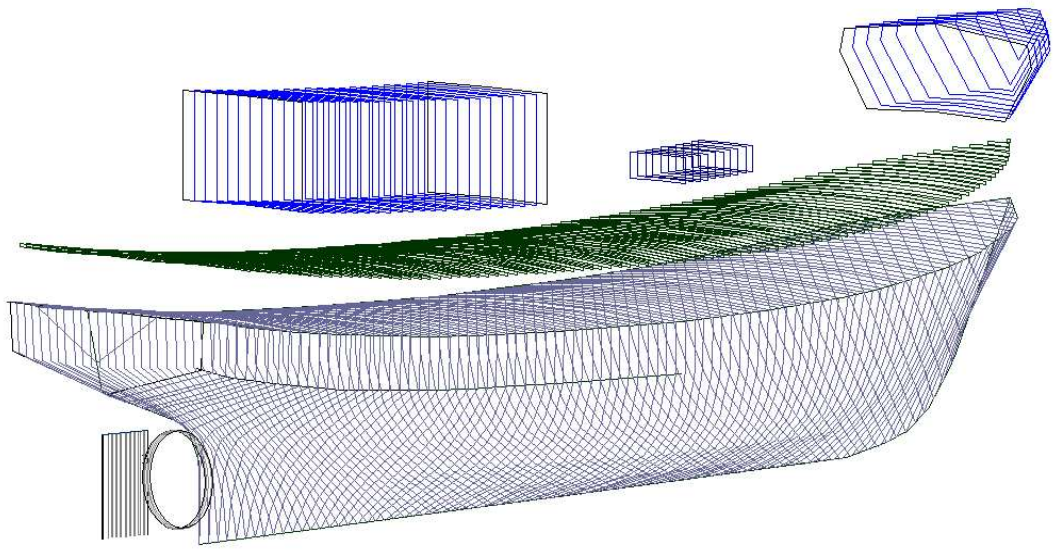
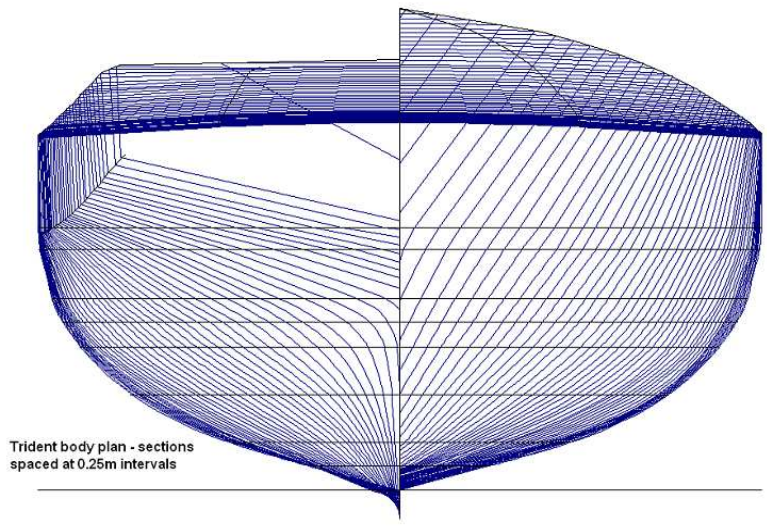
Trawler 'Trident' stability model and comparison against IMCO minimum stability standards





Trident body plan - sections spaced at 0.25m intervals

IMCO condition 1

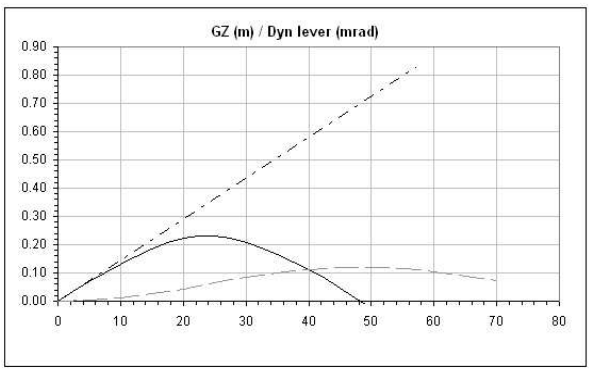
Loading condition : **IMCO 1 - Departure for fishing grounds - full fuel, water and ice onboard - Loading particulars from Original Formal Investigation and NMI report**

Dens SW =1.025 ton/m^3

Displacement SW (ton) :	188.48		
LCG fw AP (m) :	10.283		
TCG ps CL (m) :	0.000		
KG' (m) :	3.042	GMo' (m) :	0.831

Free trim stability : Heel a (°)	Right. lever GZ (m)	Dyn. lever GZa(0-a) (mrad)	Incr. stab dGZ/da (m/rad)	Draught mld at L/2 (m)	Trim at CL (m)	*(No of iterations)*
0	0.000	0.000	0.831	2.490	0.578	*4,(2)*
5	0.070	0.003	0.745	2.486	0.565	*3,(4)*
10	0.131	0.012	0.654	2.473	0.527	*3,(4)*
15	0.185	0.026	0.566	2.451	0.476	*3,(4)*
20	0.223	0.044	0.251	2.424	0.423	*3,(4)*
25	0.229	0.064	-0.095	2.402	0.379	*3,(4)*
30	0.209	0.083	-0.372	2.385	0.346	*3,(3)*
35	0.167	0.100	-0.569	2.372	0.324	*3,(3)*
40	0.112	0.112	-0.691	2.360	0.302	*3,(3)*
45	0.046	0.119	-0.771	2.348	0.293	*3,(3)*
50	-0.022	0.120	-0.775	2.330	0.260	*3,(3)*
55	-0.087	0.115	-0.715	2.299	0.229	*3,(3)*
60	-0.145	0.105	-0.518	2.247	0.183	*4,(3)*
65	-0.193	0.090	-0.522	2.158	0.100	*4,(3)*
70	-0.238	0.071	-0.522	2.029	-0.012	*4,(4)*
GZmax at 23.6°	0.230					

Stability criteria :	Actual value / Compliance	Max KG' (m)	*Crit. Points :* Subm.angle(°)
GZa(0.0°-30.0°)>0.055mrad	0.083 / OK	3.251	
GZa(0.0°-40.0°)>0.090mrad	0.112 / OK	3.135	
GZa(30.0°-40.0°)>0.030mrad	0.029 / NO	3.029	Fail
GZ(>30.0°)>0.200m	0.209 / OK	3.059	
a(GZmax)>25.0°	23.6 / NO	2.937	Fail
GMo>0.350m	0.831 / OK	3.523	
Sum. Compliance, max KG' :	NO	2.613	*Min.angle :*



GZ -v- Heel

IMCO condition 2

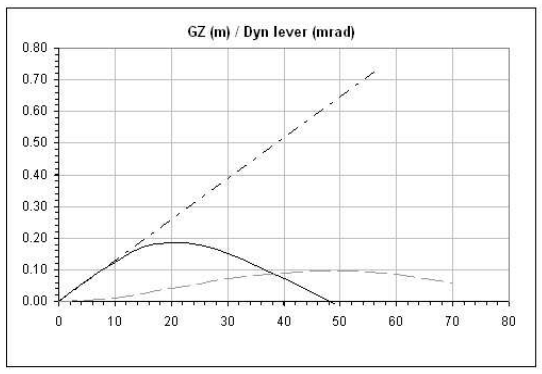
Loading condition : **IMCO 2 - Departure from fishing grounds with full catch (35% fuel & water remaining onboard) - Loading details from Original Formal Investigation and NMI report**

Dens SW =1.025 ton/m^3

Displacement SW (ton) :	224.11		
LCG fw AP (m) :	11.249		
TCG ps CL (m) :	0.000		
KG' (m) :	2.949	GMo' (m) :	0.740

Free trim stability : Heel a (°)	Right. lever GZ (m)	Dyn. lever GZa(0-a) (mrad)	Incr. stab dGZ/da (m/rad)	Draught mld at L/2 (m)	Trim at CL (m)	*(No of iterations)*
0	0.000	0.000	0.740	2.820	-0.627	*5,(2)*
5	0.064	0.003	0.720	2.816	-0.641	*3,(3)*
10	0.125	0.011	0.650	2.803	-0.680	*3,(4)*
15	0.170	0.024	0.341	2.791	-0.748	*3,(4)*
20	0.186	0.040	0.030	2.790	-0.846	*3,(4)*
25	0.178	0.056	-0.212	2.802	-0.970	*3,(4)*
30	0.151	0.070	-0.380	2.826	-1.117	*3,(4)*
35	0.114	0.082	-0.384	2.857	-1.279	*4,(Warning)*
40	0.072	0.090	-0.388	2.891	-1.441	*4,(4)*
45	0.028	0.095	-0.519	2.928	-1.622	*4,(4)*
50	-0.017	0.095	-0.523	2.968	-1.843	*4,(4)*
55	-0.063	0.092	-0.497	3.017	-2.114	*4,(4)*
60	-0.104	0.084	-0.439	3.070	-2.511	*4,(4)*
65	-0.140	0.074	-0.412	3.136	-3.088	*4,(4)*
70	-0.177	0.060	-0.423	3.240	-3.955	*4,(4)*
GZmax at 20.6°	0.186					

Stability criteria :	Actual value / Compliance	Max KG' (m)	*Crit. Points :* Subm.angle(°)
GZa(0.0°-30.0°)>0.055mrad	0.070 / OK	3.064	
GZa(0.0°-40.0°)>0.090mrad	0.090 / OK	2.950	
GZa(30.0°-40.0°)>0.030mrad	0.020 / NO	2.846	Fail
GZ(>30.0°)>0.200m	0.151 / NO	2.851	Fail
a(GZmax)>25.0°	20.6 / NO	2.715	Fail
GMo>0.350m	0.740 / OK	3.339	
Sum. Compliance, max KG' :	NO	2.511	*Min.angle :*



GZ -v- Heel

IMCO condition 3

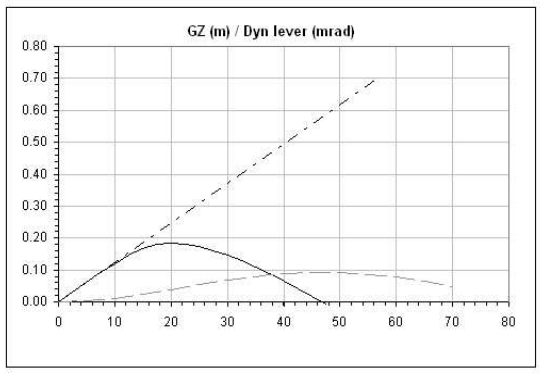
Loading condition : **IMCO 3 - Arrival at home port with full catch (10% fuel, water and stores remaining onboard) - Loading details from Original Formal Investigation and NMI report**

Dens SW =1.025 ton/m^3

Displacement SW (ton) :	219.41		
LCG fw AP (m) :	11.269		
TCG ps CL (m) :	0.000		
KG' (m) :	2.974	GMo' (m) :	0.709

Free trim stability : Heel a (°)	Right. lever GZ (m)	Dyn. lever GZa(0-a) (mrad)	Incr. stab dGZ/da (m/rad)	Draught mld at L/2 (m)	Trim at CL (m)	*(No of iterations)*
0	0.000	0.000	0.709	2.784	-0.630	*8,(2)*
5	0.061	0.003	0.685	2.780	-0.645	*3,(4)*
10	0.120	0.011	0.648	2.767	-0.685	*4,(4)*
15	0.166	0.023	0.363	2.752	-0.751	*3,(4)*
20	0.183	0.039	0.040	2.747	-0.848	*3,(4)*
25	0.175	0.054	-0.211	2.754	-0.972	*3,(4)*
30	0.148	0.069	-0.393	2.772	-1.121	*3,(4)*
35	0.109	0.080	-0.483	2.797	-1.286	*4,(4)*
40	0.065	0.088	-0.521	2.826	-1.453	*4,(4)*
45	0.018	0.091	-0.551	2.856	-1.635	*4,(4)*
50	-0.030	0.091	-0.557	2.890	-1.856	*4,(4)*
55	-0.079	0.086	-0.534	2.929	-2.127	*4,(4)*
60	-0.123	0.077	-0.469	2.970	-2.518	*5,(4)*
65	-0.162	0.064	-0.425	3.017	-3.092	*4,(4)*
70	-0.199	0.049	-0.428	3.092	-3.961	*4,(4)*
GZmax at 20.7°	0.183					

Stability criteria :	Actual value / Compliance	Max KG' (m)	*Crit. Points :* Subm.angle(°)
GZa(0.0°-30.0°)>0.055mrad	0.069 / OK	3.076	
GZa(0.0°-40.0°)>0.090mrad	0.088 / NO	2.963	Fail
GZa(30.0°-40.0°)>0.030mrad	0.019 / NO	2.863	Fail
GZ(>30.0°)>0.200m	0.148 / NO	2.870	Fail
a(GZmax)>25.0°	20.7 / NO	2.741	Fail
GMo>0.350m	0.709 / OK	3.333	
Sum. Compliance, max KG' :	NO	2.520	*Min.angle :*



GZ -v- Heel

IMCO condition 4

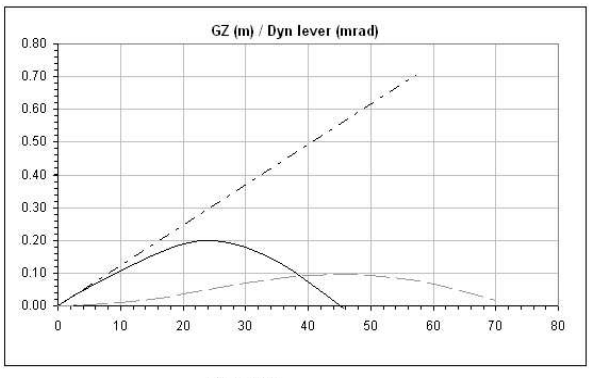
Loading condition : **IMCO 4 - Arrival at home port with 20% catch (10% fuel, water and stores remaining onboard) - Loading details from Original Formal Investigation and NMI report**

Dens SW =1.025 ton/m^3

Displacement SW (ton) :	174.11		
LCG fw AP (m) :	10.450		
TCG ps CL (m) :	0.000		
KG' (m) :	3.146	GMo' (m) :	0.708

Free trim stability : Heel a (°)	Right. lever GZ (m)	Dyn. lever GZa(0-a) (mrad)	Incr. stab dGZ/da (m/rad)	Draught mld at L/2 (m)	Trim at CL (m)	*(No of iterations)*
0	0.000	0.000	0.708	2.387	0.475	*7,(2)*
5	0.058	0.003	0.609	2.382	0.455	*3,(4)*
10	0.108	0.010	0.544	2.366	0.407	*3,(4)*
15	0.153	0.021	0.493	2.341	0.342	*4,(4)*
20	0.189	0.036	0.285	2.306	0.270	*3,(4)*
25	0.198	0.053	-0.071	2.269	0.201	*3,(4)*
30	0.178	0.070	-0.370	2.235	0.136	*3,(4)*
35	0.135	0.084	-0.608	2.203	0.076	*3,(4)*
40	0.075	0.093	-0.777	2.171	0.021	*3,(4)*
45	0.002	0.097	-0.873	2.136	-0.039	*3,(4)*
50	-0.076	0.093	-0.897	2.093	-0.112	*5,(4)*
55	-0.154	0.083	-0.848	2.037	-0.163	*4,(4)*
60	-0.225	0.067	-0.765	1.951	-0.242	*4,(4)*
65	-0.285	0.044	-0.612	1.820	-0.371	*3,(4)*
70	-0.332	0.017	-0.513	1.612	-0.603	*4,(4)*
GZmax at 24.0°	0.199					

Stability criteria :	Actual value / Compliance	Max KG' (m)	*Crit. Points :* Subm.angle(°)
GZa(0.0°-30.0°)>0.055mrad	0.070 / OK	3.258	
GZa(0.0°-40.0°)>0.090mrad	0.093 / OK	3.159	
GZa(30.0°-40.0°)>0.030mrad	0.023 / NO	3.077	Fail
GZ(>30.0°)>0.200m	0.178 / NO	3.103	Fail
a(GZmax)>25.0°	24.0 / NO	3.068	Fail
GMo>0.350m	0.708 / OK	3.504	
Sum. Compliance, max KG' :	NO	2.718	*Min.angle :*



GZ -v- Heel

IMCO condition 2 - plus 10 tonnes ballast

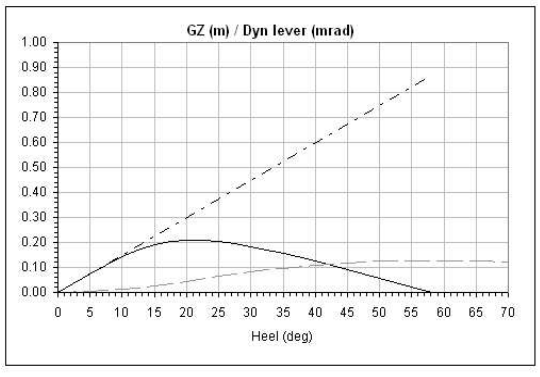
Loading condition : **IMCO Condition 2 with 10 tonnes ballast at LCG**

Dens SW =1.025 ton/m^3

Displacement SW (ton) :	234.00		
LCG fw AP (m) :	11.244		
TCG ps CL (m) :	0.000		
KG' (m) :	2.838	GMo' (m) :	0.857

Free trim stability : Heel a (°)	Right. lever GZ (m)	Dyn. lever GZa(0-a) (mrad)	Incr. stab dGZ/da (m/rad)	Draught mld at L/2 (m)	Trim at CL (m)	*(No of iterations)*
0	0.000	0.000	0.857	2.895	-0.665	*5,(2)*
5	0.074	0.003	0.844	2.891	-0.677	*3,(3)*
10	0.145	0.013	0.717	2.880	-0.714	*3,(4)*
15	0.192	0.028	0.351	2.875	-0.784	*3,(3)*
20	0.209	0.045	0.065	2.884	-0.887	*3,(4)*
25	0.205	0.064	-0.154	2.907	-1.015	*3,(4)*
30	0.185	0.081	-0.288	2.942	-1.164	*4,(4)*
35	0.157	0.096	-0.342	2.983	-1.318	*4,(4)*
40	0.126	0.108	-0.375	3.028	-1.477	*4,(4)*
45	0.092	0.118	-0.406	3.078	-1.660	*4,(4)*
50	0.055	0.124	-0.417	3.138	-1.874	*4,(4)*
55	0.020	0.127	-0.384	3.206	-2.169	*4,(4)*
60	-0.012	0.128	-0.347	3.285	-2.583	*4,(4)*
65	-0.043	0.125	-0.359	3.393	-3.176	*4,(4)*
70	-0.076	0.120	-0.388	3.561	-4.055	*4,(4)*
GZmax at 21.3°	0.210					

Stability criteria :	Actual value / Compliance	Max KG' (m)	*Crit. Points :* Subm.angle(°)
GZa(0.0°-30.0°)>0.055mrad	0.081 / OK	3.030	
GZa(0.0°-40.0°)>0.090mrad	0.108 / OK	2.915	
GZa(30.0°-40.0°)>0.030mrad	0.027 / NO	2.811	Fail
GZ(>30.0°)>0.200m	0.185 / NO	2.807	Fail
a(GZmax)>25.0°	21.3 / NO	2.668	Fail
GMo>0.350m	0.857 / OK	3.345	
Sum. Compliance, max KG' :	NO	2.505	*Min.angle :*



GZ -v- Heel

Loss condition

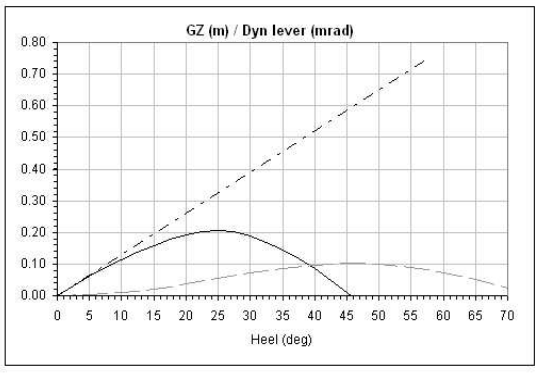
Loading condition : **Loss condition - as determined during the Original Formal Investigation**

Dens SW =1.025 ton/m^3

Displacement SW (ton) :	167.60		
LCG fw AP (m) :	10.248		
TCG ps CL (m) :	0.000		
KG' (m) :	3.161	GMo' (m) :	0.746

Free trim stability : Heel a (°)	Right. lever GZ (m)	Dyn. lever GZa(0-a) (mrad)	Incr. stab dGZ/da (m/rad)	Draught mld at L/2 (m)	Trim at CL (m)	*(No of iterations)*
0	0.000	0.000	0.746	2.322	0.701	*5,(2)*
5	0.060	0.003	0.632	2.316	0.682	*3,(4)*
10	0.112	0.010	0.555	2.300	0.633	*3,(4)*
15	0.157	0.022	0.486	2.274	0.571	*3,(4)*
20	0.194	0.037	0.307	2.238	0.501	*3,(4)*
25	0.205	0.055	-0.044	2.197	0.438	*3,(4)*
30	0.188	0.072	-0.354	2.156	0.386	*3,(4)*
35	0.145	0.087	-0.605	2.116	0.345	*3,(4)*
40	0.084	0.097	-0.786	2.075	0.315	*3,(3)*
45	0.011	0.101	-0.887	2.029	0.288	*3,(4)*
50	-0.070	0.099	-0.941	1.976	0.272	*4,(3)*
55	-0.152	0.089	-0.901	1.904	0.239	*4,(3)*
60	-0.226	0.073	-0.799	1.800	0.206	*4,(3)*
65	-0.289	0.050	-0.635	1.644	0.155	*4,(4)*
70	-0.337	0.023	-0.516	1.398	0.037	*4,(4)*
GZmax at 24.4°	0.206					

Stability criteria :	Actual value / Compliance	Max KG' (m)	*Crit. Points :* Subm.angle(°)
GZa(0.0°-30.0°)>0.055mrad	0.072 / OK	3.291	
GZa(0.0°-40.0°)>0.090mrad	0.097 / OK	3.192	
GZa(30.0°-40.0°)>0.030mrad	0.025 / NO	3.109	Fail
GZ(>30.0°)>0.200m	0.188 / NO	3.136	Fail
a(GZmax)>25.0°	24.4 / NO	3.113	Fail
GMo>0.350m	0.746 / OK	3.557	
Sum. Compliance, max KG' :	NO	2.752	*Min.angle :*



GZ -v- Heel

Loading details

Loads for IMCO condition 1

Departure for fishing grounds condition (IMCO 1)

Total Summary :	W (ton):	LCG:	TCG:	KG:	(KG'):
	188.48	10.283	0.000	3.035	3.042

Floating Condition
Dens SW =1.025 ton/m^3

Draught mld at L/2 (m) :	2.490
Trim (pos aft) (m) :	0.579
Heel a (pos ps) (deg) :	0.00
dGZ/da' (=GM') (m/rad) :	0.831

Fixed Weights :	W (ton):	LCG:	TCG:	KG:	dens*lx (tonm):
Oil fuel incl DS tank	13.00	7.910	0.000	1.970	**1.3
FW tank	4.50	19.900	0.000	1.500	0.000
Fish boxes (1200)	3.37	13.000	0.000	2.290	0.000
Ice	10.00	11.000	0.000	2.100	0.000
Crew, stores and fish gear	7.78	12.583	0.000	4.099	0.000
				**Combined FS correction For FO and FW tanks	
Light Ship:	149.83	9.971	0.000	3.197	0.000

Weight Summary :	W (ton):	LCG:	TCG:	KG:	KG':
	188.48	10.283	0.000	3.035	3.042

Loads for IMCO condition 2

Departure from fishing grounds condition - full boxed fish catch - 35% consumables remain (IMCO 2)

Total Summary :	W (ton):	LCG:	TCG:	KG:	(KG'):
	224.11	11.249	0.000	2.941	2.949

Floating Condition
Dens SW =1.025 ton/m^3

Draught mld at L/2 (m) :	2.820
Trim (pos aft) (m) :	-0.627
Heel a (pos ps) (deg) :	0.00
dGZ/da' (=GM') (m/rad) :	0.741

Fixed Weights :	W (ton):	LCG:	TCG:	KG:	dens*lx (tonm):
Oil fuel incl DS tank	5.00	7.800	0.000	1.600	**1.7
FW tank	1.50	19.820	0.000	1.070	0.000
Fish	60.00	14.340	0.000	2.310	0.000
Crew, stores and fish gear	7.78	12.583	0.000	4.099	0.000
				**Combined FS correction For FO and FW tanks	
Light Ship:	149.83	9.971	0.000	3.197	0.000

Fixed Weight Summary :	W (ton):	LCG:	TCG:	KG:	KG':
	224.11	11.249	0.000	2.941	2.949

Loads for IMCO condition 3

Arrival in Port condition - full boxed fish catch, 10% stores, etc remain (IMCO 3)

Total Summary :	W (ton):	LCG:	TCG:	KG:	(KG'):
	219.41	11.269	0.000	2.970	2.974

Floating Condition
Dens SW =1.025 ton/m^3

Draught mld at L/2 (m) :	2.784
Trim (pos aft) (m) :	-0.629
Heel a (pos ps) (deg) :	0.00
dGZ/da' (=GM') (m/rad) :	0.709

Fixed Weights :	W (ton):	LCG:	TCG:	KG:	dens*lx (tonm):
Oil fuel incl DS tank	1.30	8.000	0.000	1.300	**0.9
FW tank	0.50	19.650	0.000	0.900	0.000
Fish	60.00	14.340	0.000	2.310	0.000
Crew, stores and fish gear	7.78	12.583	0.000	4.099	0.000
				**Combined FS correction For FO and FW tanks	
Light Ship:	149.83	9.971	0.000	3.197	0.000

Fixed Weight Summary :	W (ton):	LCG:	TCG:	KG:	KG':
	219.41	11.269	0.000	2.970	2.974

Loads for IMCO condition 4

Arrival in Port condition - 20% boxed fish catch, 10% stores, etc remain (IMCO 4)

Total Summary :	W (ton):	LCG:	TCG:	KG:	(KG'):
	174.11	10.449	0.000	3.141	3.146

Floating Condition
Dens SW =1.025 ton/m^3

Draught mld at L/2 (m) :	2.387
Trim (pos aft) (m) :	0.476
Heel a (pos ps) (deg) :	0.00
dGZ/da' (=GM') (m/rad) :	0.709

Fixed Weights :	W (ton):	LCG:	TCG:	KG:	dens*lx (tonm):
Oil fuel incl DS tank	1.30	8.000	0.000	1.300	**0.8
FW tank	0.50	19.650	0.000	0.900	0.000
Fish	12.00	14.340	0.000	2.310	0.000
Fish boxes (960)	2.70	13.000	0.000	2.290	0.000
Crew, stores and fish gear	7.78	12.583	0.000	4.099	0.000
				**Combined FS correction For FO and FW tanks	
Light Ship:	149.83	9.971	0.000	3.197	0.000

Weight Summary :	W (ton):	LCG:	TCG:	KG:	KG':
	174.11	10.449	0.000	3.141	3.146

Loads for IMCO condition 2 - plus 10 tonnes ballast

Departure from grounds condition (IMCO 2) + 10T ballast - full boxed fish catch - 35% consumables remain (IMCO 2)

Total Summary :	W (ton):	LCG:	TCG:	KG:	(KG'):
	233.96	11.244	0.000	2.833	2.838

Floating Condition
Dens SW =1.025 ton/m^3

Draught mld at L/2 (m) :	2.894
Trim (pos aft) (m) :	-0.665
Heel a (pos ps) (deg) :	0.00
dGZ/da' (=GM') (m/rad) :	0.858

Fixed Weights :	W (ton):	LCG:	TCG:	KG:	dens*lx (tonm):
Oil fuel incl DS tank	5.00	7.800	0.000	1.600	**1.2
FW tank	1.35	19.840	0.000	1.260	0.000
Fish	60.00	14.340	0.000	2.310	0.000
Crew, stores and fish gear	7.78	12.583	0.000	4.099	0.000
Ballast	10.00	11.253	0.000	0.350	0.000
				**Combined FS correction For FO and FW tanks	
Light Ship:	149.83	9.971	0.000	3.197	0.000

Fixed Weight Summary :	W (ton):	LCG:	TCG:	KG:	KG':
	233.96	11.244	0.000	2.833	2.838

Loads for 1974 Loss condition

OFI - calculated loss condition - 0% fish catch - fuel stores, etc as detailed in table

Total Summary :	W (ton):	LCG:	TCG:	KG:	(KG'):
	167.59	10.245	0.000	3.153	3.161

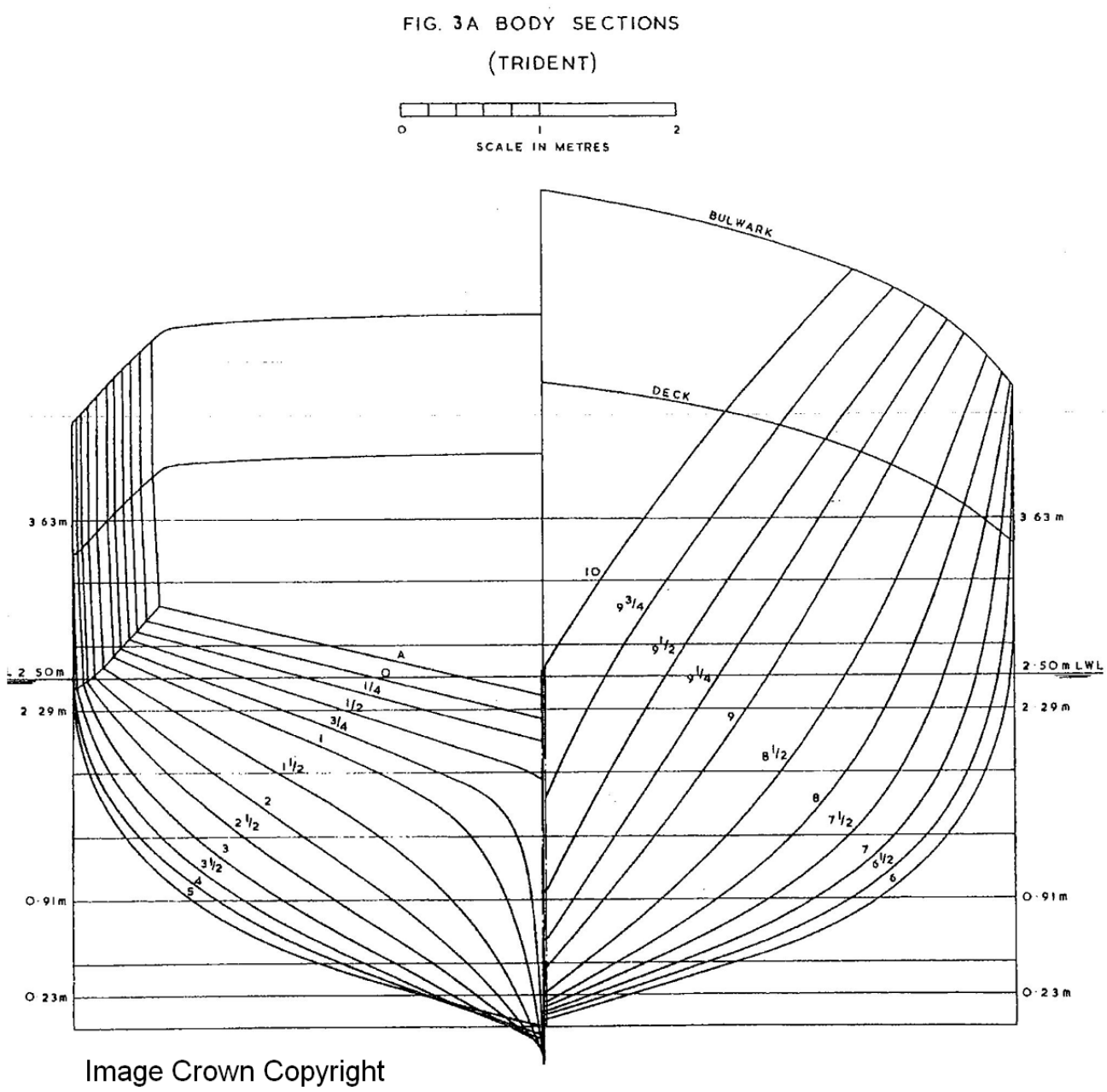
Floating Condition
Dens SW =1.025 ton/m^3

Draught mld at L/2 (m) :	2.322
Trim (pos aft) (m) :	0.704
Heel a (pos ps) (deg) :	0.00
dGZ/da' (=GM') (m/rad) :	0.746

Fixed Weights :	W (ton):	LCG:	TCG:	KG:	dens*lx (tonm):
Oil fuel	5.08	7.814	0.000	1.600	**1.36
FW tank	1.52	19.823	0.000	1.067	0.000
Fish boxes (1200)	3.37	16.379	0.000	2.286	0.000
Crew, stores and fish gear	7.78	12.583	0.000	4.099	0.000
				**Combined FS correction For FO and FW tanks	
Light Ship:	149.83	9.971	0.000	3.197	0.000

Fixed Weight Summary :	W (ton):	LCG:	TCG:	KG:	KG':
	167.59	10.245	0.000	3.153	3.161

Trident body plan from NMI report (1976)



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