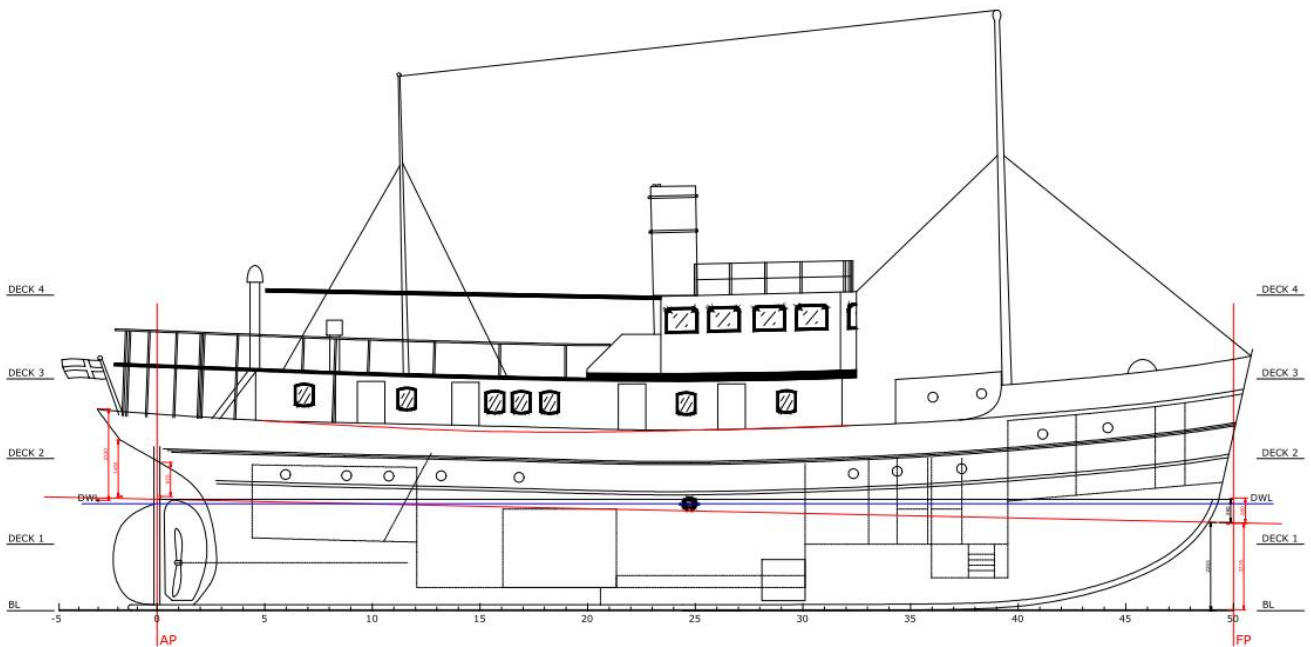


REPORT FOR:

*NYBERG/TIMGREN*

# INCLINING TEST REPORT R.2132.1000.002

August 22, 2013  
REVISION 0



## NIKOLAI II

**NIKOLAI II**  
**INCLINING TEST REPORT**  
**R.2132.1000.002**

Project: FS2132  
Client: Nyberg/Timgren  
Date: 2013-08-22  
Revision: 0

**REVISION HISTORY**

REV.	DATE	DESCRIPTION
0	2013-08-22	Initial revision
-	-	-

Foreship		
Designed	2013-08-22	KN
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# 1 Introduction

This report has been prepared on the request of Paul Nyberg.

The purpose of this report is to show the results of the Inclining Test of the vessel Nikolai II carried out in Helsinki, August 15, 2013.

## 2 Executive Summary

The lightweight (2013-08-15) and centre of gravity are the following:

- Weight: 224.7 ton
- LCG 13.47 m
- TCG: 0.00 m (portside positive)
- VCG: 2.60 m

Previous (2001-11-01) lightweight and centre of gravity are the following:

- Weight: 203.9 ton
- LCG 12.7 m
- TCG: 0.00 m (portside positive)
- VCG: 2.55 m

### 3 General

#### 3.1 General Data

Ship's Name	NIKOLAI II
Type of the Ship	Passenger Ship
Flag	Finland
Port of Registry	Helsinki
Owner	Paul Nyberg & Veronica Timgren
Builder	-
Date of Build	1903

#### 3.2 Main Dimensions

Length over all	ca. 30.00 m
Length between perpendiculars	27.50 m
Breadth max. (moulded)	6.00 m
Depth (moulded)	3.66 m
Draught (moulded, max. draught)	2.70 m

#### 3.3 Date and Place of the Test

The inclining test was carried out at August 15<sup>th</sup>, 2013 in Helsinki, Finland.

Draft survey:

Start of draft survey: August 15, 2012, 11:00

End of draft survey: August 15, 2012, 11:30

The inclining:

Start of inclining: August 15, 2012, 11:30

End of inclining: August 15, 2012, 13:30

#### 3.4 Weather and Sea Conditions

During the test weather and sea conditions were the following:

Wind velocity:	5 m/s
Wind direction:	180 deg. from bow
Sea water condition:	Calm / small waves
Sea water density:	1.005 t/m <sup>3</sup>
Sea water temperature:	14 °C
Air temperature:	18 °C

#### 3.5 Persons Attended the Test

The following persons attended the test:

- Mr. Kai Noras, Foreship Ltd., Test leader
- Mr. Pasi Mustonen, Foreship Ltd.
- Mr. Jussi Ketonen, TRAFI surveyor
- Mr. Jari Pietilä, TRAFI surveyor

## 4 Weight Survey

A detailed list of removed foreign weights (stores, provision, personnel, temporary equipment, etc.), weights to be relocated and weights to be added (missing weights) including centre of gravity were gathered during the weight survey. The result tables are presented below.

### 4.1 Removed Solid Weights

<b>SUMMARY OF REMOVED WEIGHTS</b>					
<b>DECK</b>	<b>LOCATION / ITEM</b>	<b>WEIGHT [t]</b>	<b>LCG [m]</b>	<b>TCG [m]</b>	<b>VCG [m]</b>
Deck 1	Saloon, #7, Cable and scrap	0.100	3.850	0.000	1.400
Deck 2	Aft Deck, #4, Freezer	0.150	2.200	0.000	4.750
Deck 2	Pantry, #8, Provisions	0.050	4.400	0.000	4.600
Deck 2	Restaurant, #20, Pendulum oil	0.049	10.800	0.000	4.000
Deck 2	Store, #35, Misc. Storage	0.150	19.500	2.200	4.900
Deck 2	Store, #38, Misc. Storage	0.100	20.750	2.200	4.900
Deck 3	Open deck, #0, Flowers	0.420	0.000	0.000	7.000
Deck 3	Open deck, #23, Grill	0.040	12.500	0.000	6.200
Deck 3	Pantry, #26, Cable	0.100	14.500	1.500	6.300
Deck 3	Pantry, #26, Provisions	0.150	14.500	-1.000	6.300
Deck 3	Wheelhouse, #30, Plastic cover and grill	0.050	18.500	0.000	6.100
Deck 2	Restaurant, #15, 2 Persons	0.160	8.250	0.000	4.950
Deck 2	Restaurant, #22, 2 Persons	0.160	12.100	0.000	4.950
Deck 3	Open deck, #13, Inclining Weight W1	0.236	7.150	2.348	6.450
Deck 3	Open deck, #14, Inclining Weight W2	0.236	7.750	2.348	6.450
Deck 3	Open deck, #15, Inclining Weight W3	0.235	8.350	-2.410	6.450
Deck 3	Open deck, #16, Inclining Weight W4	0.228	8.950	-2.410	6.450
Deck 3	Open deck, #17, Inclining Weight W5	0.233	9.550	0.000	6.450
<b>TOTAL</b>		<b>2.847</b>	<b>8.61</b>	<b>0.19</b>	<b>5.86</b>

Table 1 Summary of removed and relocated weights.

#### 4.2 Added Solid Weights

There were no added weights during the test.

#### 4.3 Relocated Solid Weights

There were no relocated weights during the test.



## 5 Tank Survey

The gathered data during the Tank Survey is presented below with corresponding volumes and centre of gravities.

### 5.1 Removed Tanks

Removed tanks during the test are presented here. It should be clearly noted that proper tank capacity tables or sounding tables could not be found. Values are based on measurement from the ship, drawings and information presented in previous inclining test report. Free surface effect has been calculated and the correction to the GM is 3.74 tm / 237.7 t = 0.016 m (FSM/Displacement).

Tank Name	Description	Capacity [m3]	Volume [m3]	Density [t/m3]	Weight [t]	LCG [m]	TCG [m]	VCG [m]	FSM [tm]
<b>DIESEL OIL</b>									
FO1P	Fuel Oil 1P	23.57	0	0.840	0.00				0.00
FO1S	Fuel Oil 1S	23.57	0	0.840	0.00				0.00
FO2C	Fuel Oil 2C	1.73	1.4	0.840	1.21	16.23	0.45	2.23	0.43
FOD	Day Tank	0.88	0.6	0.840	0.54	11.35	-1.43	5.00	0.02
<b>FRESH WATER</b>									
FW1P	Fresh Water 1P	3.80	3.8	1.000	3.80	23.39	0.60	0.94	0.00
FW1S	Fresh Water 1S	3.80	3.8	1.000	3.80	23.39	-0.60	0.94	0.00
<b>BALLAST WATER</b>									
FP	Fore Peak	4.40	0.0	0.000	0.00				0.00
<b>Grey Water</b>									
GW1	Gray Water 1C	3.81	0.8	1.000	0.83	16.10	0.00	0.70	3.29
					<b>Weight [t]</b>	<b>LCG [m]</b>	<b>TCG [m]</b>	<b>VCG [m]</b>	<b>FSM [tm]</b>
<b>TOTALS</b>					<b>10.19</b>	<b>21.30</b>	<b>-0.02</b>	<b>1.29</b>	<b>3.74</b>

Table 2 Removed tanks.

## 6 Draft Survey

### 6.1 Draft Survey Records

Draft Survey records are shown in figure 1 below. Draft mark readings are measured above the keel plate. Heel to portside is positive. Draft marks located on transom and stem.

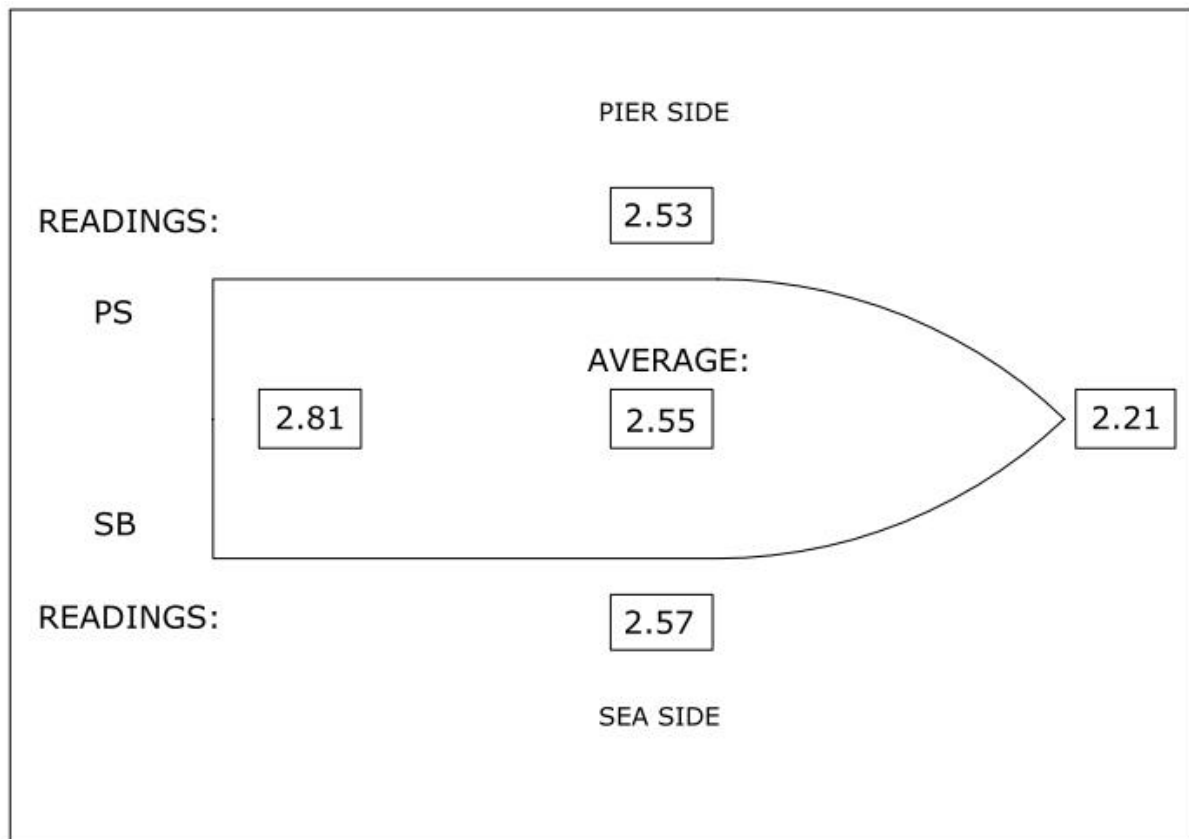


Figure 1 Draft survey readings.

### 6.2 Location of Draft Readings

- Aft Readings: at #0
- Mid Readings: 13.6 m from AP
- Fore Readings: 0.4 m aft of FP
- Distance between aft and fore Readings: 26.98 m
- Length between perpendiculars: 27.50 m

Notes: Frame #0 locates at the rudder stock. Mid ship readings are located 13.60 m forward of frame #0. Readings in the fore ship are taken from the intersection of design waterline (T=2.70 m) and stem.

### 6.3 Initial Heeling Angle

$TAN ((T_{SB} - T_{PS}) / \text{Beam}) = \text{Heeling angle} = TAN ((2.57 - 2.53) / 6.0) = -0.385^\circ$   
 (Starboard). Heeling angle is calculated from measured difference between the mid ship marks.

#### 6.4 Trim Marks

$$\text{Trim} = T_{\text{FORE}} - T_{\text{AFT}} = 2.21 - 2.81 = -0.57 \text{ m (trim negative by aft)}$$

#### 6.5 Trim LPP

$$\text{Trim} = -0.570 \times 27.50 / 26.98 = -0.581 \text{ m}$$

#### 6.6 Mean Draft at LPP/2

$$T_{\text{MEAN}} = (T_{\text{AFT}} + 4 \times T_{\text{LPP/2}} + T_{\text{FORE}}) / 6 = (2.81 + 4 \times 2.55 + 2.21) / 6 = 2.53 \text{ m (above keel)}$$

#### 6.7 Interpolated Displacement, KM and LCB During the Test

Hydrostatic values refer to baseline. Interpolated hydrostatic values are shown bolded.

(T = 2.494 m, rho=1.005 t/m3), see also appendage 1:

Trim [m]	Displacement [t]	LCB [m]	KMT [m]
-0.500	232.5	13.829	2.914
-0.581	233.3	13.752	2.920
-0.600	233.5	13.734	2.921

Table 3 Interpolated hydrostatic values.

(T = 2.544 m, rho=1.005 t/m3), see also appendage 2:

Trim [m]	Displacement [t]	LCB [m]	KMT [m]
-0.500	239.5	13.818	2.915
-0.581	239.5	13.743	2.920
-0.600	239.5	13.725	2.921

Table 4 Interpolated hydrostatic values.

(T = 2.530 m, rho=1.005 t/m3):

T [m]	Displacement [t]	LCB [m]	KMT [m]
2.494	233.3	13.752	2.920
2.530	237.7	13.745	2.920
2.544	239.5	13.743	2.920

Table 5 Interpolated hydrostatic values.

## 6.8 Displacement, KMT and LCB During the Test

(T = 2.53 m, rho=1.005t/m<sup>3</sup>):

- Displacement = 237.7 t
- LCB = 13.745 m
- KMT = 2.920 m

## 7 Inclining

Inclining was carried out by using fixed weights. Five (5) similar water filled drum weights, abt. 0.23 t each, were used to heel the vessel. In table below, distances are measured from CL to the centre of the inclining weight.

### 7.1 Inclining Weight Shifts and Total Heeling Moment

Shift	MEASURED MOMENT ARM [m]						TOTAL MOMENTS [tm]
	W1	W2	W3	W4	W5	W6	TOT
0	2.384	2.384	-2.410	-2.410	0.000	0.000	0.01
1	<b>-2.410</b>	<b>-2.410</b>	-2.410	-2.410	0.000	0.000	-2.25
2	-2.410	-2.410	-2.141	-2.410	<b>-2.410</b>	0.000	-2.75
3	<b>2.384</b>	<b>2.384</b>	-2.141	-2.410	-2.410	0.000	-0.49
4	2.384	2.384	-2.141	-2.410	<b>0.000</b>	0.000	0.07
5	2.384	2.384	<b>2.384</b>	<b>2.384</b>	0.000	0.000	2.23
6	2.384	2.384	2.384	2.384	<b>2.384</b>	0.000	2.78
7	2.384	2.384	<b>-2.410</b>	<b>-2.410</b>	2.384	0.000	0.56
8	2.384	2.384	-2.410	-2.410	<b>0.000</b>	0.000	0.01

Table 6 Inclining weight shift and total heeling moment.

## 7.2 Pendulum arrangement

One pendulum was used. Pendulum line and oil tray was in the restaurant on deck 2 ca. at frame #20. Pendulum was hanging from the washer. Pendulum weight, 2 kg, located at oil tray which was filled with lubricating oil. The following pendulum length was measured:

- Pendulum 1: 3.745 m

## 7.3 Pendulum readings

Pendulum readings are presented below. A digital angle measurement device was also used during test for quality check. The two readings matched well and so only pendulum readings will be used here.

Pendulum readings - pendulum 1																		
Shifts	Reading		Reading		Reading		Reading		Reading		Reading		Reading		Average	Defl.	Heel	
	P	S	P	S	P	S	P	S	P	S	P	S	P	S	[mm]	[mm]	[angle]	
0	430	470	433	460	438	452	445								447	0.00	-0.385	
1	326	360	315	365	310	350	322	370	335	362	335	370			343	-103.52	-1.969	
2	300	334	300	315	305	290	325	311	324	303	320				312	-135.31	-2.456	
3	401	448	415	449	372	460	382	446	386	447	385	455	388	456	421	-26.14	-0.785	
4	442	454	436	457	436	464	435	460							448	1.14	-0.368	
5	536	575	538	572	549	564	548	567							556	109.27	1.287	
6	556	617	560	618	570	595	570	588							584	137.39	1.718	
7	460	475	468	505	472	489	446	508	460	480					476	29.44	0.065	
8	426	482	418	475	420	468	423	468							448	0.64	-0.375	
Pendulum 1: location behind the mast Pendulum length [mm]: 3745																		

Table 7 Pendulum readings.

## 8 Test Analysis

### 8.1 Calculated GM-values and standard deviation (s) calculation

Table below shows individual GM-values for each shift. Standard deviation is also calculated to show the accuracy of the test. Note that the shift number two has been removed from the result calculation. This has been done because of the fairly large deviation from the rest of the recorded points. This is suspected to be an error in measurement.

Calculated GM and KG are based on average method which result is shown on this page. The moment and heel diagram is shown on the next page.

CALCULATED GM-VALUES DURING THE TEST									
Shift [#]	Average heel angle [degree]	Average heel angle [rad]	heel/shift [degree]	heel/shift [rad]	Total Moment [tm]	M Moment/shift [tm]	D Displ. [t]	GM <sub>f</sub> M/(D*sinα) [m]	(GM <sub>s</sub> -X <sub>i</sub> ) <sup>2</sup>
0	-0.385	-0.007	0.000	0.000	0.01	0.00	237.7		
1	-1.969	-0.034	-1.584	-0.028	-2.25	-2.26	237.7	0.344	0.0005
2	-2.456	-0.043	-0.487	-0.008	-2.75	-0.50	237.7	0.246	0.0056
3	-0.785	-0.014	1.671	0.029	-0.49	2.26	237.7	0.326	0.0000
4	-0.368	-0.006	0.417	0.007	0.07	0.56	237.7	0.324	0.0000
5	1.287	0.022	1.655	0.029	2.23	2.16	237.7	0.314	0.0000
6	1.718	0.030	0.431	0.008	2.78	0.55	237.7	0.310	0.0001
7	0.065	0.001	-1.652	-0.029	0.56	-2.22	237.7	0.324	0.0000
8	-0.375	-0.007	-0.441	-0.008	0.01	-0.56	237.7	0.304	0.0003
Metacentric height during experiment						GM		0.321	m
Free surface correction						GM <sub>C</sub>		0.016	m
Corrected metacentric height						GM <sub>0</sub>		0.337	m
Height of metacenter above baseline						KM		2.920	m
<b>Center of gravity above BL</b>						<b>KG</b>		<b>2.583</b>	<b>m</b>
STANDARD DEVIATION CALCULATION									
Standard deviation						$\Sigma(GM_s - X_i)^2$ :		0.0010	
						$s = \sqrt{\Sigma(GM_s - X_i)^2 / (n-1)}$ :		<b>0.0121</b>	m

Table 8 Calculated GM-values during the test and standard deviation (s).

## 8.2 Moment vs. Heel Diagram

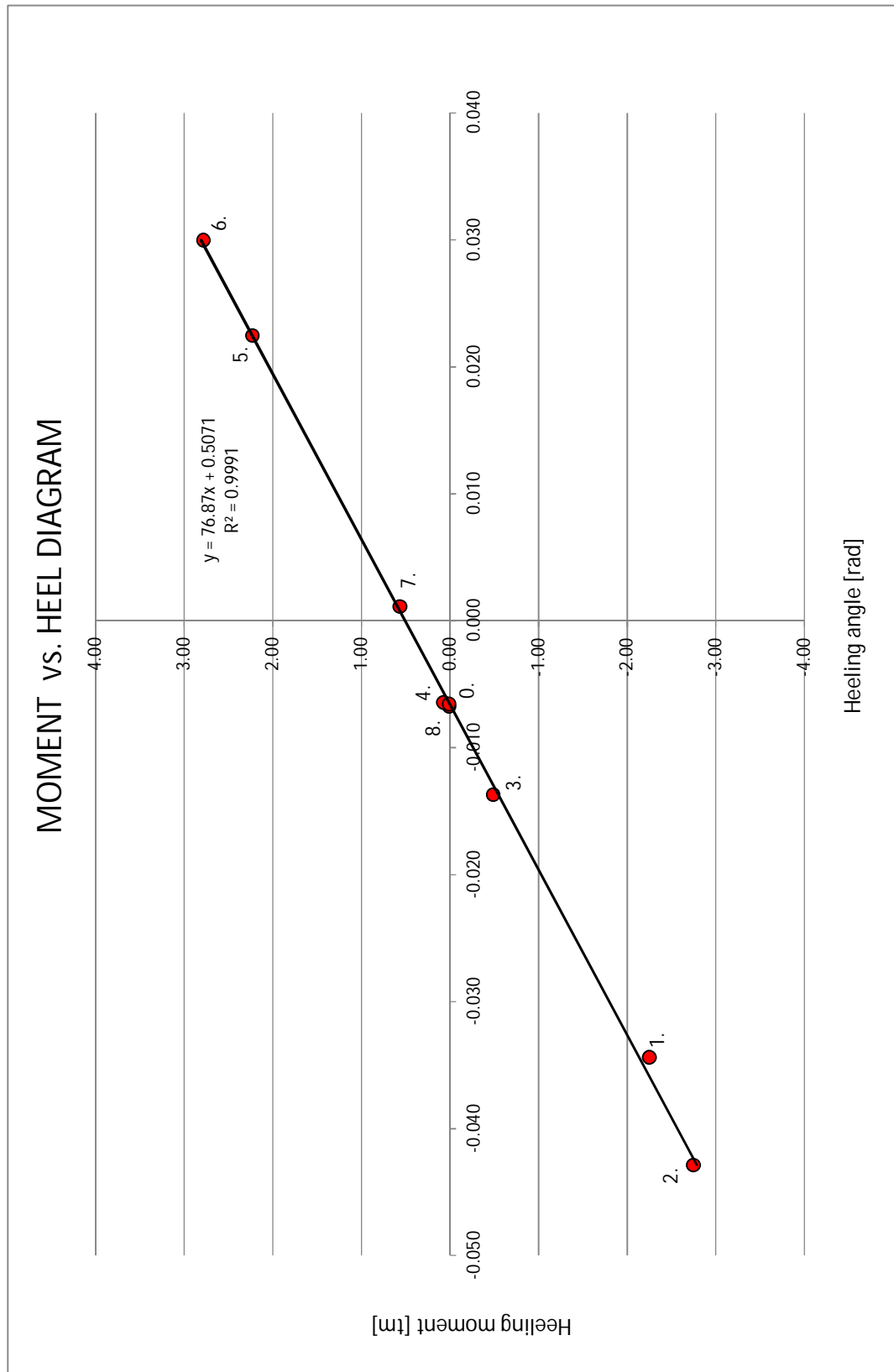


Figure 2 Moment vs. heel diagram.



## 9 Lightweight calculation

<b>VESSEL'S LIGHTWEIGHT CALCULATION</b>				
<b>Item</b>	<b>Weight [t]</b>	<b>LCG [m]</b>	<b>TCG [m]</b>	<b>VCG [m]</b>
Displacement during the test	237.7	13.75	0.00	2.58
Tanks to be subtracted	-10.2	21.30	-0.02	1.29
Solid weights to be subtracted	-2.8	8.61	0.19	5.86
Solid weights to be relocated	0.0	0.00	0.00	0.00
Solid weights to be added	0.0	0.00	0.00	0.00
<b>LIGHTWEIGHT: 2013-08-15</b>	<b>224.7</b>	<b>13.47</b>	<b>0.00</b>	<b>2.60</b>

Table 9 Lightweight calculation.

## 10 Appendages

10.1 Vessel's hydrostatic table for Tk = 2.500 – 2.550 m (2 page)

Ship Consulting Nikolai II		HYDROSTATIC BOOK							Page	*
								Page	20	
TK	m	2.200	2.250	2.300	2.350	2.400	2.450	2.500	2.550	
T	m	2.194	2.244	2.294	2.344	2.394	2.444	2.494	2.544	
VOLM	m <sup>3</sup>	191	197	203	210	216	222	229	235	
DISP	t	193	199	205	212	218	224	231	237	
DISP	t	193	199	205	212	218	224	231	237	
LCB	m	14.390	14.375	14.359	14.343	14.326	14.310	14.293	14.276	
VCB	m	1.328	1.356	1.384	1.412	1.440	1.468	1.496	1.524	
KMT	m	2.908	2.900	2.894	2.890	2.887	2.885	2.885	2.886	
KML	m	27.431	27.112	26.813	26.525	26.242	25.955	25.670	25.398	
WLA	m <sup>2</sup>	124	125	126	127	128	128	129	130	
TCP	t/cm	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
MCT	tm/cm	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	
CB		0.5451	0.5503	0.5554	0.5603	0.5652	0.5700	0.5747	0.5793	
CP		0.6941	0.6965	0.6990	0.7014	0.7038	0.7063	0.7087	0.7111	
CW		0.7775	0.7829	0.7883	0.7937	0.7988	0.8037	0.8085	0.8132	
CM		0.7853	0.7900	0.7946	0.7989	0.8031	0.8071	0.8109	0.8146	
WSA	m <sup>2</sup>	184	187	190	193	196	199	202	205	
LCA	m	13.92	13.88	13.84	13.80	13.76	13.73	13.70	13.66	
transv. metac. height m										
-1.500		3.033	3.023	3.016	3.010	3.005	3.002	3.000	2.999	
-1.400		3.022	3.013	3.005	2.999	2.994	2.991	2.990	2.989	
-1.300		3.012	3.003	2.995	2.989	2.984	2.981	2.980	2.979	
-1.200		3.002	2.993	2.985	2.979	2.974	2.971	2.970	2.970	
-1.100		2.992	2.983	2.976	2.970	2.965	2.962	2.961	2.960	
-1.000		2.983	2.974	2.966	2.961	2.956	2.953	2.952	2.952	
-0.900		2.973	2.965	2.957	2.952	2.948	2.945	2.943	2.943	
-0.800		2.964	2.956	2.949	2.943	2.939	2.937	2.936	2.935	
-0.700		2.956	2.947	2.941	2.935	2.931	2.929	2.928	2.928	
-0.600		2.948	2.939	2.932	2.927	2.924	2.922	2.921	2.921	
-0.500		2.940	2.931	2.925	2.920	2.917	2.915	2.914	2.915	
-0.400		2.933	2.924	2.918	2.913	2.910	2.908	2.907	2.908	
-0.300		2.925	2.918	2.911	2.906	2.903	2.902	2.901	2.902	
-0.200		2.919	2.911	2.905	2.900	2.897	2.896	2.895	2.896	
-0.100		2.913	2.905	2.899	2.895	2.892	2.890	2.890	2.891	
0.000		2.908	2.900	2.894	2.890	2.887	2.885	2.885	2.886	
0.100		2.903	2.895	2.889	2.885	2.882	2.880	2.880	2.881	
0.200		2.899	2.891	2.885	2.881	2.878	2.876	2.876	2.877	
0.300		2.896	2.888	2.881	2.877	2.874	2.873	2.872	2.874	
0.400		2.892	2.884	2.878	2.874	2.871	2.870	2.869	2.870	
0.500		2.889	2.881	2.875	2.871	2.868	2.867	2.867	2.868	
0.600		2.887	2.879	2.873	2.869	2.866	2.865	2.865	2.866	

Ship Consulting Nikolai II		HYDROSTATIC BOOK						Page	*
							Page	21	
TK	m	2.200	2.250	2.300	2.350	2.400	2.450	2.500	2.550
T	m	2.194	2.244	2.294	2.344	2.394	2.444	2.494	2.544
TOTAL DISPLACEMENT		t							
-1.500		198	204	211	217	224	231	237	244
-1.400		197	204	210	217	223	230	237	244
-1.300		197	203	210	216	223	229	236	243
-1.200		196	203	209	216	222	229	236	242
-1.100		196	202	209	215	222	228	235	242
-1.000		195	202	208	215	221	228	234	241
-0.900		195	201	208	214	221	227	234	241
-0.800		195	201	207	214	220	227	234	240
-0.700		194	201	207	213	220	227	233	240
-0.600		194	200	207	213	220	226	233	239
-0.500		194	200	206	213	219	226	232	239
-0.400		193	200	206	212	219	225	232	238
-0.300		193	199	206	212	219	225	232	238
-0.200		193	199	206	212	218	225	231	238
-0.100		193	199	205	212	218	225	231	238
0.000		193	199	205	212	218	224	231	237
0.100		193	199	205	211	218	224	231	237
0.200		192	199	205	211	218	224	230	237
0.300		192	199	205	211	217	224	230	237
0.400		192	198	205	211	217	224	230	236
0.500		192	198	205	211	217	223	230	236
0.600		192	198	205	211	217	223	230	236
long. centre of buoy.		m							
-1.500		12.846	12.852	12.857	12.861	12.863	12.865	12.866	12.866
-1.400		12.952	12.956	12.960	12.963	12.964	12.964	12.964	12.963
-1.300		13.057	13.060	13.063	13.064	13.064	13.063	13.062	13.059
-1.200		13.162	13.164	13.165	13.165	13.164	13.162	13.159	13.156
-1.100		13.266	13.267	13.266	13.265	13.263	13.260	13.257	13.252
-1.000		13.371	13.369	13.368	13.365	13.362	13.358	13.353	13.348
-0.900		13.475	13.472	13.469	13.465	13.460	13.455	13.449	13.443
-0.800		13.578	13.574	13.569	13.564	13.558	13.552	13.545	13.537
-0.700		13.682	13.676	13.670	13.663	13.656	13.648	13.640	13.631
-0.600		13.785	13.778	13.770	13.761	13.753	13.744	13.734	13.725
-0.500		13.887	13.878	13.869	13.860	13.850	13.839	13.829	13.818
-0.400		13.989	13.979	13.968	13.957	13.946	13.934	13.922	13.910
-0.300		14.091	14.079	14.067	14.054	14.042	14.029	14.016	14.003
-0.200		14.191	14.178	14.165	14.151	14.137	14.123	14.109	14.094
-0.100		14.291	14.277	14.262	14.247	14.232	14.217	14.201	14.186
0.000		14.390	14.375	14.359	14.343	14.326	14.310	14.293	14.276
0.100		14.488	14.472	14.455	14.438	14.420	14.402	14.384	14.367
0.200		14.586	14.568	14.550	14.531	14.513	14.494	14.475	14.456
0.300		14.682	14.663	14.644	14.624	14.605	14.585	14.565	14.545
0.400		14.778	14.758	14.737	14.717	14.696	14.675	14.654	14.634
0.500		14.873	14.851	14.830	14.808	14.786	14.765	14.743	14.721
0.600		14.967	14.944	14.921	14.899	14.876	14.853	14.831	14.808