)

ITEM	(%)	WEIGHT (t)	MID. G (m)	MOMENT (t-m)	K G (m)	MOMENT (t-m)	Q*I (t-m)
LIGHT WEIGHT		7777	7.40	57550	9.73	75670	0
CONSTANTS		175	46.31	8104	10.06	1761	
COLLAPS. STANCHON		64	-5.50	-352	14.80	947	
SECURING FITTINGS		0	0.00	0	0.00	0	
CONSTANTS	0	239	32.44	7752	11.33	2708	0
PROVISIONS		6	71.80	431	15.70	94	0
F. W. T. (P)	100	119	49.69	5913	12.61	1501	0
F. W. T. (S)	100	119	49.69	5913	12.61	1501	0
DRINK W. T. (S)	100	49	55.39	2714	12.65	620	0
DIST. W. T. (P)	101	49	55.39	2714	12.65	620	0
FRESH WATER TOTAL		336	51.35	17254	12.63	4242	0
NO.3 U.W.F.O.T. (P)	96	228	-12.61	-2875	12.83	2925	73
NO.3 U.W.F.O.T. (S)	96	228	-12.61	-2875	12.83	2925	73
NO.4 U.W.F.O.T. (P)	96	228	15.53	3541	12.83	2925	73
NO.4 U.W.F.O.T. (S)	96	228	15.53	3541	12.83	2925	73
NO.4 F.O.T. (C)	96	275	15.53	4271	0.81	223	584
NO.5 F.O.T. (C)	96	234	42.04	9837	0.82	192	438
FUEL OIL TOTAL		1421	10.87	15440	8.53	12115	1314
NO.1 D.O.T. (P)	96	47	61.64	2897	1.07	50	40
NO.1 D.O.T. (S)	97	44	61.69	2714	1.09	48	36
NO.2 D.O.T. (C)	98	27	74.79	2019	12.34	333	35
DIESEL OIL		118	64.66	7630	3.65	431	111
NO.1 CARGO HOLD	59	2499	-63.28	-158137	5.96	14894	
NO.2 CARGO HOLD	100	7414	-40.71	-301824	8.29	61462	
NO.3 CARGO HOLD	100	7868	-12.61	-99215	8.21	64596	
NO.4 CARGO HOLD	28	2160	15.90	34344	3.71	8014	
NO.5 CARGO HOLD	100	7017	43.22	303275	8.48	59504	
CARGO TOTAL		26958	-8.22	-221557	7.73	208470	
NO.1 HATCH & DECK		0	0.00	0	0.00	0	0
NO.2 HATCH & DECK		0	0.00	0	0.00	0	0
NO.3 HATCH & DECK		0	0.00	0	0.00	0	0
NO.4 HATCH & DECK		0	0.00	0	0.00	0	0
NO.5 HATCH & DECK		0	0.00	0	0.00	0	0
LUMBER TOTAL		0	0.00	0	0.00	0	0
F. P. T.		0	0.00	0	0.00	0	0
NO.1 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.1 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.2 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.2 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.3 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.3 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.4 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.4 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.5 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.5 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.1 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.1 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.2 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.2 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.3 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.3 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.4 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.4 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.5 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.5 W. B. T. (S)		0	0.00	0	0.00	0	0
A. P. T.		0	77.62	0	6.07	0	6020
NO.3 CARGO HOLD(W.B)		0	0.00	0	0.00	0	0
WATER BALLAST TOTAL		0	0.00	0	0.00	0	6020
T O T A L		36855	-3.13	-115500	8.24	303730	7445

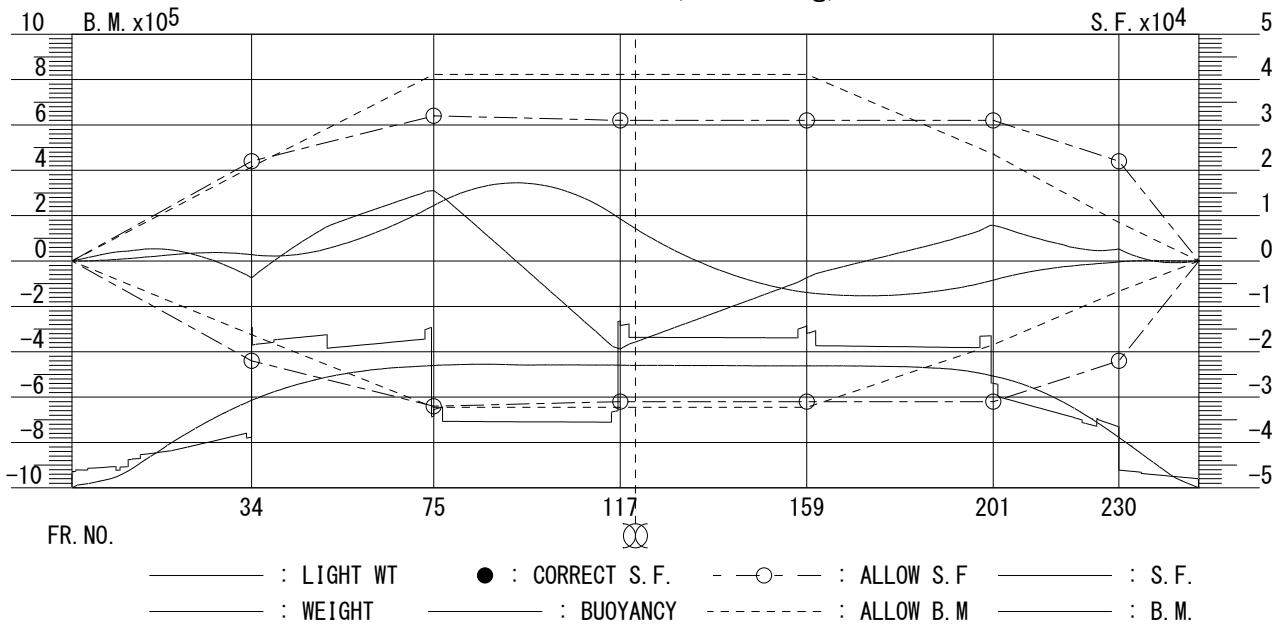
***** S U M M A R Y *****					
DISPT (t)	36855	MID. G (m)	-3.13	T. KM (m)	11.31
DRAFT (EQ) (m)	10.05	MID. B (m)	-3.51	K G (m)	8.24
DRAFT (F) (m)	9.90	B G (m)	0.38	G M (m)	3.07
DRAFT (A) (m)	10.20	MID. F (m)	1.91	GoG (m)	0.20
DRAFT (M) (m)	10.05	M. T. C. (t-m)	462.69	GoM (m)	2.87
TRIM (m)	0.30	T. P. C. (t)	40.67	I/D (%)	117.33

COND. NAME : 11-1 GRAIN LOAD. COND. (DEP) TRIM
S. F. =42.0 ft3/LT



LONGITUDINAL STRENGTH CURVE

<< In Still Water (Sea Going) >>



GRAIN HEEL MOMENT

COMPARTMENT	%	S. F. (cf/LT)	SHIFT. MOMENT (m4)	HEEL M' T (t-m)
NO. 1 CARGO HOLD	59	42.00	7034	6009
NO. 2 CARGO HOLD	100	42.00	542	463
NO. 3 CARGO HOLD	100	42.00	567	484
NO. 4 CARGO HOLD	28	42.00	18180	15531
NO. 5 CARGO HOLD	100	42.00	536	458
T O T A L		-	-	22945
ACTUAL HEELING MOMENT		(t-m)		22945
ALLOWABLE HEELING MOMENT		(t-m)		24442

SUMMARY

DISPLACEMENT (t)	36855
DRAFT (MEAN) (m)	10.05
S T R E N G T H	
MAX. BEND. MT. (KN-m)	344592 (FR. 93.8)
" RATE (%)	42 (FR. 93.8)
" SHEAR. FORCE (KN)	-19387 (FR. 117.0)
" RATE (%)	63 (FR. 117.0)
S T A B I L I T Y	
ACTUAL GoM (m)	2.87
REQUIRED GoM (m)	1.20
J U D G E M E N T	G O O D

X. UNTRIMMED CONDITION

* * * SUMMARY TABLE * * *

CONDITION NO.		14-1	14-2			
CONDITION		GRAIN LOAD. (UNTRIMMED)				
		S.F. = 55 ft ³ /LT				
ITEM		DEP.	ARR.			
LIGHT WEIGHT	(t)	7777	7777			
CONSTANTS	(t)	239	239			
PROVISIONS	(t)	6	6			
FRESH WATER TOTAL	(t)	336	34			
FUEL OIL TOTAL	(t)	1421	129			
DIESEL OIL	(t)	118	6			
CARGO TOTAL	(t)	25577	25577			
LUMBER TOTAL	(t)	0	0			
WATER BALLAST TOTAL	(t)	0	0			
DEADWEIGHT	(t)	27697	25991			
DISPLACEMENT	(t)	35474	33768			
DRAFT (m)	EQUIVALENT	9.72	9.29			
	FORE	9.05	8.96			
	AFT	10.36	9.61			
	MEAN	9.71	9.29			
TRIM	(m)	1.31	0.65			
MID. F	(m)	1.60	1.10			
MID. B	(m)	-3.72	-3.98			
MID. G	(m)	-2.04	-3.12			
M. T. C.	(t-m)	455.1	444.7			
T. P. C.	(t)	40.4	40.1			
I/D	(%)	120.00	107.50			
T. KM	(m)	11.31	11.33			
K G	(m)	8.69	8.65			
G M	(m)	2.62	2.68			
GG _o	(m)	0.04	0.01			
GoM	(m)	2.58	2.67			
GoM (ALLOWABLE)	(m)	1.23	1.28			
JUDGEMENT		Good	Good			
S T A B I L I T Y	AREA 0-30 (m-rad)	0.374	0.399			
	AREA 30- θ_u (m-rad)	0.247	0.280			
	AREA 0- θ_u (m-rad)	0.621	0.679			
	MAX GoZ (m)	1.47	1.68			
	MAX GoZ ANGLE (deg)	40.0	40.2			
	FLOOD. ANGLE (deg)	68.8	71.6			
	$\theta_o \leq 16$ (deg)	0.5	0.5			
	C = b / a -	4.606	4.985			
	RES. DYNAMICAL (m-rad)	0.5548	0.6092			
	ANGLE OF HEEL (deg)	2.37	2.41			
	ACTUAL HEEL. M' T (t-m)	3873	3873			
	ALLOW. HEEL. M' T (t-m)	21292	20975			
SHEARING FORCE (KN)	MAX	-3982	3447			
	ALLOW.	-22000	11034			
BENDING MOMENT (KN-m)	MAX	33925	112064			
	ALLOW.	325213	823000			

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

< > shows S.F. after BHD Correction.

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

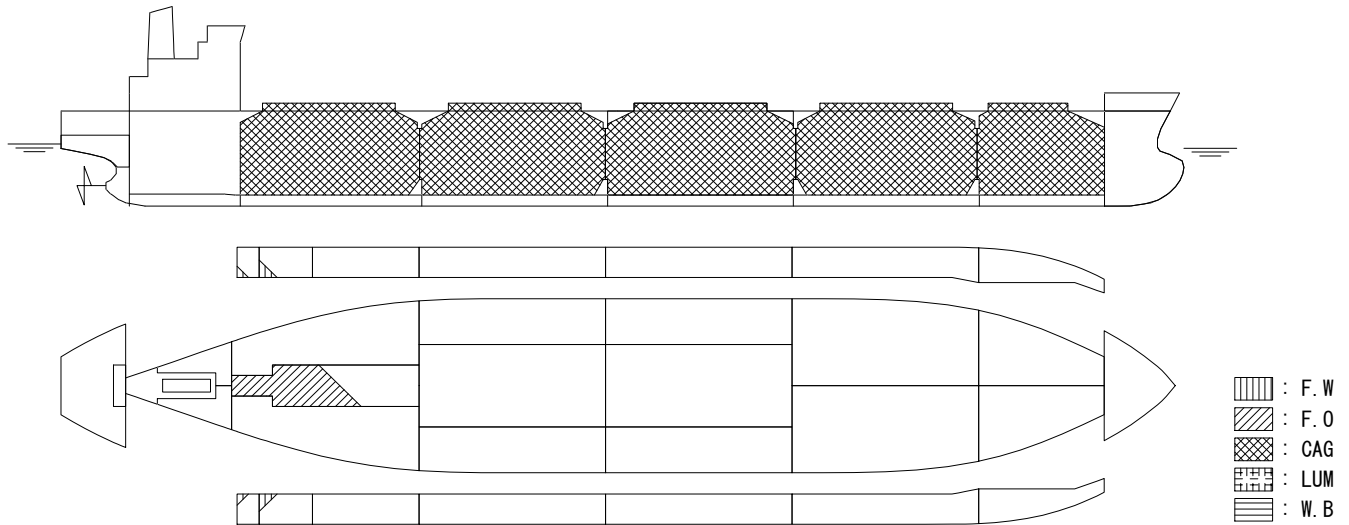
※ shows the Rate for Ship Length (Lumber/Fore End)

CONDITION NAME : 14-2 GRAIN LOAD COND. (ARR)
UNTRIMMED S.F.=55.0 ft3/LT

ITEM	(%)	WEIGHT (t)	MID. G (m)	MOMENT (t-m)	K G (m)	MOMENT (t-m)	$\rho \cdot I$ (t-m)
LIGHT WEIGHT		7777	7.40	57550	9.73	75670	0
CONSTANTS		175	46.31	8104	10.06	1761	
COLLAPS. STANCHON		64	-5.50	-352	14.80	947	
SECURING FITTINGS		0	0.00	0	0.00	0	
CONSTANTS	0	239	32.44	7752	11.33	2708	0
PROVISIONS		6	71.80	431	15.70	94	0
F. W. T. (P)	10	12	49.69	596	10.65	128	8
F. W. T. (S)	10	12	49.69	596	10.65	128	8
DRINK W. T. (S)	10	5	55.39	277	10.77	54	4
DIST. W. T. (P)	10	5	55.39	277	10.77	54	4
FRESH WATER TOTAL		34	51.35	1746	10.71	364	24
NO.3 U.W.F.O.T. (P)		0	0.00	0	0.00	0	0
NO.3 U.W.F.O.T. (S)		0	0.00	0	0.00	0	0
NO.4 U.W.F.O.T. (P)		0	0.00	0	0.00	0	0
NO.4 U.W.F.O.T. (S)		0	0.00	0	0.00	0	0
NO.4 F.O.T. (C)		0	0.00	0	0.00	0	0
NO.5 F.O.T. (C)	53	129	42.04	5423	0.45	58	438
FUEL OIL TOTAL		129	42.04	5423	0.45	58	438
NO.1 D.O.T. (P)	6	3	61.64	185	0.14	0	18
NO.1 D.O.T. (S)	7	3	61.69	185	0.15	0	18
NO.2 D.O.T. (C)		0	0.00	0	0.00	0	0
DIESEL OIL		6	61.67	370	0.00	0	36
NO.1 CARGO HOLD	100	3106	-63.28	-196548	8.56	26587	
NO.2 CARGO HOLD	100	5573	-40.71	-226877	8.29	46200	
NO.3 CARGO HOLD	100	5884	-12.61	-74197	8.21	48308	
NO.4 CARGO HOLD	100	5744	15.90	91330	8.24	47331	
NO.5 CARGO HOLD	100	5270	43.22	227769	8.48	44690	
CARGO TOTAL		25577	-6.98	-178523	8.33	213116	
NO.1 HATCH & DECK		0	0.00	0	0.00	0	0
NO.2 HATCH & DECK		0	0.00	0	0.00	0	0
NO.3 HATCH & DECK		0	0.00	0	0.00	0	0
NO.4 HATCH & DECK		0	0.00	0	0.00	0	0
NO.5 HATCH & DECK		0	0.00	0	0.00	0	0
LUMBER TOTAL		0	0.00	0	0.00	0	0
F. P. T.		0	0.00	0	0.00	0	0
NO.1 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.1 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.2 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.2 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.3 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.3 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.4 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.4 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.5 UPP. W. T. (P)		0	0.00	0	0.00	0	0
NO.5 UPP. W. T. (S)		0	0.00	0	0.00	0	0
NO.1 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.1 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.2 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.2 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.3 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.3 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.4 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.4 W. B. T. (S)		0	0.00	0	0.00	0	0
NO.5 W. B. T. (P)		0	0.00	0	0.00	0	0
NO.5 W. B. T. (S)		0	0.00	0	0.00	0	0
A. P. T.		0	0.00	0	0.00	0	0
NO.3 CARGO HOLD (W.B)		0	0.00	0	0.00	0	0
WATER BALLAST TOTAL		0	0.00	0	0.00	0	0
TOTAL		33768	-3.12	-105251	8.65	292010	498

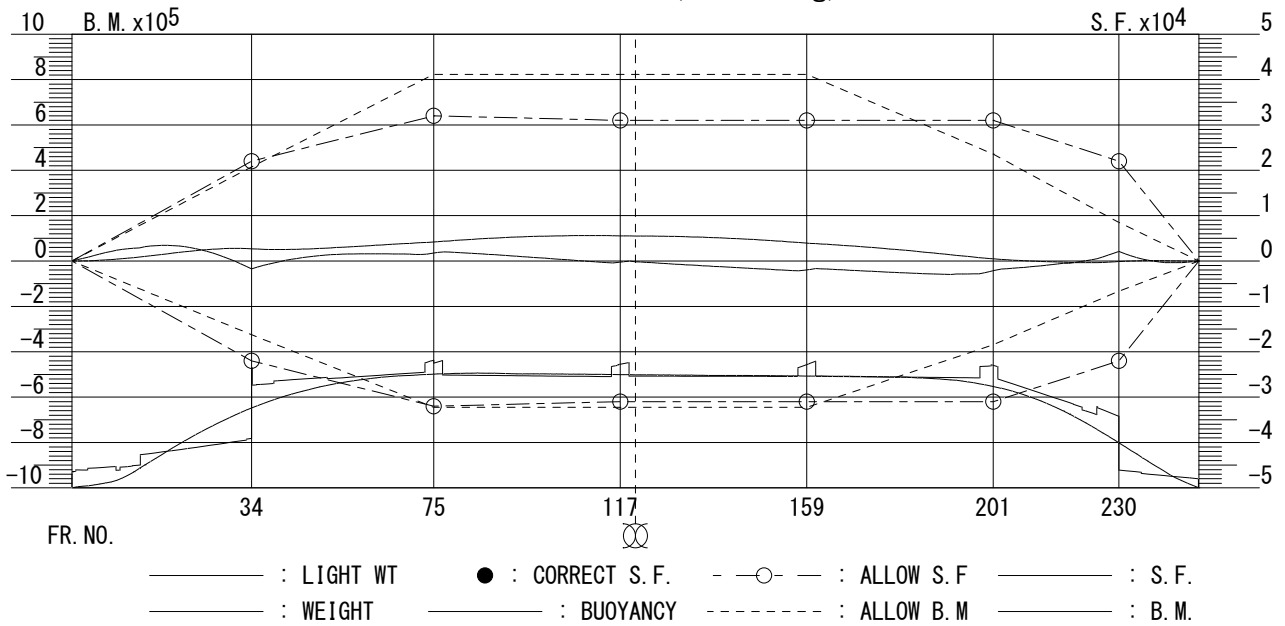
***** SUMMARY *****					
DISPT (t)	33768	MID. G (m)	-3.12	T. KM (m)	11.33
DRAFT (EQ) (m)	9.29	MID. B (m)	-3.98	K G (m)	8.65
DRAFT (F) (m)	8.96	B G (m)	0.86	G M (m)	2.68
DRAFT (A) (m)	9.61	MID. F (m)	1.10	GoG (m)	0.01
DRAFT (M) (m)	9.29	M. T. C. (t-m)	444.66	GoM (m)	2.67
TRIM (m)	0.65	T. P. C. (t)	40.08	I/D (%)	107.50

**COND. NAME : 14-2 GRAIN LOAD. COND. (ARR)
UNTRIMMED S.F.=55.0 ft3/LT**



LONGITUDINAL STRENGTH CURVE

<< In Still Water (Sea Going) >>



GRAIN HEEL MOMENT

COMPARTMENT	%	S.F. (cf/LT)	SHIFT. MOMENT (m4)	HEEL M' T (t-m)
NO. 1 CARGO HOLD	100	55.00	825	538
NO. 2 CARGO HOLD	100	55.00	1158	755
NO. 3 CARGO HOLD	100	55.00	1495	975
NO. 4 CARGO HOLD	100	55.00	1329	867
NO. 5 CARGO HOLD	100	55.00	1131	738
T O T A L		-	-	3873
ACTUAL HEELING MOMENT		(t-m)		3873
ALLOWABLE HEELING MOMENT		(t-m)		20975

SUMMARY

DISPLACEMENT (t)	33768
DRAFT (MEAN) (m)	9.29
S T R E N G T H	
MAX. BEND. MT. (KN-m)	112064 (FR. 110. 3)
" RATE (%)	14 (FR. 110. 3)
" SHEAR. FORCE (KN)	3447 (FR. 17. 1)
" RATE (%)	10 (FR. 230. 0)
S T A B I L I T Y	
ACTUAL GoM (m)	2.67
REQUIRED GoM (m)	1.28
J U D G E M E N T	G O O D

X I . LOADING DATA