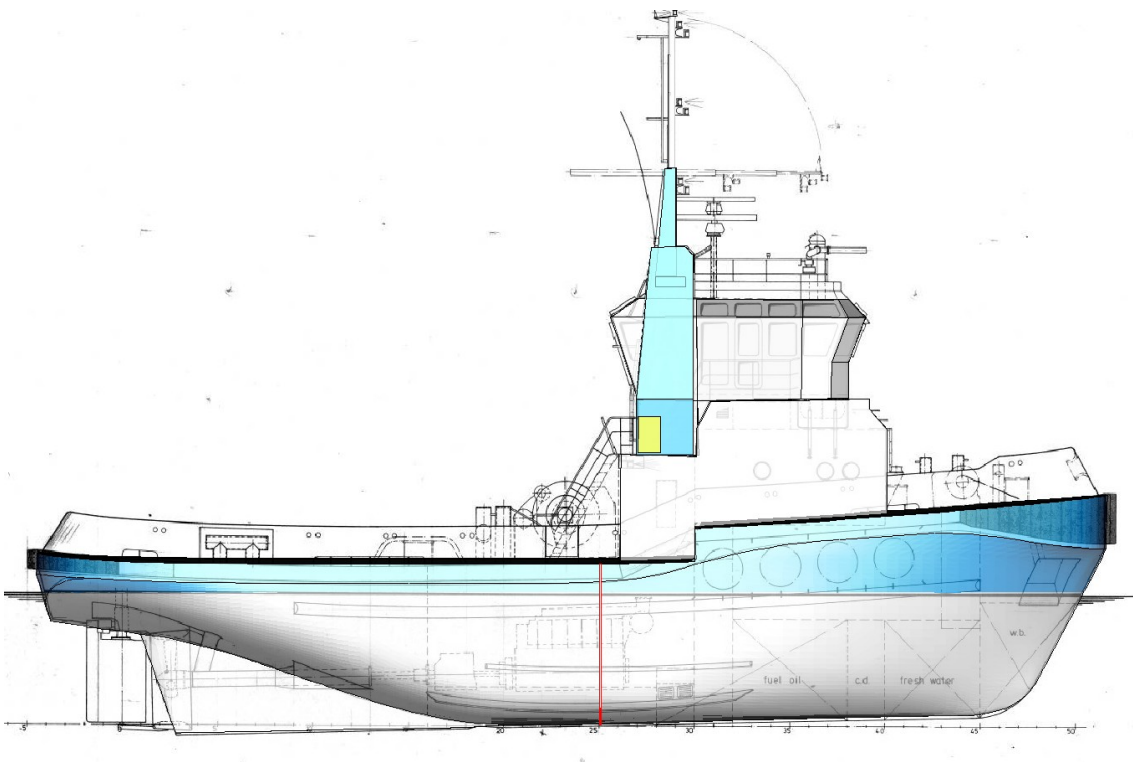


INTACT STABILITY

SMIT POLEN



RAPPORT VOOR ONDERZOEKSRAAD VOOR VEILIGHEID

ASD SHIP DESIGN B.V.
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REPORT NUMBER ASD 11-04
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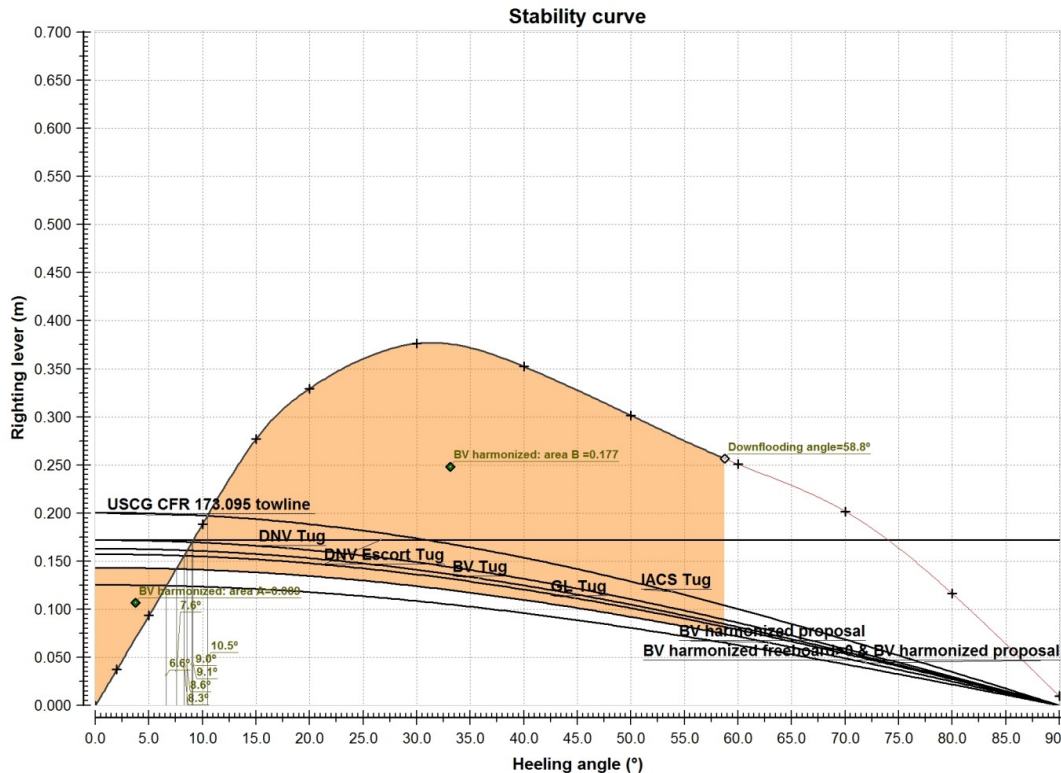
1 Purpose

The purpose of this document is to investigate the stability characteristics of the harbour tug Smit Polen. The tug was involved in an overturning incident, as consequence of a collision, but was able to recover.

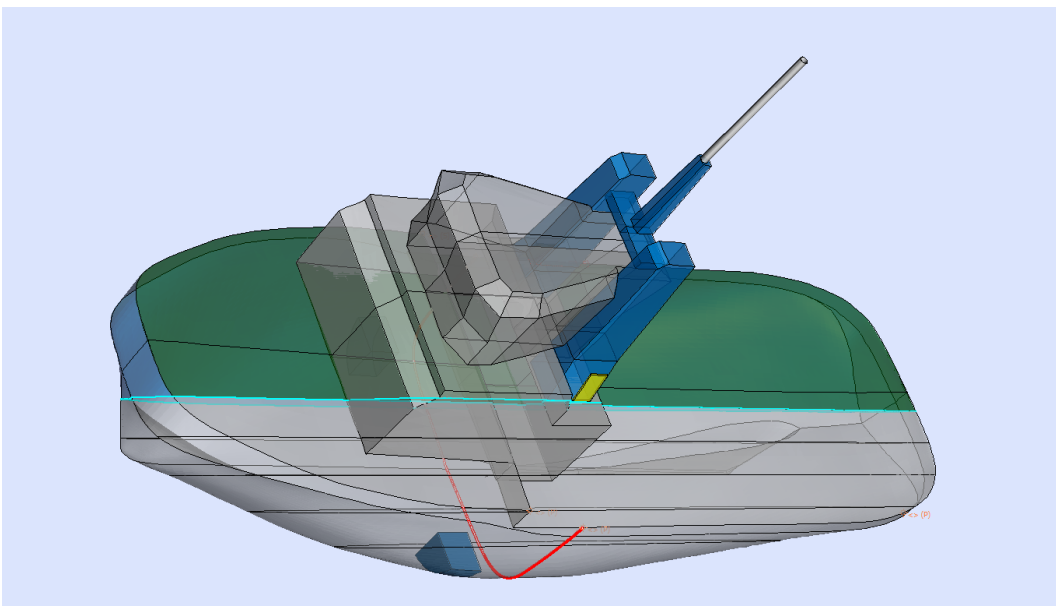
2 Summary

The loading condition during the incident was reconstructed and analysed. It is shown that the tug during the incident complied with all available requirements for a tug with non-azimuthing propellers towing over the aftship.

It is shown that the ship has a relative high arm of stability at the downflooding angle of 59°.



Smit Polen at an heeling angle of 59°.



3 Stability calculations

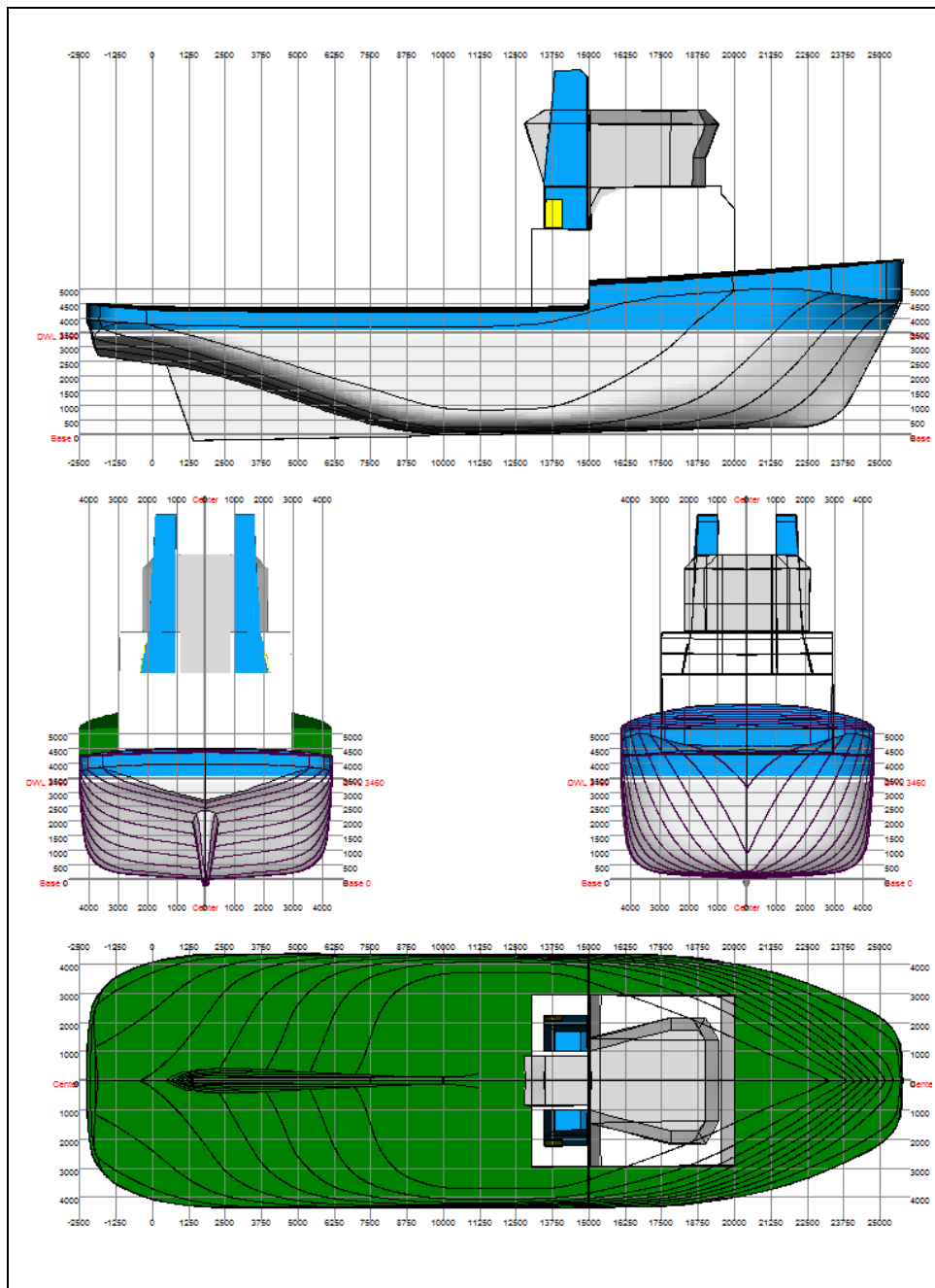
3.1 Basic information

The calculations are based on the received Linesplan, General Arrangement & Stability Booklet and the reconstruction of the loading condition received from the ship.

3.2 Linesplan

The following parts of the ship have been taken into account:

1. Hull up to main deck including skeg
2. First layer of deckhouse
3. Buoyancy of nozzles and rudders has been taken into account in the lightship weight
4. Non-Buoyancy of sea inlet chests has been taken into account in the hull form



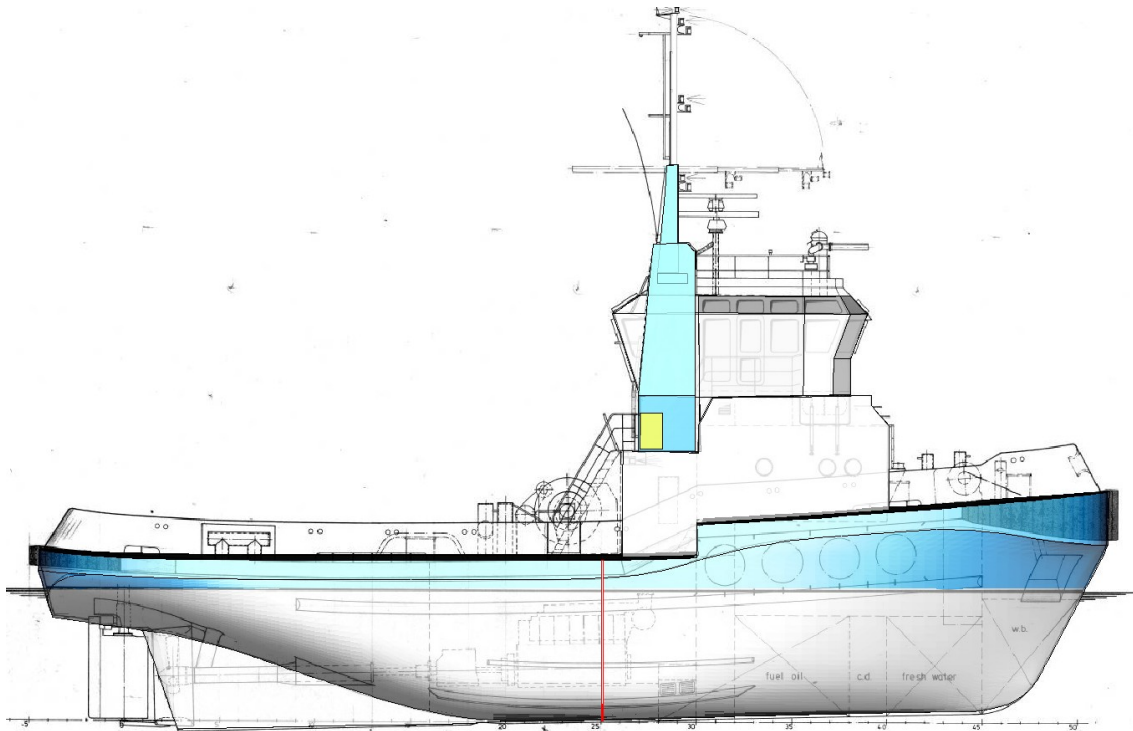
3.3 Characteristics of the lightship

The applied lightship weight is derived from the stability booklet:

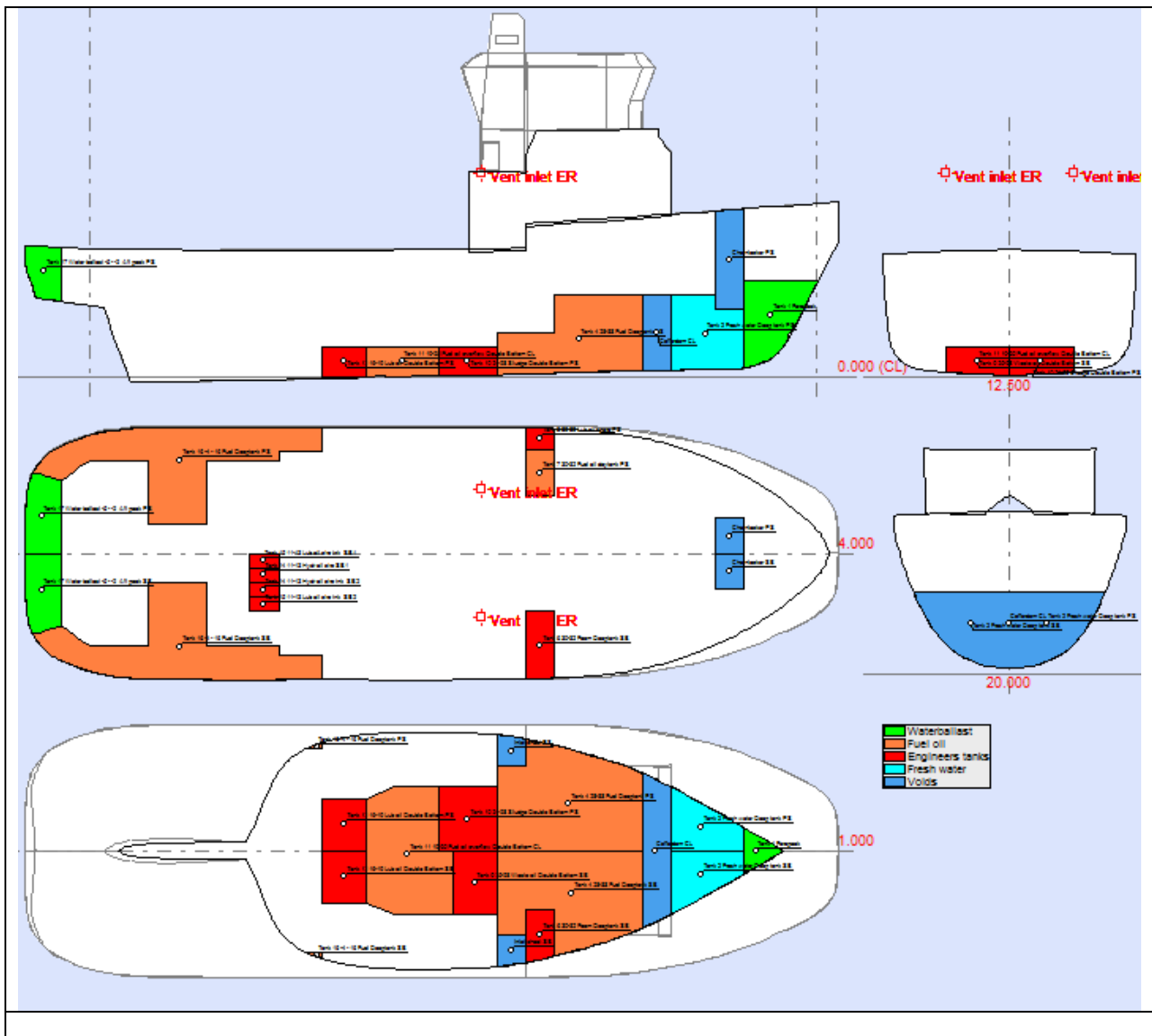
- $W_{sm} = 339.34$ ton
- $VCG = 3.570$ m
- $LCG = 12.130$ m
- $TCG = 0.000$ m

3.4 Openings taken into account

All openings of the tug were closed with exception of the air inlet to the engine room PS&SB, and indicated in the following drawing, with the following coordinates: $z / x / y = 7.00, 13.50, 2.20$ m.



3.5 Tank arrangement



3.6 Tank space information

	Relative density	Volume	Weight	VCG	LCG	TCG	Max FSM
		(m ³)	(tonnes)	(m)	(m)	(m)	(t*m)
Waterballast							
Tank 1 Forepeak	1.025	8.125	8.328	2.366	23.220	0.000 (CL)	5.810
Tank 17 Water ballast -5 - -2 Aft peak PS	1.025	4.216	4.321	3.739	-1.565	1.194 (PS)	1.839
Tank 17 Water ballast -5 - -2 Aft peak SB	1.025	4.216	4.321	3.739	-1.565	-1.194 (SB)	1.840
Total		16.557	16.971	3.065	10.599	0.000 (CL)	9.488
Fuel oil							
Tank 4 28-38 Fuel Deeptank PS	0.850	33.843	28.767	1.435	16.850	1.696 (PS)	15.889
Tank 4 28-38 Fuel Deeptank SB	0.850	31.959	27.165	1.463	16.931	-1.630 (SB)	13.065
Tank 7 30-32 Fuel oil daytank PS	0.850	4.101	3.486	2.850	15.500	2.775 (PS)	0.259
CL	1.000	10.661	10.661	0.534	10.921	-0.100 (SB)	17.331
Tank 16 -4 - 16 Fuel Deeptank PS	0.850	25.391	21.583	3.254	3.744	3.071 (PS)	9.217
Tank 16 -4 - 16 Fuel Deeptank SB	0.850	25.391	21.583	3.254	3.744	-3.071 (SB)	9.217
Total		131.346	113.244	2.094	11.274	0.116 (PS)	64.978
Engineers tanks							
Tank 6 30-32 Foam Deeptank SB	1.000	7.654	7.654	2.411	15.495	-3.024 (SB)	1.031
Tank 8 30-32 Lub oil spare PS	0.850	1.669	1.418	2.972	15.491	3.874 (PS)	0.033
Tank 9 25-28 Waste oil Double Bottom SB	1.000	2.898	2.898	0.551	13.243	-1.074 (SB)	1.304
Tank 10 24-28 Sludge Double Bottom PS	1.000	3.892	3.892	0.548	12.989	1.075 (PS)	1.739
Tank 12 16-19 Lub oil Double Bottom PS	1.000	2.207	2.207	0.578	8.781	0.864 (PS)	0.714
Tank 12 16-19 Lub oil Double Bottom SB	1.000	2.207	2.207	0.578	8.782	-0.864 (SB)	0.714
Tank 13 30-32 19 Lub oil SB	1.000	1.588	1.588	4.650	-2.100	0.000 (CL)	0.000
Tank 15 11-13 Lub oil circ tnk SB1	0.850	1.691	1.438	2.916	6.000	-0.395 (SB)	0.069
Tank 15 11-13 Lub oil circ tnk SB2	0.850	1.675	1.424	2.902	6.000	-1.604 (SB)	0.069
Tank 14 11-13 Hydr oil circ SB1	0.850	0.707	0.601	3.621	6.000	-0.750 (SB)	0.009
Tank 14 11-13 Hydr oil circ tnk SB2	0.850	0.701	0.596	3.616	6.000	-1.250 (SB)	0.009
Total		25.301	24.334	1.710	12.025	-0.848 (SB)	5.693
Fresh water							
Tank 2 Fresh water Deep tank PS	1.000	10.778	10.778	1.718	21.045	1.075 (PS)	3.406
Tank 2 Fresh water Deep tank SB	1.000	10.778	10.778	1.718	21.045	-1.075 (SB)	3.406
Total		21.555	21.555	1.718	21.045	0.000 (CL)	6.813

4 Assumptions for loading conditions

4.1 Investigated conditions

The following loading conditions have been investigated with the stability programme *Delftship*:

- I. 100% consumables
- II. 50% consumables
- III. 10% consumables
- IV. condition during accident

The vessel including tanks is modelled in Delftship, and these loading conditions have been calculated, taking into account the original lightship weight and centre of gravity as mentioned in the stability booklet.

4.2 Applied heeling arms

The ship is fitted with two controllable propellers in fixed nozzles. The diameter per propeller amounts to 2150 mm and the power per propeller amounts to 882 kW. The bollard pull of the vessel is 35 tonnes.

The heeling arms for the various classification societies is based on the following data:

			Loading condition			condition incident
			100%	50%	10%	
Bollard pull		[t]	35.0	35.0	35.0	35.0
Fastening point towing line / Towing bitt above base		[m]	4.750	4.750	4.750	4.750
Centre line propeller above base			1.180	1.180	1.180	1.180

4.2.1 Heeling arm ABS

			Loading condition			condition incident
			100%	50%	10%	
ABS Tug						
Bollard pull		[t]	35.0	35.0	35.0	35.0
Reduction factor to obtain transverse towline pull		[-]	0.500	0.500	0.500	0.500
Transverse line pull		[t]	17.5	17.5	17.5	17.5
Fastening point towing line / Towing bitt above base		[m]	4.750	4.750	4.750	4.750
Centre of effort above baseline (= 1/2 T)		[m]	1.746	1.605	1.422	1.626
Tow line heeling arm to centre of effort		[m]	3.004	3.145	3.328	3.125
Tow line heeling moment		[t m]	53	55	58	55
Heeling arm = Tow line heeling moment / Δ		[m]	0.110	0.132	0.164	0.125
Reduction function for heeling arm		[-]	cos θ	cos θ	cos θ	cos θ
Residual dynamic stability from first intercept up to	req:		0.090	0.090	0.090	0.090

4.2.2 Heeling arm USCG

			Loading condition			condition incident
			100%	50%	10%	
USCG Towline pull criterion						
Number of screws	N	[-]	2	2	2	2
Shaft horsepower per shaft	P	[kW]	883	883	883	883
Propeller diameter	D	[m]	2.150	2.150	2.150	2.150
Fraction of propeller slipstream deflected	s	[-]	0.560	0.560	0.560	0.560
Transverse line pull		[t]	12.3	12.3	12.3	12.3
Dynamic transverse line pull	2 x tr. Line pull	[t]	24.6	24.6	24.6	24.6
Apparent f			0.70	0.70	0.70	0.70
Centre line propeller above base			1.18	1.18	1.18	1.18
Vertical distance from propellershaft to towing bitt	h	[m]	3.570	3.570	3.570	3.570
Tow line heeling moment		[t m]	88	88	88	88
Heeling arm	HA	[m]	0.184	0.210	0.248	0.202
Reduction function for heeling arm			cos θ	cos θ	cos θ	cos θ
Requirement: residual dynamic stability from first intercept up to the maximum righting arm, 40°, or downflooding > 0.0106 meter-radians	req: actual:		0.0106	0.0106	0.0106	0.0106

4.2.3 Heeling arm DNV Tug

			Loading condition			condition incident
			100%	50%	10%	
DNV Tug						
Bollard pull	BP		35.0	35.0	35.0	35.0
Reduction factor to obtain transverse towline pull from bollard pull	C_T		0.600	0.600	0.600	0.600
Transverse towline pull	$F_{thr} = BP \times C_T$	F_{thr}	21.0	21.0	21.0	21.0
Fastening point towing line above base	FP		4.750	4.750	4.750	4.750
Centre line propellers above base	CL		1.180	1.180	1.180	1.180
Towing heeling arm	$h = FP - CL$	h	3.570	3.570	3.570	3.570
Towing heeling moment			75	75	75	75
Heeling arm = Towing heeling moment / Δ	HL_θ		0.157	0.179	0.211	0.172
Reduction function for heeling arm			$\cos \theta$	$\cos \theta$	$\cos \theta$	$\cos \theta$
Requirement: residual dynamic stability from first intercept up to the second intercept, or downflooding > 0.09 meter-radians	req: actual:		0.090	0.090	0.090	0.090
Alternative: area righting curve not less than 1.4 times area of heeling lever curve, between 0° and second intercept or downflooding.						

4.2.4 Heeling arm BV Tug

			Loading condition			condition incident
			100%	50%	10%	
Bureau Veritas Tug						
Bollard pull	BP		35.0	35.0	35.0	35.0
Reduction factor to obtain transverse towline pull from bollard pull	CL		0.650	0.650	0.650	0.650
Transverse towline pull	$T = BP \times C$	T	22.75	22.8	22.8	22.8
Fastening point towing line above base	FP		4.750	4.750	4.750	4.750
Centre of effort : half draught			1.746	1.605	1.422	1.626
Towing heeling arm	$h = FP - CL$	h	3.004	3.145	3.328	3.125
Towing heeling moment			68	72	76	71
Heeling arm = Towing heeling moment / Δ	HL_θ		0.143	0.171	0.213	0.163
Reduction function for heeling arm			$\cos \theta$	$\cos \theta$	$\cos \theta$	$\cos \theta$
Requirement: residual dynamic stability from first intercept up to GZ max, downflooding, 40 > 0.011 meter-radians	req: actual:		0.011	0.011	0.011	0.011

4.2.5 Heeling arm GL Tug

			Loading condition			condition incident
			100%	50%	10%	
GL Tug						
Bollard pull	T		35.0	35.0	35.0	35.0
Reduction factor to obtain transverse towline pull from bollard pull	c		0.700	0.700	0.700	0.700
Transverse towline pull	F_{thr}		24.5	24.5	24.5	24.5
Fastening point towing line above base	FP		4.750	4.750	4.750	4.750
Vertical centre of buoyancy	vcb		2.095	1.926	1.706	1.951
Towing heeling arm	$h = FP - vcb$	h	2.655	2.824	3.044	2.799
Towing heeling moment			65	69	75	69
Heeling arm = Towing heeling moment / Δ	HL_θ		0.136	0.165	0.210	0.157
Reduction function for heeling arm			$\cos \theta$	$\cos \theta$	$\cos \theta$	$\cos \theta$
Requirement: residual dynamic stability from first intercept up to the second intercept, or downflooding > 0.09 meter-radians	req: actual:		0.090	0.090	0.090	0.090
Alternative: area righting curve not less than 1.4 times area of heeling lever curve, between 0° and second intercept or downflooding.						

4.2.6 Heeling arm IACS

			Loading condition			condition incident
			100%	50%	10%	
IACS Unified interpretation Tug						
Bollard pull	T		35.0	35.0	35.0	35.0
Reduction factor to obtain transverse towline pull from bollard pull	c		0.700	0.700	0.700	0.700
Transverse towline pull	F_{thr}		24.5	24.5	24.5	24.5
Fastening point towing line above base	FP		4.750	4.750	4.750	4.750
Centre line of propellers above base	cl		1.180	1.180	1.180	1.180
Towing heeling arm $h = FP - vcb$	h		3.570	3.570	3.570	3.570
Towing heeling moment			87	87	87	87
Heeling arm = Towing heeling moment / Δ	HL_{θ}		0.183	0.209	0.246	0.201
Reduction function for heeling arm			cos θ	cos θ	cos θ	cos θ
Requirement: residual dynamic stability from first intercept up to the second intercept, or downflooding > 0.09 meter-radians	req:		0.090	0.090	0.090	0.090
Alternative: area righting curve not less than 1.4 times area of heeling lever curve, between 0° and second intercept or downflooding.	actual:					

4.2.7 Heeling arm BV Harmonized

			Loading condition			condition incident
			100%	50%	10%	
Harmonized proposal BV						
Bollard pull	BP		35.0	35.0	35.0	35.0
Reduction factor to obtain transverse towline pull from bollard pull	c		0.500	0.500	0.500	0.500
Transverse towline pull $F_{thr} = BP \times C$	F_{thr}		17.5	17.5	17.5	17.5
Fastening point towing line above base	FP		4.750	4.750	4.750	4.750
Centre line propellers above base	CL		1.180	1.180	1.180	1.180
Towing heeling arm $h = FP - CL$	h		3.570	3.570	3.570	3.570
Towing heeling moment			62	62	62	62
Heeling arm = Towing heeling moment / Δ	HL_{θ}		0.131	0.149	0.176	0.143
Reduction function for heeling arm			cos θ	cos θ	cos θ	cos θ

4.2.8 Summary of calculation heeling arms

	c: fraction of bollard pull			condition incident
	100%	50%	10%	
ABS Tug	0.500	0.500	0.500	0.500
USCG Towline pull criterion	0.704	0.704	0.704	0.704
DNV Tug	0.600	0.600	0.600	0.600
Bureau Veritas Tug	0.650	0.650	0.650	0.650
GL Tug	0.700	0.700	0.700	0.700
IACS Unified interpretation Tug	0.700	0.700	0.700	0.700
Harmonized proposal BV	0.500	0.500	0.500	0.500

	vertical centre of resistance			condition incident
	100%	50%	10%	
ABS Tug	1.746	1.605	1.422	1.626
USCG Towline pull criterion	1.180	1.180	1.180	1.180
DNV Tug	1.180	1.180	1.180	1.180
Bureau Veritas Tug	1.746	1.605	1.422	1.626
GL Tug	2.095	1.926	1.706	1.951
IACS Unified interpretation Tug	1.180	1.180	1.180	1.180
Harmonized proposal BV	1.180	1.180	1.180	1.180

	h towing aft			condition incident
	100%	50%	10%	
ABS Tug	3.004	3.145	3.328	3.125
USCG Towline pull criterion	3.570	3.570	3.570	3.570
DNV Tug	3.570	3.570	3.570	3.570
Bureau Veritas Tug	3.004	3.145	3.328	3.125
GL Tug	2.655	2.824	3.044	2.799
IACS Unified interpretation Tug	3.570	3.570	3.570	3.570
Harmonized proposal BV	3.570	3.570	3.570	3.570

In meters:

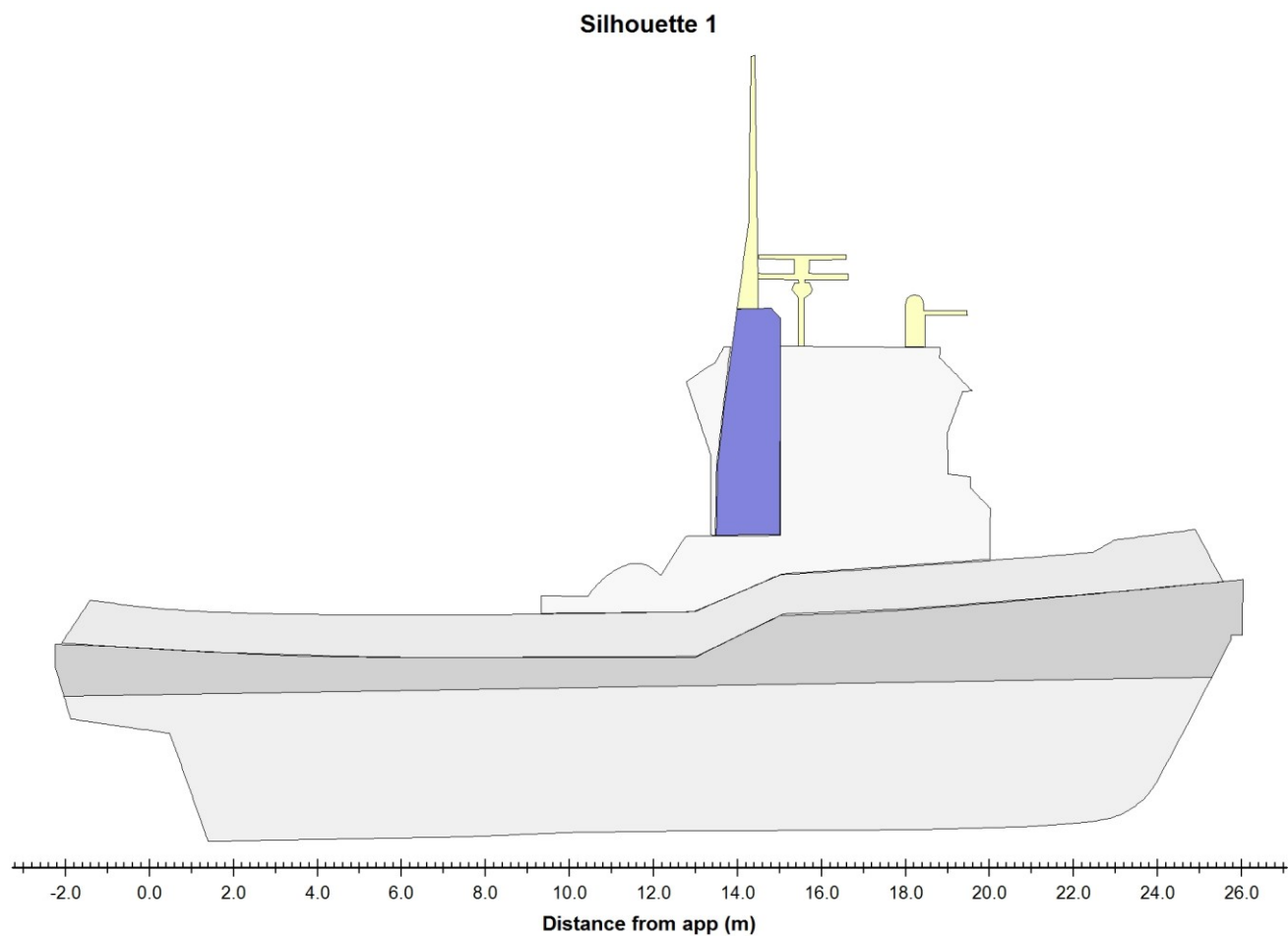
	Heeling arm towing aft			condition incident
	loading condition:			
	100%	50%	10%	
ABS Tug	0.110	0.132	0.164	0.125
USCG Towline pull criterion	0.184	0.210	0.248	0.202
DNV Tug	0.157	0.179	0.211	0.172
Bureau Veritas Tug	0.143	0.171	0.213	0.163
GL Tug	0.136	0.165	0.210	0.157
IACS Unified interpretation Tug	0.183	0.209	0.246	0.201
Harmonized proposal BV	0.131	0.149	0.176	0.143

As fraction of lowest value:

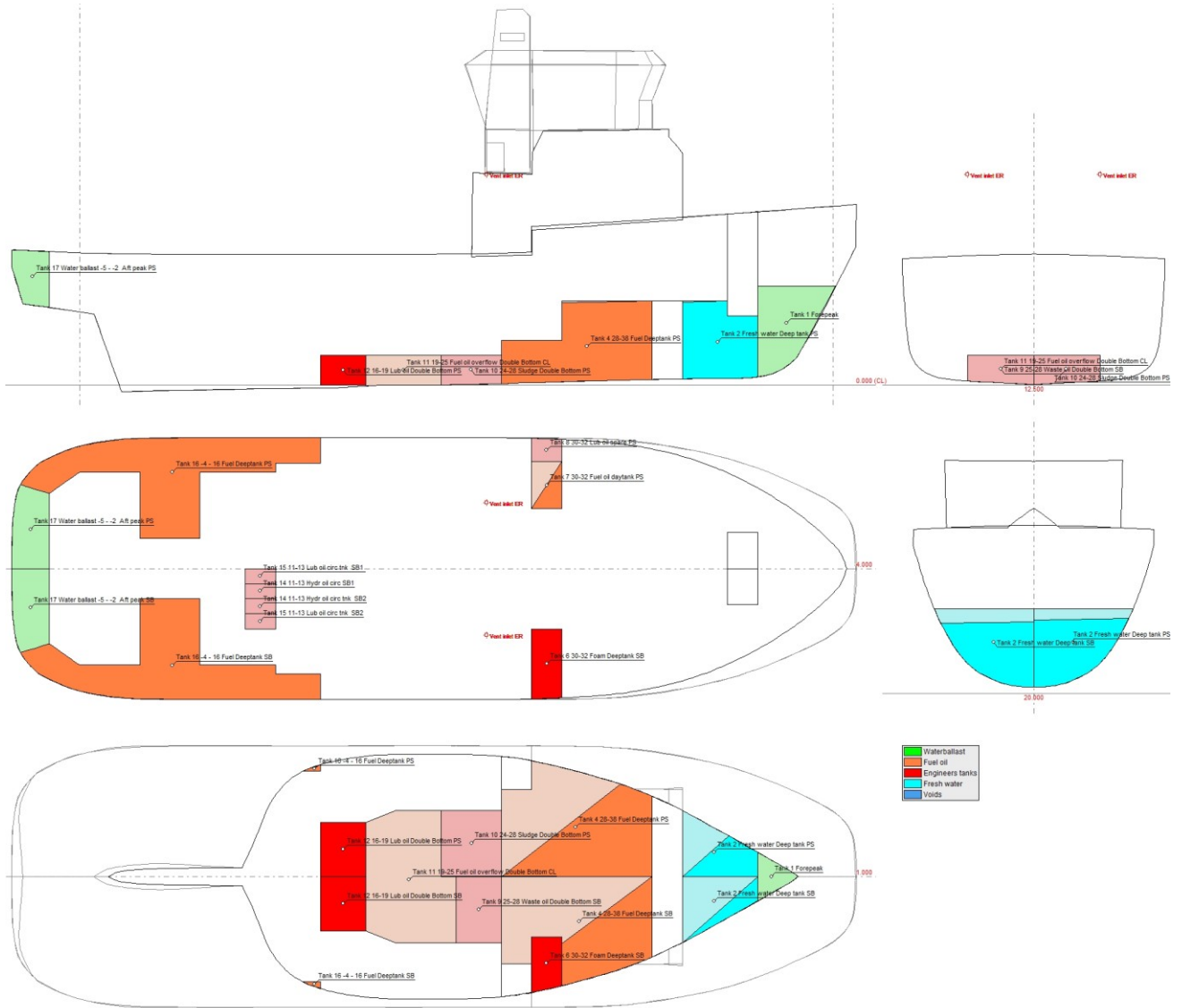
	Heeling arm towing aft			condition incident
	100%	50%	10%	
ABS Tug	0.81	0.80	0.78	0.80
USCG Towline pull criterion	1.35	1.27	1.18	1.28
DNV Tug	1.15	1.08	1.01	1.09
Bureau Veritas Tug	1.05	1.03	1.02	1.04
GL Tug	1.00	1.00	1.00	1.00
IACS Unified interpretation Tug	1.34	1.26	1.17	1.28
Harmonized proposal BV	0.96	0.90	0.84	0.91

5 Loading conditions

5.1 Loading condition: 100%



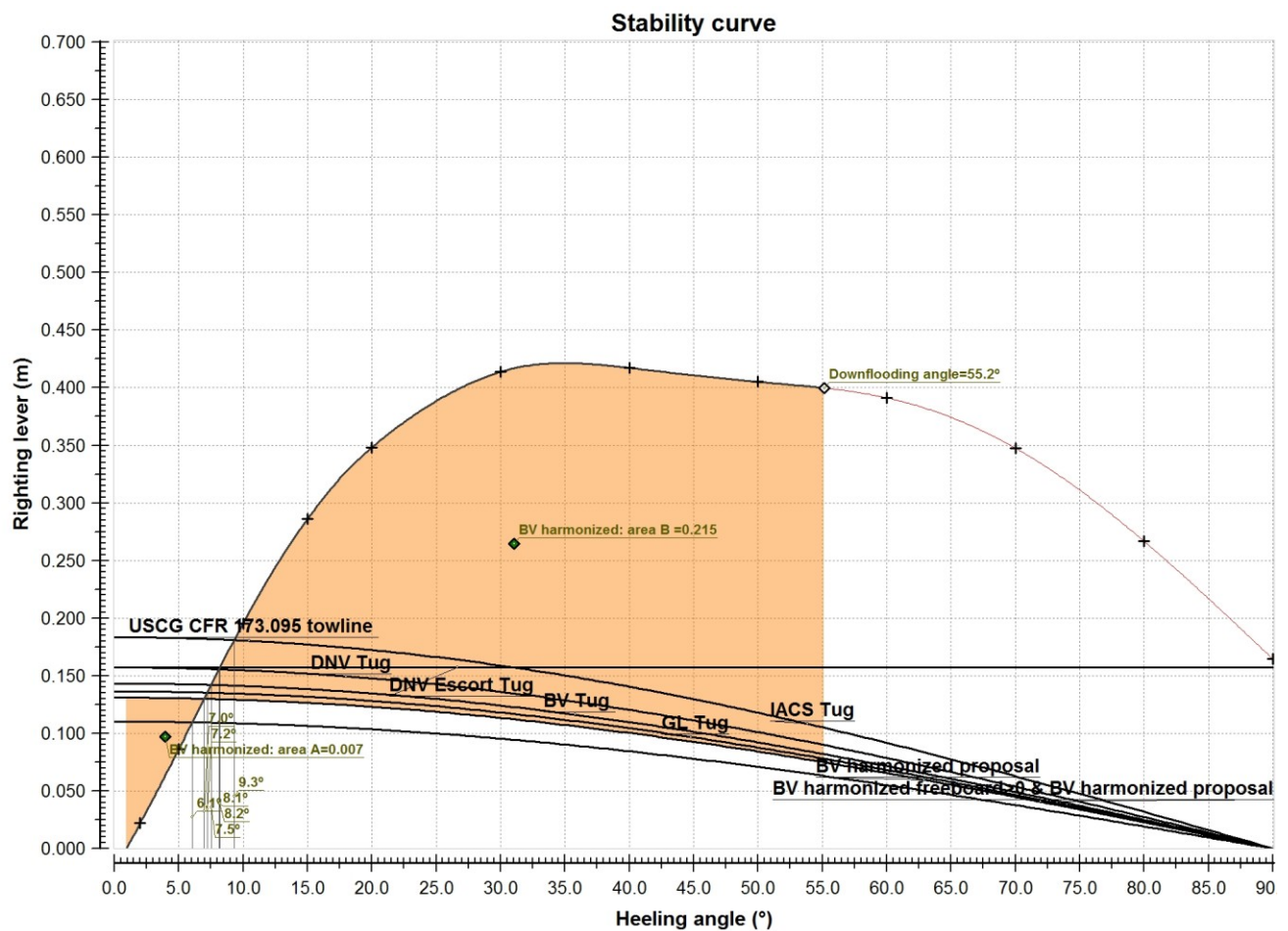
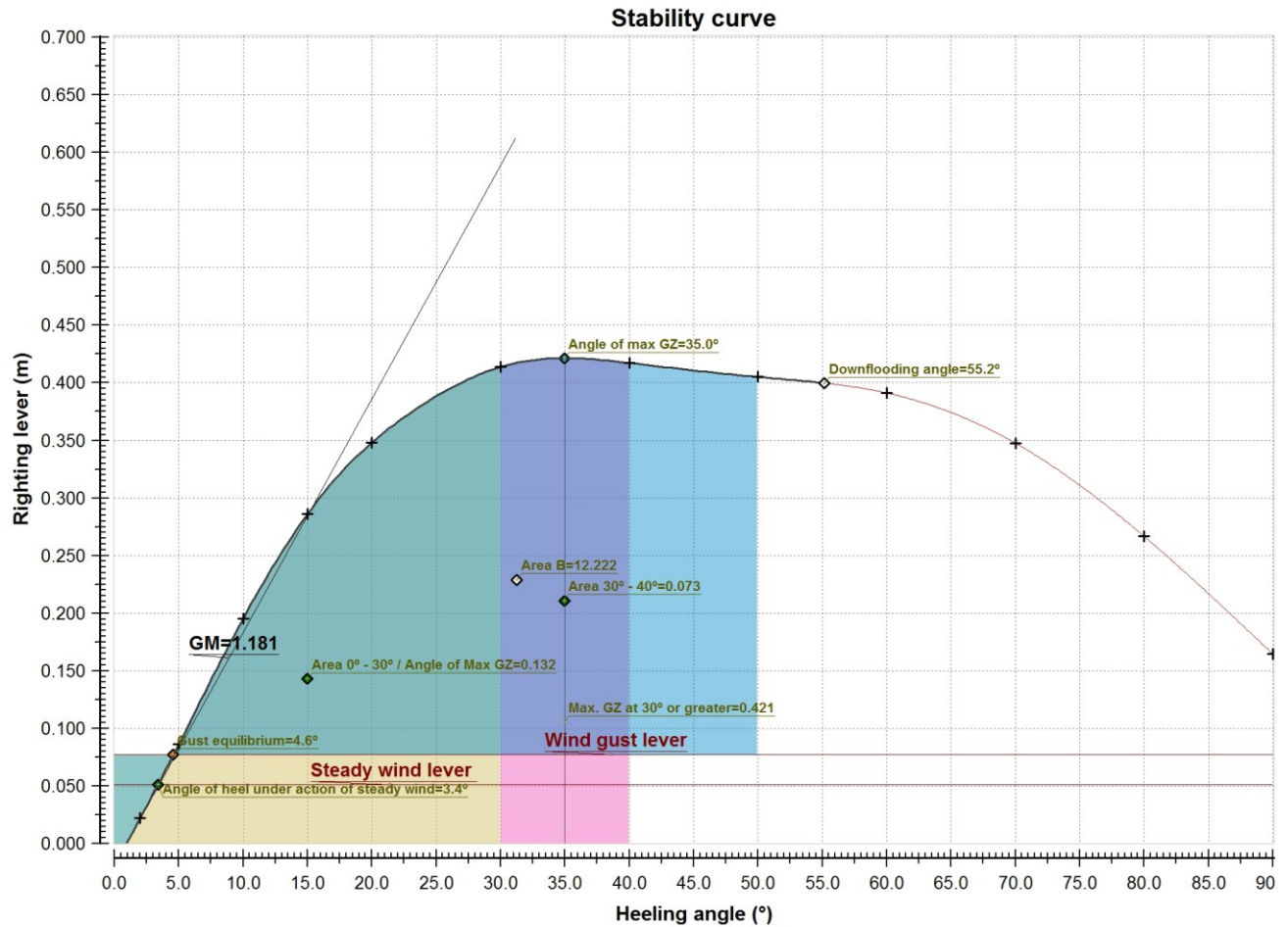
TUG STABILITY REQUIREMENTS



Description	Density	Fill%	Weight	VCG	LCG	TCG	FSM
	(t/m ³)		(tonnes)	(m)	(m)	(m)	(t*m)
Waterballast							
Tank 1 Forepeak	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak PS	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak SB	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Waterballast			0.000	0.000	0.000	0.000 (CL)	0.00
Fuel oil							
Tank 4 28-38 Fuel Deeptank PS	0.8500	98.0	28.191	1.407	16.838	1.690 (PS)	12.97
Tank 4 28-38 Fuel Deeptank SB	0.8500	98.0	26.622	1.436	16.920	-1.623 (SB)	12.97
Tank 7 30-32 Fuel oil daytank PS	0.8500	98.0	3.416	2.823	15.500	2.775 (PS)	0.26
Tank 11 19-25 Fuel oil overflow Double Bottom CL	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 16 -4 - 16 Fuel Deeptank PS	0.8500	100.0	21.581	3.254	3.744	3.071 (PS)	0.00
Tank 16 -4 - 16 Fuel Deeptank SB	0.8500	100.0	21.581	3.254	3.744	-3.071 (SB)	0.00
Totals for Fuel oil			101.392	2.249	11.240	0.137 (PS)	26.20
Engineers tanks							
Tank 6 30-32 Foam Deeptank SB	1.0000	100.0	7.654	2.411	15.495	-3.024 (SB)	0.00
Tank 8 30-32 Lub oil spare PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 9 25-28 Waste oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 10 24-28 Sludge Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom PS	1.0000	100.0	2.207	0.578	8.781	0.864 (PS)	0.00
Tank 12 16-19 Lub oil Double Bottom SB	1.0000	100.0	2.207	0.578	8.782	-0.864 (SB)	0.00
Tank 13 30-32 19 Lub oil SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Engineers tanks			12.068	1.740	13.039	-1.918 (SB)	0.00
Fresh water							
Tank 2 Fresh water Deep tank PS	1.0000	98.0	10.562	1.696	21.047	1.066 (PS)	3.35
Tank 2 Fresh water Deep tank SB	1.0000	98.0	10.562	1.696	21.047	-1.066 (SB)	3.35
Totals for Fresh water			21.124	1.696	21.047	0.000 (CL)	6.71
Provisions							
Provisions 100%			0.500	5.500	18.500	0.000 (CL)	0.00
Stores			2.000	3.750	14.000	0.000 (CL)	0.00
Totals for Provisions			2.500	4.100	14.900	0.000 (CL)	0.00
Crew and effects							
Crew & Effects			0.500	9.500	18.000	0.000 (CL)	0.00
Lightship			339.340	3.570	12.130	0.000 (CL)	
Deadweight			137.584	2.179	12.995	-0.067 (SB)	32.91
Displacement			476.924	3.169	12.379	-0.019 (SB)	32.91

Hydrostatic particulars

List	-0.9 (SB) (Degr.)	KM	4.419 (m)
Draught aft pp	3.282 (m)	VCG	3.169 (m)
Mean moulded draught	3.492 (m)	GG'	0.069 (m)
Draught forward pp	3.702 (m)	VCG'	3.238 (m)
Trim	0.420 (m)	Max VCG'	0.000 (m)
Draught aftmark	3.282 (m)	GM solid	1.250 (m)
Mean draught	3.492 (m)	G'M liquid	1.181 (m)
Draught forward mark	3.702 (m)	Immersion rate	2.071 (t/cm)
Trim marks	0.420 (m)	MCT	3.886 (t*m/cm)



Righting levers

Heeling angle	Draught	Trim	Displacement	KN sin(θ)	VCG sin(θ)	GG' sin(θ)	TCG cos(θ)	GZ	Area
(<i>Degr.</i>)	(<i>m</i>)	(<i>m</i>)	(<i>tonnes</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>mrad</i>)
0.0 (CL)	3.493	0.419	476.937	0.000	0.000	0.000	0.019	-0.019	0.000
-2.0 (SB)	3.492	0.421	476.904	0.154	0.111	0.002	0.019	0.022	0.000
-5.0 (SB)	3.488	0.434	476.849	0.385	0.276	0.004	0.019	0.086	0.003
-10.0 (SB)	3.476	0.472	476.803	0.769	0.550	0.004	0.019	0.196	0.015
-15.0 (SB)	3.469	0.518	477.050	1.129	0.820	0.005	0.019	0.286	0.036
-20.0 (SB)	3.473	0.510	476.987	1.455	1.084	0.005	0.018	0.348	0.064
-30.0 (SB)	3.524	0.326	476.983	2.020	1.584	0.005	0.017	0.414	0.132
-40.0 (SB)	3.638	-0.029	476.929	2.473	2.037	0.004	0.015	0.417	0.205
-50.0 (SB)	3.793	-0.643	476.922	2.849	2.427	0.004	0.012	0.405	0.277
-60.0 (SB)	3.992	-1.750	476.926	3.149	2.744	0.003	0.010	0.391	0.346
-70.0 (SB)	4.353	-3.861	476.951	3.335	2.978	0.003	0.007	0.348	0.411
-80.0 (SB)	5.446	-9.758	476.926	3.393	3.121	0.002	0.003	0.267	0.465
-90.0 (SB)	-12.010	-11492.741	476.898	3.337	3.169	0.003	0.000	0.164	0.503

Evaluation of criteria

Offshore supply vessels

Offshore supply vessels from 24 to 100 m. in length.

Description	Attained value	Criterion	Required value	Complies
Area 0° - 30° / Angle of Max GZ	0.1317 (<i>mrad</i>)	>=	0.0550 (<i>mrad</i>)	YES
Downflooding angle	0.0 (<i>Degr.</i>)			
Calculated angle	35.0 (<i>Degr.</i>)			
Area 30° - 40°	0.0732 (<i>mrad</i>)	>=	0.0300 (<i>mrad</i>)	YES
Max. GZ at 30° or greater	0.421 (<i>m</i>)	>=	0.200 (<i>m</i>)	YES
Lower angle	30.0 (<i>Degr.</i>)			
Upper angle	90.0 (<i>Degr.</i>)			
Angle of max GZ	35.0 (<i>Degr.</i>)	>=	15.0 (<i>Degr.</i>)	YES
Initial metacentric height	1.181 (<i>m</i>)	>=	0.150 (<i>m</i>)	YES
Severe wind and rolling criterion				YES
Wind silhouette:	Silhouette 1			
Wind pressure	51.4 (<i>kg/m²</i>)			
Wind area	104.82 (<i>m²</i>)			
Steady wind lever	0.051 (<i>m</i>)			
Deck immersion angle	9.44 (<i>Degr.</i>)			
Wind gust lever	0.077 (<i>m</i>)			
Ratio of areaA/areaB	0.531	<=	1.000	YES
Maximum allowed static heeling angle	3.4 (<i>Degr.</i>)	<=	16.0 (<i>Degr.</i>)	YES
Max allowed ratio static angle/deck immersion angle	0.359	<=	0.800	YES

Intact stability for towing vessels

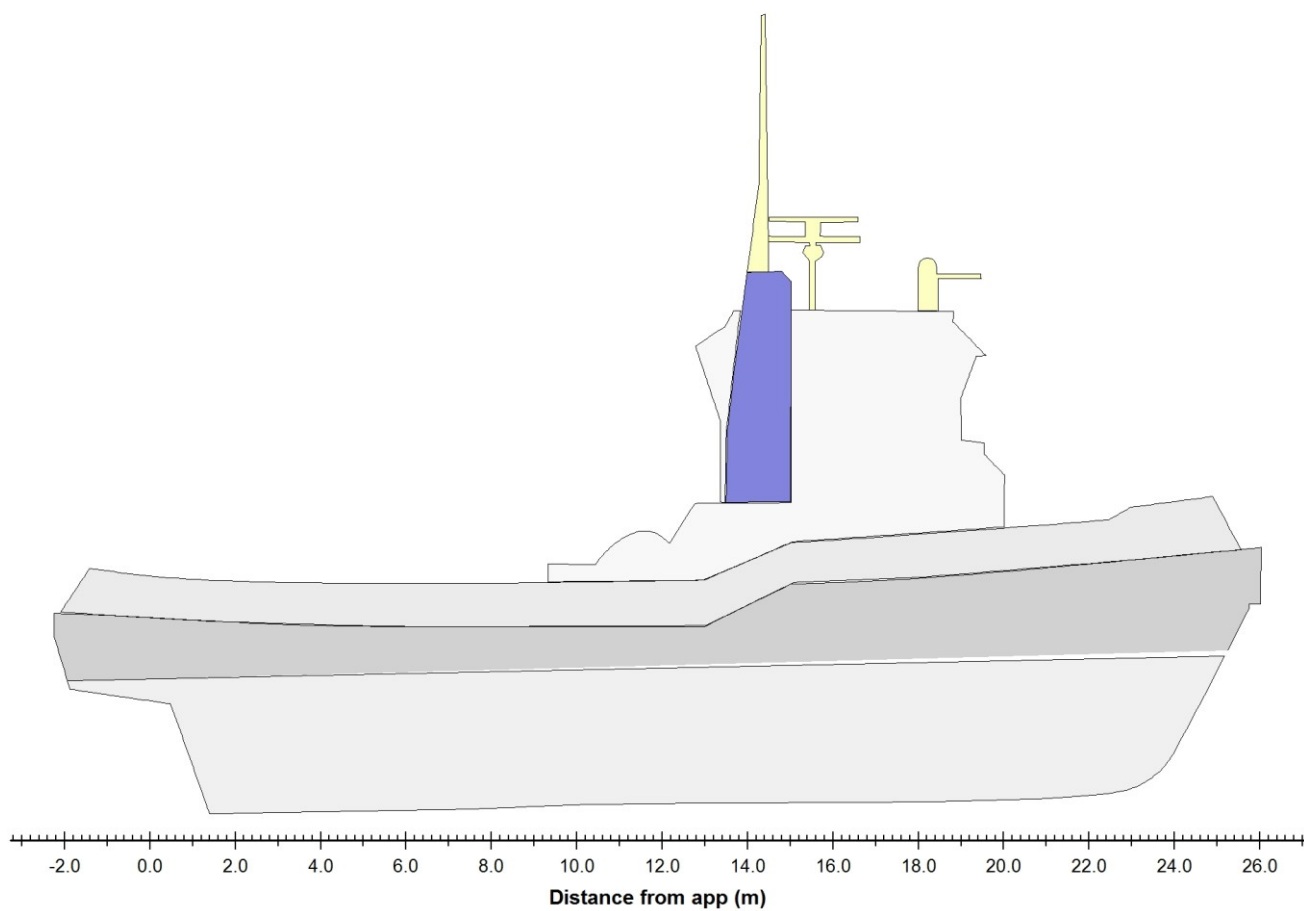
<i>Tugs</i>				
Description	Attained value	Criterion	Required value	Complies
ABS Towing moment	6.1 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	52.570 (t*m)			
ABS area A1 first intercept to min (fi+40; downflooding)>0.090	0.1761 (mrad)	>=	0.0900 (mrad)	YES
USCG CFR 173.095 towline	9.3 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
USCG area first intercept to min (40, max GZ, downflooding)>0.0106	0.0796 (mrad)	>=	0.0106 (mrad)	YES
DNV Tug	8.1 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Tug area first intercept to min(second intercept, downflooding)>0.090	0.1966 (mrad)	>=	0.0900 (mrad)	YES
DNV Tug area GZ 0- min(second intercept, downflooding)	0.3131 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area heeling arm 0-min(second intercept, downflooding)	0.1265 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area GZ>1.40 Area heeling arm	2.4755	>=	1.4000	YES
DNV Escort Tug	8.2 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Escort Tug area GZ first intercept-20	0.0546 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm first intercept -20	0.0324 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ>1.25 area heeling arm	1.6873	>=	1.2500	YES
DNV Escort Tug area GZ 0-min(40, downflooding)	0.2050 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm 0-min(40, downflooding)	0.1072 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ > 1.40 area heeling arm	1.9129	>=	1.4000	YES
BV Tug	7.5 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	68.341 (t*m)			
BV Tug area first intercept to min(GZ max, 40, downflooding)	0.0967 (mrad)	>=	0.0110 (mrad)	YES
GL Tug	7.2 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	65.048 (t*m)			
GL Tug area first intercept to min(second intercept, downflooding)	0.2109 (mrad)	>=	0.0900 (mrad)	YES
GL Tug area GZ 0-min(second intercept, downflooding)	0.3131 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area heeling arm 0-min(second intercept, downflooding)	0.1097 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area GZ > 1.40 area heeling arm	2.8532	>=	1.4000	YES
IACS Tug	9.3 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
IACS Tug area first intercept to min (second intercept, downflooding)	0.1791 (mrad)	>=	0.0900 (mrad)	YES
IACS Tug area GZ curve 0- min (second intercept, downflooding)	0.3131 (mrad)	>=	0.0000 (mrad)	YES
IACS Tug area heeling arm 0-min (second intercept, downflooding)	0.1475 (mrad)	>=	0.0000 (mrad)	YES
IACS Tugs area GZ > 1.40 area heeling arm	2.1219	>=	1.4000	YES
BV harmonized proposal	7.0 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	62.475 (t*m)			
BV harmonized: area A	0.0070 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized: area B	0.2147 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized B/A>1	30.5946	>=	1.0000	YES
BV harmonized freeboard>0	7.0 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	0.000 (t*m)			
Additional heeling moment:	BV harmonized proposal			
Total combined heeling moment	62.475 (t*m)			
Attained value smaller than deck immersion angle	7.0 (Degr.)	<	9.4 (Degr.)	YES
Weight	0.000 (tonnes)			
Trv. location of weight	0.000 (m)			

Critical points

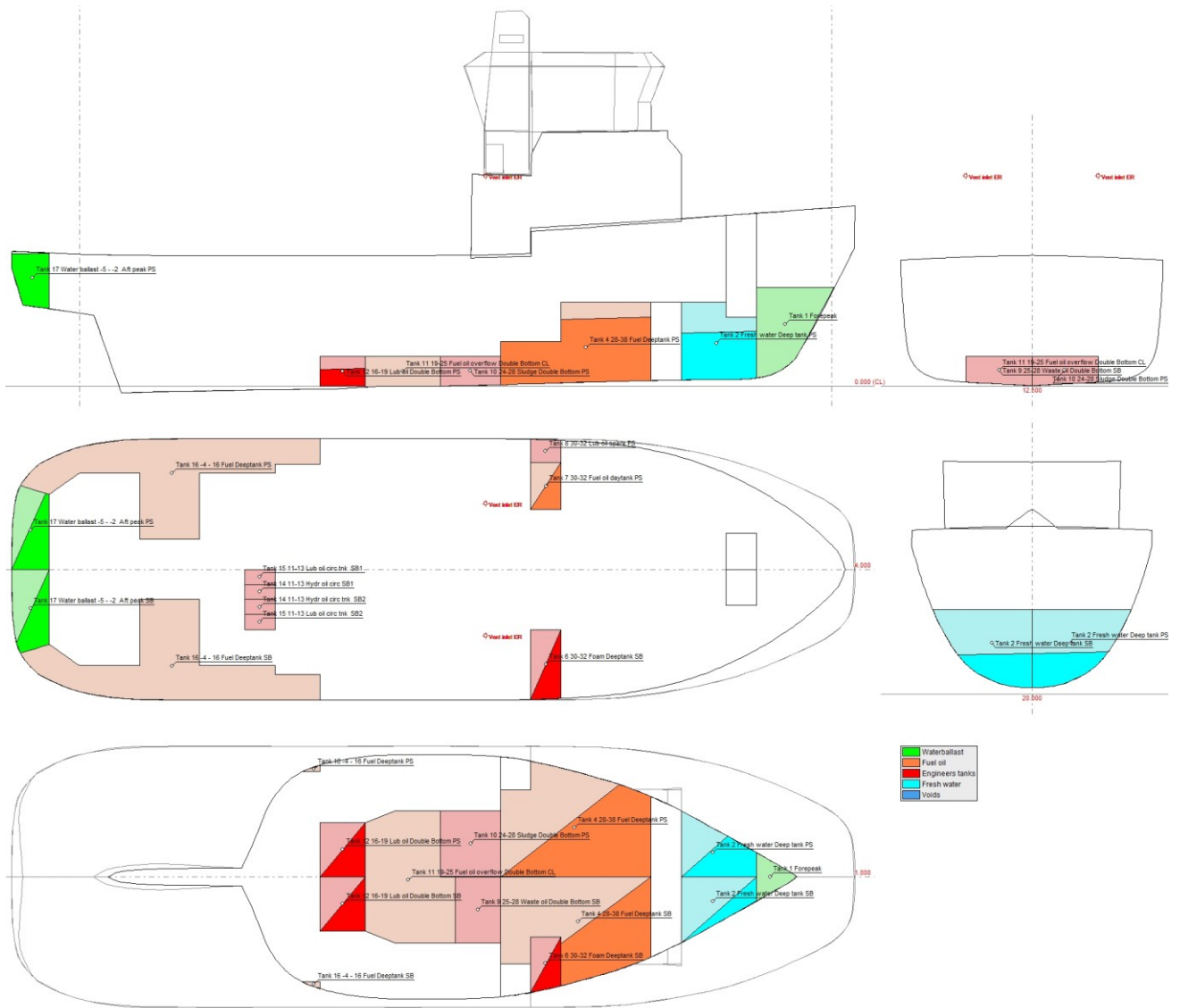
Description	Type	Dist. to wl	Submersion angle
		(m)	(Degr.)
Vent inlet ER	Downflooding	3.455	-55.2

5.2 Loading condition: 50%

Silhouette 1



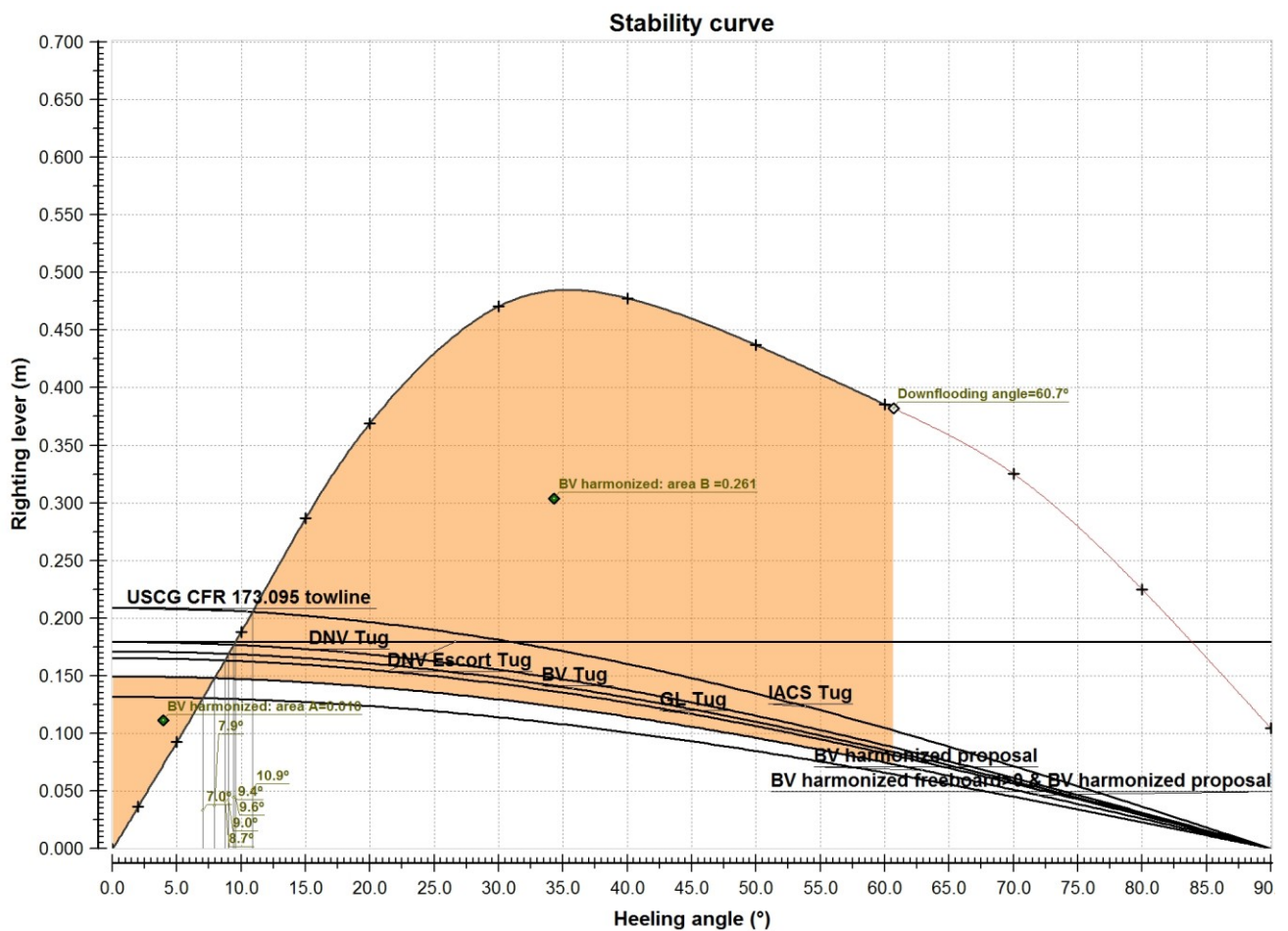
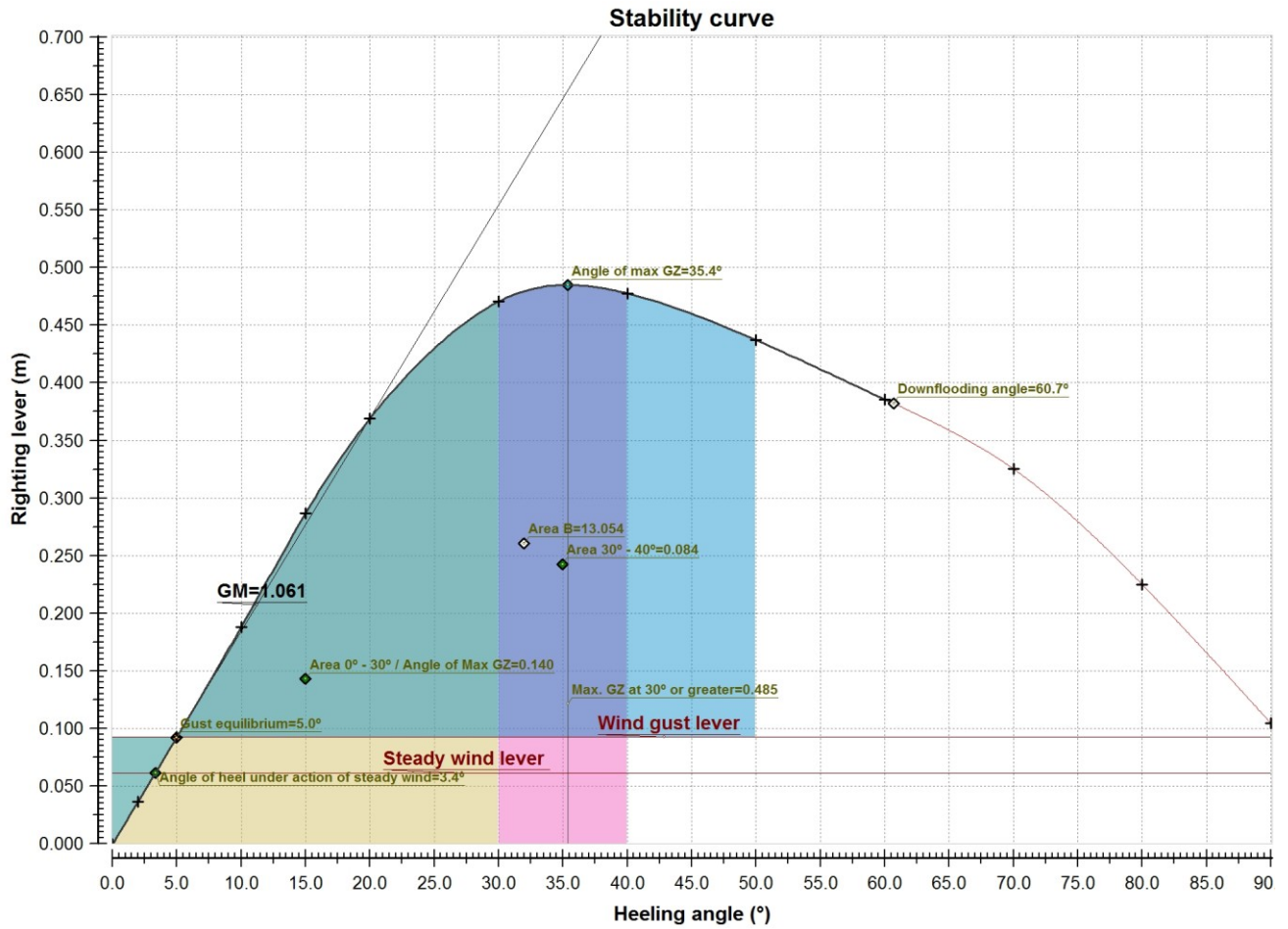
TUG STABILITY REQUIREMENTS



Description	Density	Fill%	Weight	VCG	LCG	TCG	FSM
	(t/m ³)		(tonnes)	(m)	(m)	(m)	(t*m)
Waterballast							
Tank 1 Forepeak	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak PS	1.0250	97.9	4.230	3.724	-1.560	1.200 (PS)	1.36
Tank 17 Water ballast -5 - -2 Aft peak SB	1.0250	97.9	4.230	3.724	-1.560	-1.200 (SB)	1.36
Totals for Waterballast			8.460	3.724	-1.560	0.000 (CL)	2.71
Fuel oil							
Tank 4 28-38 Fuel Deeptank PS	0.8500	81.9	23.560	1.191	16.714	1.639 (PS)	11.89
Tank 4 28-38 Fuel Deeptank SB	0.8500	86.7	23.560	1.286	16.849	-1.579 (SB)	12.29
Tank 7 30-32 Fuel oil daytank PS	0.8500	98.0	3.416	2.823	15.500	2.775 (PS)	0.26
Tank 11 19-25 Fuel oil overflow Double Bottom CL	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 16 -4 - 16 Fuel Deeptank PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 16 -4 - 16 Fuel Deeptank SB	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Fuel oil			50.536	1.346	16.695	0.216 (PS)	24.44
Engineers tanks							
Tank 6 30-32 Foam Deeptank SB	1.0000	50.0	3.827	1.480	15.491	-2.926 (SB)	0.81
Tank 8 30-32 Lub oil spare PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 9 25-28 Waste oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 10 24-28 Sludge Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom PS	1.0000	49.8	1.100	0.364	8.813	0.828 (PS)	0.71
Tank 12 16-19 Lub oil Double Bottom SB	1.0000	49.8	1.100	0.364	8.813	-0.828 (SB)	0.71
Tank 13 30-32 19 Lub oil SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Engineers tanks			6.027	1.073	13.053	-1.858 (SB)	2.24
Fresh water							
Tank 2 Fresh water Deep tank PS	1.0000	51.0	5.500	1.166	21.062	0.848 (PS)	2.35
Tank 2 Fresh water Deep tank SB	1.0000	51.0	5.500	1.166	21.062	-0.848 (SB)	2.35
Totals for Fresh water			11.000	1.166	21.062	0.000 (CL)	4.69
Provisions							
Provisions 50%			0.250	5.500	18.500	0.000 (CL)	0.00
Stores			2.000	3.750	14.000	0.000 (CL)	0.00
Totals for Provisions			2.250	3.944	14.500	0.000 (CL)	0.00
Crew and effects							
Crew & Effects			0.500	9.500	18.000	0.000 (CL)	0.00
Lightship			339.340	3.570	12.130	0.000 (CL)	
Deadweight			78.773	1.681	15.011	-0.004 (SB)	34.08
Displacement			418.113	3.214	12.673	-0.001 (SB)	34.08

Hydrostatic particulars

List	0.0 (SB) (Degr.)	KM	4.357 (m)
Draught aft pp	2.943 (m)	VCG	3.214 (m)
Mean moulded draught	3.210 (m)	GG'	0.081 (m)
Draught forward pp	3.478 (m)	VCG'	3.296 (m)
Trim	0.535 (m)	Max VCG'	0.000 (m)
Draught aftmark	2.943 (m)	GM solid	1.143 (m)
Mean draught	3.210 (m)	G'M liquid	1.061 (m)
Draught forward mark	3.478 (m)	Immersion rate	1.956 (t/cm)
Trim marks	0.535 (m)	MCT	3.318 (t*m/cm)



Righting levers

Heeling angle	Draught	Trim	Displacement	KN sin(θ)	VCG sin(θ)	GG' sin(θ)	TCG cos(θ)	GZ	Area
(<i>Degr.</i>)	(<i>m</i>)	(<i>m</i>)	(<i>tonnes</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>mrad</i>)
0.0 (CL)	3.210	0.535	418.092	0.000	0.000	0.000	0.001	-0.001	0.000
-2.0 (SB)	3.209	0.538	418.092	0.152	0.112	0.003	0.001	0.036	0.001
-5.0 (SB)	3.206	0.552	418.094	0.380	0.280	0.007	0.001	0.092	0.004
-10.0 (SB)	3.191	0.603	418.053	0.760	0.558	0.014	0.001	0.188	0.016
-15.0 (SB)	3.167	0.684	417.911	1.139	0.832	0.020	0.001	0.287	0.037
-20.0 (SB)	3.146	0.774	418.111	1.494	1.099	0.025	0.001	0.369	0.066
-30.0 (SB)	3.120	0.819	418.123	2.111	1.607	0.032	0.001	0.471	0.140
-40.0 (SB)	3.130	0.755	418.134	2.582	2.066	0.038	0.001	0.478	0.224
-50.0 (SB)	3.135	0.563	418.002	2.942	2.462	0.042	0.000	0.437	0.304
-60.0 (SB)	3.083	0.120	418.110	3.215	2.784	0.046	0.000	0.386	0.376
-70.0 (SB)	2.926	-0.848	418.117	3.394	3.020	0.048	0.000	0.325	0.439
-80.0 (SB)	2.525	-3.468	418.233	3.438	3.165	0.048	0.000	0.225	0.487
-90.0 (SB)	-12.010	-5252.404	418.309	3.365	3.214	0.047	0.000	0.104	0.516

Evaluation of criteria

Offshore supply vessels

Offshore supply vessels from 24 to 100 m. in length.

Description	Attained value	Criterion	Required value	Complies
Area 0° - 30° / Angle of Max GZ	0.1402 (<i>mrad</i>)	>=	0.0550 (<i>mrad</i>)	YES
Downflooding angle	0.0 (<i>Degr.</i>)			
Calculated angle	35.4 (<i>Degr.</i>)			
Area 30° - 40°	0.0840 (<i>mrad</i>)	>=	0.0300 (<i>mrad</i>)	YES
Max. GZ at 30° or greater	0.485 (<i>m</i>)	>=	0.200 (<i>m</i>)	YES
Lower angle	30.0 (<i>Degr.</i>)			
Upper angle	90.0 (<i>Degr.</i>)			
Angle of max GZ	35.4 (<i>Degr.</i>)	>=	15.0 (<i>Degr.</i>)	YES
Initial metacentric height	1.061 (<i>m</i>)	>=	0.150 (<i>m</i>)	YES
Severe wind and rolling criterion				YES
Wind silhouette:	Silhouette 1			
Wind pressure	51.4 (<i>kg/m²</i>)			
Wind area	110.56 (<i>m²</i>)			
Steady wind lever	0.062 (<i>m</i>)			
Deck immersion angle	13.25 (<i>Degr.</i>)			
Wind gust lever	0.092 (<i>m</i>)			
Ratio of areaA/areaB	0.447	<=	1.000	YES
Maximum allowed static heeling angle	3.4 (<i>Degr.</i>)	<=	16.0 (<i>Degr.</i>)	YES
Max allowed ratio static angle/deck immersion angle	0.253	<=	0.800	YES

Intact stability for towing vessels

Tugs

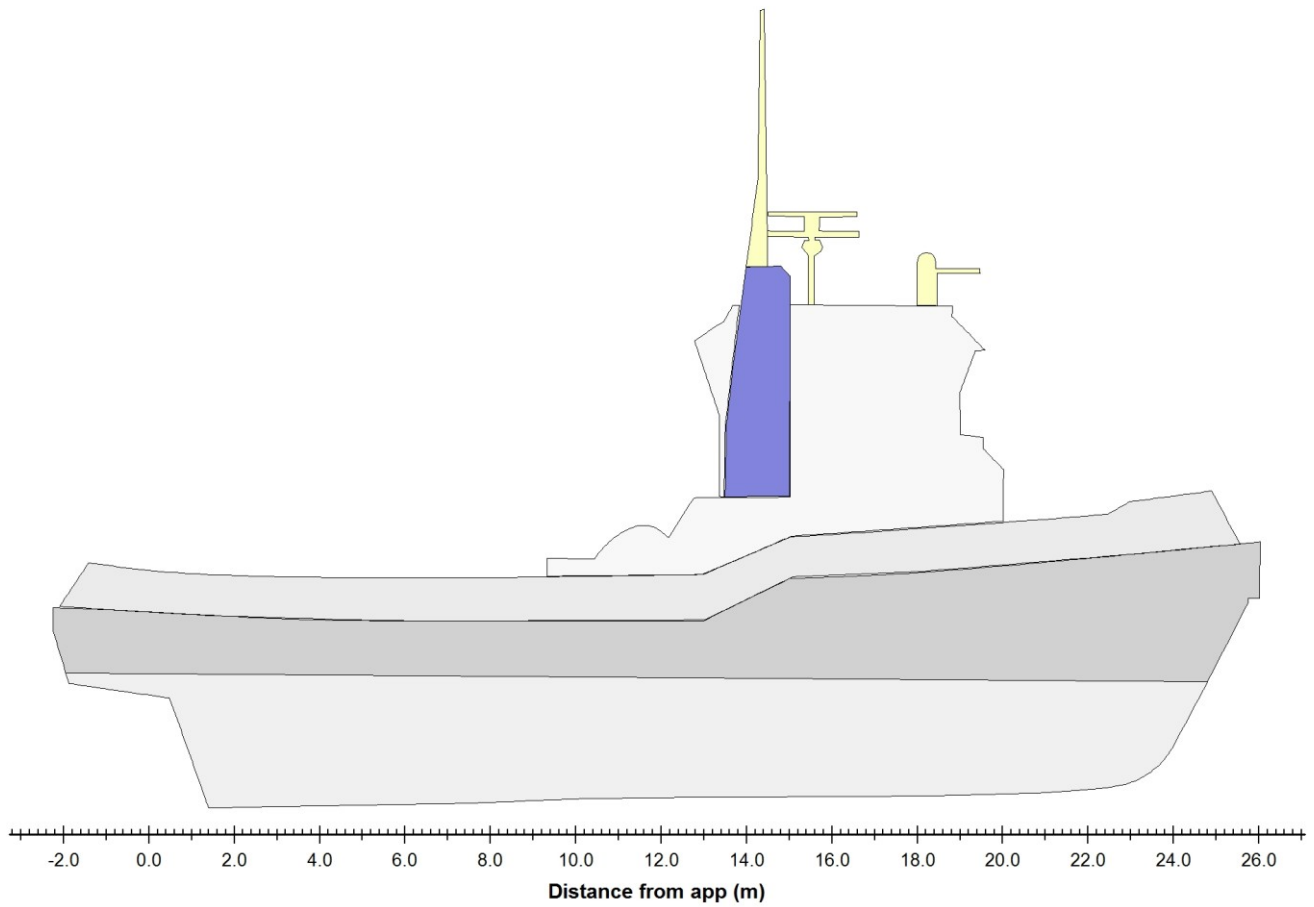
Description	Attained value	Criterion	Required value	Complies
ABS Towing moment	7.0 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	55.037 (t*m)			
ABS area A1 first intercept to min (fi+40; downflooding)>0.090	0.1931 (mrad)	>=	0.0900 (mrad)	YES
USCG CFR 173.095 towline	10.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
USCG area first intercept to min (40, max GZ, downflooding)>0.0106	0.0844 (mrad)	>=	0.0106 (mrad)	YES
DNV Tug	9.4 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Tug area first intercept to min(second intercept, downflooding)>0.090	0.2395 (mrad)	>=	0.0900 (mrad)	YES
DNV Tug area GZ 0- min(second intercept, downflooding)	0.3809 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area heeling arm 0-min(second intercept, downflooding)	0.1563 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area GZ>1.40 Area heeling arm	2.4374	>=	1.4000	YES
DNV Escort Tug	9.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Escort Tug area GZ first intercept-20	0.0510 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm first intercept -20	0.0327 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ>1.25 area heeling arm	1.5589	>=	1.2500	YES
DNV Escort Tug area GZ 0-min(40, downflooding)	0.2242 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm 0-min(40, downflooding)	0.1251 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ > 1.40 area heeling arm	1.7925	>=	1.4000	YES
BV Tug	9.0 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	71.549 (t*m)			
BV Tug area first intercept to min(GZ max, 40, downflooding)	0.0998 (mrad)	>=	0.0110 (mrad)	YES
GL Tug	8.7 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	69.090 (t*m)			
GL Tug area first intercept to min(second intercept, downflooding)	0.2495 (mrad)	>=	0.0900 (mrad)	YES
GL Tug area GZ 0-min(second intercept, downflooding)	0.3809 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area heeling arm 0-min(second intercept, downflooding)	0.1440 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area GZ > 1.40 area heeling arm	2.6449	>=	1.4000	YES
IACS Tug	10.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
IACS Tug area first intercept to min (second intercept, downflooding)	0.2187 (mrad)	>=	0.0900 (mrad)	YES
IACS Tug area GZ curve 0- min (second intercept, downflooding)	0.3809 (mrad)	>=	0.0000 (mrad)	YES
IACS Tug area heeling arm 0-min (second intercept, downflooding)	0.1823 (mrad)	>=	0.0000 (mrad)	YES
IACS Tugs area GZ > 1.40 area heeling arm	2.0892	>=	1.4000	YES
BV harmonized proposal	7.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	62.475 (t*m)			
BV harmonized: area A	0.0104 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized: area B	0.2610 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized B/A>1	25.1319	>=	1.0000	YES
BV harmonized freeboard>0	7.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	0.000 (t*m)			
Additional heeling moment:	BV harmonized proposal			
Total combined heeling moment	62.475 (t*m)			
Attained value smaller than deck immersion angle	7.9 (Degr.)	<	13.3 (Degr.)	YES
Weight	0.000 (tonnes)			
Trv. location of weight	0.000 (m)			

Critical points

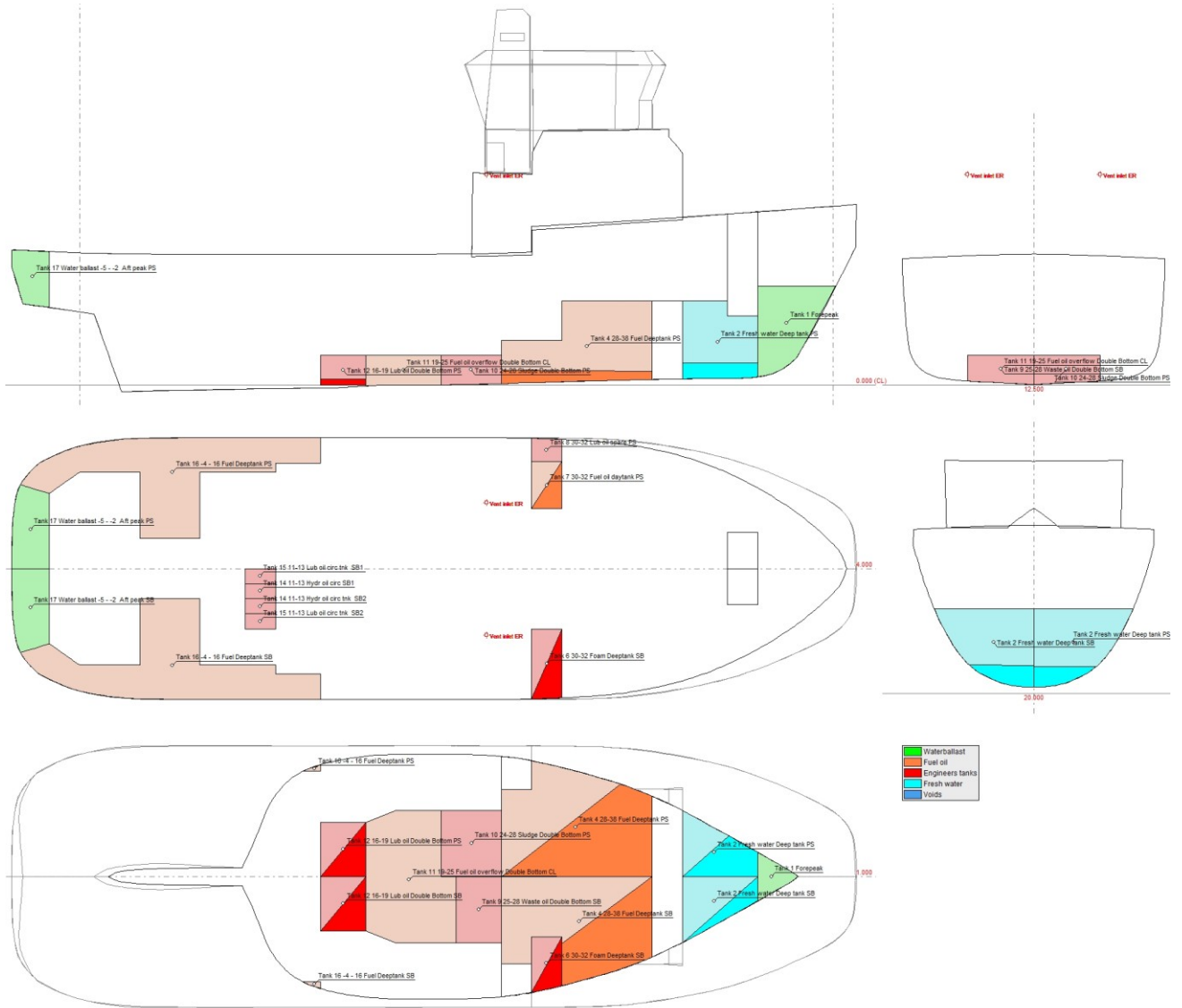
Description	Type	Dist. to wl	Submersion angle
		(m)	(Degr.)
Vent inlet ER	Downflooding	3.766	-60.7

5.3 Loading condition: 10%

Silhouette 1



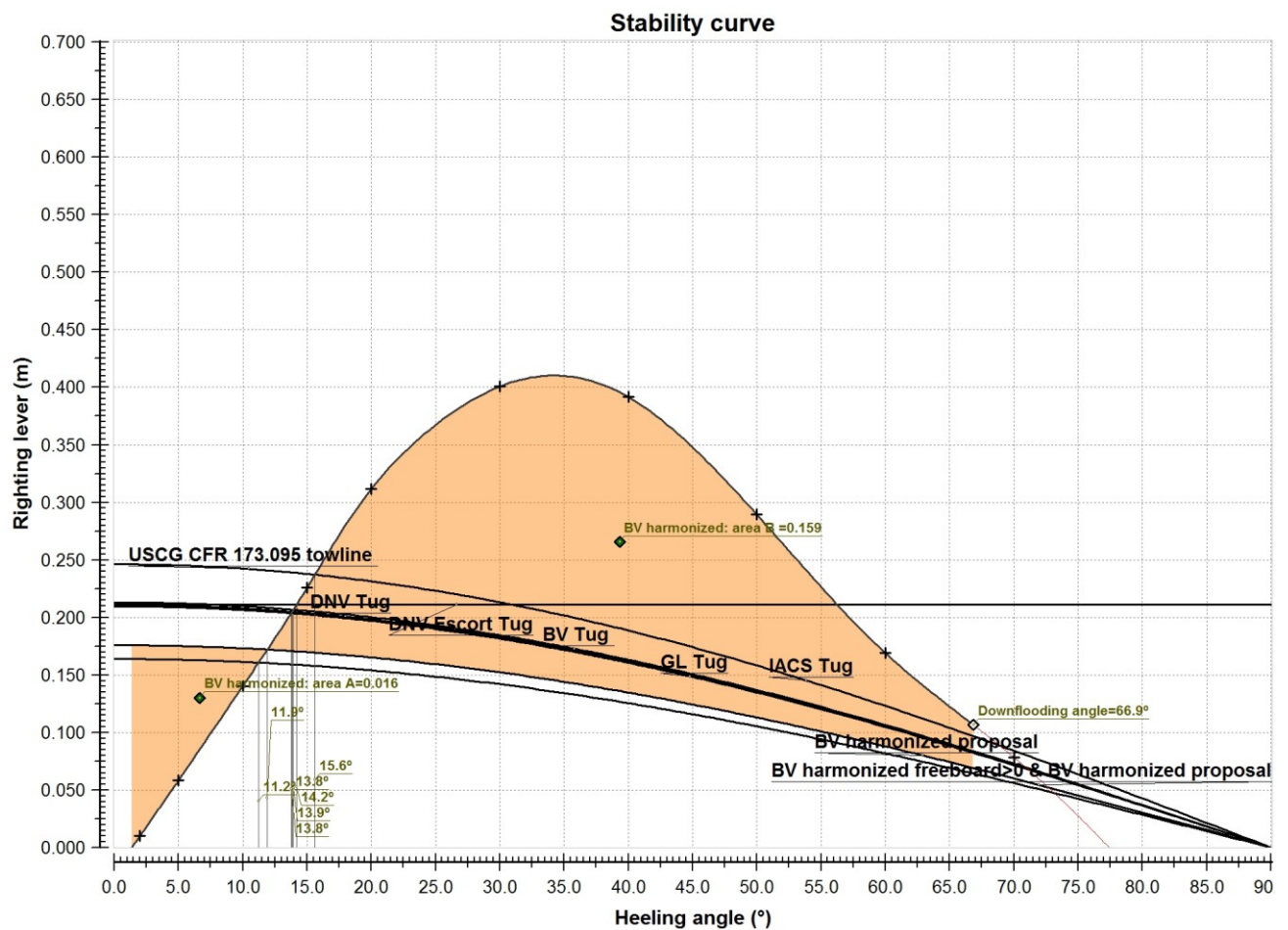
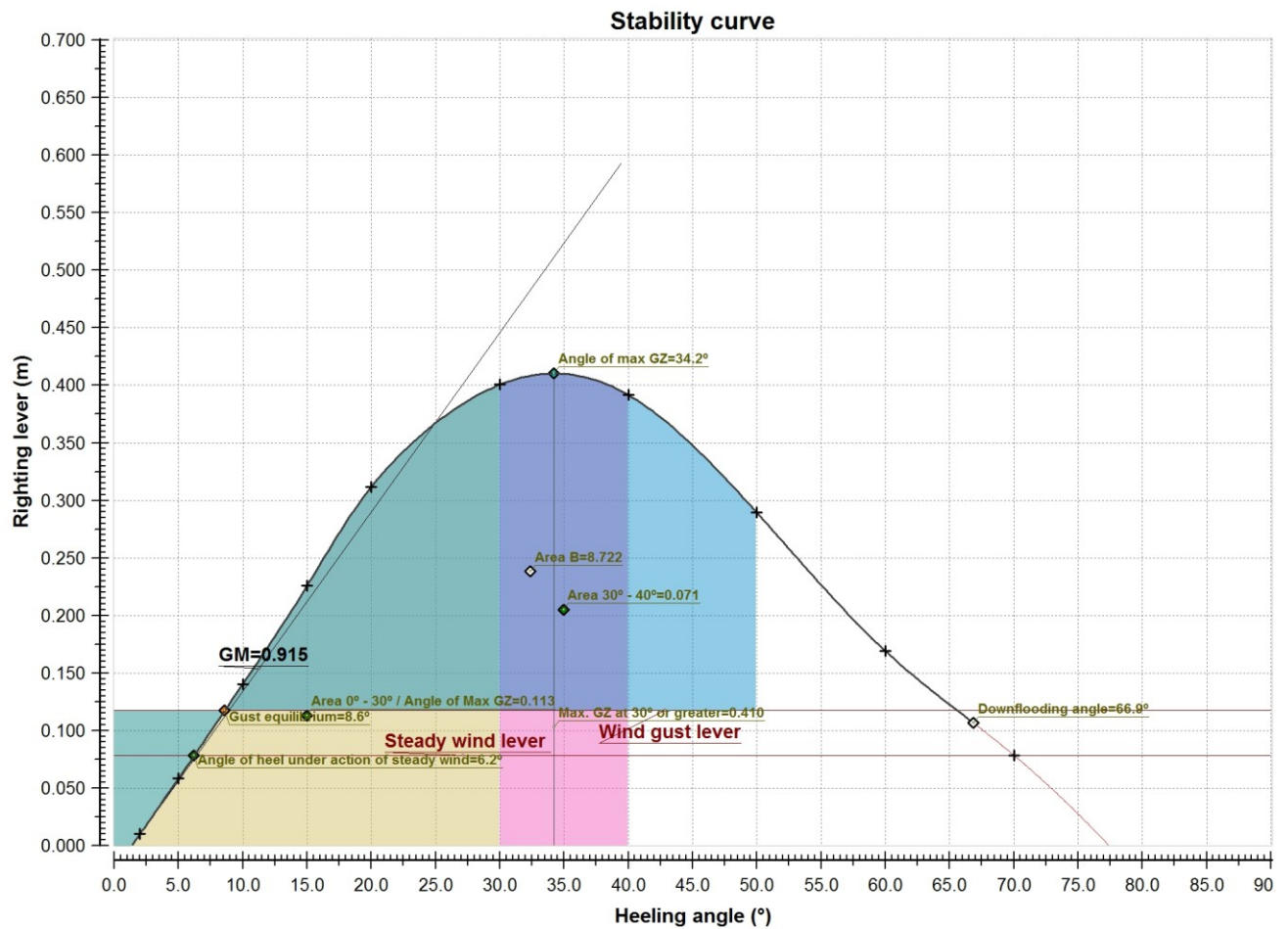
TUG STABILITY REQUIREMENTS



Description	Density	Fill%	Weight	VCG	LCG	TCG	FSM
	(t/m ³)		(tonnes)	(m)	(m)	(m)	(t*m)
Waterballast							
Tank 1 Forepeak	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak PS	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak SB	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Waterballast			0.000	0.000	0.000	0.000 (CL)	0.00
Fuel oil							
Tank 4 28-38 Fuel Deeptank PS	0.8500	11.3	3.260	0.354	16.176	1.195 (PS)	7.95
Tank 4 28-38 Fuel Deeptank SB	0.8500	12.0	3.260	0.362	16.234	-1.121 (SB)	6.25
Tank 7 30-32 Fuel oil daytank PS	0.8500	98.0	3.416	2.823	15.500	2.775 (PS)	0.26
Tank 11 19-25 Fuel oil overflow Double Bottom CL	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 16 -4 - 16 Fuel Deeptank PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 16 -4 - 16 Fuel Deeptank SB	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Fuel oil			9.936	1.205	15.963	0.979 (PS)	14.45
Engineers tanks							
Tank 6 30-32 Foam Deeptank SB	1.0000	9.8	0.750	0.602	15.478	-2.661 (SB)	0.38
Tank 8 30-32 Lub oil spare PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 9 25-28 Waste oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 10 24-28 Sludge Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom PS	1.0000	9.1	0.200	0.157	8.996	0.591 (PS)	0.50
Tank 12 16-19 Lub oil Double Bottom SB	1.0000	9.1	0.200	0.157	8.996	-0.591 (SB)	0.50
Tank 13 30-32 19 Lub oil SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Engineers tanks			1.150	0.447	13.223	-1.735 (SB)	1.37
Fresh water							
Tank 2 Fresh water Deep tank PS	1.0000	10.2	1.100	0.544	20.994	0.523 (PS)	0.62
Tank 2 Fresh water Deep tank SB	1.0000	10.2	1.100	0.544	20.994	-0.523 (SB)	0.62
Totals for Fresh water			2.200	0.544	20.994	0.000 (CL)	1.25
Provisions							
Provisions 10%			0.050	5.500	18.500	0.000 (CL)	0.00
Stores			2.000	3.750	14.000	0.000 (CL)	0.00
Totals for Provisions			2.050	3.793	14.110	0.000 (CL)	0.00
Crew and effects							
Crew & Effects			0.500	9.500	18.000	0.000 (CL)	0.00
Lightship			339.340	3.570	12.130	0.000 (CL)	
Deadweight			15.836	1.655	16.287	0.488 (PS)	17.07
Displacement			355.176	3.485	12.315	0.022 (PS)	17.07

Hydrostatic particulars

List	1.4 (PS) (Degr.)	KM	4.447 (m)
Draught aft pp	2.935 (m)	VCG	3.485 (m)
Mean moulded draught	2.844 (m)	GG'	0.048 (m)
Draught forward pp	2.754 (m)	VCG'	3.533 (m)
Trim	-0.181 (m)	Max VCG'	0.000 (m)
Draught aftmark	2.935 (m)	GM solid	0.963 (m)
Mean draught	2.844 (m)	G'M liquid	0.915 (m)
Draught forward mark	2.754 (m)	Immersion rate	1.899 (t/cm)
Trim marks	-0.181 (m)	MCT	3.038 (t*m/cm)



Righting levers

Heeling angle	Draught	Trim	Displacement	KN sin(θ)	VCG sin(θ)	GG' sin(θ)	TCG cos(θ)	GZ	Area
(<i>Degr.</i>)	(<i>m</i>)	(<i>m</i>)	(<i>tonnes</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>mrad</i>)
0.0 (CL)	2.845	-0.182	355.091	0.000	0.000	0.000	0.022	-0.022	0.000
2.0 (PS)	2.844	-0.179	355.065	0.155	0.122	0.002	0.022	0.010	0.000
5.0 (PS)	2.840	-0.162	355.028	0.388	0.304	0.004	0.022	0.058	0.002
10.0 (PS)	2.825	-0.102	355.002	0.776	0.605	0.009	0.021	0.140	0.010
15.0 (PS)	2.800	-0.007	355.143	1.162	0.902	0.013	0.021	0.226	0.026
20.0 (PS)	2.765	0.108	355.174	1.541	1.192	0.017	0.020	0.312	0.050
30.0 (PS)	2.694	0.244	355.110	2.184	1.742	0.023	0.019	0.401	0.113
40.0 (PS)	2.613	0.208	355.147	2.675	2.240	0.027	0.017	0.392	0.184
50.0 (PS)	2.494	0.044	355.173	3.003	2.669	0.030	0.014	0.289	0.244
60.0 (PS)	2.242	-0.379	355.088	3.230	3.018	0.032	0.011	0.169	0.284
70.0 (PS)	1.662	-1.478	355.267	3.393	3.274	0.033	0.007	0.078	0.305
80.0 (PS)	-0.033	-4.999	355.316	3.437	3.432	0.033	0.004	-0.031	0.310
90.0 (PS)	-12.010	-7545.648	355.169	3.356	3.485	0.035	0.000	-0.164	0.293

Evaluation of criteria

Offshore supply vessels

Offshore supply vessels from 24 to 100 m. in length.

Description	Attained value	Criterion	Required value	Complies
Area 0° - 30° / Angle of Max GZ	0.1133 (<i>mrad</i>)	>=	0.0550 (<i>mrad</i>)	YES
Downflooding angle	0.0 (<i>Degr.</i>)			
Calculated angle	34.2 (<i>Degr.</i>)			
Area 30° - 40°	0.0707 (<i>mrad</i>)	>=	0.0300 (<i>mrad</i>)	YES
Max. GZ at 30° or greater	0.410 (<i>m</i>)	>=	0.200 (<i>m</i>)	YES
Lower angle	30.0 (<i>Degr.</i>)			
Upper angle	90.0 (<i>Degr.</i>)			
Angle of max GZ	34.2 (<i>Degr.</i>)	>=	15.0 (<i>Degr.</i>)	YES
Initial metacentric height	0.915 (<i>m</i>)	>=	0.150 (<i>m</i>)	YES
Severe wind and rolling criterion				YES
Wind silhouette:	Silhouette 1			
Wind pressure	51.4 (<i>kg/m²</i>)			
Wind area	121.69 (<i>m²</i>)			
Steady wind lever	0.078 (<i>m</i>)			
Deck immersion angle	18.10 (<i>Degr.</i>)			
Wind gust lever	0.118 (<i>m</i>)			
Ratio of areaA/areaB	0.576	<=	1.000	YES
Maximum allowed static heeling angle	6.2 (<i>Degr.</i>)	<=	16.0 (<i>Degr.</i>)	YES
Max allowed ratio static angle/deck immersion angle	0.344	<=	0.800	YES

Intact stability for towing vessels

Tugs

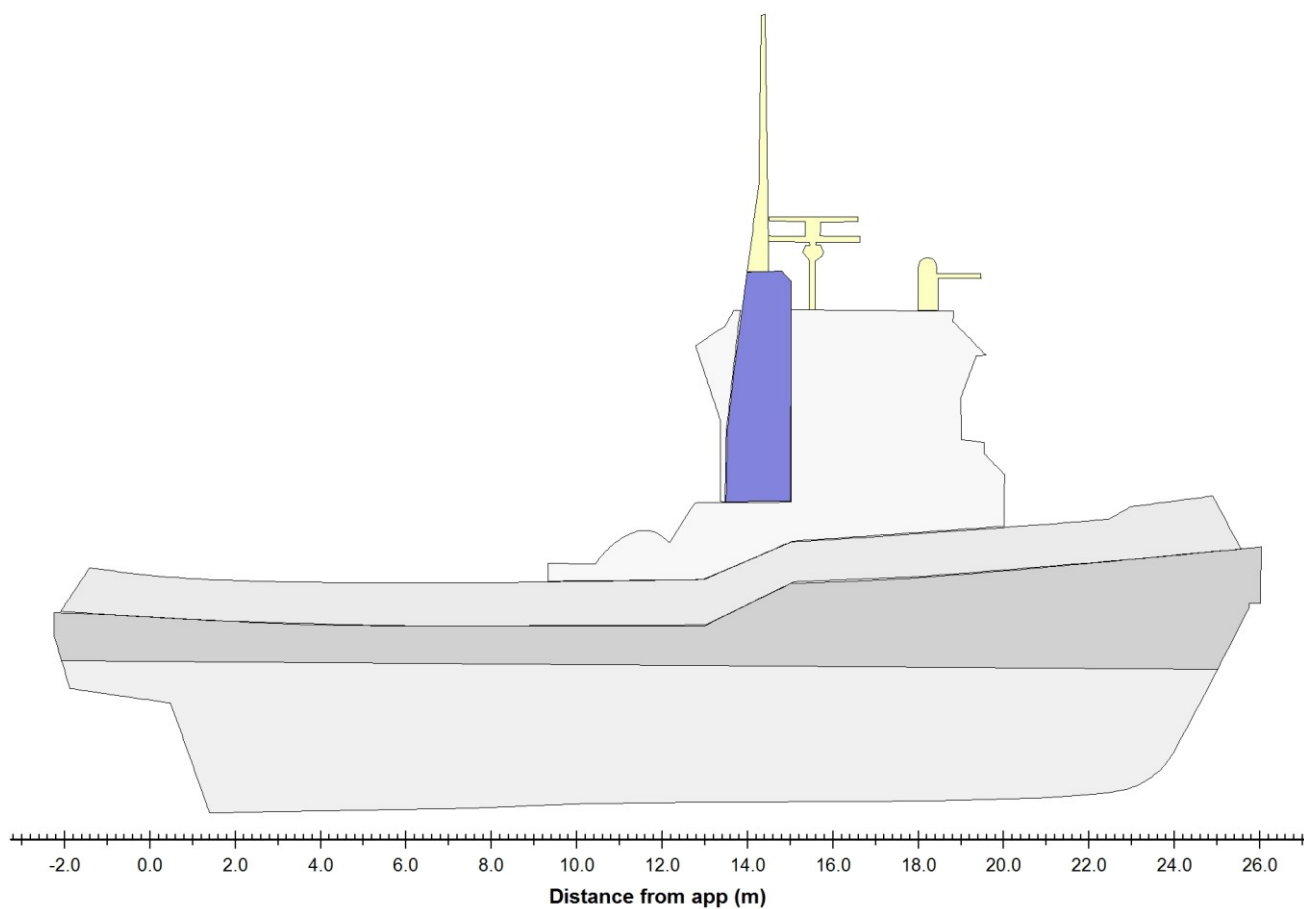
Description	Attained value	Criterion	Required value	Complies
ABS Towing moment	11.2 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	58.222 (t*m)			
ABS area A1 first intercept to min (fi+40; downflooding)>0.090	0.1410 (mrad)	>=	0.0900 (mrad)	YES
USCG CFR 173.095 towline	15.6 (Degr.)	<	15.0 (Degr.)	NO
Calculated heeling moment	87.465 (t*m)			
USCG area first intercept to min (40, max GZ, downflooding)>0.0106	0.0424 (mrad)	>=	0.0106 (mrad)	YES
DNV Tug	13.8 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Tug area first intercept to min(second intercept, downflooding)>0.090	0.1350 (mrad)	>=	0.0900 (mrad)	YES
DNV Tug area GZ 0- min(second intercept, downflooding)	0.3006 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area heeling arm 0-min(second intercept, downflooding)	0.1891 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area GZ>1.40 Area heeling arm	1.5901	>=	1.4000	YES
DNV Escort Tug	14.2 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Escort Tug area GZ first intercept-20	0.0267 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm first intercept -20	0.0214 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ>1.25 area heeling arm	1.2474	>=	1.2500	NO
DNV Escort Tug area GZ 0-min(40, downflooding)	0.1843 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm 0-min(40, downflooding)	0.1423 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ > 1.40 area heeling arm	1.2945	>=	1.4000	NO
BV Tug	13.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	75.689 (t*m)			
BV Tug area first intercept to min(GZ max, 40, downflooding)	0.0526 (mrad)	>=	0.0110 (mrad)	YES
GL Tug	13.8 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.480 (t*m)			
GL Tug area first intercept to min(second intercept, downflooding)	0.1359 (mrad)	>=	0.0900 (mrad)	YES
GL Tug area GZ 0-min(second intercept, downflooding)	0.3006 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area heeling arm 0-min(second intercept, downflooding)	0.1878 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area GZ > 1.40 area heeling arm	1.6006	>=	1.4000	YES
IACS Tug	15.6 (Degr.)	<	15.0 (Degr.)	NO
Calculated heeling moment	87.465 (t*m)			
IACS Tug area first intercept to min (second intercept, downflooding)	0.1116 (mrad)	>=	0.0900 (mrad)	YES
IACS Tug area GZ curve 0- min (second intercept, downflooding)	0.3006 (mrad)	>=	0.0000 (mrad)	YES
IACS Tug area heeling arm 0-min (second intercept, downflooding)	0.2206 (mrad)	>=	0.0000 (mrad)	YES
IACS Tugs area GZ > 1.40 area heeling arm	1.3630	>=	1.4000	NO
BV harmonized proposal	11.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	62.475 (t*m)			
BV harmonized: area A	0.0164 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized: area B	0.1595 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized B/A>1	9.7279	>=	1.0000	YES
BV harmonized freeboard>0	11.9 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	0.000 (t*m)			
Additional heeling moment:	BV harmonized proposal			
Total combined heeling moment	62.475 (t*m)			
Attained value smaller than deck immersion angle	11.9 (Degr.)	<	18.1 (Degr.)	YES
Weight	0.000 (tonnes)			
Trv. location of weight	0.000 (m)			

Critical points

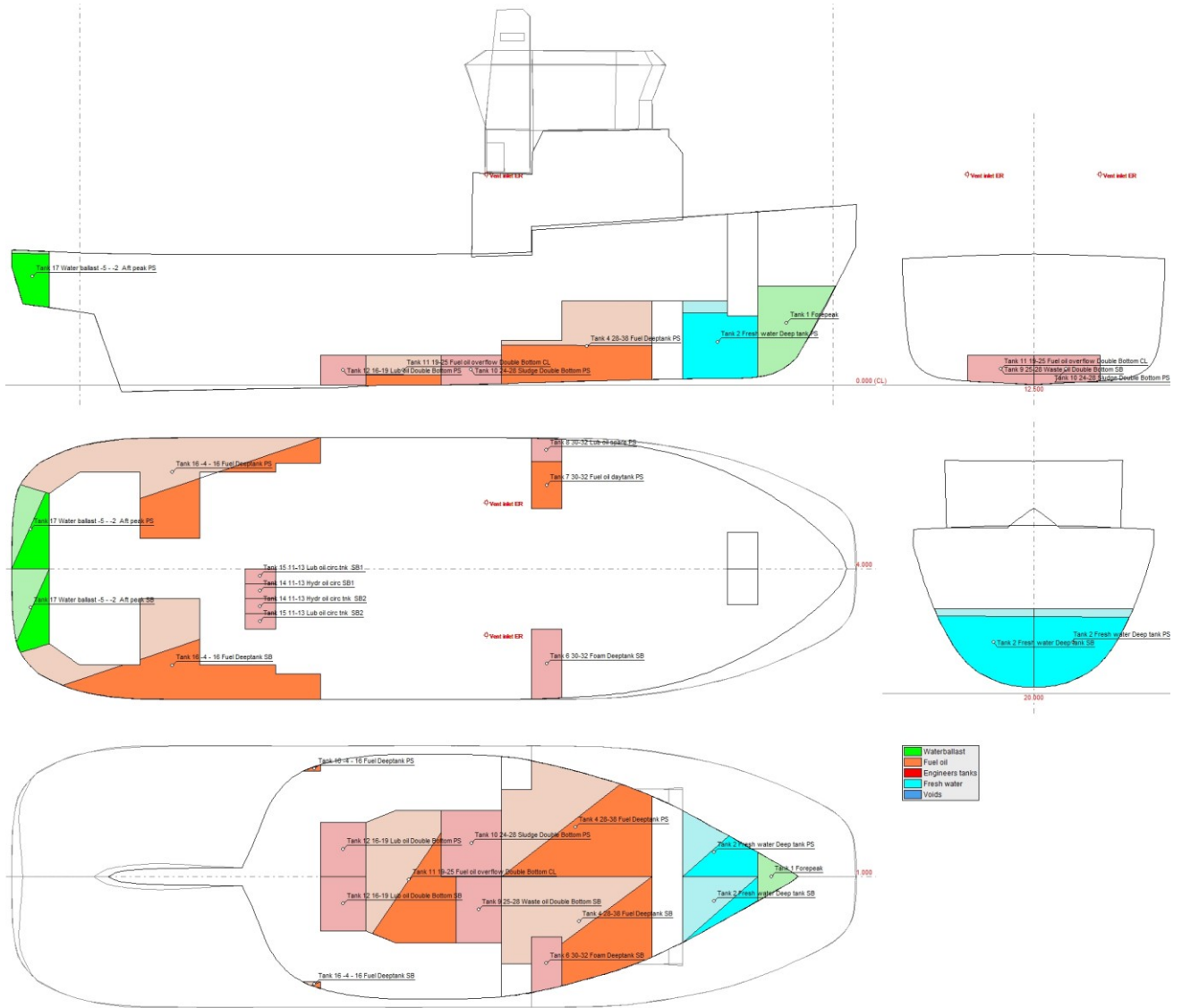
Description	Type	Dist. to wl	Submersion angle
		(m)	(Degr.)
Vent inlet ER	Downflooding	4.109	66.9

5.4 Loading condition: during accident

Silhouette 1



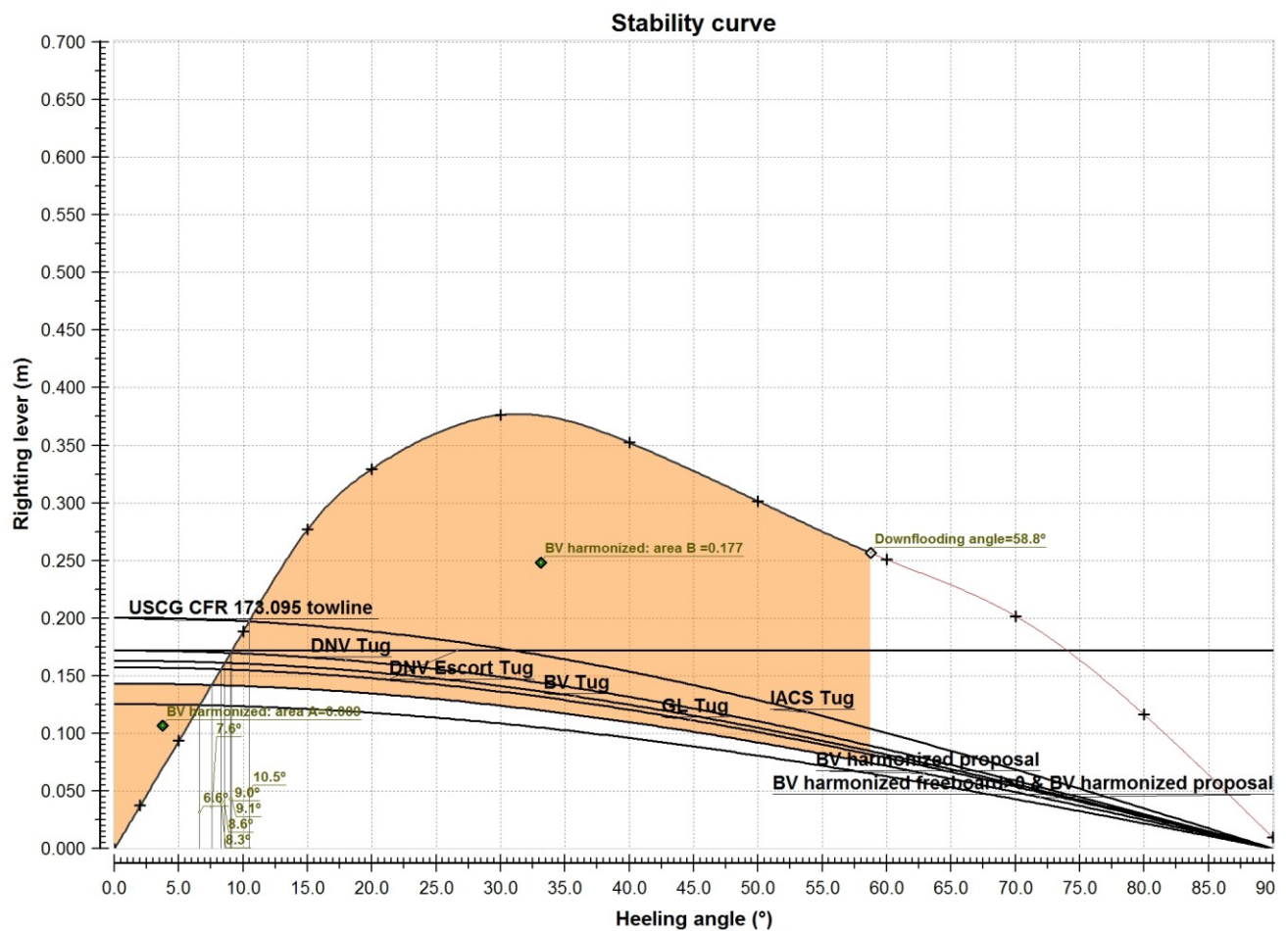
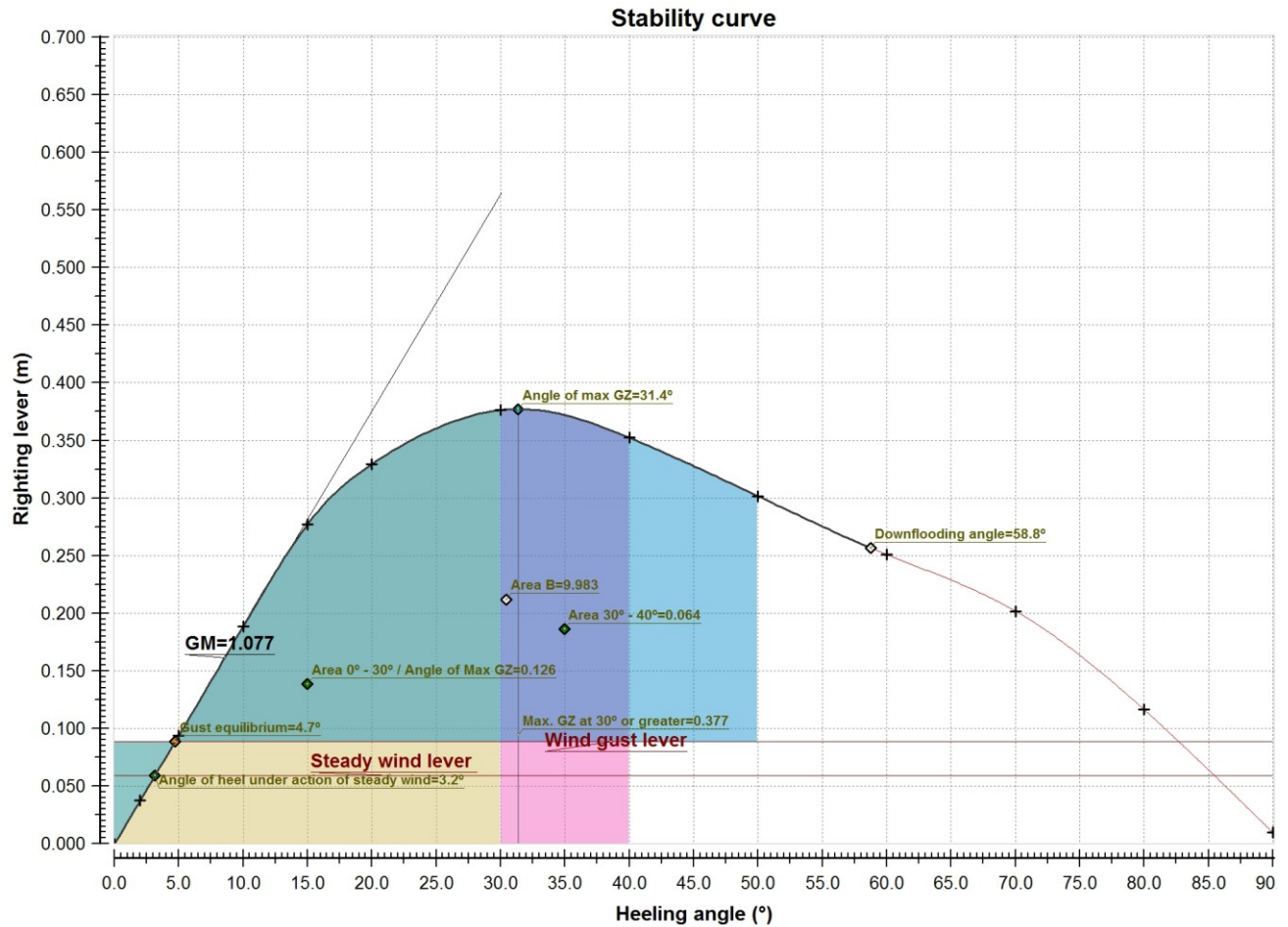
TUG STABILITY REQUIREMENTS



Description	Density	Fill%	Weight	VCG	LCG	TCG	FSM
	(t/m ³)		(tonnes)	(m)	(m)	(m)	(t*m)
Waterballast							
Tank 1 Forepeak	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak PS	1.0000	94.9	4.000	3.702	-1.559	1.198 (PS)	1.79
Tank 17 Water ballast -5 - -2 Aft peak SB	1.0000	94.9	4.000	3.702	-1.559	-1.198 (SB)	1.79
Totals for Waterballast			8.000	3.702	-1.559	0.000 (CL)	3.58
Fuel oil							
Tank 4 28-38 Fuel Deeptank PS	0.8500	48.5	13.940	0.797	16.376	1.506 (PS)	14.86
Tank 4 28-38 Fuel Deeptank SB	0.8500	63.3	17.200	0.986	16.623	-1.462 (SB)	10.48
Tank 7 30-32 Fuel oil daytank PS	0.8500	100.0	3.486	2.850	15.500	2.775 (PS)	0.00
Tank 11 19-25 Fuel oil overflow Double Bottom CL	1.0000	30.4	3.240	0.209	10.919	-0.094 (SB)	17.33
Tank 16 -4 - 16 Fuel Deeptank PS	0.8500	67.3	14.535	2.898	4.120	3.032 (PS)	9.01
Tank 16 -4 - 16 Fuel Deeptank SB	0.8500	74.7	16.120	2.983	4.022	-3.049 (SB)	9.15
Totals for Fuel oil			68.521	1.881	10.630	0.002 (PS)	60.83
Engineers tanks							
Tank 6 30-32 Foam Deeptank SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 8 30-32 Lub oil spare PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 9 25-28 Waste oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 10 24-28 Sludge Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 13 30-32 19 Lub oil SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Engineers tanks			0.000	0.000	0.000	0.000 (CL)	0.00
Fresh water							
Tank 2 Fresh water Deep tank PS	1.0000	81.2	8.750	1.512	21.071	0.980 (PS)	2.74
Tank 2 Fresh water Deep tank SB	1.0000	81.2	8.750	1.512	21.071	-0.980 (SB)	2.74
Totals for Fresh water			17.500	1.512	21.071	0.000 (CL)	5.49
Provisions							
Provisions 50%			0.250	5.500	18.500	0.000 (CL)	0.00
Stores			2.000	3.750	14.000	0.000 (CL)	0.00
Totals for Provisions			2.250	3.944	14.500	0.000 (CL)	0.00
Crew and effects							
Crew & Effects			0.500	9.500	18.000	0.000 (CL)	0.00
Lightship			339.340	3.570	12.130	0.000 (CL)	
Deadweight			96.771	2.052	11.638	0.002 (PS)	69.90
Displacement			436.111	3.233	12.021	0.000 (PS)	69.90

Hydrostatic particulars

List	0.0 (PS) (Degr.)	KM	4.470 (m)
Draught aft pp	3.341 (m)	VCG	3.233 (m)
Mean moulded draught	3.251 (m)	GG'	0.160 (m)
Draught forward pp	3.162 (m)	VCG'	3.393 (m)
Trim	-0.179 (m)	Max VCG'	0.000 (m)
Draught aftmark	3.341 (m)	GM solid	1.237 (m)
Mean draught	3.251 (m)	G'M liquid	1.077 (m)
Draught forward mark	3.162 (m)	Immersion rate	2.042 (t/cm)
Trim marks	-0.179 (m)	MCT	3.724 (t*m/cm)



Righting levers

Heeling angle	Draught	Trim	Displacement	KN sin(θ)	VCG sin(θ)	GG' sin(θ)	TCG cos(θ)	GZ	Area
(<i>Degr.</i>)	(<i>m</i>)	(<i>m</i>)	(<i>tonnes</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>mrad</i>)
0.0 (CL)	3.251	-0.179	435.935	0.000	0.000	0.000	0.000	0.000	0.000
2.0 (PS)	3.251	-0.176	435.950	0.156	0.113	0.006	0.000	0.037	0.001
5.0 (PS)	3.248	-0.163	436.118	0.390	0.282	0.014	0.000	0.094	0.004
10.0 (PS)	3.236	-0.122	436.032	0.777	0.561	0.027	0.000	0.189	0.016
15.0 (PS)	3.221	-0.071	436.174	1.153	0.837	0.038	0.000	0.277	0.037
20.0 (PS)	3.218	-0.064	436.184	1.484	1.106	0.049	0.000	0.329	0.064
30.0 (PS)	3.241	-0.248	436.136	2.061	1.617	0.068	0.000	0.376	0.126
40.0 (PS)	3.310	-0.654	436.162	2.515	2.078	0.084	0.000	0.352	0.191
50.0 (PS)	3.401	-1.349	436.110	2.869	2.477	0.091	0.000	0.302	0.248
60.0 (PS)	3.481	-2.589	436.028	3.142	2.800	0.091	0.000	0.251	0.296
70.0 (PS)	3.568	-5.111	435.988	3.327	3.038	0.087	0.000	0.202	0.336
80.0 (PS)	3.850	-12.361	436.081	3.381	3.184	0.081	0.000	0.116	0.364
90.0 (PS)	-12.010	-14104.036	435.992	3.313	3.233	0.070	0.000	0.009	0.375

Evaluation of criteria

Offshore supply vessels

Offshore supply vessels from 24 to 100 m. in length.

Description	Attained value	Criterion	Required value	Complies
Area 0° - 30° / Angle of Max GZ	0.1260 (<i>mrad</i>)	>=	0.0550 (<i>mrad</i>)	YES
Downflooding angle	0.0 (<i>Degr.</i>)			
Calculated angle	31.4 (<i>Degr.</i>)			
Area 30° - 40°	0.0645 (<i>mrad</i>)	>=	0.0300 (<i>mrad</i>)	YES
Max. GZ at 30° or greater	0.377 (<i>m</i>)	>=	0.200 (<i>m</i>)	YES
Lower angle	30.0 (<i>Degr.</i>)			
Upper angle	90.0 (<i>Degr.</i>)			
Angle of max GZ	31.4 (<i>Degr.</i>)	>=	15.0 (<i>Degr.</i>)	YES
Initial metacentric height	1.077 (<i>m</i>)	>=	0.150 (<i>m</i>)	YES
Severe wind and rolling criterion				YES
Wind silhouette:	Silhouette 1			
Wind pressure	51.4 (<i>kg/m²</i>)			
Wind area	110.74 (<i>m²</i>)			
Steady wind lever	0.059 (<i>m</i>)			
Deck immersion angle	12.60 (<i>Degr.</i>)			
Wind gust lever	0.088 (<i>m</i>)			
Ratio of areaA/areaB	0.593	<=	1.000	YES
Maximum allowed static heeling angle	3.2 (<i>Degr.</i>)	<=	16.0 (<i>Degr.</i>)	YES
Max allowed ratio static angle/deck immersion angle	0.251	<=	0.800	YES

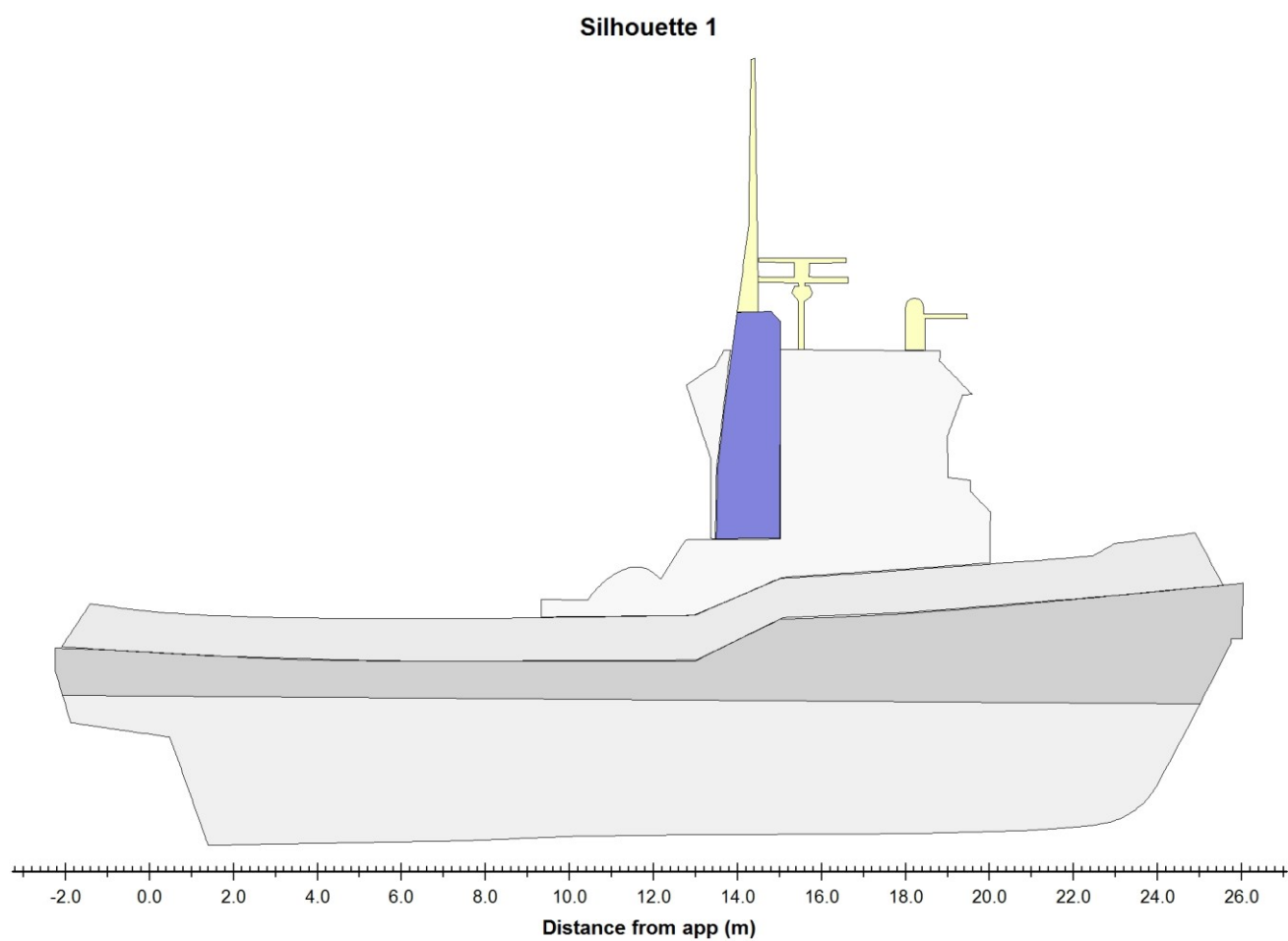
Intact stability for towing vessels

<i>Tugs</i>				
Description	Attained value	Criterion	Required value	Complies
ABS Towing moment	6.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	54.688 (t*m)			
ABS area A1 first intercept to min (fi+40; downflooding)>0.090	0.1456 (mrad)	>=	0.0900 (mrad)	YES
USCG CFR 173.095 towline	10.5 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
USCG area first intercept to min (40, max GZ, downflooding)>0.0106	0.0492 (mrad)	>=	0.0106 (mrad)	YES
DNV Tug	9.0 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Tug area first intercept to min(second intercept, downflooding)>0.090	0.1569 (mrad)	>=	0.0900 (mrad)	YES
DNV Tug area GZ 0- min(second intercept, downflooding)	0.2903 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area heeling arm 0-min(second intercept, downflooding)	0.1469 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area GZ>1.40 Area heeling arm	1.9756	>=	1.4000	YES
DNV Escort Tug	9.1 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Escort Tug area GZ first intercept-20	0.0499 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm first intercept -20	0.0326 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ>1.25 area heeling arm	1.5307	>=	1.2500	YES
DNV Escort Tug area GZ 0-min(40, downflooding)	0.1905 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm 0-min(40, downflooding)	0.1200 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ > 1.40 area heeling arm	1.5882	>=	1.4000	YES
BV Tug	8.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	71.094 (t*m)			
BV Tug area first intercept to min(GZ max, 40, downflooding)	0.0625 (mrad)	>=	0.0110 (mrad)	YES
GL Tug	8.3 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	68.600 (t*m)			
GL Tug area first intercept to min(second intercept, downflooding)	0.1672 (mrad)	>=	0.0900 (mrad)	YES
GL Tug area GZ 0-min(second intercept, downflooding)	0.2903 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area heeling arm 0-min(second intercept, downflooding)	0.1344 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area GZ > 1.40 area heeling arm	2.1591	>=	1.4000	YES
IACS Tug	10.5 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
IACS Tug area first intercept to min (second intercept, downflooding)	0.1373 (mrad)	>=	0.0900 (mrad)	YES
IACS Tug area GZ curve 0- min (second intercept, downflooding)	0.2903 (mrad)	>=	0.0000 (mrad)	YES
IACS Tug area heeling arm 0-min (second intercept, downflooding)	0.1714 (mrad)	>=	0.0000 (mrad)	YES
IACS Tugs area GZ > 1.40 area heeling arm	1.6934	>=	1.4000	YES
BV harmonized proposal	7.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	62.475 (t*m)			
BV harmonized: area A	0.0095 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized: area B	0.1773 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized B/A>1	18.7272	>=	1.0000	YES
BV harmonized freeboard>0	7.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	0.000 (t*m)			
Additional heeling moment:	BV harmonized proposal			
Total combined heeling moment	62.475 (t*m)			
Attained value smaller than deck immersion angle	7.6 (Degr.)	<	12.6 (Degr.)	YES
Weight	0.000 (tonnes)			
Trv. location of weight	0.000 (m)			

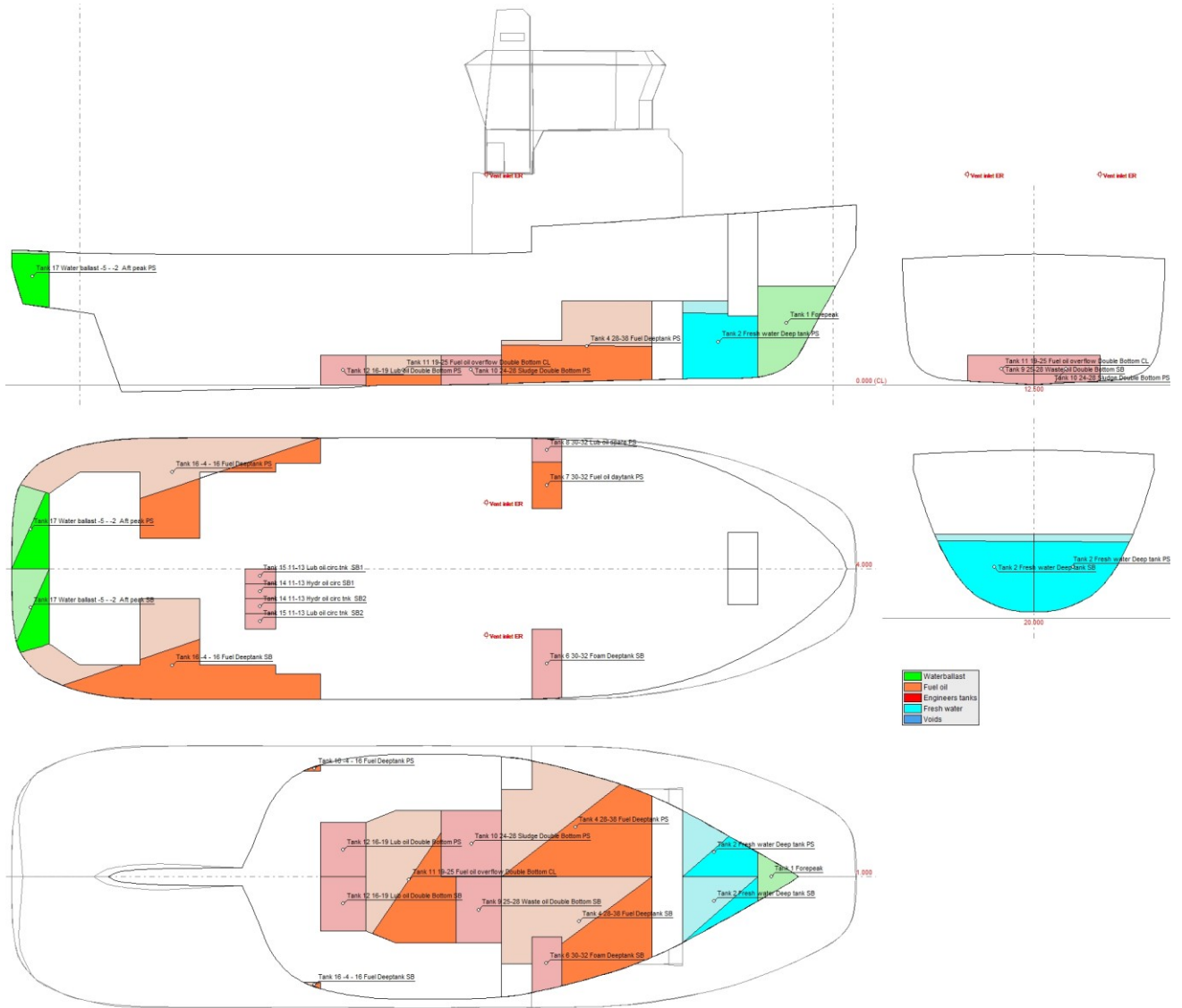
Critical points

Description	Type	Dist. to wl	Submersion angle
		(m)	(Degr.)
Vent inlet ER	Downflooding	3.755	58.8

5.5 Loading condition: during accident (deckhouse not taken into account)



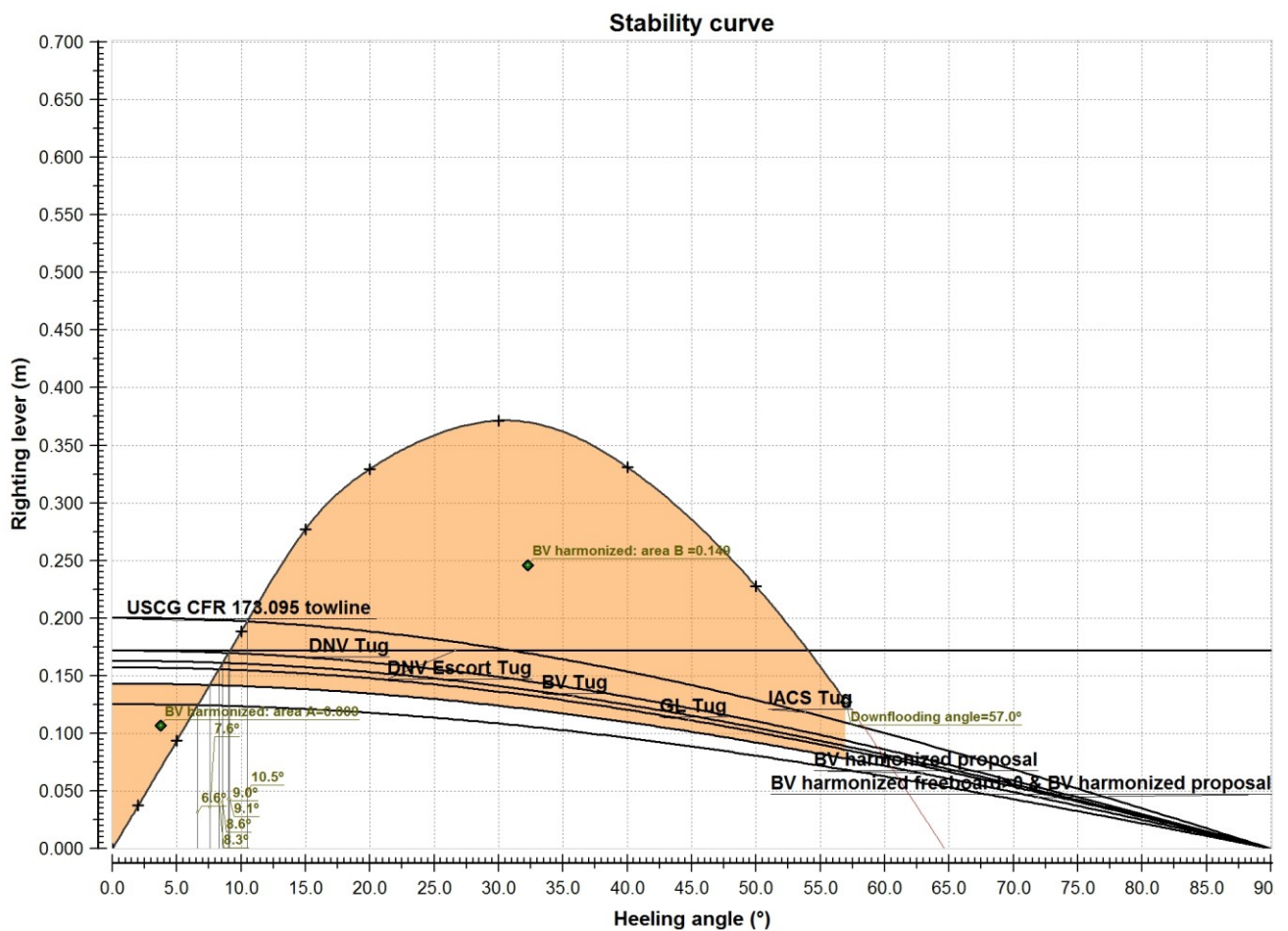
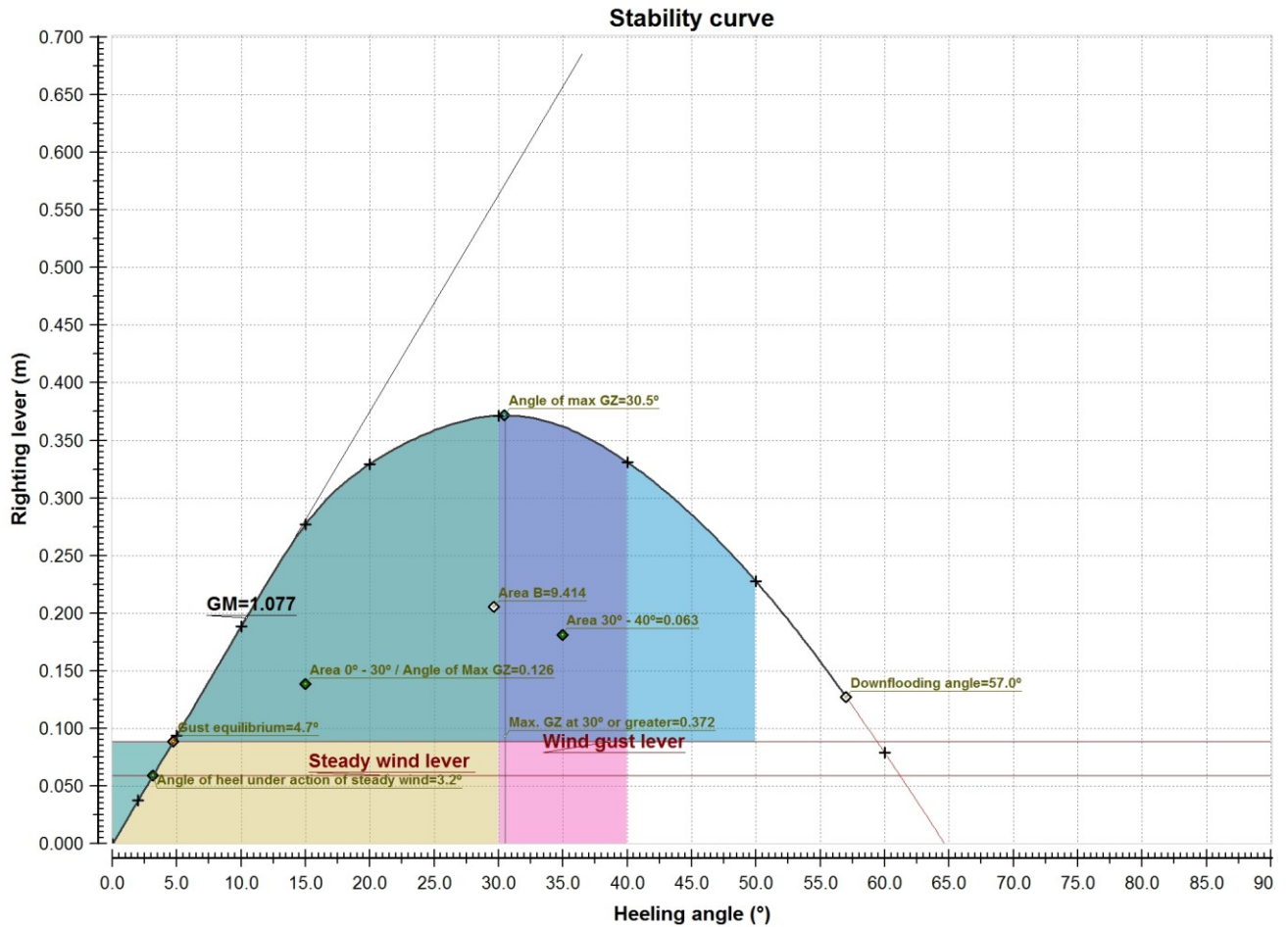
TUG STABILITY REQUIREMENTS



Description	Density	Fill%	Weight	VCG	LCG	TCG	FSM
	(t/m ³)		(tonnes)	(m)	(m)	(m)	(t*m)
Waterballast							
Tank 1 Forepeak	1.0250	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 17 Water ballast -5 - -2 Aft peak PS	1.0000	94.9	4.000	3.702	-1.559	1.198 (PS)	1.79
Tank 17 Water ballast -5 - -2 Aft peak SB	1.0000	94.9	4.000	3.702	-1.559	-1.198 (SB)	1.79
Totals for Waterballast			8.000	3.702	-1.559	0.000 (CL)	3.58
Fuel oil							
Tank 4 28-38 Fuel Deeptank PS	0.8500	48.5	13.940	0.797	16.376	1.506 (PS)	14.86
Tank 4 28-38 Fuel Deeptank SB	0.8500	63.3	17.200	0.986	16.624	-1.462 (SB)	10.48
Tank 7 30-32 Fuel oil daytank PS	0.8500	100.0	3.486	2.850	15.500	2.775 (PS)	0.00
Tank 11 19-25 Fuel oil overflow Double Bottom CL	1.0000	30.4	3.240	0.209	10.919	-0.094 (SB)	17.33
Tank 16 -4 - 16 Fuel Deeptank PS	0.8500	67.3	14.535	2.898	4.120	3.032 (PS)	9.01
Tank 16 -4 - 16 Fuel Deeptank SB	0.8500	74.7	16.120	2.983	4.022	-3.049 (SB)	9.15
Totals for Fuel oil			68.521	1.881	10.630	0.002 (PS)	60.83
Engineers tanks							
Tank 6 30-32 Foam Deeptank SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 8 30-32 Lub oil spare PS	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 9 25-28 Waste oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 10 24-28 Sludge Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom PS	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 12 16-19 Lub oil Double Bottom SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 13 30-32 19 Lub oil SB	1.0000	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 15 11-13 Lub oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ SB1	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Tank 14 11-13 Hydr oil circ tnk SB2	0.8500	0.0	0.000	0.000	0.000	0.000 (CL)	0.00
Totals for Engineers tanks			0.000	0.000	0.000	0.000 (CL)	0.00
Fresh water							
Tank 2 Fresh water Deep tank PS	1.0000	81.2	8.750	1.512	21.071	0.980 (PS)	2.74
Tank 2 Fresh water Deep tank SB	1.0000	81.2	8.750	1.512	21.071	-0.980 (SB)	2.74
Totals for Fresh water			17.500	1.512	21.071	0.000 (CL)	5.49
Provisions							
Provisions 50%			0.250	5.500	18.500	0.000 (CL)	0.00
Stores			2.000	3.750	14.000	0.000 (CL)	0.00
Totals for Provisions			2.250	3.944	14.500	0.000 (CL)	0.00
Crew and effects							
Crew & Effects			0.500	9.500	18.000	0.000 (CL)	0.00
Lightship			339.340	3.570	12.130	0.000 (CL)	
Deadweight			96.771	2.052	11.638	0.002 (PS)	69.90
Displacement			436.111	3.233	12.021	0.000 (PS)	69.90

Hydrostatic particulars

List	0.0 (PS) (Degr.)	KM	4.470 (m)
Draught aft pp	3.341 (m)	VCG	3.233 (m)
Mean moulded draught	3.251 (m)	GG'	0.160 (m)
Draught forward pp	3.162 (m)	VCG'	3.393 (m)
Trim	-0.179 (m)	Max VCG'	0.000 (m)
Draught aftmark	3.341 (m)	GM solid	1.237 (m)
Mean draught	3.251 (m)	G'M liquid	1.077 (m)
Draught forward mark	3.162 (m)	Immersion rate	2.042 (t/cm)
Trim marks	-0.179 (m)	MCT	3.724 (t*m/cm)



Righting levers

Heeling angle	Draught	Trim	Displacement	KN sin(θ)	VCG sin(θ)	GG' sin(θ)	TCG cos(θ)	GZ	Area
(<i>Degr.</i>)	(<i>m</i>)	(<i>m</i>)	(<i>tonnes</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>m</i>)	(<i>mrad</i>)
0.0 (CL)	3.251	-0.179	435.951	0.000	0.000	0.000	0.000	0.000	0.000
2.0 (PS)	3.251	-0.176	435.932	0.156	0.113	0.006	0.000	0.037	0.001
5.0 (PS)	3.248	-0.163	436.109	0.390	0.282	0.014	0.000	0.094	0.004
10.0 (PS)	3.236	-0.121	436.107	0.777	0.561	0.027	0.000	0.189	0.016
15.0 (PS)	3.220	-0.071	436.116	1.153	0.837	0.038	0.000	0.277	0.037
20.0 (PS)	3.218	-0.065	436.120	1.484	1.106	0.049	0.000	0.330	0.064
30.0 (PS)	3.245	-0.244	436.118	2.056	1.617	0.068	0.000	0.372	0.126
40.0 (PS)	3.335	-0.634	436.121	2.493	2.078	0.084	0.000	0.331	0.188
50.0 (PS)	3.503	-1.227	436.114	2.795	2.477	0.091	0.000	0.228	0.238
60.0 (PS)	3.789	-2.154	436.113	2.970	2.800	0.091	0.000	0.079	0.265
70.0 (PS)	4.348	-3.870	436.111	3.030	3.038	0.087	0.000	-0.096	0.264
80.0 (PS)	5.996	-8.703	436.181	2.985	3.184	0.080	0.000	-0.280	0.231
90.0 (PS)	-12.010	-9120.658	436.109	2.846	3.233	0.070	0.000	-0.457	0.167

Evaluation of criteria

Offshore supply vessels

Offshore supply vessels from 24 to 100 m. in length.

Description	Attained value	Criterion	Required value	Complies
Area 0° - 30° / Angle of Max GZ	0.1257 (<i>mrad</i>)	>=	0.0550 (<i>mrad</i>)	YES
Downflooding angle	0.0 (<i>Degr.</i>)			
Calculated angle	30.5 (<i>Degr.</i>)			
Area 30° - 40°	0.0625 (<i>mrad</i>)	>=	0.0300 (<i>mrad</i>)	YES
Max. GZ at 30° or greater	0.372 (<i>m</i>)	>=	0.200 (<i>m</i>)	YES
Lower angle	30.0 (<i>Degr.</i>)			
Upper angle	90.0 (<i>Degr.</i>)			
Angle of max GZ	30.5 (<i>Degr.</i>)	>=	15.0 (<i>Degr.</i>)	YES
Initial metacentric height	1.077 (<i>m</i>)	>=	0.150 (<i>m</i>)	YES
Severe wind and rolling criterion				YES
Wind silhouette:	Silhouette 1			
Wind pressure	51.4 (<i>kg/m²</i>)			
Wind area	110.74 (<i>m²</i>)			
Steady wind lever	0.059 (<i>m</i>)			
Deck immersion angle	12.59 (<i>Degr.</i>)			
Wind gust lever	0.088 (<i>m</i>)			
Ratio of areaA/areaB	0.629	<=	1.000	YES
Maximum allowed static heeling angle	3.2 (<i>Degr.</i>)	<=	16.0 (<i>Degr.</i>)	YES
Max allowed ratio static angle/deck immersion angle	0.251	<=	0.800	YES

Intact stability for towing vessels

<i>Tugs</i>				
Description	Attained value	Criterion	Required value	Complies
ABS Towing moment	6.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	54.688 (t*m)			
ABS area A1 first intercept to min (fi+40; downflooding)>0.090	0.1393 (mrad)	>=	0.0900 (mrad)	YES
USCG CFR 173.095 towline	10.5 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
USCG area first intercept to min (40, max GZ, downflooding)>0.0106	0.0455 (mrad)	>=	0.0106 (mrad)	YES
DNV Tug	9.0 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Tug area first intercept to min(second intercept, downflooding)>0.090	0.1291 (mrad)	>=	0.0900 (mrad)	YES
DNV Tug area GZ 0- min(second intercept, downflooding)	0.2596 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area heeling arm 0-min(second intercept, downflooding)	0.1441 (mrad)	>=	0.0000 (mrad)	YES
DNV Tug area GZ>1.40 Area heeling arm	1.8015	>=	1.4000	YES
DNV Escort Tug	9.1 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	74.970 (t*m)			
DNV Escort Tug area GZ first intercept-20	0.0500 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm first intercept -20	0.0326 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ>1.25 area heeling arm	1.5311	>=	1.2500	YES
DNV Escort Tug area GZ 0-min(40, downflooding)	0.1883 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area heeling arm 0-min(40, downflooding)	0.1200 (mrad)	>=	0.0000 (mrad)	YES
DNV Escort Tug area GZ > 1.40 area heeling arm	1.5694	>=	1.4000	YES
BV Tug	8.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	71.094 (t*m)			
BV Tug area first intercept to min(GZ max, 40, downflooding)	0.0584 (mrad)	>=	0.0110 (mrad)	YES
GL Tug	8.3 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	68.600 (t*m)			
GL Tug area first intercept to min(second intercept, downflooding)	0.1391 (mrad)	>=	0.0900 (mrad)	YES
GL Tug area GZ 0-min(second intercept, downflooding)	0.2596 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area heeling arm 0-min(second intercept, downflooding)	0.1319 (mrad)	>=	0.0000 (mrad)	YES
GL Tug area GZ > 1.40 area heeling arm	1.9688	>=	1.4000	YES
IACS Tug	10.5 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	87.465 (t*m)			
IACS Tug area first intercept to min (second intercept, downflooding)	0.1099 (mrad)	>=	0.0900 (mrad)	YES
IACS Tug area GZ curve 0- min (second intercept, downflooding)	0.2596 (mrad)	>=	0.0000 (mrad)	YES
IACS Tug area heeling arm 0-min (second intercept, downflooding)	0.1681 (mrad)	>=	0.0000 (mrad)	YES
IACS Tugs area GZ > 1.40 area heeling arm	1.5441	>=	1.4000	YES
BV harmonized proposal	7.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	62.475 (t*m)			
BV harmonized: area A	0.0095 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized: area B	0.1490 (mrad)	>=	0.0000 (mrad)	YES
BV harmonized B/A>1	15.7346	>=	1.0000	YES
BV harmonized freeboard>0	7.6 (Degr.)	<	15.0 (Degr.)	YES
Calculated heeling moment	0.000 (t*m)			
Additional heeling moment:	BV harmonized proposal			
Total combined heeling moment	62.475 (t*m)			
Attained value smaller than deck immersion angle	7.6 (Degr.)	<	12.6 (Degr.)	YES
Weight	0.000 (tonnes)			
Trv. location of weight	0.000 (m)			

Critical points

Description	Type	Dist. to wl	Submersion angle
		(m)	(Degr.)
Vent inlet ER	Downflooding	3.755	57.0