Comparative Sea Trials on Peter Ross 'Hydrodynamic' Trawl Floats

Consultancy Services Report No.15

May 1990

SEA FISH INDUSTRY AUTHORITY

Seafish Technology

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SUMMARY

This report describes sea trials which were carried out by Seafish Technology for Peter Ross Fishing Services Ltd to compare the performance of Peter Ross "hydrodynamic" floats with conventional spherical floats.

A hard ground trawl was towed with conventional spherical floats (13 x 11in and 2 x 8in) over one piece of ground at a range of speeds both with and against the tide and its performance recorded.

These spherical floats were then replaced by ten Peter Ross "hydrodynamic" floats of lower total buoyancy. The trawl was then towed over the same piece of ground again at the same range of speeds both with and against the tide and a further block of performance data recorded.

Two further blocks of comparative data were also recorded but in shallower water of only 10-12 fathoms and with correspondingly less warp out than the first two comparative blocks.

Comparing the first two blocks in deeper water the Peter Ross "hydrodynamic" floats gave a marginally lower mean headline height than the spherical floats at the lowest towing speed. However at higher towing speeds the Peter Ross "hydrodynamic" floats gave greater headline heights than the spherical floats due to their hydrodynamic effect (10% more at 2.8 knots and 6% more at 3.10 knots).

The hydrodynamic floats deployed successfully on shooting the trawl and were filmed on video.

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COMPARATIVE SEA TRIALS ON PETER ROSS "HYDRODYNAMIC" TRAWL FLOATS

1 INTRODUCTION

Peter Ross Fishing Services Ltd contracted the Seafish Technology Division of Sea Fish Industry Authority to carry out comparative trials on a "hydrodynamic" design of trawl net float. This design of trawl float is produced under U.K. Patent No. 2,143,413.

Mr Alan Donaldson of Gourdon, made his vessel M.F.V. EMMA KATHLEEN and a trawl available to Peter Ross Fishing Services Ltd for two days to compare the patented trawl float design to the conventional spherical floats normally used.

M.F.V. EMMA KATHLEEN is a conventional aft wheelhouse trawler fitted with a three quarter length shelter deck and powered by a Gardner engine of 310 b.h.p. at 1600 r.p.m.

The aim of the trials was to carry out complete tows both with and against the tide using the trawl exactly as rigged for normal fishing operations. The normal spherical floats would then be removed from the net and replaced by a number of the patented "hydrodynamic" floats which represented a lower total buoyancy than the spherical floats. No other changes were to be made to the trawl or its rigging apart from the change of floats.

A further tow would then be made both with and against the tide to assess any change of trawl geometry, especially headline height, compared to that obtained using the spherical floats.

2 TRIALS EQUIPMENT AND PROCEDURE

2.1 Fishing Gear

The net used for the trials was a four panel hard ground trawl with cut away lower wings, 450 x 4½in mesh fishing circle, 72ft headline, 40ft fishing line and 29ft 6in ground gear extensions on each side.

The headline of the net comprised a 12ft bosom section with 26ft on the wings and 4ft extensions.

The ground gear was made up of 14in rockhoppers in the bosom and bunt sections and rubber discs on the ground gear extensions.

The sweep system comprised 25 fathom wire singles with 20 fathom splits, the top split being wire and the bottom split being chain.

The doors used were a single slot Bison design of 5ft 7in long by 4ft high (1.70 metres x 1.22 metres).

The standard flotation used on the trawl is shown in Fig 1 and comprises five 11in floats in the bosom section, two 8in floats in the quarters and four 11in floats evenly distributed along each wing.

2.2 Instrumentation

Although the aim of the trials was to assess the headline heights achieved with the "hydrodynamic" floats compared to the spherical floats, it was decided that the full set of gear instrumentation should be used.

This enabled both the complete gear geometry and gear drag to be measured over a range of vessel speeds.

The gear geometry was measured by Scanmar distance sensors on the doors and wing ends, and a Scanmar height sensor on the centre of the headline.

Gear drag was measured by tension links placed in-line in the towing strops which took the load from the warps via chain stoppers on the warps. The warp declinations and divergence angles necessary to calculate drag were measured by angular position transducers attached to the towing strops near to the centreline towing point.

Vessel speed was measured by a Braystoke towed log suspended from a pole 4 metres from the vessel's side. The log was maintained at least 6 metres below the water surface so as not to be affected by the waterflow around the vessel.

Details of the instrumentation are given in Appendix I.

2.3 Trials

Trials were carried out within one hours steaming distance of Montrose, as there were tows of adequate and constant depth.

The original aim of the trials had been to carry out two complete blocks of tows over exactly the same piece of ground with the trawl rigged exactly as used for normal fishing operations fitted with conventional spherical floats. Two blocks of tows were felt to be necessary to demonstrate the variation in results obtained even when towing one set of gear over the same piece of ground twice.

One block of tows is defined as a series of five engine r.p.m. settings with or against the tide and then the same five engine r.pm. settings on a reciprocal course. As a vessel speed log is used rather than a net speed log, this enables the tide speed to be estimated, and also its effect on gear performance demonstrated.

In practice, on the first day of the trials as the weather forecast for the second day was poor, it was therefore decided to carry out only one block of tows with the conventional spherical floats and one with the Peter Ross "hydrodynamic" floats on the first day.

The first block of tows was conducted with conventional spherical floats attached to the headline as shown in Fig 1. These floats were of various makes and so samples were later taken from the vessel and the buoyancy measured by Peter Ross at the Marine Laboratory in Aberdeen. The buoyancy of these floats is given in Appendix II and was 129kgs in total.

The gear was shot with the tide in 27 fathoms of water. 100 fathoms of warp were shot which was the amount recommended by the skipper for that depth of water.

The engine r.p.m. was set at 1100 and the gear allowed to settle. Readings were then taken over a five minute period before increasing r.p.m. to 1150, 1200, 1250 and 1300 in turn. The gear was allowed to settle at each r.p.m. setting before the five minute period of data readings.

After taking data readings at 1300 r.p.m. the gear was hauled, the vessel turned onto the reciprocal course and the gear shot away against the tide.

As before readings were taken at the same r.p.m. settings allowing time for the gear to settle.

The results for Block 1 are given in Appendix III and plotted in Fig 3.

When the gear was hauled at the end of Block 1 all of the spherical floats were removed from the headline and replaced by ten of the Peter Ross "hydrodynamic" floats distributed as shown in Fig 2. These ten floats were all of the same size. As for the spherical floats, the buoyancy was measured by Peter Ross at the Marine Laboratory and was 102kgs in total as detailed in Appendix II.

For this second block the gear was again towed with and against the tide over exactly the same ground as for Block 1 and at the same range of engine r.p.m. settings. The results for Block 2 are shown in Appendix III and plotted in Fig 4.

On the second day of trials the weather was poor. It was therefore decided that further comparative results could only be made in shallow water of about 12 fathoms depth in the lee of the land.

Only 50 fathoms of warp could be shot in the shallow water as problems were experienced with door stability when more was shot.

Firstly, Block 3 was conducted with the Peter Ross "hydrodyanmic" floats, as these were already on the trawl. Again the same five r.p.m. settings were used as for Blocks 1 and 2 over reciprocal courses. However in this case the gear was first towed against the tide.

After Block 3 was completed the trawl was brought aboard and the spherical floats replaced on the headline as they had been distributed for Block 1 as shown in Fig 1.

Block 4 was then conducted towing the gear against the tide first.

The results for Blocks 3 and 4 are given in Appendix IV and plotted in Figs 5 and 6 respectively.

3 RESULTS

On examination of the results for Blocks 1-4 shown in Figs 3-6, a number of data points can be seen which appear not to fit the general curves.

For example in Block 1, Fig 3, the door spread increases suddenly at 1300 r.p.m. when towing with the tide. This type of discontinuity in the performance curves of fishing gear is common on trials at sea. It may be explained by a sudden change in the consistency of the ground over which the doors are moving and therefore affecting their spreading ability.

Towing with the tide in Block 2, Fig 4, the door spread gradually decreases with r.p.m. whereas in Block 1 it is constant with a sudden increase at high r.p.m. Again this is probably due to the door performance over the variable ground conditions. During the trials there was certainly evidence that the doors had been over patches of extremely soft mud which had caused polish well up the face of the doors.

In order to compare the relative performance of the Peter Ross "hydrodynamic" floats with the spherical floats, the mean headline heights with and against the tide were calculated and are given in Appendix V.

Comparing the mean headline heights for Blocks 1 and 2 (see Appendix V) it can be seen that at the lowest vessel speed (lowest engine r.p.m.) the spherical floats gave a marginally greater headline height than the "hydrodyanmic" floats. However, at higher vessel speeds, the average headline heights are greater with the "hydrodynamic" floats than with the spherical floats.

For Blocks 3 and 4, which were conducted in shallow water with shorter warps, the door spreads and hence wingend spreads are reduced compared to Blocks 1 and 2. However the door spreads for Blocks 3 and 4 are very constant at about 37 metres both with and against the tide. The mean headline heights with the "hydrodynamic" floats are marginally lower than with the spherical floats at all vessel speeds. However, the maximum difference is only 3% which is not considered a significant difference.

4 CONCLUSIONS

1. In the deeper water tows (Blocks 1 and 2), the 10 "hydrodynamic" floats of 102kgs buoyancy distributed as shown in Fig 2 gave greater headline heights than 13 x 11in and 2 x 8in spherical floats of 129kgs buoyancy distributed as shown in Fig 1. Only at the lowest speed was the headline height lower with the "hydrodynamic" floats than with the spherical floats.

2. Compared to the spherical floats, the "hydrodynamic" floats gave headline heights of -2.7% at the lowest speed, +10.2% at the middle speed and +6.5% at the highest speed.

3. On shooting and hauling, the "hydrodynamic" floats were observed to be streaming free of the net and in the correct orientation. This was recorded on video film.

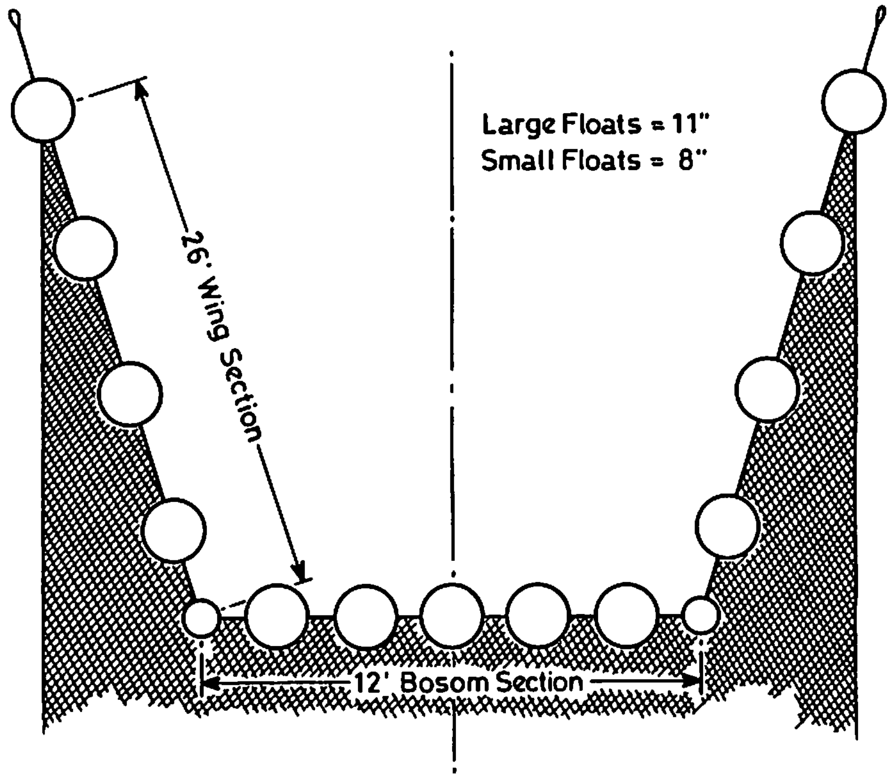


Fig.1 Layout of Spherical Trawl Floats

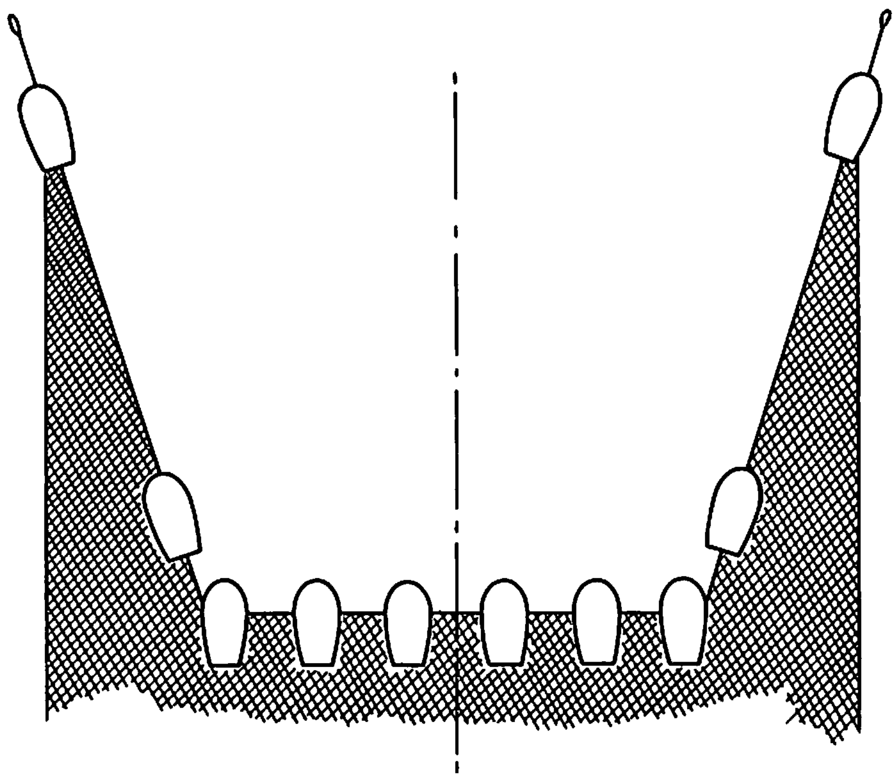


Fig.2 Layout of Peter Ross 'Hydrodynamic Floats

Fig.1-2

TRAWL FLOAT COMPARISON
M.F.V. EMMA KATHLEEN

BLOCK 1
SPHERICAL FLOATS

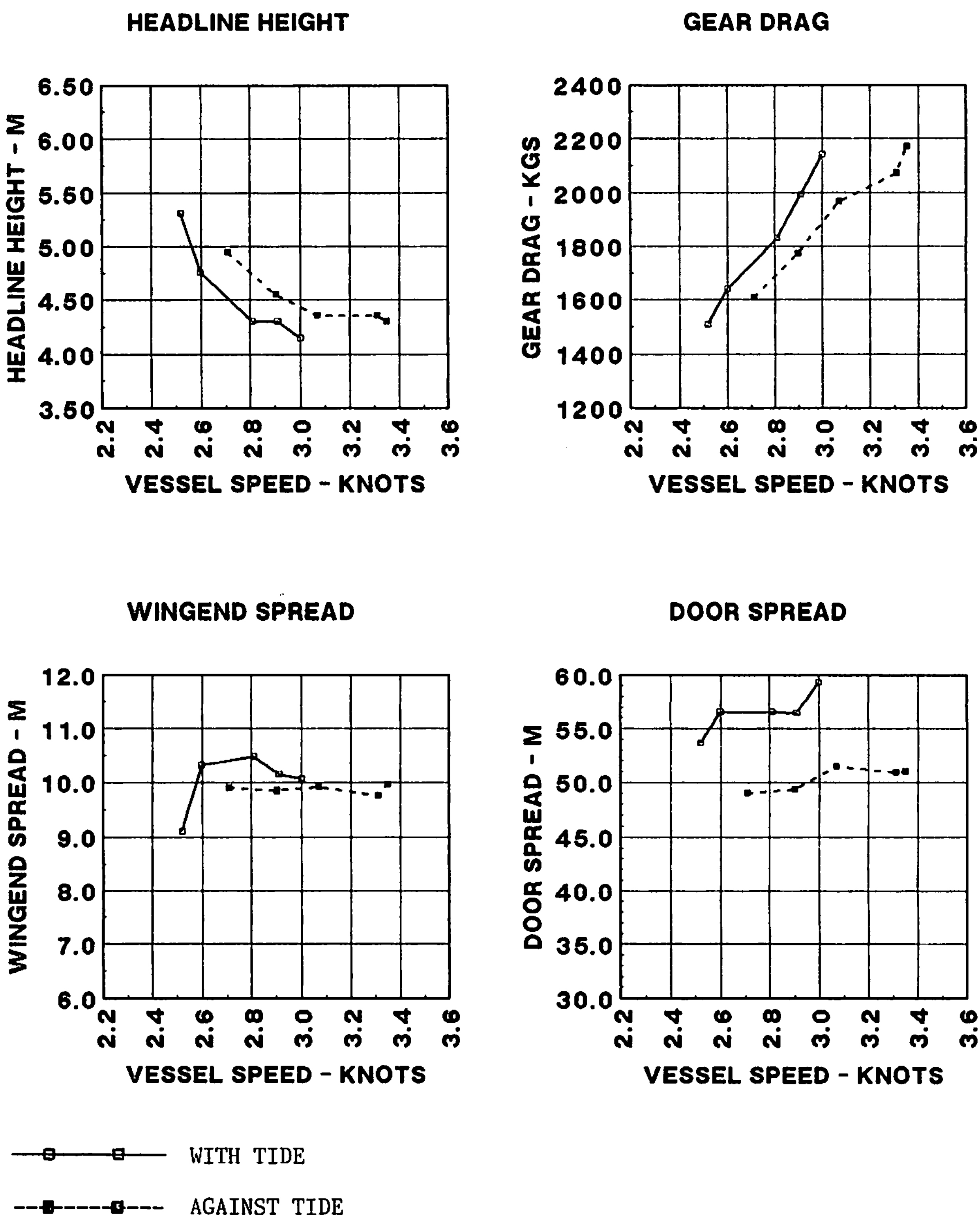
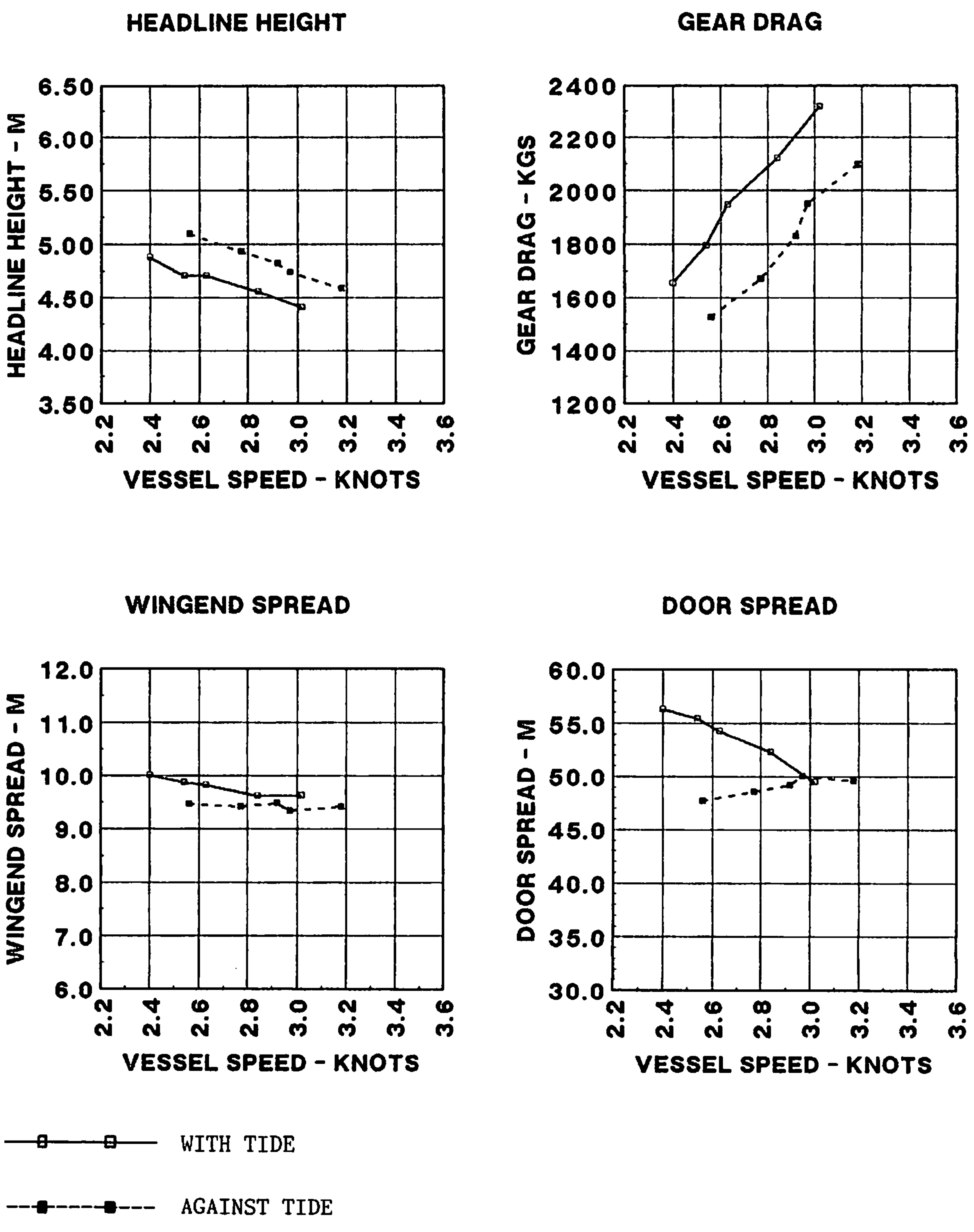


FIG 3

Results for Block 1 (Spherical Floats)

TRAWL FLOAT COMPARISON
M.F.V. EMMA KATHLEEN

BLOCK 2
PETER ROSS HYDRODYNAMIC FLOATS

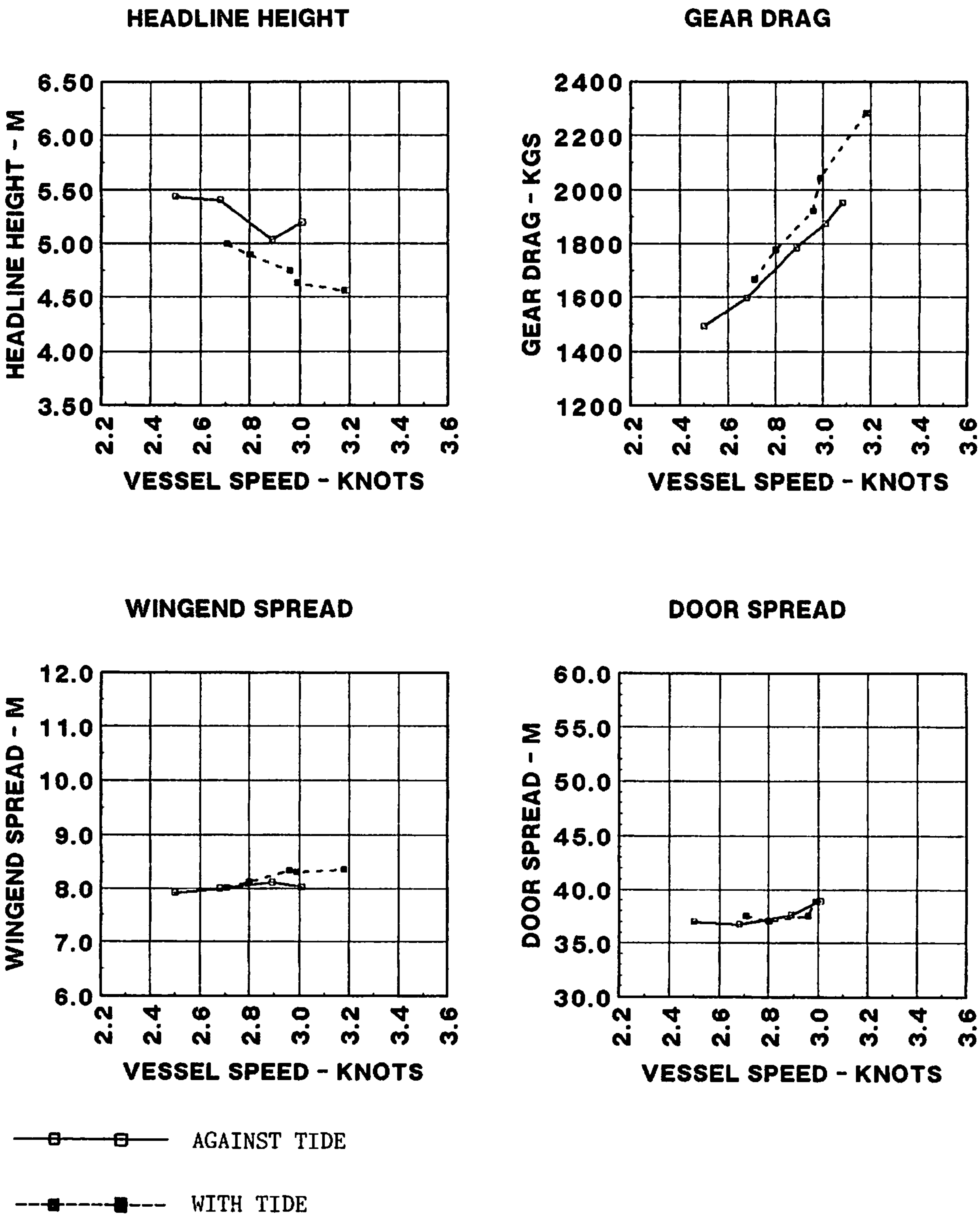


Results for Block 2 ("Hydrodynamic" Floats)

FIG.4

TRAWL FLOAT COMPARISON
M.F.V. EMMA KATHLEEN

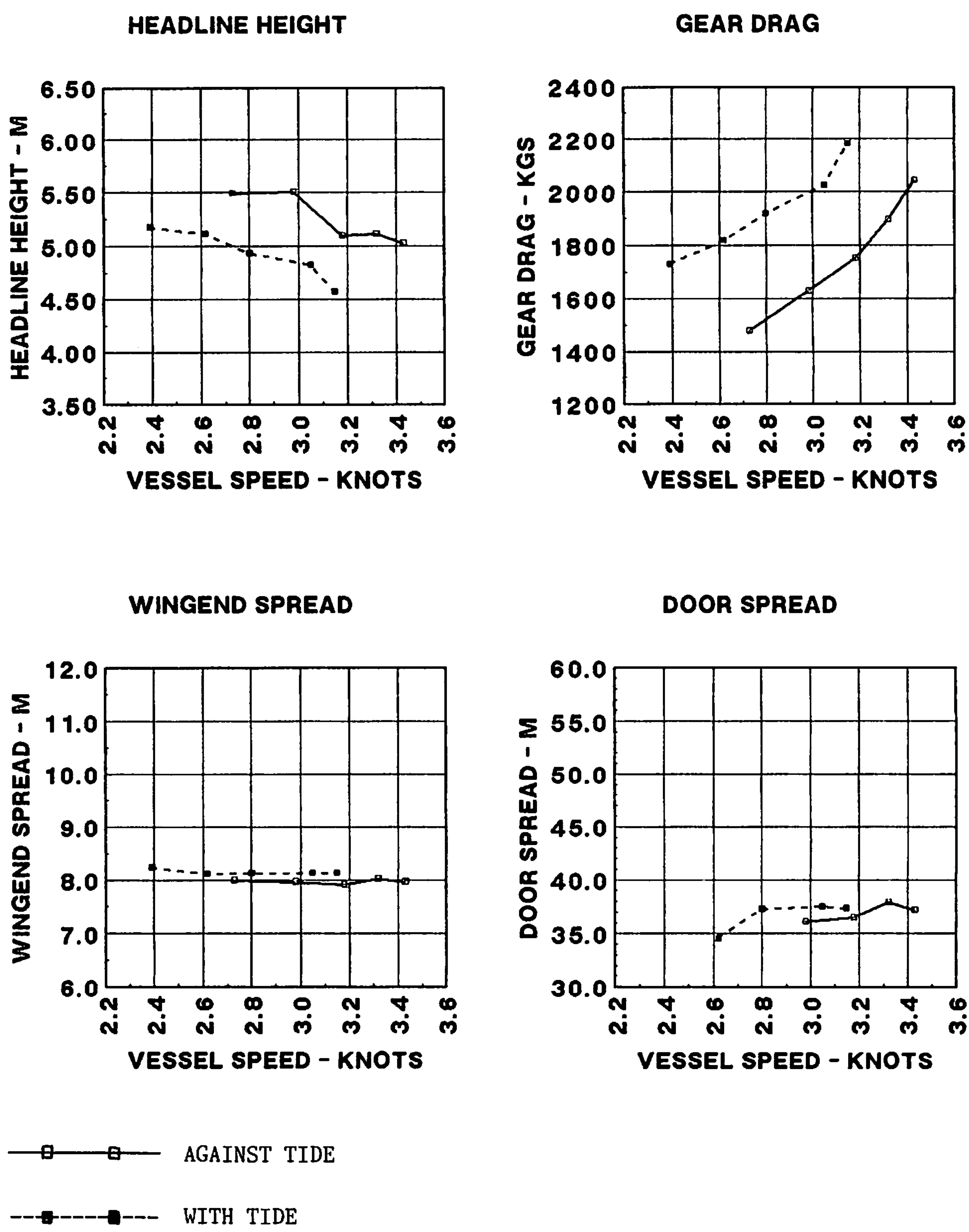
BLOCK 3
PETER ROSS HYDRODYNAMIC FLOATS



Results for Block 3 ("Hydrodynamic" Floats) FIG.5

TRAWL FLOAT COMPARISON
M.F.V. EMMA KATHLEEN

BLOCK 4
SPHERICAL FLOATS



Results for Block 4 (Spherical Floats)

FIG.6

APPENDIX I

INSTRUMENTATION

Parameter		Instrument		Logging
Door spread	(	Scanmar distance	)	
Wingend spread	– (	and height sensors	)	– Visual
Headline height	(		)	
Vessel speed		Braystoke log	)	
			)	
Warp tension P.&.S.		5 tonne tension links	)	– Orion Data Logger
Warp declination P.&.S	_ (	Angular position	)	
Warp divergence	(	transducers	)	

APPENDIX II

DETAILS OF FLOTATION

1. Conventional Spherical Floats

Make	Size Inches Diameter	No.	Buoyancy kgs	Total Buoyancy kgs
Nokalon	11	9	9.50	85.50
Rosendahl	11	2	9.30	18.60
Balmoral	11	1	9.32	9.32
IIM	11	1	9.07	9.07
Nokalon	8	2	3.20	6.40
				*128.89

2. Peter Ross "Hydrodynamic" Floats

No.	Average Buoyancy kgs	Total Buoyancy kgs
10	10.245	*102.45

$$\frac{\text{Spherical float buoyancy}}{\text{"hydrodynamic" float buoyancy}} = \frac{128.89}{102.45} = 1.258$$

OR Spherical floats represent 25.8% more buoyancy than Peter Ross "hydrodynamic" floats.

NOTE: * These figures were supplied by Peter Ross Fishing Services Ltd after measurements were taken at the Marine Laboratory, Aberdeen.

APPENDIX III

Results for Blocks 1 and 2

BLOCK 1

M.F.V. EMMA KATHLEEN — SPHERICAL FLOATS — WARP AFT: 100 FTMS.

RUN NO	DEPTH FTM	ENG RPM	SPEED SHIP KN	SPEED NET KN	WARP-LOAD P. KGS	WARP-LOAD S. KGS	WARP-DECLN P. °	WARP-DECLN S. °	WARP DIV. °	HLINE HT. M	W'END SPRD M	DOOR SPRD M	WARPLOAD P.+S. KGS	MEAN DECLN °	GEAR DRAG KGS
WITH TIDE															
1	27.0	1100	2.52	-	774	853	22.1	19.5	13.9	5.31	9.10	53.67	1627	20.8	1508
2	27.0	1150	2.60	-	929	853	24.0	19.6	14.7	4.76	10.32	56.60	1782	21.8	1639
3	26.0	1200	2.81	-	986	986	21.9	19.0	14.9	4.30	10.48	56.60	1972	20.5	1830
4	26.0	1250	2.91	-	1159	1003	24.8	17.9	14.7	4.30	10.15	56.52	2162	21.4	1995
5	28.0	1300	3.00	-	1172	1118	20.9	17.3	15.0	4.15	10.08	59.33	2290	19.1	2143
AGAINST TIDE															
6	26.0	1100	2.71	-	906	836	23.4	19.4	13.1	4.95	9.90	49.05	1742	21.4	1610
7	26.0	1150	2.90	-	961	924	20.7	16.1	13.4	4.55	9.85	49.39	1885	18.4	1775
8	26.0	1200	3.07	-	1110	984	22.3	14.9	13.6	4.36	9.92	51.48	2094	18.6	1969
9	26.0	1250	3.31	-	1003	1189	19.2	16.1	13.1	4.36	9.76	50.92	2192	17.7	2074
10	26.0	1300	3.35	-	1243	1054	18.9	15.9	13.8	4.30	9.97	50.98	2297	17.4	2174

BLOCK 2

M.F.V. EMMA KATHLEEN — PETER ROSS HYDRODYNAMIC FLOATS — WARP AFT: 100 FTMS.

RUN NO	DEPTH FTM	ENG RPM	SPEED SHIP KN	SPEED NET KN	WARP-LOAD P. KGS	WARP-LOAD S. KGS	WARP-DECLN P. °	WARP-DECLN S. °	WARP DIV. °	HLINE HT. M	W'END SPRD M	DOOR SPRD M	WARPLOAD P.+S. KGS	MEAN DECLN °	GEAR DRAG KGS
WITH TIDE															
1	26.0	1100	2.40	-	922	854	21.6	17.8	15.1	4.88	10.01	56.35	1776	19.7	1656
2	26.0	1150	2.54	-	966	959	21.3	17.7	15.2	4.71	9.87	55.46	1925	19.5	1797
3	27.0	1200	2.63	-	1065	1023	21.1	18.0	15.1	4.71	9.82	54.31	2088	19.6	1948
4	28.0	1250	2.84	-	1189	1093	21.8	18.5	14.8	4.56	9.62	52.33	2282	20.2	2122
5	28.0	1300	3.02	-	1340	1165	22.3	19.4	14.6	4.41	9.63	49.55	2505	20.9	2319
AGAINST TIDE															
6	28.0	1100	2.56	-	845	802	22.4	19.4	13.4	5.10	9.47	47.75	1647	20.9	1527
7	28.0	1150	2.77	-	873	926	21.0	20.1	13.4	4.94	9.42	48.59	1799	20.6	1671
8	26.0	1200	2.92	-	995	981	20.2	21.6	13.4	4.83	9.48	49.19	1976	20.9	1832
9	26.0	1250	2.97	-	1085	1005	19.8	20.0	13.7	4.74	9.34	50.04	2090	19.9	1949
10	26.0	1300	3.18	-	1110	1110	19.0	16.3	13.8	4.59	9.42	49.63	2220	17.7	2099

APPENDIX IV

Results for Blocks 3 and 4

BLOCK 3

M.F.V. EMMA KATHLEEN — PETER ROSS HYDRODYNAMIC FLOATS — WARP AFT: 50 FTMS.

RUN NO	DEPTH FTM	ENG RPM	SPEED SHIP KN	SPEED NET KN	WARP-LOAD P. KGS	WARP-LOAD S. KGS	WARP-DECLN P. °	WARP-DECLN S. °	WARP DIV. °	HLINE HT. M	W'END SPRD M	DOOR SPRD M	WARPLOAD P.+S. KGS	MEAN DECLN °	GEAR DRAG KGS
AGAINST TIDE															
1	11.0	1100	2.50	-	759	838	19.7	16.2	20.4	5.44	7.91	37.00	1597	18.0	1493
2	11.0	1150	2.68	-	767	941	19.9	16.0	20.3	5.41	8.00	36.75	1708	18.0	1597
3	11.0	1200	2.89	-	964	943	19.5	15.5	20.8	5.04	8.11	37.61	1907	17.5	1786
4	12.0	1250	3.01	-	999	1010	19.5	16.4	21.6	5.20	8.03	38.91	2009	18.0	1874
5	12.0	1300	3.08	-	1055	1048	20.2	16.7	22.0	-	-	-	2103	18.5	1954
WITH TIDE															
6	12.0	1100	2.71	-	902	886	20.1	16.6	20.7	5.00	8.01	37.52	1788	18.4	1666
7	11.0	1150	2.80	-	980	918	19.5	15.7	20.5	4.90	8.12	37.05	1898	17.6	1777
8	11.0	1200	2.96	-	1038	1010	18.7	15.8	20.8	4.75	8.34	37.51	2048	17.3	1921
9	11.0	1250	2.99	-	1078	1096	17.9	15.0	21.6	4.63	8.30	38.90	2174	16.5	2045
10	11.0	1300	3.18	-	1242	1183	17.4	15.1	21.6	4.56	8.36	-	2425	16.3	2283

BLOCK 4

M.F.V. EMMA KATHLEEN — SPHERICAL FLOATS — WARP AFT: 50 FTMS.

RUN NO	DEPTH FTM	ENG RPM	SPEED SHIP KN	SPEED NET KN	WARP-LOAD P. KGS	WARP-LOAD S. KGS	WARP-DECLN P. °	WARP-DECLN S. °	WARP DIV. °	HLINE HT. M	W'END SPRD M	DOOR SPRD M	WARPLOAD P.+S. KGS	MEAN DECLN °	GEAR DRAG KGS
AGAINST TIDE															
1	11.0	1100	2.73	-	800	797	22.2	16.9	19.5	5.49	8.00	-	1597	19.6	1480
2	11.0	1150	2.98	-	849	906	21.8	16.1	19.9	5.51	7.97	36.15	1755	19.0	1632
3	11.0	1200	3.18	-	910	974	21.8	15.6	20.2	5.10	7.91	36.55	1884	18.7	1754
4	10.0	1250	3.32	-	1041	997	22.4	14.6	21.0	5.12	8.03	37.92	2038	18.5	1897
5	10.0	1300	3.43	-	1101	1070	19.0	14.4	20.6	5.03	7.97	37.23	2171	16.7	2043
WITH TIDE															
6	10.0	1100	2.39	-	907	935	18.6	16.6	18.8	5.18	8.24	-	1842	17.6	1730
7	11.0	1150	2.62	-	1007	938	18.9	17.8	18.9	5.12	8.12	34.60	1945	18.4	1818
8	11.0	1200	2.80	-	1104	963	19.2	18.7	20.6	4.94	8.14	37.30	2067	19.0	1920
9	11.0	1250	3.05	-	1129	1064	18.8	20.7	20.8	4.83	8.13	37.55	2193	19.8	2026
10	11.0	1300	3.15	-	1178	1192	18.5	21.5	20.7	4.58	8.13	37.35	2370	20.0	2186

APPENDIX V

Comparison of Headline Heights

	BLOCK 1			BLOCK 2			
	SPHERICAL FLOATS			PETER ROSS FLOATS			
ENG RPM	HEADLINE HEIGHTS			HEADLINE HEIGHTS			HEADLINE HT DIFFERENCE ROSS/SPHERICAL
	WITH TIDE M	AGAINST TIDE M	MEAN M	WITH TIDE M	AGAINST TIDE M	MEAN M	%
1100	5.31	4.95	5.13	4.88	5.10	4.99	-2.7
1150	4.76	4.55	4.66	4.71	4.94	4.83	+3.7
1200	4.30	4.36	4.33	4.71	4.83	4.77	+10.2
1250	4.30	4.36	4.33	4.56	4.74	4.65	+7.4
1300	4.15	4.30	4.23	4.41	4.59	4.50	+6.5

	BLOCK 3			BLOCK 4			
	PETER ROSS FLOATS			SPHERICAL FLOATS			
ENG RPM	HEADLINE HEIGHTS			HEADLINE HEIGHTS			HEADLINE HT DIFFERENCE ROSS/SPHERICAL
	AGAINST TIDE M	WITH TIDE M	MEAN M	AGAINST TIDE M	WITH TIDE M	MEAN M	%
1100	5.44	5.00	5.22	5.49	5.18	5.34	-2.2
1150	5.41	4.90	5.16	5.51	5.12	5.32	-3.0
1200	5.04	4.75	4.90	5.10	4.94	5.02	-2.5
1250	5.20	4.63	4.92	5.12	4.83	4.98	-1.2
1300	-	4.56	-	5.03	4.58	4.81	-