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*Karppinen Tuomo - Rintala Sakari:*

MV Estonia Accident Investigation. Stability calculations with water on  
the tank deck.

Research Report VAL313-7331.

VTT Manufacturing Technology.

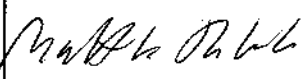


Espoo 1997.

# **MV ESTONIA ACCIDENT INVESTIGATION**

**Stability calculations with water on the tank deck**

**Research Report VAL313-7331**

**Espoo, Finland  
27 November, 1997**

Title Stability calculations with water on the tank deck	
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Author(s) Tuomo Karppinen & Sakari Rintala	No. of pages/appendices 37
Keywords Stability	
Summary The stability of MV ESTONIA has been estimated using the current most accurate estimates of the actual loading condition on the accident night and assuming that different amounts of water flooded three compartments on the tank deck. These compartments located in the fore part of the ship between frames #85 and #120. The volume of water flooded into the tank deck varied from 0 ton to 1300 ton.  The free water surface thus arising on the tank deck reduces the stability of the ship. The mass of water in the three compartments on the tank deck did, however, not make the initial transverse stability negative. Since the stability was in all the cases positive, the vessel would have been floating upright without the action of any outside inclining moments. The list angle due to the wind heeling moment would have been increased due to the significant reduction of the transverse metacentric height.	
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## 1 Introduction

The transverse stability of MV ESTONIA has been estimated using the current most accurate estimates of the actual loading condition on the accident night and assuming that different amounts of water flooded three compartments on the tank deck. These compartments located in the fore part of the ship between frames # 85 and # 120. Amount of water flooded into the tank deck varied from 0 ton to 1300 tons.

## 2 Computation method

The program package NAPA was used in the stability calculations. NAPA (The Naval Architectural Package) is a computer-aided engineering system used in the basic design work for a ship project and in naval architectural calculations. The package comprises the definition of hull form, superstructures, bulkheads, decks and compartments. Besides stability and damage analysis, NAPA can be used when calculating hydrostatics, tank volumes, capacities, loading conditions, inclining test results etc.

The NAPA program package is used world wide by shipyards, consultants, navies etc. In Finland, NAPA has been a long time the standard method by which the shipyards have made hydrostatic calculations.

The hull form definition of MV ESTONIA introduced by the report VALC177 has been used in the stability calculations which were actually made at Ship Consulting Ltd.

## 3 Loading conditions

MV ESTONIA's main particulars and the loading condition departure from Tallin are presented in Table 3.1.

Table 3.1. MV ESTONIA's main particulars and departure loading condition.

	Symbol	Dimension	Actual values
Length over all	Loa	m	155.4
Waterline length	Lwl	m	144.8
Length btw. perp.	Lpp	m	137.4
Beam mld, A-deck	B	m	24.2
Waterline beam	Bwl	m	23.6
Draught mean	T	m	5.355
Draught at forw. perp	Tf	m	5.118
Draught at aft perp.	Ta	m	5.593
Trim, positive by bow		m	-0.475
Displacement	$\nabla$	m <sup>3</sup>	11961

In the stability calculations the change of the transverse metacentric height  $GM_T$  was investigated when different volumes of water flooded three compartments on the tank deck. These compartments were separated from each other by transverse watertight bulkheads. The locations of the compartments are shown in Table 3.2.

Table 3.2. Locations of the compartments on the tank deck.

Name of the compartment	Frames of the compartment	Distances from AP m	Volume of the compartment [m <sup>3</sup> ]
T410	#110-#120	101.8-109.8	491
T510	#98 -#110	92.2-101.8	709
T610	#85- #98	81.8-92.8	782

Altogether eight combinations of the loading conditions were studied by changing the volume of water on the tank between 0 and 1300 tons.

## 4 Results and discussion

The results of the calculations are shown in Figs 4.1.a-4.8.d and a summary of the results is presented in Table 4.1.

*Table 4.1. Summary of the stability calculations.*

Loading cond.	Water [ton] T410	Water [ton] T510	Water [ton] T610	Water on the tank deck [ton]	Displ. [ton]	Draught [m]	Trim [m]	GM <sub>r</sub> [m]
K0	0	0	0	0	11961	5.355	-0.475	1.15
K1	0	0	100	100	12061	5.398	-0.369	0.51
K2	0	0	200	200	12161	5.440	-0.264	0.60
K3	0	100	200	300	12261	5.485	-0.122	0.22
K4	0	200	300	500	12461	5.571	0.122	0.23
K5	100	250	350	700	12661	5.658	0.414	0.11
K6	200	350	450	1000	12961	5.785	0.814	0.14
K7	300	450	550	1300	13261	5.909	1.265	0.20

Because the doors on the tank deck had quite high doorsteps (about 1 m), water would not have been able to spread from a compartment to another immediately. The free surface of water on the tank deck would have reduced the stability of the vessel. In practice the mass of water in the three compartments on the tank deck would, however, not have been able to make the stability (the transverse metacentric height) negative. Due to the positive stability in all the cases considered the vessel would not have attained a permanent list. Since the stability would have been reduced by the free water surface, the inclining angle of the vessel due to wind forces would have somewhat increased. The free water surface would have had a remarkable effect on the rolling motion of the vessel.

LOADING CONDITION K.0, DEP. FROM TALLIN, heeling tanks unsym

LOADING COMPONENTS

Name		Max. weight	Mass	Center of gravity cgx cgy cgz			Free s. moment
HEAVY FUEL OIL, RHO= 0.900							
T10	DEEP TANK 10	171.1	97.2	74.20	2.75	2.03	146.7
T11	DEEP TANK 11	171.1	97.2	74.20	-2.75	2.03	146.7
T36	DAY TANK 36	23.1	22.5	36.23	9.28	2.76	9.1
T38	SETTLING TAN.	28.9	18.0	32.35	8.96	2.36	7.3
Total of HEAVY FUEL OIL		394.3	234.9	67.36	1.58	2.13	309.9
DIESEL OIL, RHO= 0.860							
T18	DB TANK 18	61.1	27.5	58.20	3.50	0.22	250.5
T20	DB TANK 20	17.8	8.6	59.81	8.31	0.30	15.0
T41	DAY TANK 41	12.8	8.6	31.04	-8.91	2.48	3.3
Total of DIESEL OIL		91.7	44.7	53.28	2.04	0.67	268.9
FRESH WATER, RHO= 1.000							
T4A	FW TANK 4 A	72.2	69.0	114.24	4.23	2.83	54.5
T4B	FW TANK 4 B	72.2	69.0	114.24	-4.23	2.83	54.5
T5	FW TANK 5	146.5	145.0	113.61	0.00	2.68	0.0
T56	FW TANK 56	148.3	45.0	9.93	1.35	1.18	40.9
T57	FW TANK 57	148.3	45.0	9.93	-1.35	1.18	40.9
T17	CIRCUL TANK .	19.7	18.0	58.24	-9.00	0.55	13.6
T22	COOLING WATE.	2.9	2.0	55.40	8.90	0.43	1.6
T29	COOLING WATE.	16.6	15.0	45.85	-8.68	0.61	11.4
Total of FRESH WATER		626.6	408.0	85.74	-0.67	2.22	217.3
BALLAST WATER, RHO= 1.025							
T1	FORE PEAK TA.	178.9	175.8	134.08	0.00	4.02	0.0
T14	HEELING TANK.	185.1	185.0	77.54	8.87	2.63	0.0
Total of BALLAST WATER		364.0	360.8	105.09	4.55	3.31	0.0
PAS							
(PAS)	PASSENGERS & .	0.0	110.0	71.50	0.00	16.40	0.0
TRA							
(TRA)	TRAILERS 34 .	0.0	970.0	70.00	-2.00	9.50	0.0
CREW							
(CREW)	CREW	0.0	20.0	60.00	0.00	22.00	0.0
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0



Displacement (rho=1.01)

11961.4 63.80 -0.01 10.65 796.0

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 P3/B  
 ESTONIA

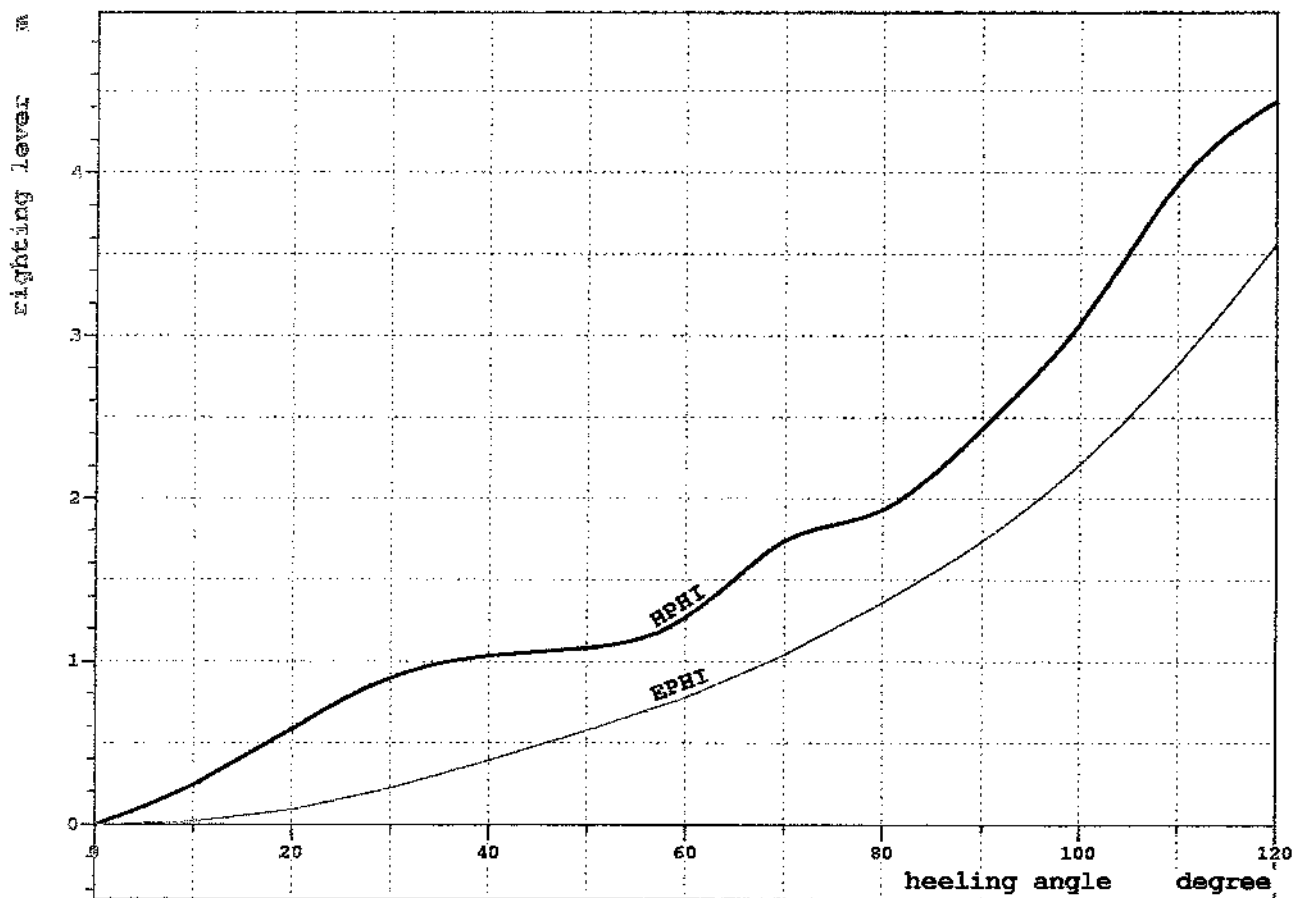
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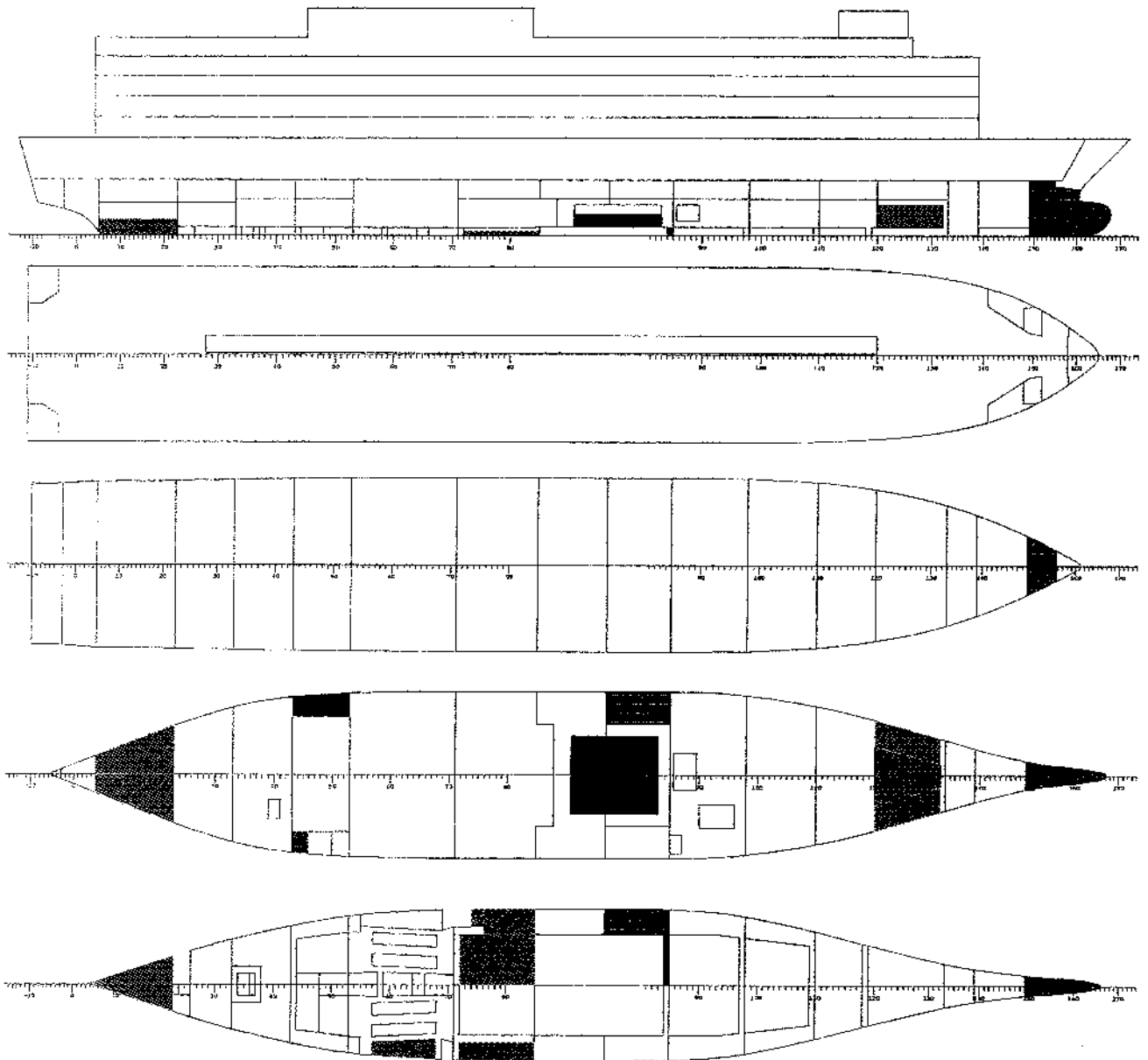
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F L O A T I N G P O S I T I O N

Draught moulded	5.355	m	KM	11.87	m
Trim	-0.475	m	KG	10.65	m
TA	5.593	m	GMO	1.22	m
TF	5.118	m	GMCORR	-0.07	m
Trimming moment	-12664	tonm	GM	1.15	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.004	0.00	0.000	0.0	0.000
10.0	0.040	0.24	0.019	125.2	0.010
20.0	0.185	0.58	0.091	212.5	0.018
30.0	0.314	0.90	0.223	307.4	0.026
40.0	0.282	1.03	0.394	375.8	0.031
50.0	0.183	1.08	0.578	406.1	0.034
60.0	0.246	1.27	0.779	406.5	0.034
70.0	0.625	1.74	1.042	389.1	0.033
80.0	0.759	1.93	1.362	354.1	0.030
90.0	1.237	2.43	1.739	306.0	0.026
100.0	1.895	3.08	2.217	249.0	0.021
110.0	2.807	3.94	2.829	187.1	0.016
120.0	3.389	4.43	3.565	123.3	0.010





LOADING CONDITION K.1, DEP. FROM TALLIN, heeling tanks unsym

LOADING COMPONENTS

Name		Max. weight	Mass	Center of gravity cgx cgy cgz			Free s. moment
HEAVY FUEL OIL, RHO= 0.900							
T10	DEEP TANK 10	171.1	97.2	74.20	2.75	2.03	146.7
T11	DEEP TANK 11	171.1	97.2	74.20	-2.75	2.03	146.7
T36	DAY TANK 36	23.1	22.5	36.23	9.28	2.76	9.1
T38	SETTLING TAN.	28.9	18.0	32.35	8.96	2.36	7.3
Total of HEAVY FUEL OIL		394.3	234.9	67.36	1.58	2.13	309.9
DIESEL OIL, RHO= 0.860							
T18	DB TANK 18	61.1	27.5	58.20	3.50	0.22	250.5
T20	DB TANK 20	17.8	8.6	59.81	8.31	0.30	15.0
T41	DAY TANK 41	12.8	8.6	31.04	-8.91	2.48	3.3
Total of DIESEL OIL		91.7	44.7	53.28	2.04	0.67	268.9
FRESH WATER, RHO= 1.000							
T4A	FW TANK 4 A	72.2	69.0	114.24	4.23	2.83	54.5
T4B	FW TANK 4 B	72.2	69.0	114.24	-4.23	2.83	54.5
T5	FW TANK 5	146.5	145.0	113.61	0.00	2.68	0.0
T56	FW TANK 56	148.3	45.0	9.93	1.35	1.18	40.9
T57	FW TANK 57	148.3	45.0	9.93	-1.35	1.18	40.9
T17	CIRCUL TANK .	19.7	18.0	58.24	-9.00	0.55	13.6
T22	COOLING WATE.	2.9	2.0	55.40	8.90	0.43	1.6
T29	COOLING WATE.	16.6	15.0	45.85	-8.68	0.61	11.4
Total of FRESH WATER		626.6	408.0	85.74	-0.67	2.22	217.3
BALLAST WATER, RHO= 1.025							
T1	FORE PEAK TA.	178.9	175.8	134.08	0.00	4.02	0.0
T14	HEELING TANK.	185.1	185.0	77.54	8.87	2.63	0.0
Total of BALLAST WATER		364.0	360.8	105.09	4.55	3.31	0.0
BALLAST WATER, RHO= 1.010							
T610		789.4	100.0	86.93	0.00	1.43	8258.5
PAS							
(PAS)	PASSENGERS &	0.0	110.0	71.50	0.00	16.40	0.0
TRA							
(TRA)	TRAILERS 34 .	0.0	970.0	70.00	-2.00	9.50	0.0
CREW							
(CREW)	CREW	0.0	20.0	60.00	0.00	22.00	0.0

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 ESTONIA

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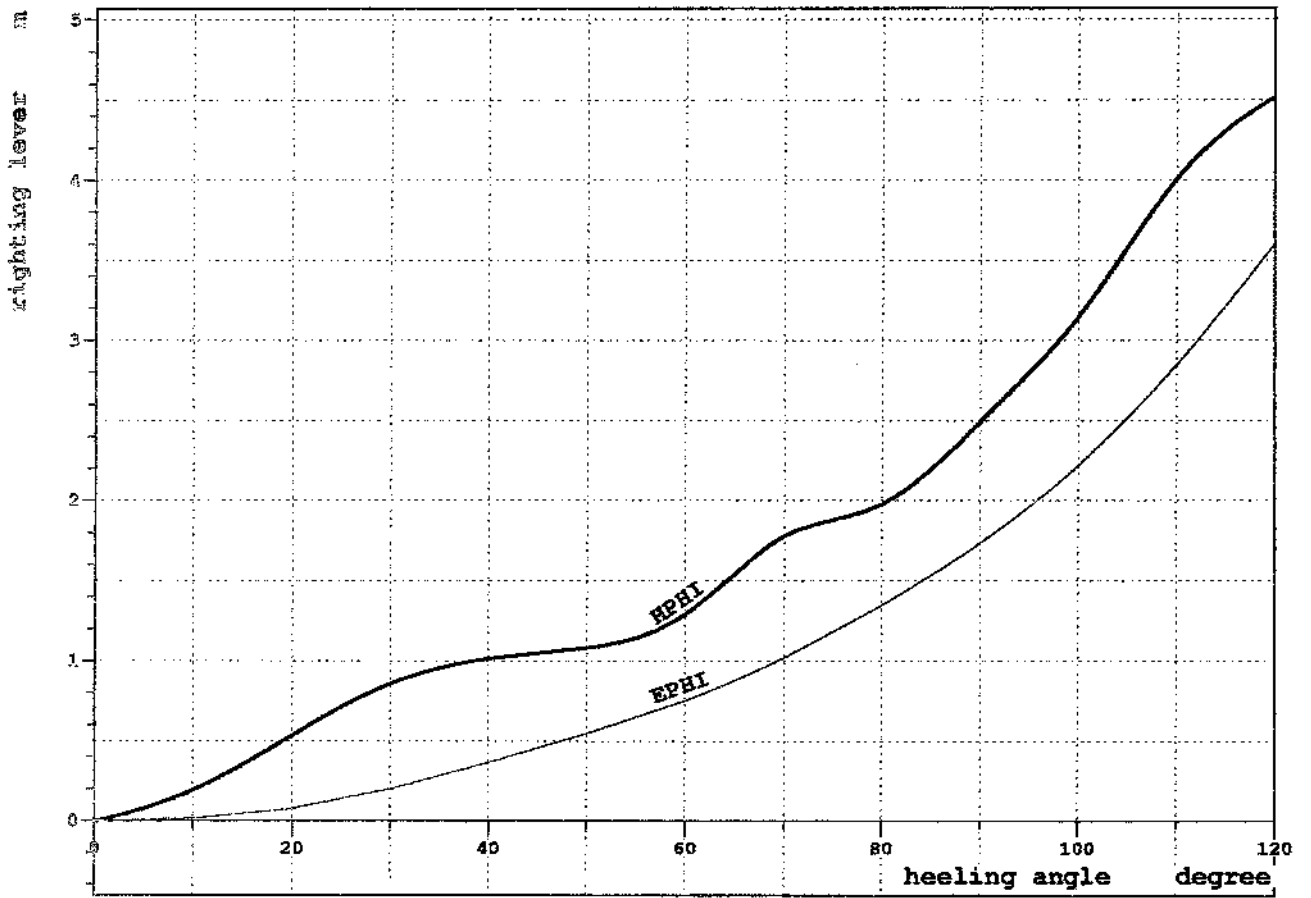
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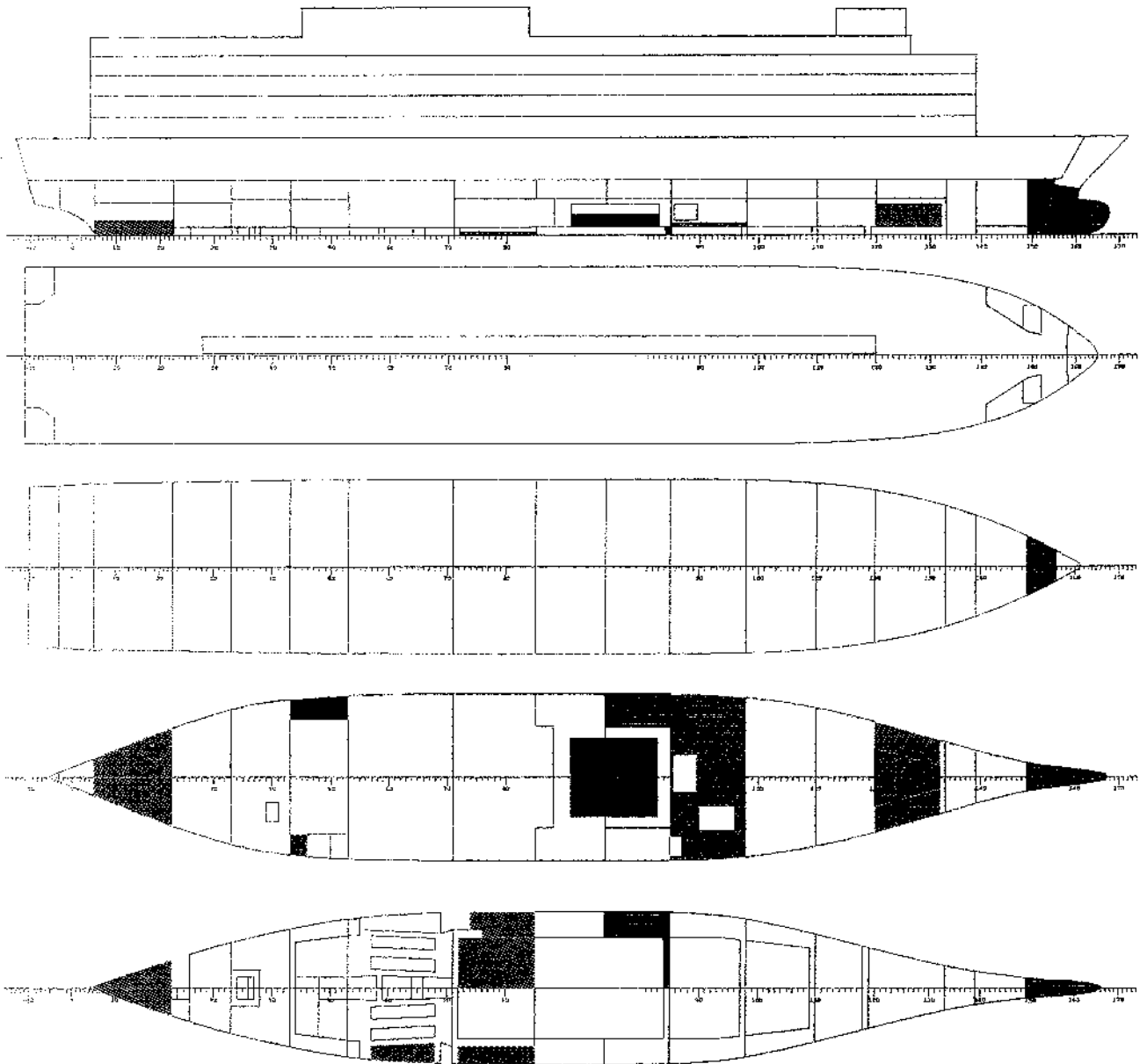
Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgz	cgz		
-----							
PRO							
-----							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
Deadweight		2328.4	77.49	-0.05	6.46		9054.5
Lightweight		9733.0	60.76	0.00	11.56		
Displacement (rho=1.01)		12061.4	63.99	-0.01	10.57		9054.5

F L O A T I N G P O S I T I O N

Draught moulded	5.398	m	KM	11.84	m
Trim	-0.369	m	KG	10.57	m
TA	5.582	m	GMO	1.26	m
TF	5.213	m	GMCORR	-0.75	m
Trimming moment	-9860	tonm	GM	0.51	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.004	0.00	0.000	0.0	0.000
10.0	0.042	0.19	0.014	833.8	0.069
20.0	0.188	0.54	0.077	1027.4	0.085
30.0	0.321	0.86	0.200	1144.2	0.095
40.0	0.300	1.01	0.366	1179.3	0.098
50.0	0.209	1.08	0.549	1132.1	0.094
60.0	0.282	1.29	0.751	1024.7	0.085
70.0	0.664	1.78	1.020	876.9	0.073
80.0	0.792	1.98	1.348	694.7	0.058
90.0	1.270	2.49	1.734	488.2	0.040
100.0	1.922	3.14	2.224	267.1	0.022
110.0	2.828	4.01	2.849	41.5	0.003
120.0	3.407	4.52	3.599	-179.7	-0.015







Ship Consulting  
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 P3/B  
 ESTONIA

LOADING CONDITIONS

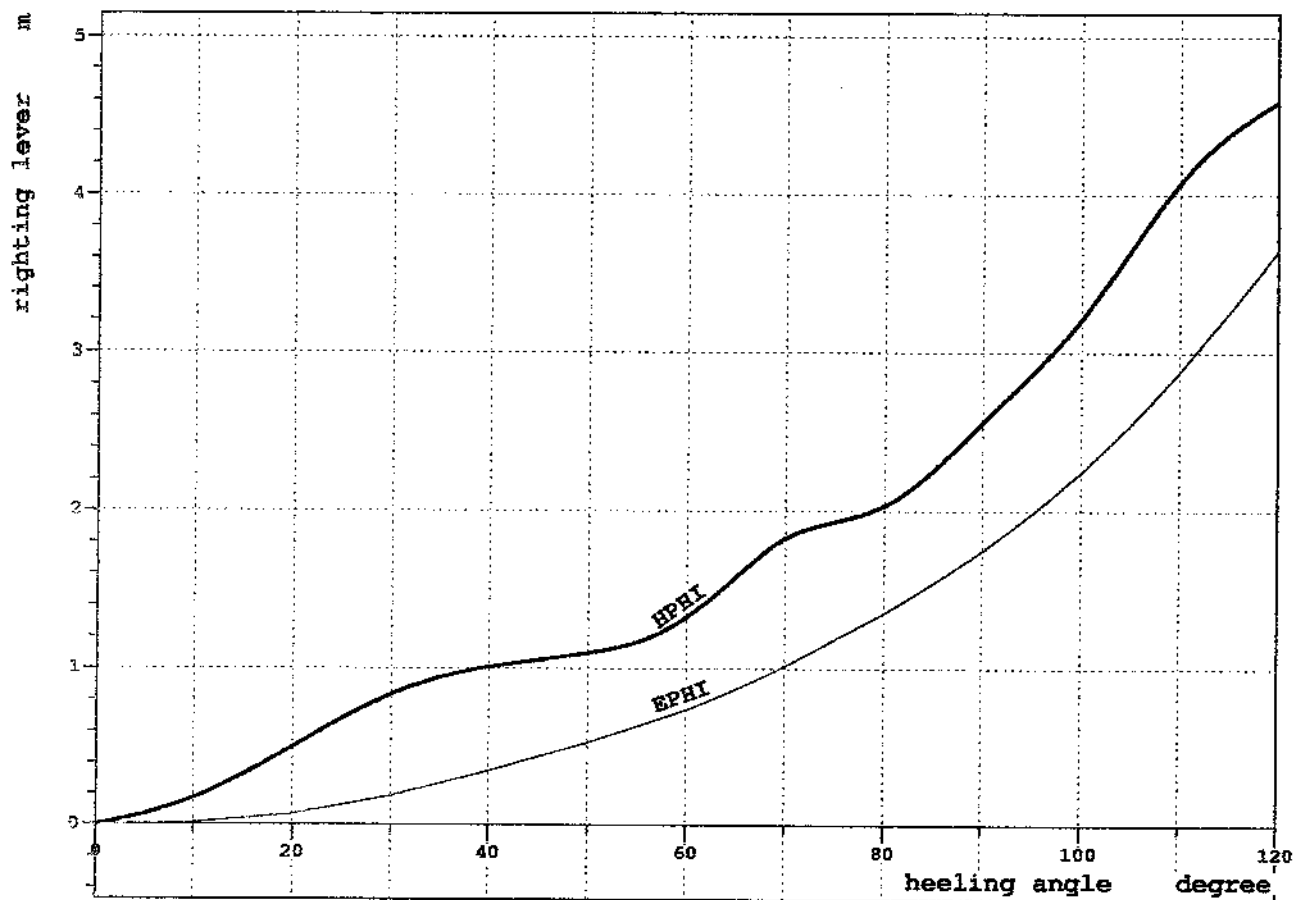
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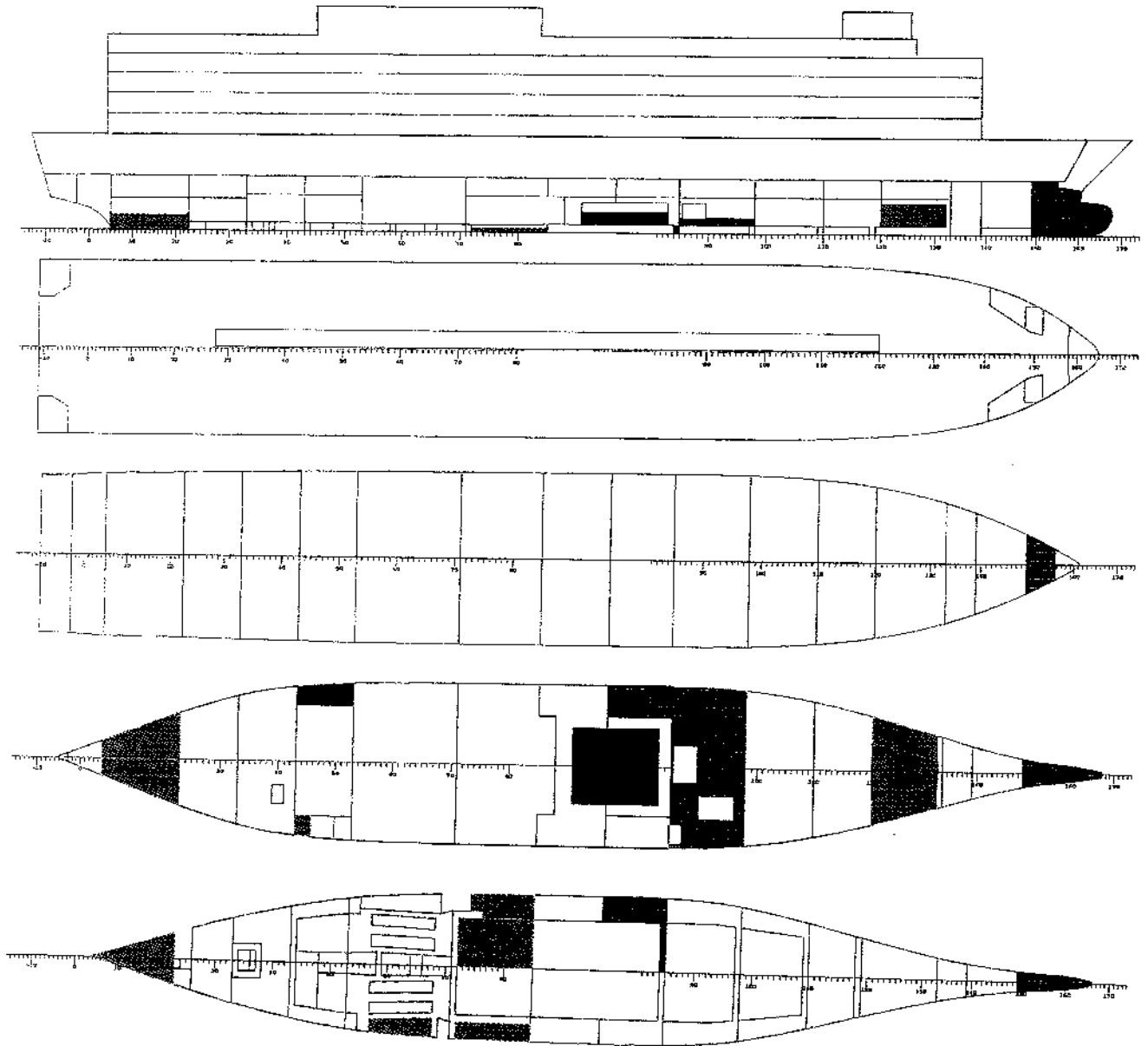
Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgz	cgz		
-----							
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
Deadweight		2428.4	77.89	-0.04	6.27		8579.2
Lightweight		9733.0	60.76	0.00	11.56		
Displacement (rho=1.01)		12161.4	64.18	-0.01	10.50		8579.2

F L O A T I N G P O S I T I O N

Draught moulded	5.440	m	KM	11.81	m
Trim	-0.264	m	KG	10.50	m
TA	5.572	m	GM0	1.31	m
TF	5.308	m	GMCORR	-0.71	m
Trimming moment	-7060	tonm	GM	0.60	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.002	0.00	0.000	0.0	0.000
10.0	0.046	0.17	0.012	1265.6	0.104
20.0	0.192	0.50	0.069	1698.4	0.140
30.0	0.330	0.83	0.187	1822.9	0.150
40.0	0.318	1.01	0.350	1804.0	0.148
50.0	0.235	1.10	0.533	1683.0	0.138
60.0	0.316	1.32	0.740	1485.6	0.122
70.0	0.702	1.83	1.016	1233.8	0.101
80.0	0.823	2.03	1.353	937.0	0.077
90.0	1.303	2.56	1.749	608.8	0.050
100.0	1.946	3.21	2.250	262.3	0.022
110.0	2.848	4.08	2.887	-88.7	-0.007
120.0	3.423	4.59	3.649	-431.4	-0.035





LOADING CONDITION K.3, DEP. FROM TALLIN, heeling tanks unsym

LOADING COMPONENTS

Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgy	cgz		
HEAVY FUEL OIL, RHO= 0.900							
T10	DEEP TANK 10	171.1	97.2	74.20	2.75	2.03	146.7
T11	DEEP TANK 11	171.1	97.2	74.20	-2.75	2.03	146.7
T36	DAY TANK 36	23.1	22.5	36.23	9.28	2.76	9.1
T38	SETTLING TAN.	28.9	18.0	32.35	8.96	2.36	7.3
Total of HEAVY FUEL OIL		394.3	234.9	67.36	1.58	2.13	309.9

DIESEL OIL, RHO= 0.860

T18	DB TANK 18	61.1	27.5	58.20	3.50	0.22	250.5
T20	DB TANK 20	17.8	8.6	59.81	8.31	0.30	15.0
T41	DAY TANK 41	12.8	8.6	31.04	-8.91	2.48	3.3
Total of DIESEL OIL		91.7	44.7	53.28	2.04	0.67	268.9

FRESH WATER, RHO= 1.000

T4A	FW TANK 4 A	72.2	69.0	114.24	4.23	2.83	54.5
T4B	FW TANK 4 B	72.2	69.0	114.24	-4.23	2.83	54.5
T5	FW TANK 5	146.5	145.0	113.61	0.00	2.68	0.0
T56	FW TANK 56	148.3	45.0	9.93	1.35	1.18	40.9
T57	FW TANK 57	148.3	45.0	9.93	-1.35	1.18	40.9
T17	CIRCUL TANK .	19.7	18.0	58.24	-9.00	0.55	13.6
T22	COOLING WATE.	2.9	2.0	55.40	8.90	0.43	1.6
T29	COOLING WATE.	16.6	15.0	45.85	-8.68	0.61	11.4
Total of FRESH WATER		626.6	408.0	85.74	-0.67	2.22	217.3

BALLAST WATER, RHO= 1.025

T1	FORE PEAK TA.	178.9	175.8	134.08	0.00	4.02	0.0
T14	HEELING TANK.	185.1	185.0	77.54	8.87	2.63	0.0
Total of BALLAST WATER		364.0	360.8	105.09	4.55	3.31	0.0

BALLAST WATER, RHO= 1.010

T510		716.2	100.0	96.82	0.00	1.49	5066.5
T610		789.4	200.0	86.98	0.12	1.66	7783.2
Total of BALLAST WATER		1505.6	300.0	90.26	0.08	1.61	12849.7

PAS

(PAS)	PASSENGERS &	0.0	110.0	71.50	0.00	16.40	0.0
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TRA

(TRA)	TRAILERS 34 .	0.0	970.0	70.00	-2.00	9.50	0.0
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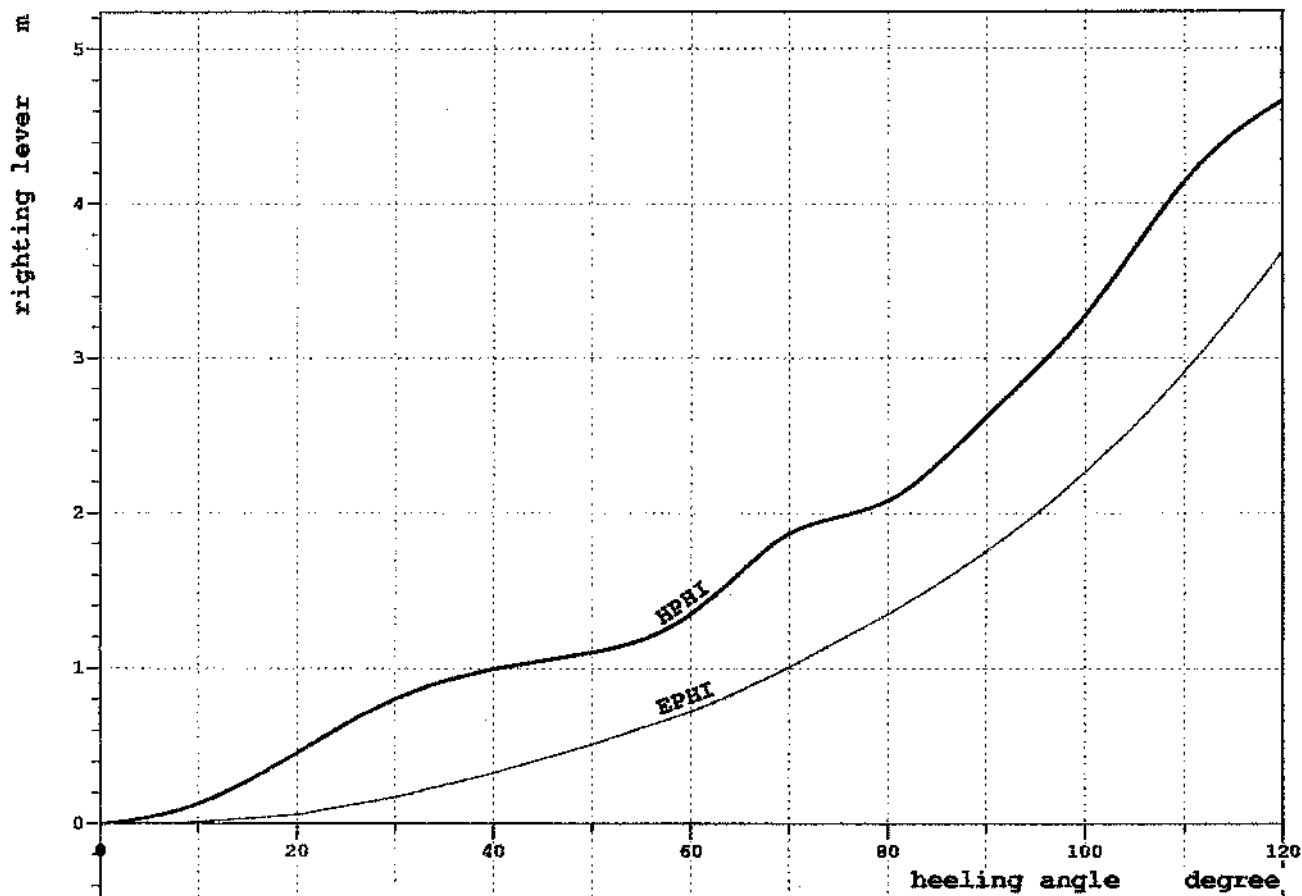
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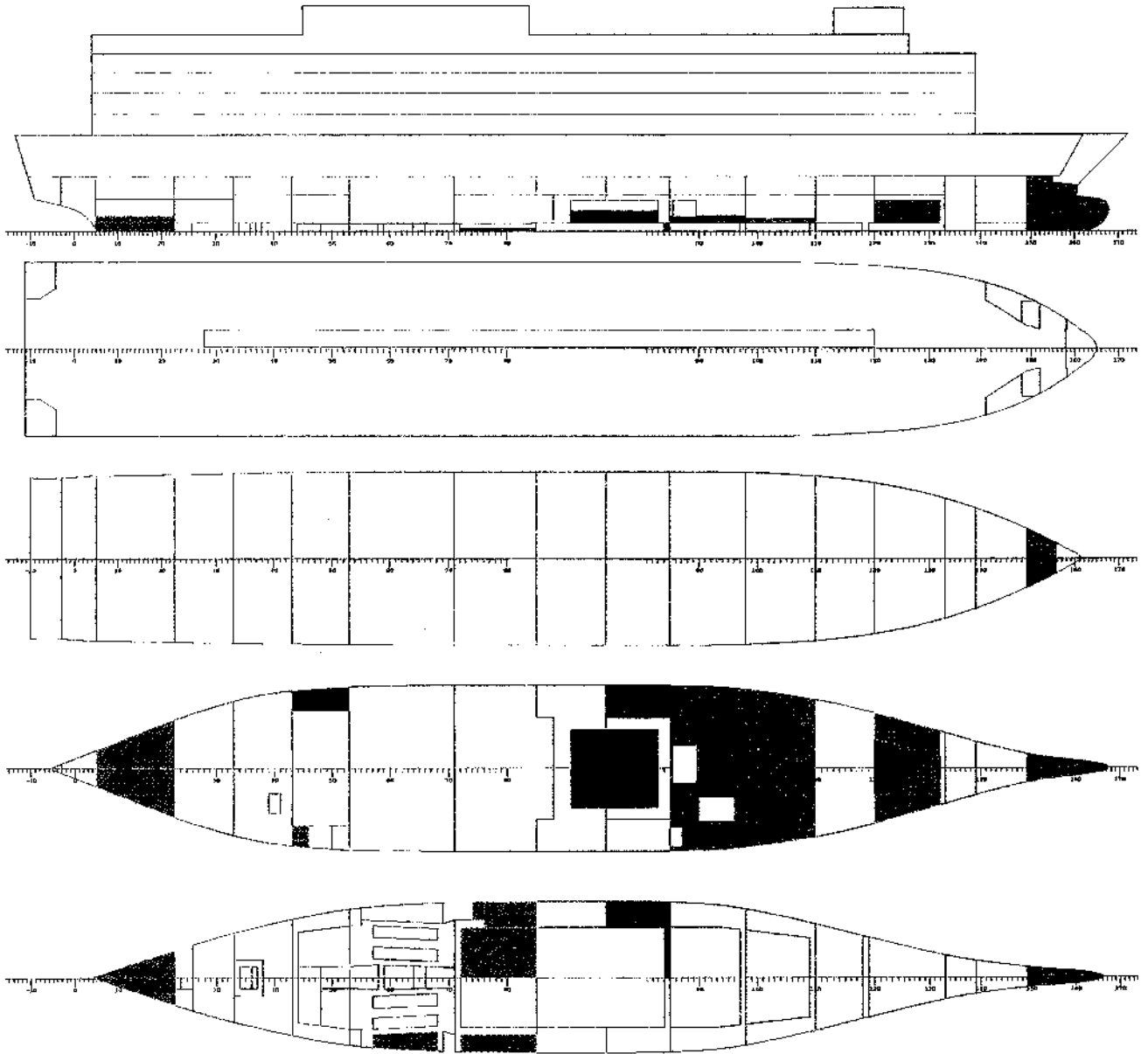
Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgy	cgz		
-----							
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
Deadweight		2528.4	78.64	-0.03	6.08	13645.7	
Lightweight		9733.0	60.76	0.00	11.56		
Displacement (rho=1.01)		12261.4	64.45	-0.01	10.43	13645.7	

F L O A T I N G   P O S I T I O N

Draught moulded	5.485	m	KM	11.76	m
Trim	-0.122	m	KG	10.43	m
TA	5.546	m	GM0	1.33	m
TF	5.424	m	GMCORR	-1.11	m
Trimming moment	-3267	tonm	GM	0.22	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.002	0.00	0.000	0.0	0.000
10.0	0.050	0.13	0.009	1850.5	0.151
20.0	0.200	0.46	0.058	2404.7	0.196
30.0	0.344	0.80	0.170	2567.9	0.209
40.0	0.344	0.99	0.328	2525.8	0.206
50.0	0.271	1.10	0.511	2340.1	0.191
60.0	0.364	1.35	0.720	2050.1	0.167
70.0	0.754	1.87	1.002	1684.9	0.137
80.0	0.870	2.08	1.347	1259.2	0.103
90.0	1.350	2.62	1.753	791.5	0.065
100.0	1.986	3.27	2.265	300.0	0.024
110.0	2.883	4.15	2.914	-196.4	-0.016
120.0	3.454	4.66	3.688	-679.6	-0.055





LOADING CONDITION K.4, DEP. FROM TALLIN, heeling tanks unsym

LOADING COMPONENTS

Name	Max. weight	Mass	Center of gravity			Free s. moment
			cgx	cgy	cgz	

HEAVY FUEL OIL, RHO= 0.900

T10	DEEP TANK 10	171.1	97.2	74.20	2.75	2.03	146.7
T11	DEEP TANK 11	171.1	97.2	74.20	-2.75	2.03	146.7
T36	DAY TANK 36	23.1	22.5	36.23	9.28	2.76	9.1
T38	SETTLING TAN.	28.9	18.0	32.35	8.96	2.36	7.3
Total of HEAVY FUEL OIL		394.3	234.9	67.36	1.58	2.13	309.9

DIESEL OIL, RHO= 0.860

T18	DB TANK 18	61.1	27.5	58.20	3.50	0.22	250.5
T20	DB TANK 20	17.8	8.6	59.81	8.31	0.30	15.0
T41	DAY TANK 41	12.8	8.6	31.04	-8.91	2.48	3.3
Total of DIESEL OIL		91.7	44.7	53.28	2.04	0.67	268.9

FRESH WATER, RHO= 1.000

T4A	FW TANK 4 A	72.2	69.0	114.24	4.23	2.83	54.5
T4B	FW TANK 4 B	72.2	69.0	114.24	-4.23	2.83	54.5
T5	FW TANK 5	146.5	145.0	113.61	0.00	2.68	0.0
T56	FW TANK 56	148.3	45.0	9.93	1.35	1.18	40.9
T57	FW TANK 57	148.3	45.0	9.93	-1.35	1.18	40.9
T17	CIRCUL TANK .	19.7	18.0	58.24	-9.00	0.55	13.6
T22	COOLING WATE.	2.9	2.0	55.40	8.90	0.43	1.6
T29	COOLING WATE.	16.6	15.0	45.85	-8.68	0.61	11.4
Total of FRESH WATER		626.6	408.0	85.74	-0.67	2.22	217.3

BALLAST WATER, RHO= 1.025

T1	FORE PEAK TA.	178.9	175.8	134.08	0.00	4.02	0.0
T14	HEELING TANK.	185.1	185.0	77.54	8.87	2.63	0.0
Total of BALLAST WATER		364.0	360.8	105.09	4.55	3.31	0.0

BALLAST WATER, RHO= 1.010

T510		716.2	200.0	96.83	0.00	1.78	5632.4
T610		789.4	300.0	87.05	0.29	1.91	8217.0
Total of BALLAST WATER		1505.6	500.0	90.96	0.18	1.86	13849.4

PAS

(PAS)	PASSENGERS & .	0.0	110.0	71.50	0.00	16.40	0.0
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TRA

(TRA)	TRAILERS 34 .	0.0	970.0	70.00	-2.00	9.50	0.0
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CREW

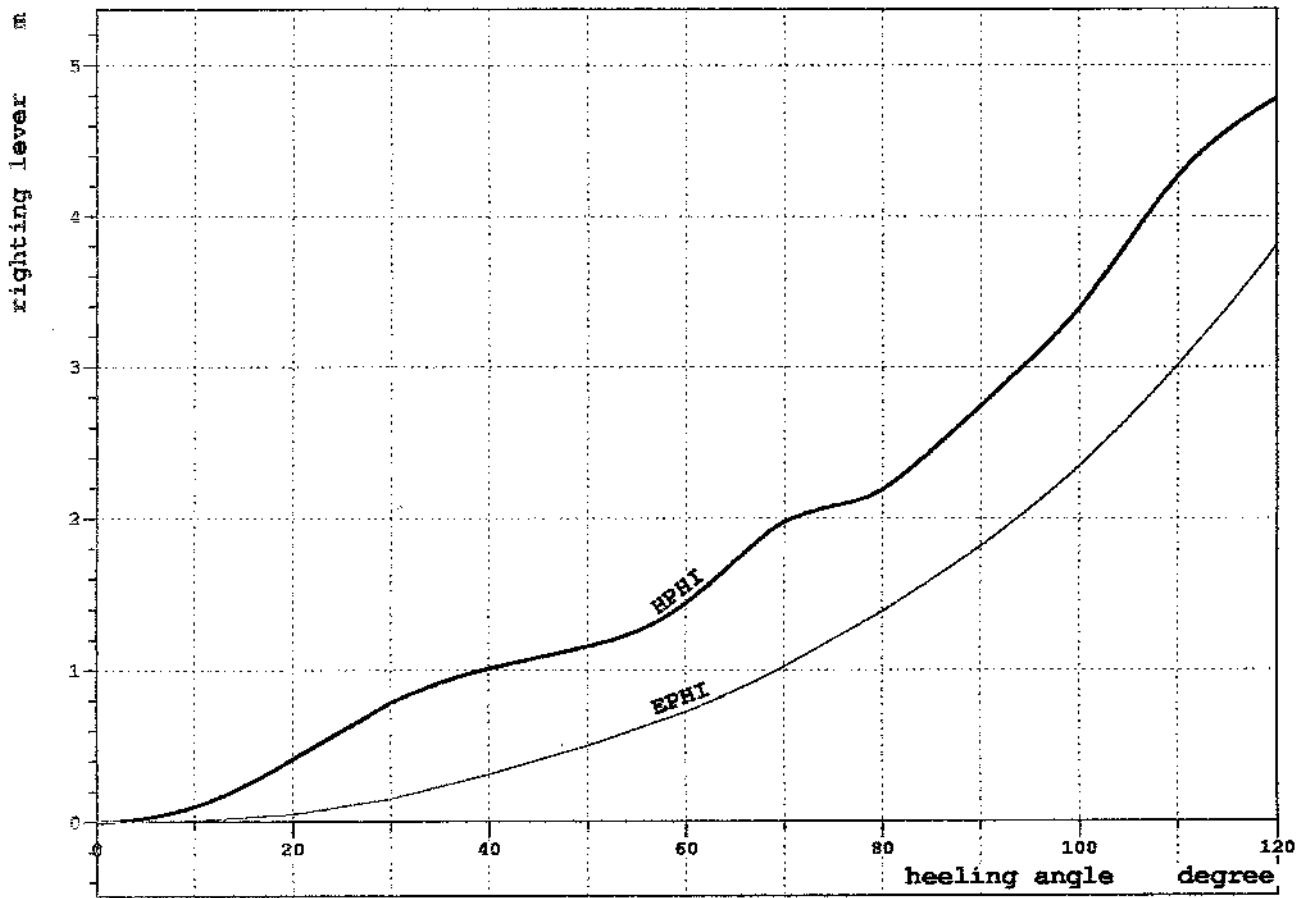


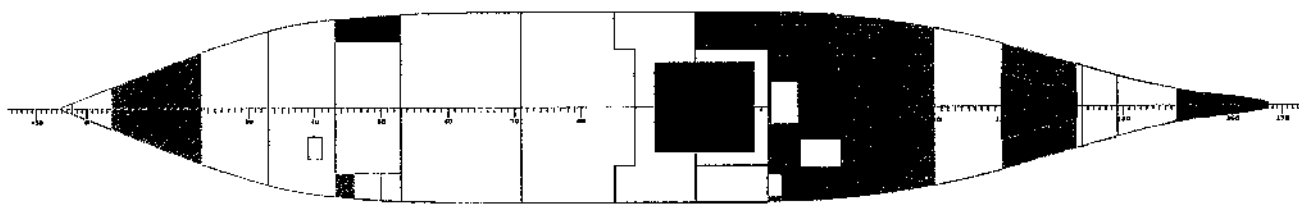
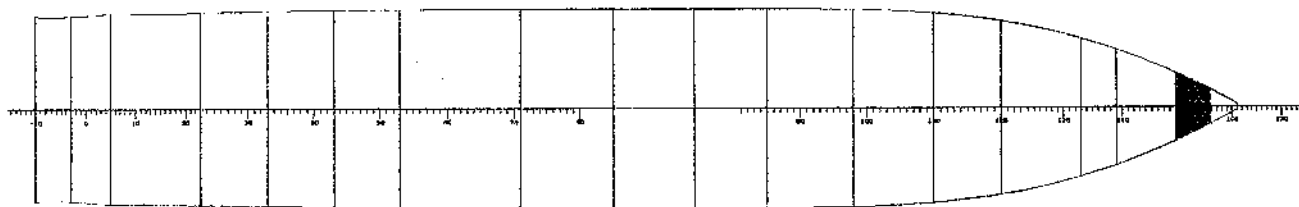
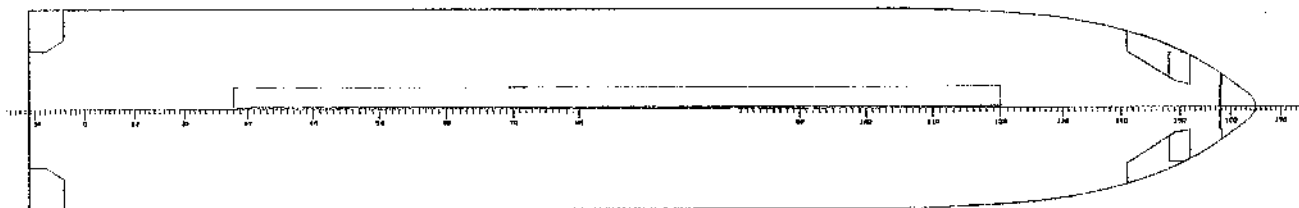
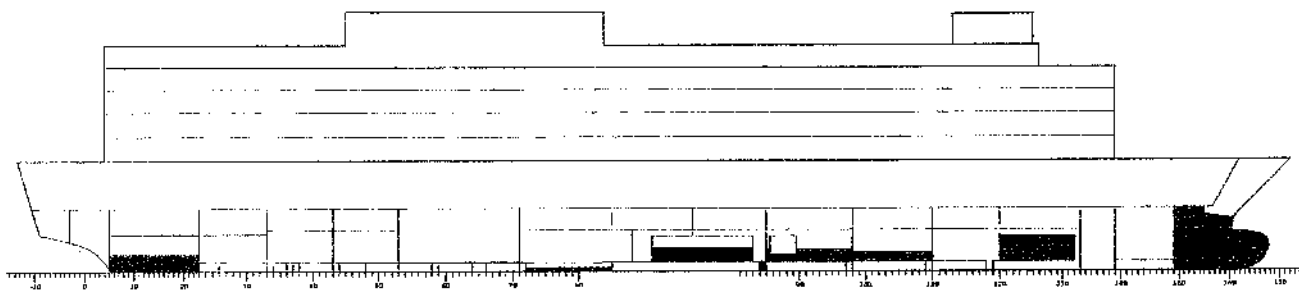
Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgy	cgz		
-----							
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
Deadweight		2728.4	79.62	-0.01	5.80		14645.5
Lightweight		9733.0	60.76	0.00	11.56		
Displacement (rho=1.01)		12461.4	64.89	0.00	10.30		14645.5

F L O A T I N G P O S I T I O N

Draught moulded	5.571	m	KM	11.70	m
Trim	0.122	m	KG	10.30	m
TA	5.510	m	GMO	1.40	m
TF	5.631	m	GMCORR	-1.18	m
Trimming moment	3247	tonm	GM	0.23	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.003	0.00	0.000	0.0	0.000
10.0	0.054	0.10	0.006	2449.7	0.197
20.0	0.204	0.41	0.048	3362.5	0.270
30.0	0.363	0.78	0.153	3508.9	0.282
40.0	0.384	1.01	0.312	3393.9	0.272
50.0	0.334	1.16	0.501	3109.0	0.249
60.0	0.443	1.44	0.723	2696.2	0.216
70.0	0.834	1.98	1.023	2188.3	0.176
80.0	0.939	2.19	1.386	1604.3	0.129
90.0	1.420	2.74	1.814	968.1	0.078
100.0	2.037	3.39	2.347	302.3	0.024
110.0	2.923	4.27	3.017	-369.3	-0.030
120.0	3.485	4.78	3.812	-1022.9	-0.082





LOADING CONDITION K.5, DEP. FROM TALLIN, heeling tanks unsym

LOADING COMPONENTS

Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgy	cgz		
HEAVY FUEL OIL, RHO= 0.900							
T10	DEEP TANK 10	171.1	97.2	74.20	2.75	2.03	146.7
T11	DEEP TANK 11	171.1	97.2	74.20	-2.75	2.03	146.7
T36	DAY TANK 36	23.1	22.5	36.23	9.28	2.76	9.1
T38	SETTLING TAN.	28.9	18.0	32.35	8.96	2.36	7.3
Total of HEAVY FUEL OIL		394.3	234.9	67.36	1.58	2.13	309.9

DIESEL OIL, RHO= 0.860							
T18	DB TANK 18	61.1	27.5	58.20	3.50	0.22	250.5
T20	DB TANK 20	17.8	8.6	59.81	8.31	0.30	15.0
T41	DAY TANK 41	12.8	8.6	31.04	-8.91	2.48	3.3
Total of DIESEL OIL		91.7	44.7	53.28	2.04	0.67	268.9

FRESH WATER, RHO= 1.000							
T4A	FW TANK 4 A	72.2	69.0	114.24	4.23	2.83	54.5
T4B	FW TANK 4 B	72.2	69.0	114.24	-4.23	2.83	54.5
T5	FW TANK 5	146.5	145.0	113.61	0.00	2.68	0.0
T56	FW TANK 56	148.3	45.0	9.93	1.35	1.18	40.9
T57	FW TANK 57	148.3	45.0	9.93	-1.35	1.18	40.9
T17	CIRCUL TANK .	19.7	18.0	58.24	-9.00	0.55	13.6
T22	COOLING WATE.	2.9	2.0	55.40	8.90	0.43	1.6
T29	COOLING WATE.	16.6	15.0	45.85	-8.68	0.61	11.4
Total of FRESH WATER		626.6	408.0	85.74	-0.67	2.22	217.3

BALLAST WATER, RHO= 1.025							
T1	FORE PEAK TA.	178.9	175.8	134.08	0.00	4.02	0.0
T14	HEELING TANK.	185.1	185.0	77.54	8.87	2.63	0.0
Total of BALLAST WATER		364.0	360.8	105.09	4.55	3.31	0.0

BALLAST WATER, RHO= 1.010							
T410		495.9	100.0	105.89	0.00	1.52	2140.8
T510		716.2	250.0	96.83	0.00	1.92	5885.8
T610		789.4	350.0	87.07	0.34	2.04	8401.7
Total of BALLAST WATER		2001.5	700.0	93.25	0.17	1.92	16428.4

PAS							
(PAS)	PASSENGERS & .	0.0	110.0	71.50	0.00	16.40	0.0

TRA							
(TRA)	TRAILERS 34 .	0.0	970.0	70.00	-2.00	9.50	0.0

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LOADING CONDITIONS

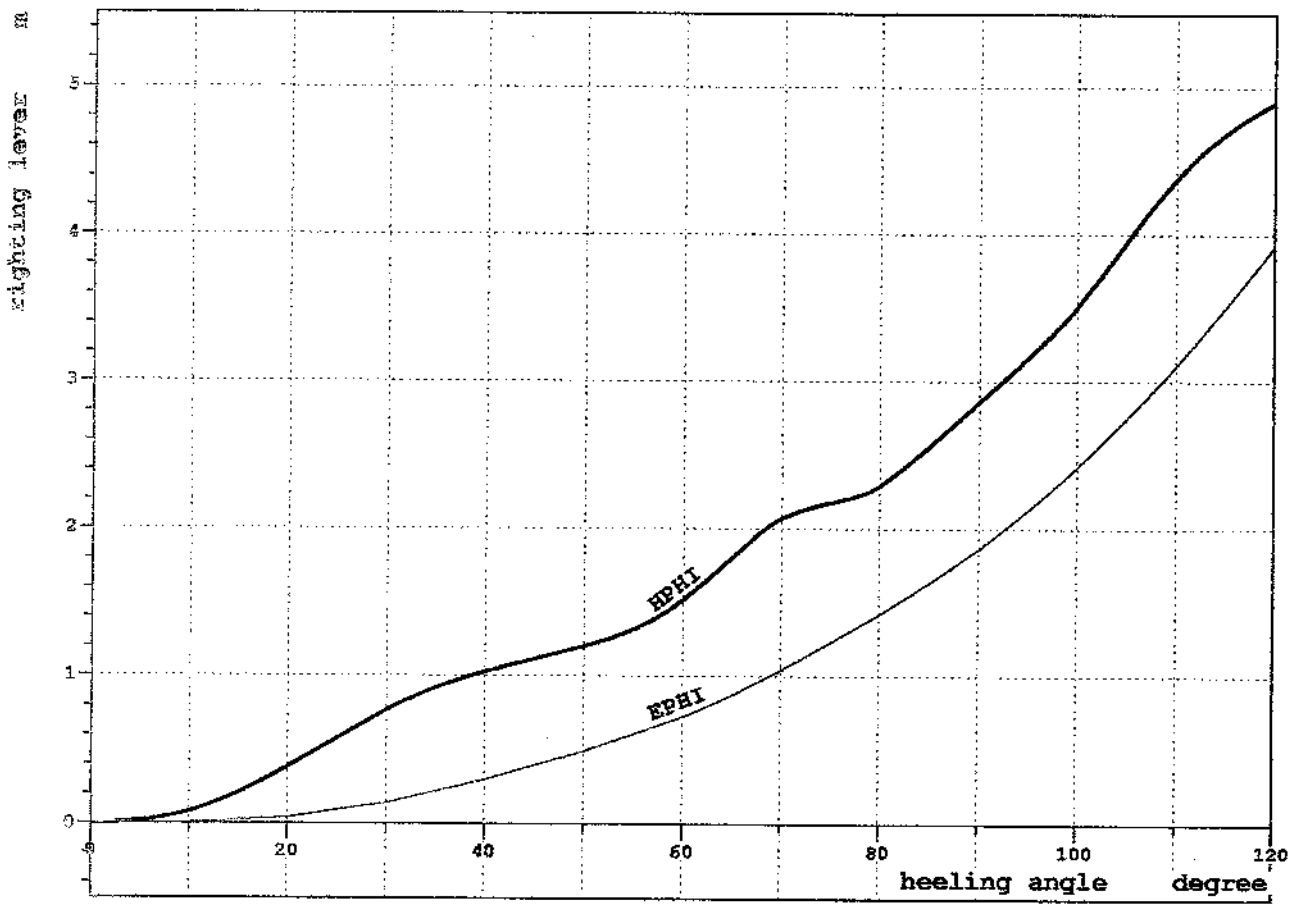
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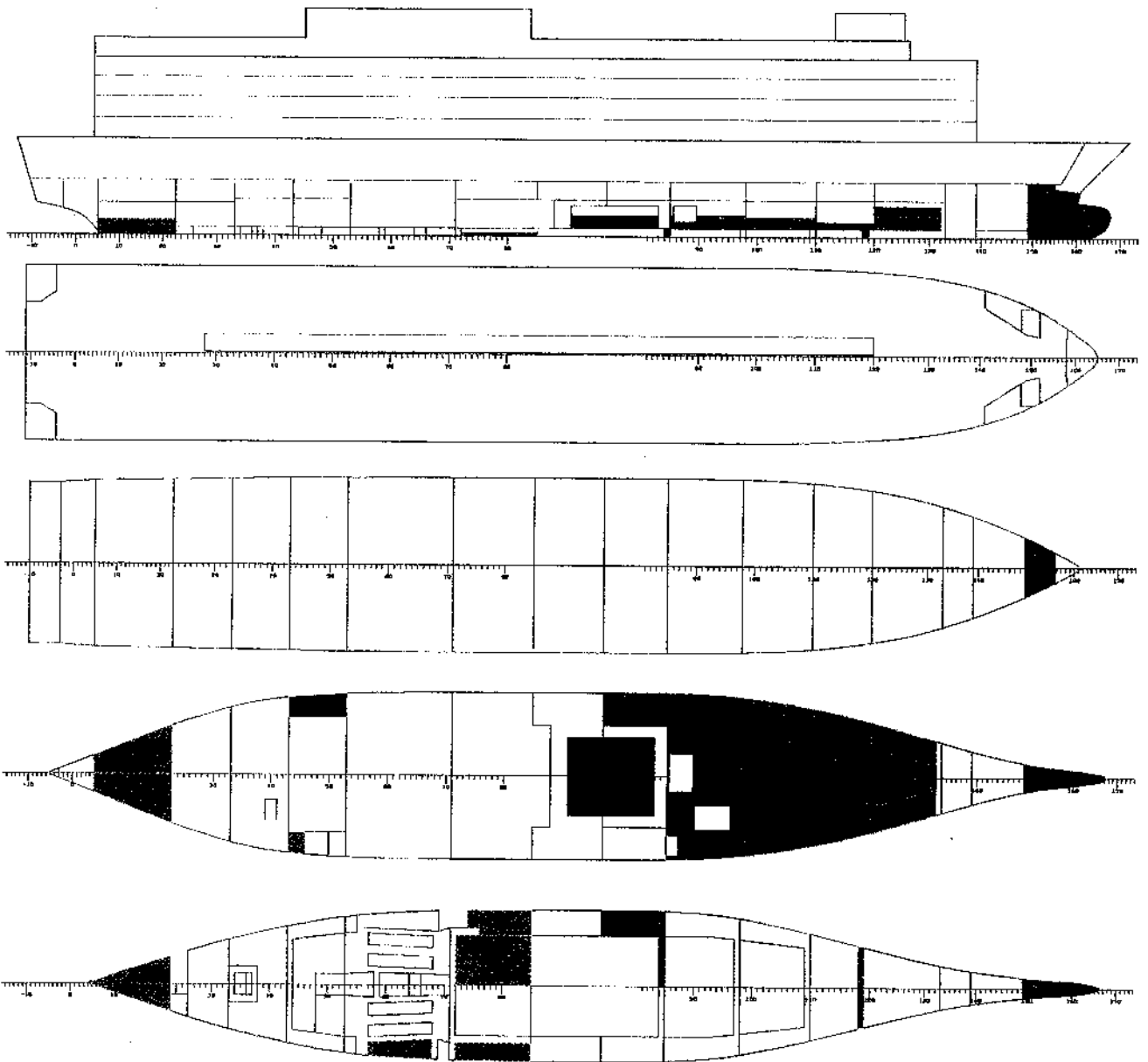
Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgy	cgz		
-----							
CREW							
(CREW)	CREW	0.0	20.0	60.00	0.00	22.00	0.0
-----							
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
-----							
Deadweight		2928.4	80.94	0.00	5.54		17224.4
Lightweight		9733.0	60.76	0.00	11.56		
Displacement (rho=1.01)		12661.4	65.43	0.00	10.17		17224.4

F L O A T I N G P O S I T I O N

Draught moulded	5.658	m	KM	11.63	m
Trim	0.414	m	KG	10.17	m
TA	5.451	m	GMO	1.47	m
TF	5.865	m	GMCORR	-1.36	m
Trimming moment	11025	tonm	GM	0.11	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.005	-0.01	0.000	0.0	0.000
10.0	0.056	0.08	0.004	2945.3	0.233
20.0	0.209	0.38	0.041	4152.7	0.328
30.0	0.378	0.77	0.141	4355.4	0.344
40.0	0.418	1.03	0.300	4212.9	0.333
50.0	0.384	1.20	0.495	3857.4	0.305
60.0	0.512	1.52	0.727	3344.1	0.264
70.0	0.908	2.07	1.042	2712.4	0.214
80.0	1.006	2.29	1.422	1986.8	0.157
90.0	1.487	2.86	1.870	1196.6	0.095
100.0	2.091	3.51	2.423	369.7	0.029
110.0	2.971	4.39	3.112	-464.8	-0.037
120.0	3.525	4.90	3.928	-1277.2	-0.101





LOADING CONDITION K.6, DEP. FROM TALLIN, heeling tanks unsym

LOADING COMPONENTS

Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgy	cgz		
HEAVY FUEL OIL, RHO= 0.900							
T10	DEEP TANK 10	171.1	97.2	74.20	2.75	2.03	146.7
T11	DEEP TANK 11	171.1	97.2	74.20	-2.75	2.03	146.7
T36	DAY TANK 36	23.1	22.5	36.23	9.28	2.76	9.1
T38	SETTLING TAN.	28.9	18.0	32.35	8.96	2.36	7.3
Total of HEAVY FUEL OIL		394.3	234.9	67.36	1.58	2.13	309.9

DIESEL OIL, RHO= 0.860							
T18	DB TANK 18	61.1	27.5	58.20	3.50	0.22	250.5
T20	DB TANK 20	17.8	8.6	59.81	8.31	0.30	15.0
T41	DAY TANK 41	12.8	8.6	31.04	-8.91	2.48	3.3
Total of DIESEL OIL		91.7	44.7	53.28	2.04	0.67	268.9

FRESH WATER, RHO= 1.000							
T4A	FW TANK 4 A	72.2	69.0	114.24	4.23	2.83	54.5
T4B	FW TANK 4 B	72.2	69.0	114.24	-4.23	2.83	54.5
T5	FW TANK 5	146.5	145.0	113.61	0.00	2.68	0.0
T56	FW TANK 56	148.3	45.0	9.93	1.35	1.18	40.9
T57	FW TANK 57	148.3	45.0	9.93	-1.35	1.18	40.9
T17	CIRCUL TANK .	19.7	18.0	58.24	-9.00	0.55	13.6
T22	COOLING WATE.	2.9	2.0	55.40	8.90	0.43	1.6
T29	COOLING WATE.	16.6	15.0	45.85	-8.68	0.61	11.4
Total of FRESH WATER		626.6	408.0	85.74	-0.67	2.22	217.3

BALLAST WATER, RHO= 1.025							
T1	FORE PEAK TA.	178.9	175.8	134.08	0.00	4.02	0.0
T14	HEELING TANK.	185.1	185.0	77.54	8.87	2.63	0.0
Total of BALLAST WATER		364.0	360.8	105.09	4.55	3.31	0.0

BALLAST WATER, RHO= 1.010							
T410		495.9	200.0	105.76	0.00	1.97	2659.7
T510		716.2	350.0	96.84	0.00	2.19	6355.0
T610		789.4	450.0	87.10	0.40	2.29	8751.5
Total of BALLAST WATER		2001.5	1000.0	94.24	0.18	2.20	17766.2

PAS							
(PAS)	PASSENGERS & .	0.0	110.0	71.50	0.00	16.40	0.0

TRA							
(TRA)	TRAILERS 34 .	0.0	970.0	70.00	-2.00	9.50	0.0

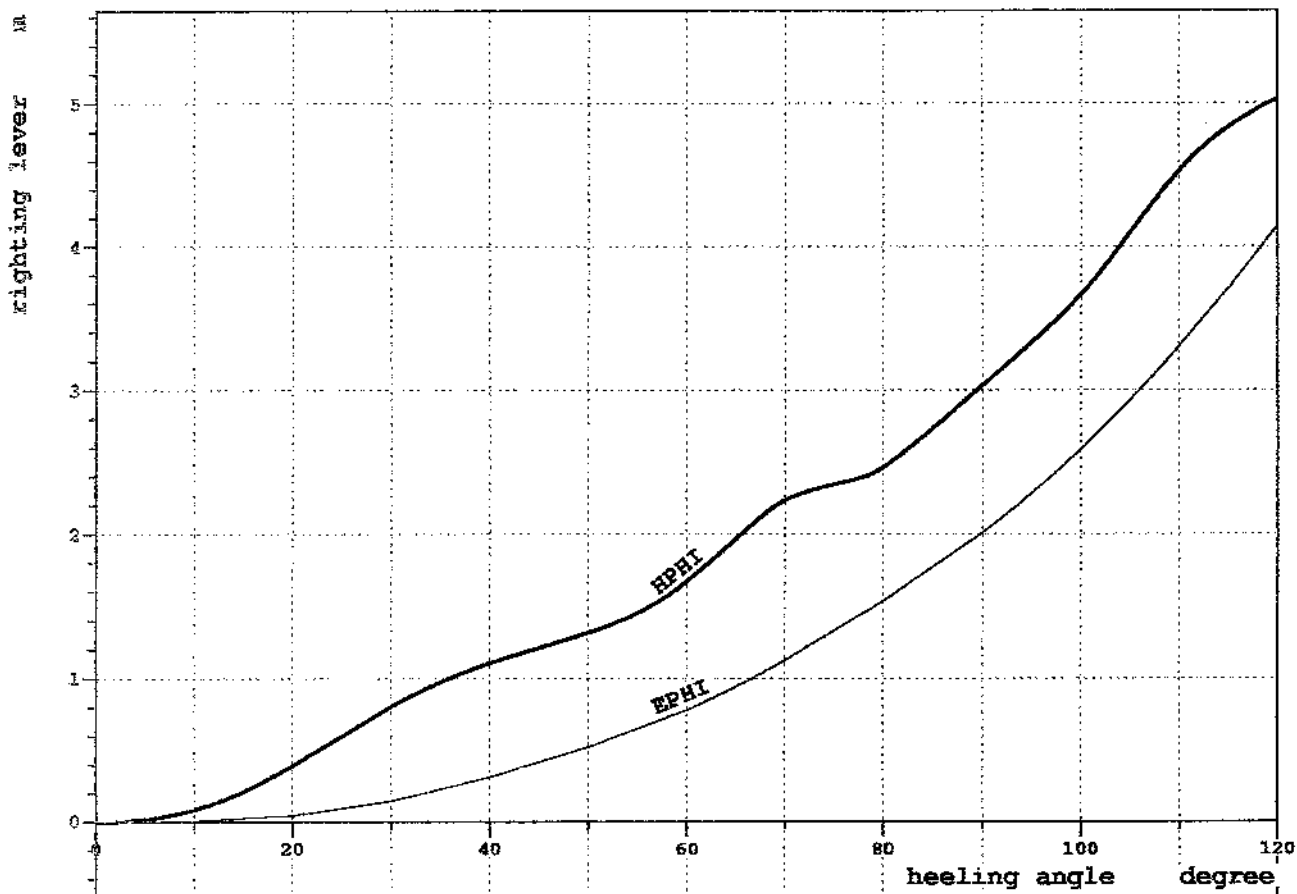


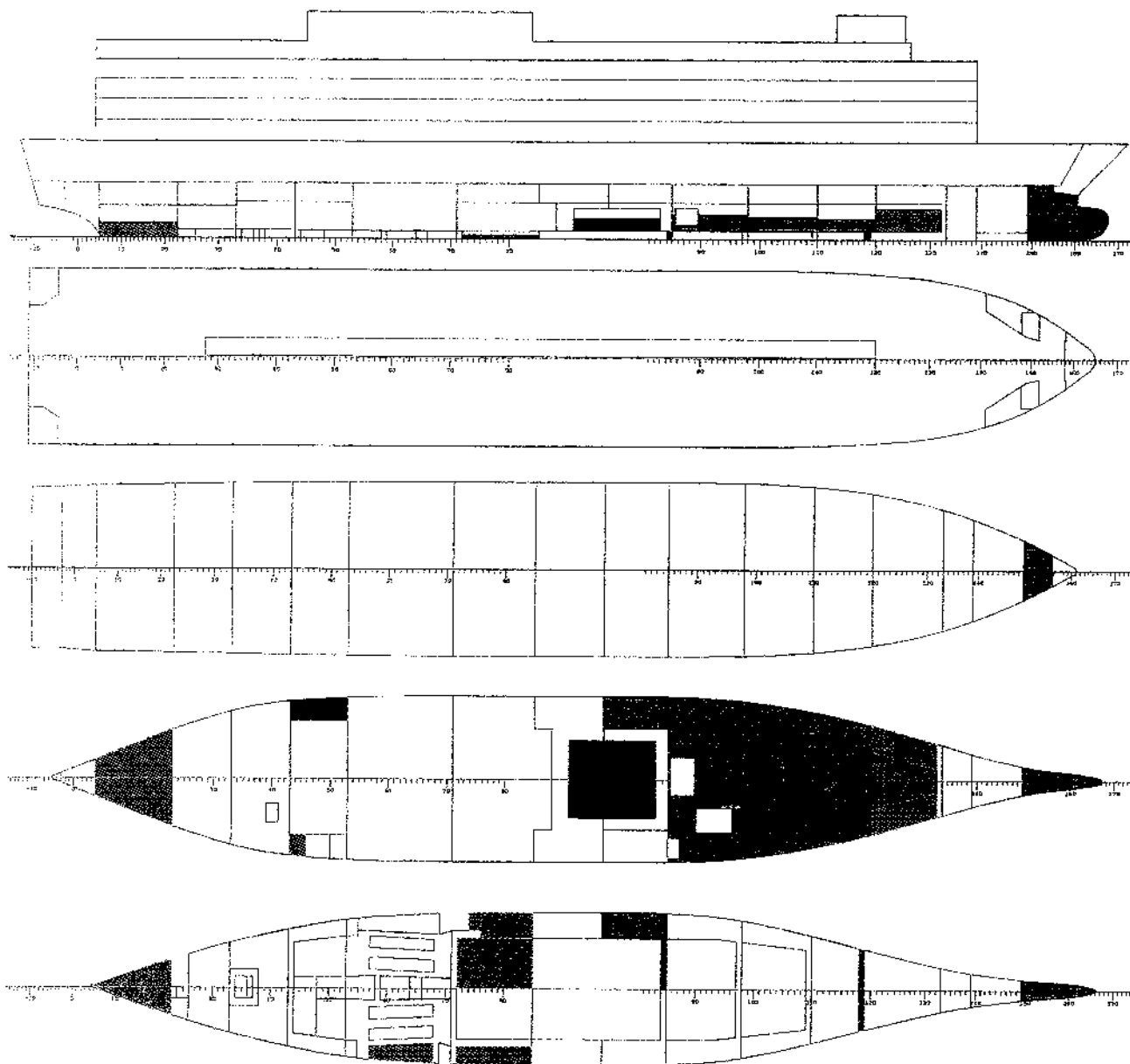
Name	Max. weight	Mass	Center of gravity			Free s. moment	
			cgx	cgz	cgz		
CREW							
(CREW)	CREW	0.0	20.0	60.00	0.00	22.00	0.0
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
Deadweight		3228.4	82.39	0.02	5.29		18562.3
Lightweight		9733.0	60.76	0.00	11.56		
Displacement (rho=1.01)		12961.4	66.15	0.01	10.00		18562.3

F L O A T I N G P O S I T I O N

Draught moulded	5.785	m	KM	11.57	m
Trim	0.814	m	KG	10.00	m
TA	5.378	m	GMO	1.58	m
TF	6.192	m	GMCORR	-1.43	m
Trimming moment	21727	tonm	GM	0.14	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.010	-0.01	0.000	0.0	0.000
10.0	0.054	0.08	0.004	3191.4	0.246
20.0	0.203	0.39	0.042	4600.9	0.355
30.0	0.382	0.80	0.146	4782.3	0.369
40.0	0.445	1.10	0.314	4608.5	0.356
50.0	0.430	1.31	0.525	4206.2	0.325
60.0	0.582	1.67	0.780	3635.0	0.280
70.0	0.979	2.23	1.123	2936.5	0.227
80.0	1.071	2.46	1.531	2137.4	0.165
90.0	1.548	3.03	2.008	1269.3	0.098
100.0	2.136	3.66	2.590	362.5	0.028
110.0	3.007	4.53	3.305	-551.3	-0.043
120.0	3.552	5.03	4.145	-1439.7	-0.111





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Name		Max. weight	Mass	Center of gravity cgx cgz			Free s. moment
CREW							
(CREW)	CREW	0.0	20.0	60.00	0.00	22.00	0.0
PRO							
(PRO)	PROVISION & .	0.0	80.0	46.00	0.00	10.00	0.0
Deadweight			3528.4	83.60	0.04	5.13	19893.7
Lightweight			9733.0	60.76	0.00	11.56	
Displacement (rho=1.01)			13261.4	66.84	0.01	9.85	19893.7

F L O A T I N G P O S I T I O N

Draught moulded	5.909	m	KM	11.54	m
Trim	1.205	m	KG	9.85	m
TA	5.306	m	GMO	1.70	m
TF	6.512	m	GMCORR	-1.50	m
Trimming moment	32395	tonm	GM	0.20	m

HEEL degree	MS m	HPHI m	EPHI rad*m	FSMOM tm	DGZ m
0.0	-0.014	-0.01	0.000	0.0	0.000
10.0	0.047	0.11	0.005	3127.1	0.236
20.0	0.189	0.46	0.051	4170.0	0.314
30.0	0.373	0.89	0.169	4353.5	0.328
40.0	0.453	1.23	0.356	4201.7	0.317
50.0	0.452	1.46	0.591	3840.4	0.290
60.0	0.624	1.84	0.875	3319.6	0.250
70.0	1.016	2.41	1.249	2681.5	0.202
80.0	1.107	2.63	1.688	1951.2	0.147
90.0	1.576	3.19	2.194	1157.9	0.087
100.0	2.151	3.80	2.802	329.4	0.025
110.0	3.013	4.65	3.539	-505.4	-0.038
120.0	3.552	5.12	4.398	-1320.3	-0.100

