The Performance of High Speed Fishing Vessels in Service

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SEA FISH INDUSTRY AUTHORITY
Industrial Development Unit

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SUMMARY

This report describes a study into the performance of high speed vessels used for static fishing. Definitions of high speed and displacement craft are given.

As a significant number of high speed vessels are now used for commercial fishing, and little operational data has been collected, it was decided to undertake trials on a number of such vessels to obtain in-service performance data.

Trials were carried out on six potting vessels of between 8 and 12 metres length, in order to measure the fuel consumption and maximum speed for varying loads carried on board.

The results have been given in terms of litres of fuel consumed per mile, so that a ready comparison can be made of the relative costs of higher speed.

Vessel maximum speeds were found to vary between 12 and 16 knots, and added loads made very little difference to performance at low speeds, but had a much greater detrimental effect at high speed.

Only two of the vessels actually achieved planing characteristics and almost all skippers felt the boats were performing better than the actual results demonstrated.

The importance of speed must be considered against the operational requirements of the vessel. Is more time required on the fishing grounds or are more distant grounds needed to be reached in a day. The economics of this can only be decided by relating the extra cost in fuel consumption to the time gained. These arguments are discussed in the report but a more complete analysis may be necessary for each case.

Finally recommendations are made that studies should be made of lighter construction methods for high speed craft and studies also carried out of semi-displacement craft operating in the lower speed ranges actually achieved by the trials vessels. These may well be more appropriate to the fishermens needs.

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1 INTRODUCTION

This report describes a study undertaken by the Industrial Development Unit of the Sea Fish Industry Authority as part of the 1984-85 Commission A.1.2. from the Ministry of Agriculture, Fisheries and Food.

As a significant number of high speed vessels are now being employed for commercial fishing, it was felt necessary to collect data on the performance of these vessels under actual service conditions.

This data would then allow any prospective purchaser of a high speed vessel to make realistic economic calculations and performance estimates before deciding if the high speed vessel was more suitable than a conventional displacement vessel for a given operation.

The desire for higher speed in static fishing vessel operations is due mainly to the benefits of reduced steaming time to the fishing grounds or the ability to fish grounds farther afield in a given working day. However, each individual fishing operation is different and other benefits may include the ability to fish in areas of very fast tidal streams or the ability to fish more sets of gear over a given tide.

The definition of a high speed vessel is very vague, but for the purpose of this report it will be taken to be any vessel whose speed to length ratio exceeds 1.60 as defined in the formula $0.5521 \times V/\sqrt{L}$.

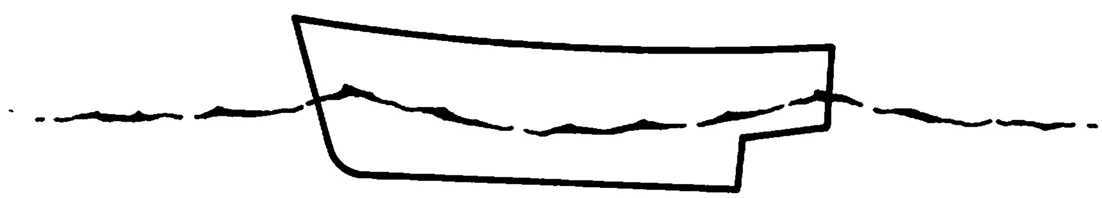
2 PERFORMANCE CHARACTERISTICS OF DISPLACEMENT AND PLANING VESSELS

2.1 Definitions

Most fishing vessels are built with a hull form which places them in the "displacement vessel" category of possible vessel designs. A much smaller number of fishing vessels are built to designs which place them in the "planing vessel" category with the intention of use at higher speed than would be possible with a displacement vessel hull. The type of hull may be defined by reference to the wave pattern which vessel movement creates, as defined below.

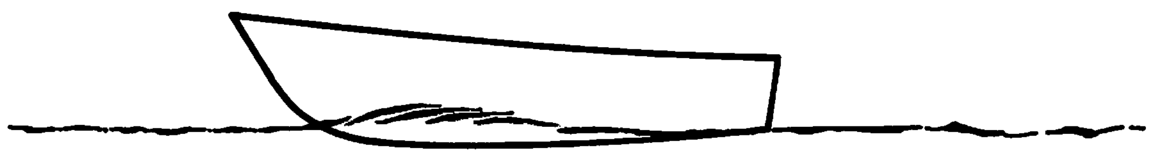
a) **Displacement Vessel**

This type of vessel is limited in its maximum speed by the waves which its forward motion creates. The hull does not rise noticeably above the zero speed position when at full speed, and has a large wave crest at the bow and stern with a single trough in between. The displacement vessel will always reach a speed *where* a large increase in power leads to a very small increase in speed, and this phenomenon limits the maximum speed of the vessel.



b) **Planing Vessel**

At low speeds this type of vessel behaves as a displacement vessel. Its hull is usually ill-suited to driving in this speed range. As speed increases the bow rises on the bow wave and the vessel goes through a region of very high resistance. If more power is available the whole hull rises up further and begins to overtake the bow wave as speed increases. The hull is now noticeably above its zero speed position in the water and is skimming over the surface of the water with no wave crests at the bow or stern. At this point the vessel is said to be planing.



Vessels can and do exist in between these two categories, where the bow wave still exists but the stern wave is left well behind the vessel.

2.2 Speed/Power Relationships

The most convenient way to demonstrate the performance characteristics of any vessel is to plot the resistance against speed. However, if two vessels of differing sizes and weights are to be compared it is more traditional to plot the resistance per unit weight (specific resistance) against the speed/length ratio (which, using the convenient values of vessel speed V in knots and vessel length L in metres is defined by the formula $0.5521 \times V/\sqrt{L}$. As an example a 10m vessel running at 10 knots has a speed length ratio of 1.75).

Fig. 1 shows two curves of resistance per unit weight (specific resistance) against speed-length ratios, representing a displacement vessel and planing vessel of the same size and weight. Fig. 1 is taken from Ref. 1 and the symbols and units defined in the nomenclature.

The curve for the displacement vessel is characterised by the smooth continuous rise in resistance to the point where a very small rise in speed-length ratio gives a very large rise in specific resistance. For the vessel in question it would be very difficult to push it above a speed-length ratio of 1.60.

For the planing vessel, the curve rises in a similar way to the displacement vessel, up to a speed length ratio of 1.50. Above this point there is a hump in the curve after which the specific resistance does not rise so quickly. Effectively this means that the speed can be increased more easily above the hump than below it.

As some fast boats fall midway between the characteristics of displacement and planing vessels, planing in itself cannot be the arbiter of whether a boat is fast or not. For the purposes of this report any vessel which exceeds a speed - length ratio of 1.60 is considered to be a high speed vessel.

It can be seen for the two example vessels, which are of identical weights and lengths, that each has a speed range of operation where it is better than the other. At low speed the displacement vessel has lower resistance, and at high speed the planing vessel has lower resistance.

Although resistance is a means of comparing two different vessels, it is the power that needs to be installed to overcome the resistance and its subsequent fuel consumption which are the true measures of efficiency.

To go from a curve of resistance to a curve of required horsepower and then to a curve of fuel consumption would require inputs of the propeller characteristics and engine fuel consumption data. Although neither of these two items is of constant efficiency, the final curve of fuel consumption against speed will generally reflect the type of basic resistance curve which the vessel has. That is to say, if a vessel is planing its speed/fuel consumption curve will have a characteristic hump as for the resistance curve. For a displacement vessel the speed/fuel consumption curve will continue to rise smoothly to the point where, at high speed, a large increase in fuel consumption will give only a small increase in speed.

3 TRIALS

3.1 Vessel Selection

As little performance data had been collected on high speed vessels, it was decided to undertake limited trials on a cross section of vessel types, rather than doing more detailed trials on fewer vessels.

Appendix I shows the vessels and principal characteristics.

Initially five vessels were selected and trials carried out. As one vessel was part of a series of five sisterships, a sixth trial was carried out on another vessel in the series to see if a different propeller made any improvement to the performance.

The five initial vessels selected were considered representative of the range of sizes, hull forms and machinery powers which are built for commercial fishing.

All vessels were considered to be planing type hull forms as opposed to displacement type or semi-displacement type (midway between a planing hull form and displacement hull form). The planing hulls were of two distinct types, namely hard chine and trihedral dory type. Examples of these two hull forms are given in Figs. 2 and 3.

3.2 Trials Procedure

As only a small number of parameters was to be measured due to the limited time available for each trial, it was decided that speed and fuel consumption should be monitored for a range of loads on board.

The load on board each vessel was made up of all fuel, trials personnel and gear, and any other gear not normally carried for a commercial trip. Additional loads were simulated by a number of water containers which were evenly distributed over the working deck and filled as required.

Fuel flow was measured by the I.D.U. 'Envirosystems' fuel flow meter and results at full power checked to ensure they were in line with the engine manufacturers fuel consumption figures.

Vessel speed was measured either by a pole log hung over the stern or by running a measured distance if this was available. Problems were encountered due to the inaccuracy of a log purchased specifically for high speed operation, and so a log normally used at lower speeds was substituted and found to be more accurate. When possible this log was calibrated after being installed on each vessel by either running a set distance between navigational points or running a set distance on an electronic navigator.

The log was suspended on a pole from a large 'G' clamp hooked over the transom. The log was lowered until the impeller was fully immersed in the vessel wake outside of the propeller line. It is hoped that this log can be further developed to give confidence in its use without constant calibration.

3.3 Trial Results

The principal particulars and specifications of the six vessels used in the trials are given in Appendix I. The trial results are given in Appendix II and plotted in Figs. 4 to 9.

s the speed trial of 'Sweet Promise' (see Fig. 7) was carried out on a normal fishing trip, no figures are given for increased loads on board.

If each speed/fuel consumption curve is compared with the speed/resistance curves in Fig. 1, it can be seen that none has the continually steepening curve with increased speed length ratio as for the displacement vessel.

However only two vessels, namely 'Sea Jade' and 'Nautilus' definitely exceeded the hump speed and appeared to be truly planing. For 'Sea Jade' lightly loaded the speed/fuel consumption curve levels out so that the fuel consumed per mile is constant between about 12 knots and top speed. This means that if the vessel is steaming at a speed of 12 knots or more the skipper can save time by increasing the speed with no increase in actual fuel consumed. As extra load is carried, however, the fuel consumption curves do not quite level out. Even so, the extra fuel consumed for the top two knots in each case, is very small.

Although 'Nautilus' had the highest fuel consumption in the trials, she was also the fastest vessel in the group. Below planing speed the curves are similar to a displacement vessel but once planing above the hump speed it appears to be marginally more economic to actually steam at higher speed. The maximum speed of 'Nautilus' was not reached in practice due to the fuel flow meter preventing the monitored engine reaching its full power. The second engine had to be matched to the monitored engine in order to ensure equal power output and so was also below maximum power.

The fuel consumption curve for 'Vixen' shows that the vessel was not actually planing. This could be due to the weed growth on the underside of the hull. For its size 'Vixen' has a comparatively large power unit and would be expected to be faster than found on trials.

The fuel consumption curves for 'J.N.P.' are marginally worse than those for 'Plus Two' which is an identical sistership apart from a different propeller. The improvement in performance between 'J.N.P.' and 'Plus Two' is possibly due in part to the propeller change, but also to the fact that 'Plus Two' had a clean underside whereas 'J.N.P.' had heavy weed growth.

The curve for 'Sweet Promise'shows an almost straight line rise in fuel consumption with speed. There is however a small hump in the curve which may be due to resistance characteristics or experimental scatter.

The common factor for all vessels is basically that unless operating in a true planing mode, more fuel is consumed the faster the vessel steams. Even though a vessel which can plane may be able to increase its speed without consuming any more fuel for a given distance, it would always consume less fuel if the speed was reduced to say half full speed.

As an example of this, the fuel consumed for a given distance at nine knots can be compared for each vessel against the fuel consumed at full speed. In every case and at every load condition substantially less fuel is used for a given distance at nine knots than at full speed.

This effectively means that the ability to economise is always there if required. However, if this lower speed was to be the service speed, then the type of hull form most suited to this speed would probably be different to the hard chine or trihedral dory forms.

The effect of added weight varies from one vessel to another. However, adding weight reduces top speed in all cases and also requires more fuel per mile for a given speed. The added weight also affects the performance much more at the top end of the speed range than at the bottom.

For example, the performance of 'J.N.P.', 'Plus Two' and 'Nautilus' are hardly affected at all between 8.0 and 9.0 knots by added weight. The speed/fuel consumption curves almost run into each other in this speed range. At the upper end of the speed range the curves spread apart requiring much greater fuel consumption at a given speed for each load added.

The significance of this reduction in performance and increase in fuel consumption due to added weight is very important for a high speed vessel. It infers that, if the weight of a vessel can be reduced, then the performance will be increased.

For all vessels the lowest load shown on the speed/fuel consumption curve approximately represents a full load of fuel. In some cases this weight of fuel could be reduced significantly leading in fact to lower fuel consumption. Although in some cases a full load of fuel must be taken on due to the problems of obtaining fuel, other vessels, which can obtain fuel readily and easily, could perhaps only fill to half capacity and benefit from either increased performance or reduced fuel consumption.

In order to give some idea of the load carrying ability to attain a given speed Table 1 was drawn up from the trial results (See Appendix II).

TABLE 1
SPEED/LOAD CAPABILITY

Vessel	Horsepower (length-metres)	Speed Knots	Fuel Consumption Litres/Mile	Load Tonnes
Sea Jade	184	16.0	-	-
	(10.1)	14.0	2.57	0.63
		12.0	2.88	1.76
		11.0	2.77	1.76
Vixen	190	16.0	-	-
	(8.3)	14.0	-	-
		12.0	-	-
		11.0	3.38	0.46
J.N.P.	270	16.0	-	-
	(12.0)	14.0	-	-
		12.0	3.70	1.43
		11.0	3.80	2.05
Plus Two	270	16.0	-	
	(12.0)	14.0	3.76	1.08
		12.0	3.60	2.57
		11.0	3.05	2.57
Sweet Promise	320	16.0	-	-
	(10.3)	14.0	4.25	0.74
		12.0)		
		11.0)	No increased load carried	
Nautilus	424	16.0	5.40	1.73
	(10.0)	14.0	6.05	2.49
		12.0	6.18	
		11.0	6.24	2.49

4 VESSEL CONSTRUCTION AND LAYOUT

4.1 Construction

All vessels used in the trials were of G.R.P. hull construction with either plywood, G.R.P. sheathed plywood, or G.R.P. decks and superstructures.

Although no actual weights of vessels were taken, by reference to manufacturer's brochures and S.F.I.A. marine surveyors under whom some of the vessels were built, the hull scantlings appear to be approximately the same as for displacement vessels of the same general dimensions.

Most displacement vessels, however, tend to have some ballast fitted and often have a greater amount of outfit and heavier deck gear, giving a greater total vessel weight for a given size.

The resistance curves given in Fig. 1 show two different types of boat namely displacement and planing. The curves shown are in fact for vessels of similar dimensions and weights. In practice though, as mentioned above, the displacement boat would generally be heavier.

In general the hull thickness and weight of small G.R.P. vessels is determined more by the need for a stiff non-flexing hull rather than just strength alone. If therefore a vessel was to be constructed more lightly the hull construction method would have to be stiffer than for the traditional single skin G.R.P. construction.

Although the technology exists to construct stiffer lighter hulls, the problem is whether or not this reduction in weight would produce a workable vessel or not.

4.2 Layout

All vessels used in the trials had forward wheelhouses with the pot hauler on the starboard side, either beside the wheelhouse or immediately aft of it. This layout gives a large clear rectangular deck aft on which to stow pots or other gear.

Engines were either sited amidships with a straight shaft, or else right aft driving the propeller via a 'V' drive located under the working deck forward of the engine.

Working decks were either located above the engine top giving a completely flush working deck, or else below engine top level requiring an engine cover box protruding up into the working deck space.

Drawings of three of the boats used in the trials are shown in Appendix I, demonstrating the permutations in layout.

5 OPERATION AND ECONOMICS

5.1 High Speed v Conventional Vessels

There are a number of reasons why a high speed vessel may be used for fishing, but these can be summarised in three sections.

1. To fish grounds farther afield requiring either (a) a larger vessel or (b) a faster vessel.

2. To reduce steaming time to and from the fishing grounds giving (a) a shorter working day to complete a given task (b) more fishing time on the grounds or (c) the ability to run home quickly in case of bad weather.

3. To enable a particular fishing operation to be carried out e.g. (a) to overcome a very fast tide or (b) to fish more gear over a limited time dictated by tides.

As every fishing operation is different, especially in small scale coastal fishing operations, it is impossible to generalise on the economics or benefits of high speed vessels as opposed to conventional displacement vessels.

However, if a high speed vessel is compared with a conventional vessel of the same length and beam it can be assumed that the high speed vessel will use more fuel to cover a given distance.

If the particular operation would have required a larger conventional displacement vessel than the high speed vessel, the fuel costs may be nearer to equal. In this case the larger displacement vessel would probably cost more in terms of capital, but be nearer equal in terms of fuel cost.

Before any economic estimates can be made it is important to look at the type and size of conventional vessel required for a given operation and compare it with the size of high speed vessel to undertake the same operation. This must be done rather than simply comparing the two vessel types of equal size.

Once speed has been identified as being a significant factor in the operating cycle of the boat, the elements for discussion in selecting a suitable design are:-

(i) What is the minimum speed needed to complete the steaming duties required of the vessel in the desired time?

(ii) What will be the load carried by the vessel at different times in the operating cycle?

(iii) What are the benefits (if any) of running at a higher speed than defined in (i) above.

(iv) How often is it convenient to take fuel? What are the time loss/delay costs of refuelling on every trip, every second trip, etc.

By producing answers to these questions the prospective owner may ask for tenders against specified load/speed characteristics for his vessel and thus have some reasonable expectation that his requirements might be met, and against which a trials procedure can be drawn up.

It cannot be stressed too strongly that vessel operational speeds are limited by the loads to be carried, and only when the loads can be accurately identified can a builder produce a realistic specification for a proposed vessel.

5.2 Choice of Hull Form

In many of the instances tested in the trials, the operational speed with any load that might be considered appropriate to the vessels operational requirements led to a limitation in speed to within the range which could be met by the fast round bilge hull type.

References 2 and 3 both give the fast round bilge hull types as being the most suitable for speed-length ratios up to about 3.0. In practice this means that, if a vessel of 10.0 metres waterline length has a speed of less than 17.0 knots, it should have a round bilge hull form for minimum fuel consumption.

However, most published data on the resistance of fast vessels does not directly apply to the dimensions and forms of fishing vessels, and so further trials would be necessary to find out if the round bilge hull type could attain the same performance using less fuel.

6 CONCLUSIONS

1. The maximum speeds of the vessels used in the trials varied from twelve to sixteen knots, with the equivalent of a full load of fuel on board but no deck load.

2. Added load on board made very little difference to performance at low speeds, but had a much greater detrimental effect at high speed.

3. It appears that a reduction in weight either by lighter hull construction or by the carrying of less fuel would give improved performance and lower fuel consumption.

4. Hull fouling appears to have an extremely detrimental effect on vessel performance especially at higher speeds.

5. The skipper/owners of some of the trials vessels thought that the boats were performing better than they actually did on trials.

6. Only two of the vessels appeared to achieve a true planing characteristic. That is, once a certain level of speed has been reached the vessel can afford to go faster with little, if any, rise in the fuel consumption per mile.

7. When calculating the economics of operating a high speed vessel, the costs should be compared with the size of displacement vessel able to undertake the same task, rather than necessarily a vessel of the same dimensions.

7 RECOMMENDATIONS

1. A study should be made into the use of stiffer and lighter structures for high speed vessels, in order to reduce vessel weight and fuel consumption.

2. Data should be gathered on high speed vessel operation so that a complete economic analysis can be made.

3. Trials should be carried out on one or two round bilge semi-displacement vessels, to see if they are more efficient than planing hull forms in the speed range encountered on the trials in this report.

8 NOMENCLATURE

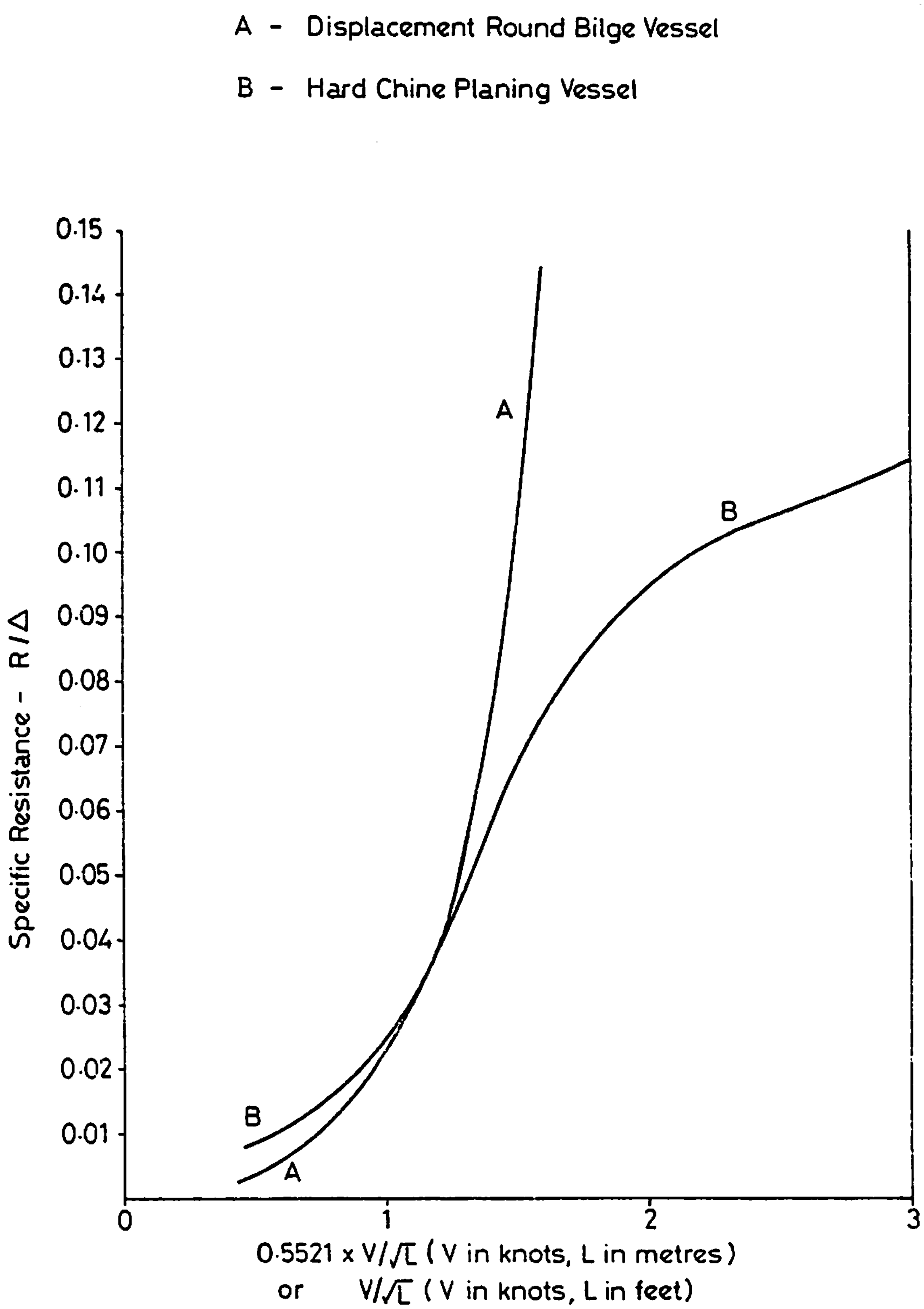
		Metric	Imperial
L	Length on Waterline	Metres	Feet
R	Resistance	KGS	lbs
S	Vessel Weight	KGS	lbs
V	Vessel Speed	Knots	Knots
$0.5521\ V/\sqrt{L}$	Speed Length Ratio	Knots/metres	

REFERENCES

1. "Aero-hydrodynamics of sailing" C. A. Marchaj (ADLARD COLES LIMITED)

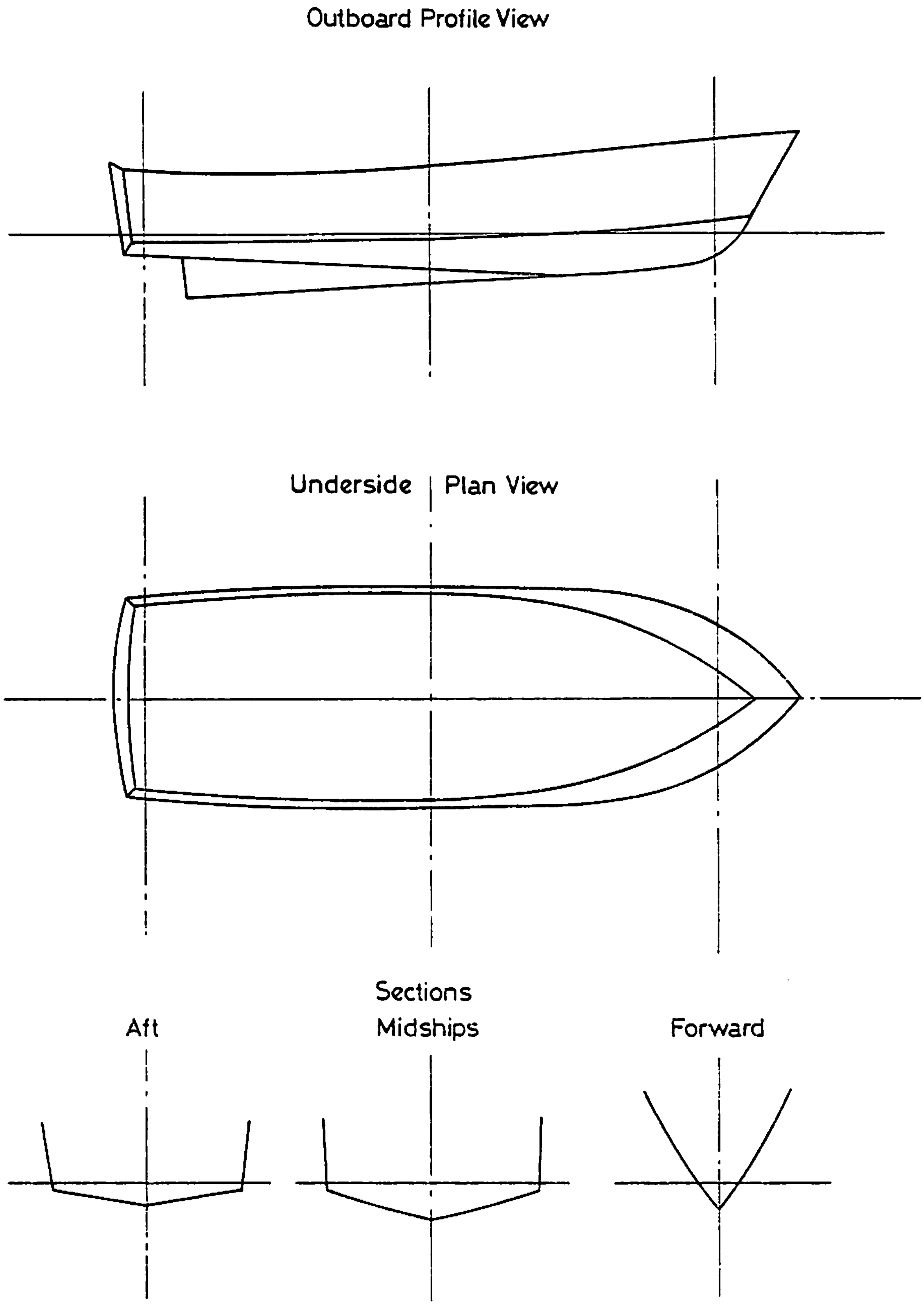
2. "Resistance and propulsion of motor-boats" D. De Groot (Paper published in "International Shipbuilding Progress" Vol 2 - No. 6 - 1955)

3. "High speed small craft" P. Du Cane (David & Charles)



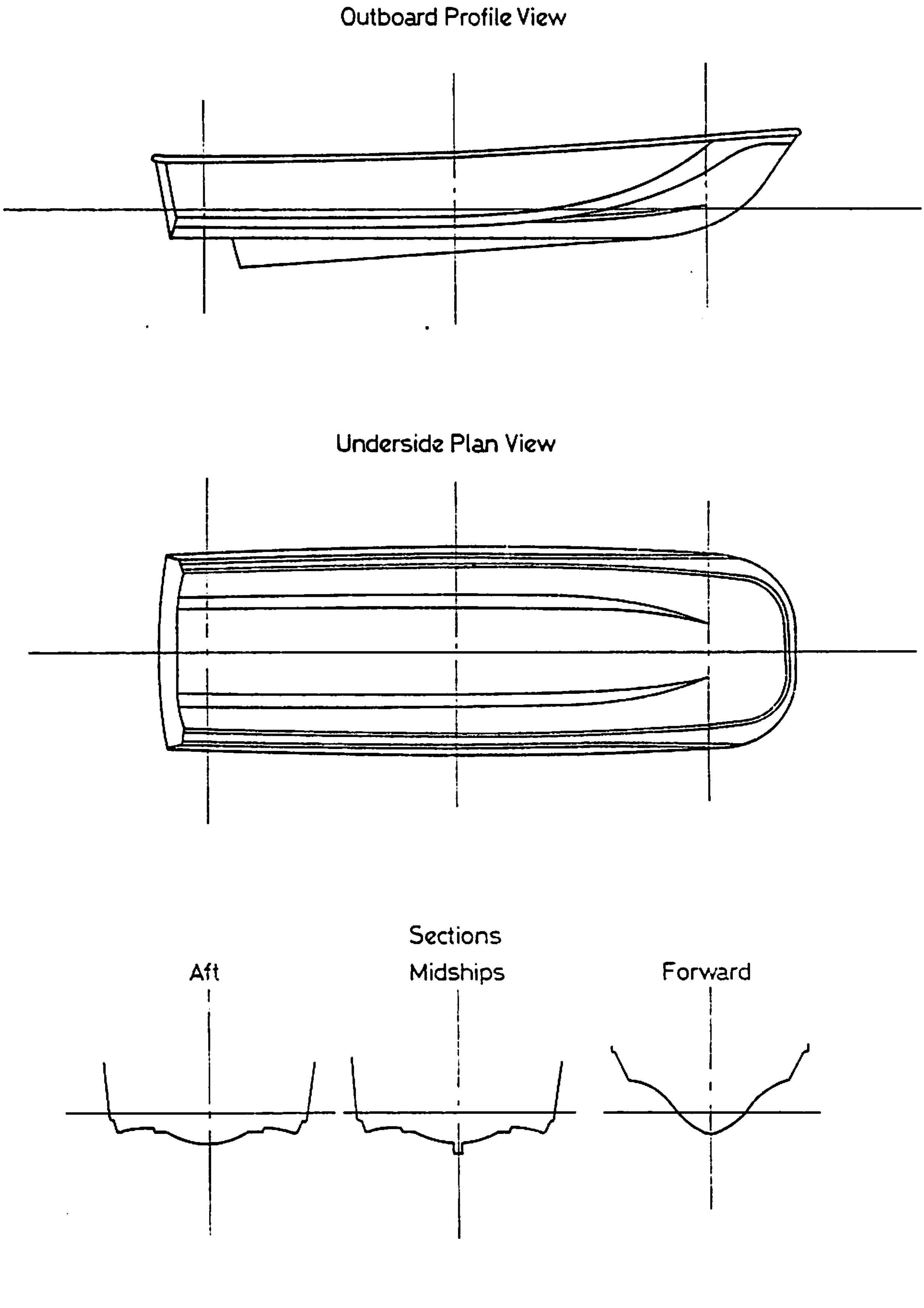
Specific Resistance v Speed-Length Ratio

Fig.1



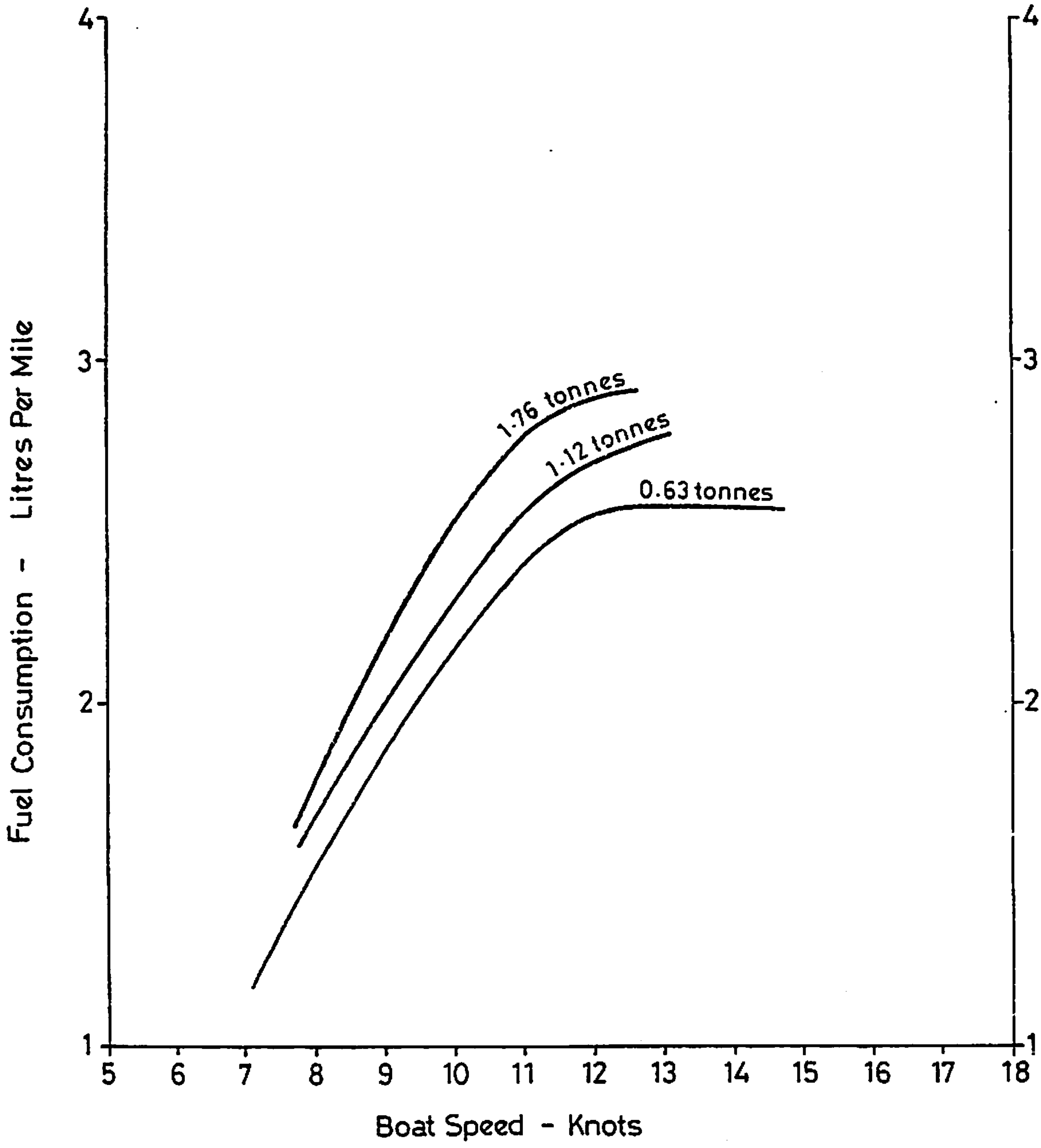
Typical Hard Chine Hull Form

Fig.2



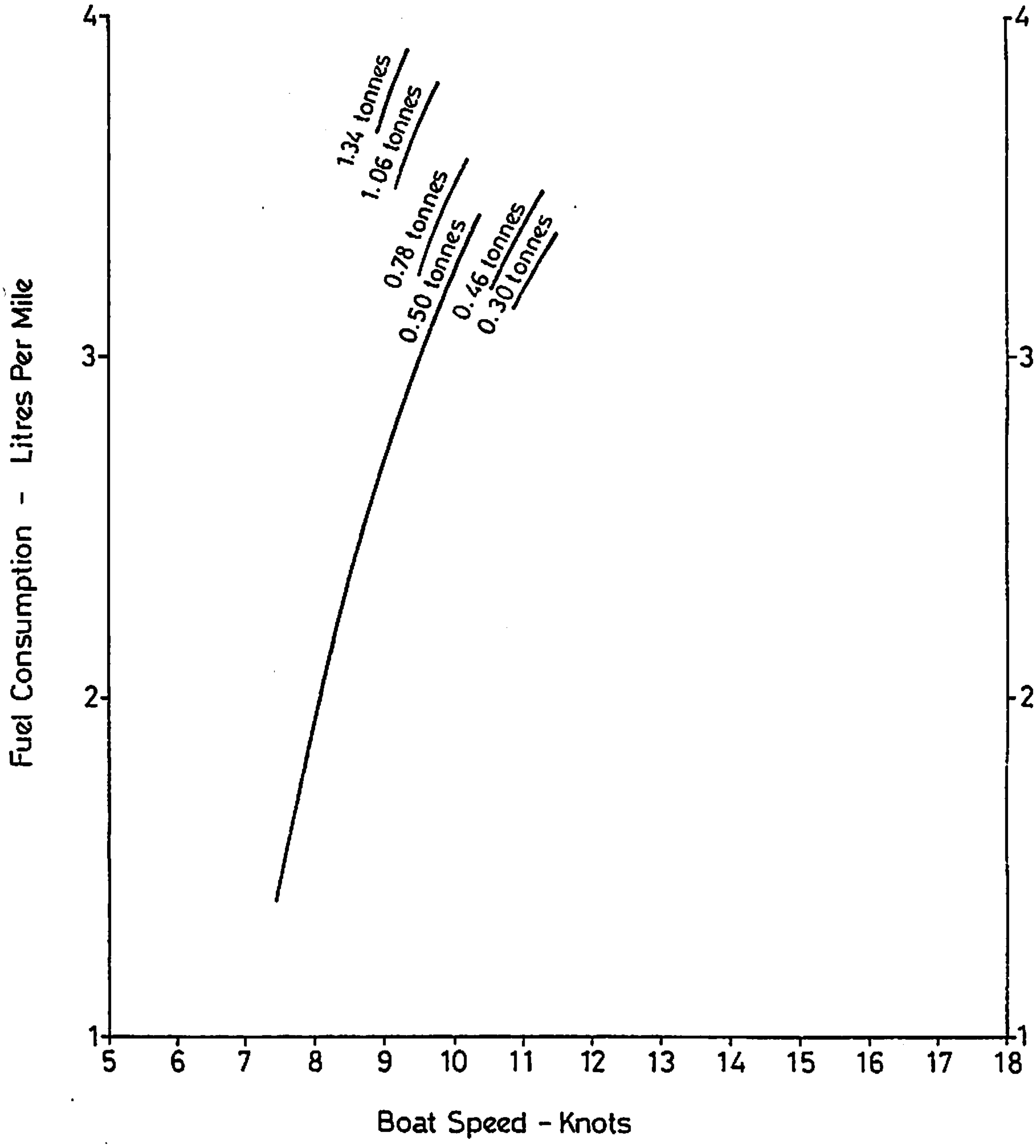
Typical Trihedral Dory Hull Form

Fig.3



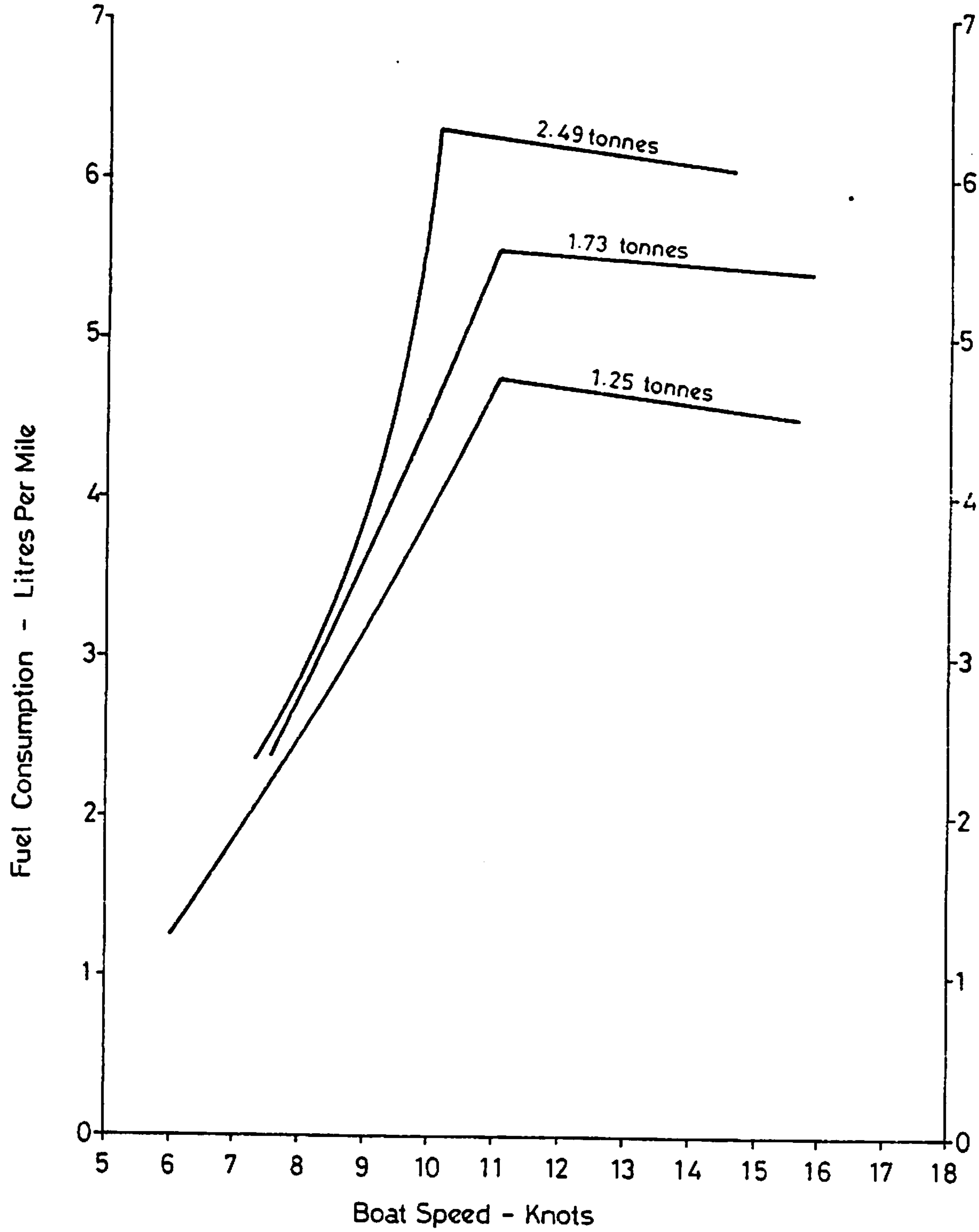
'Sea Jade' - Speed / Fuel Consumption

Fig. 4



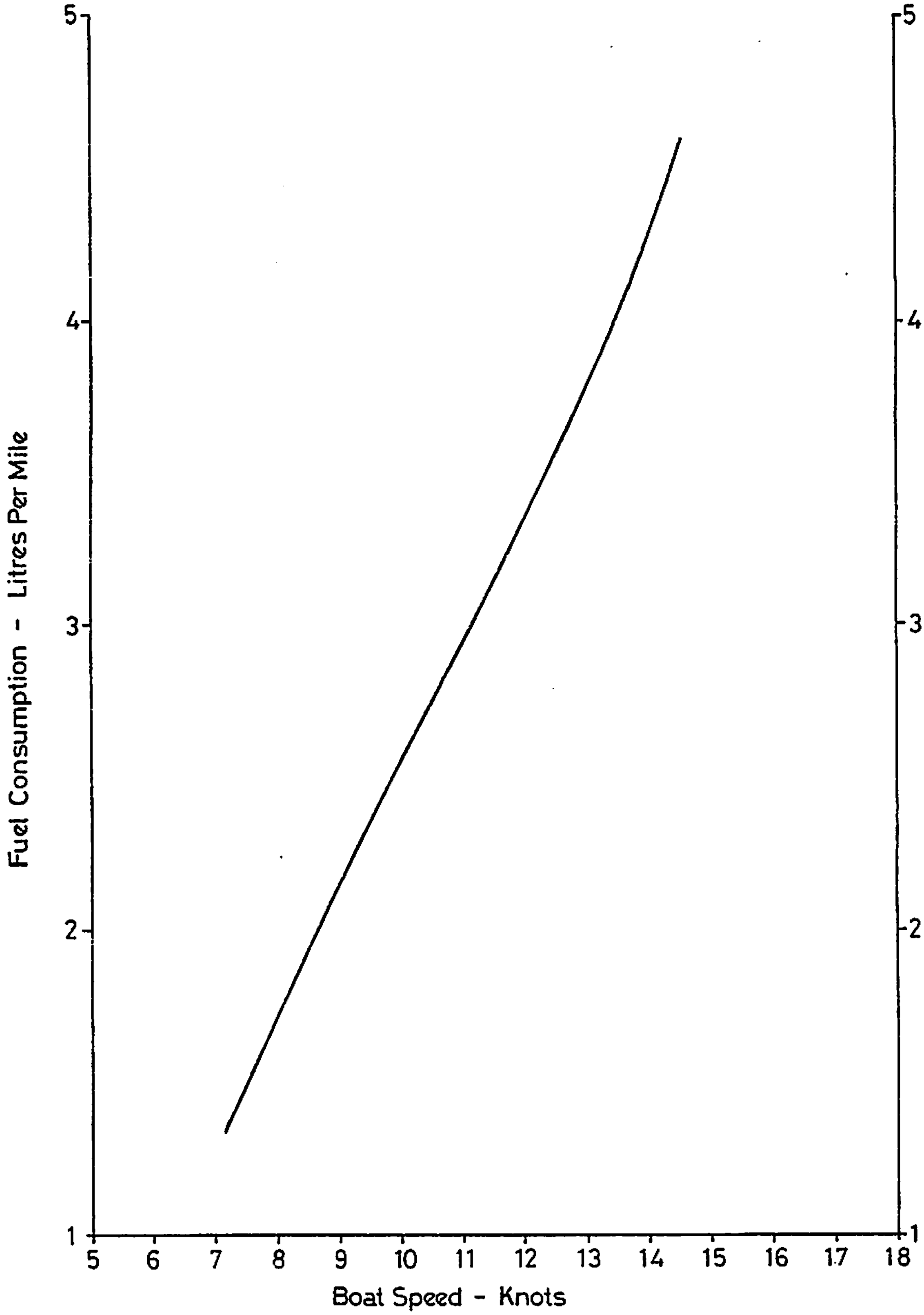
'Vixen' - Speed / Fuel Consumption

Fig. 5



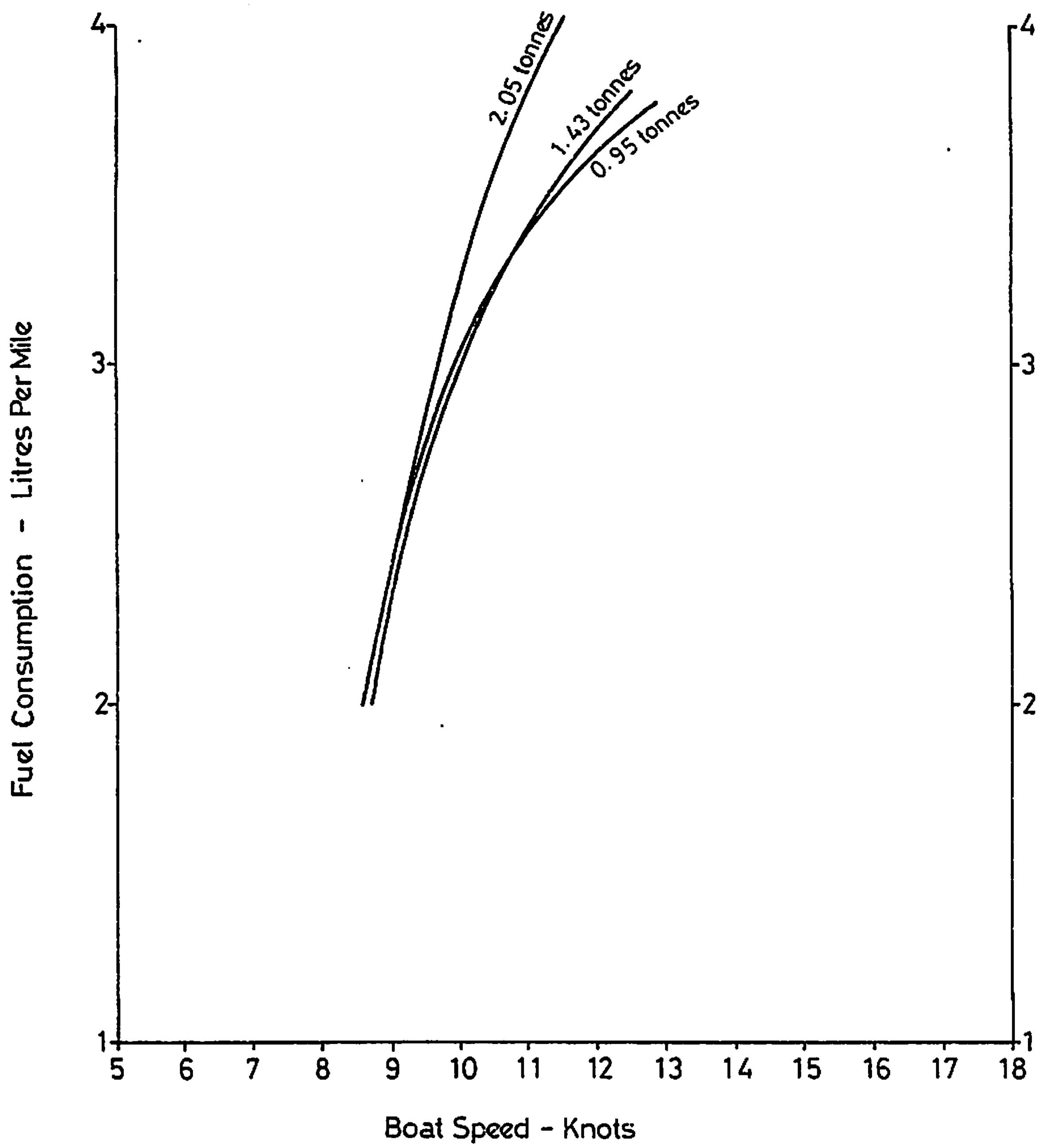
'Nautilus' - Speed / Fuel Consumption

Fig. 6



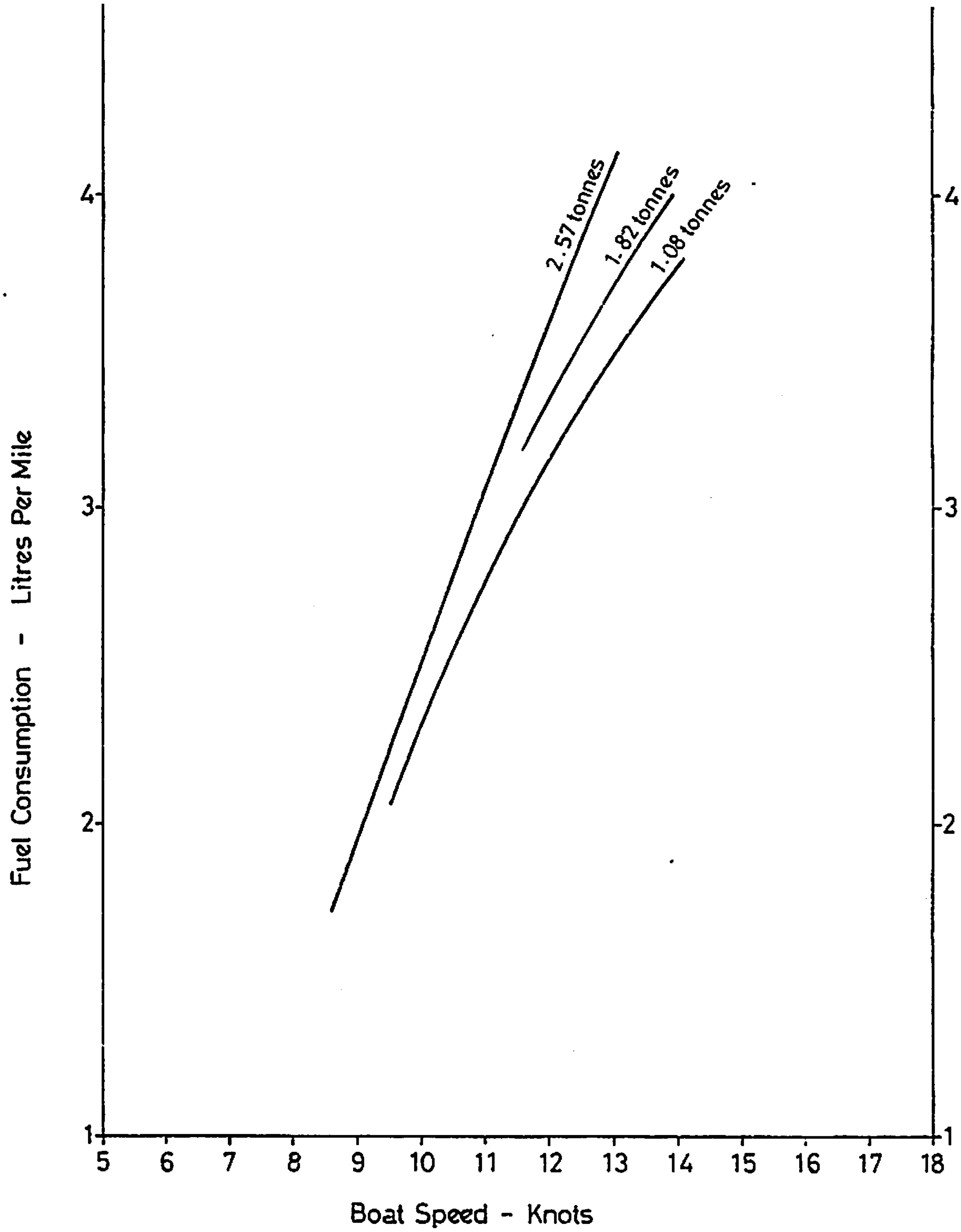
'Sweet Promise' - Speed/Fuel Consumption

Fig.7



'J.N.P.' - Speed / Fuel Consumption

Fig.8



'PlusTwo' - Speed/Fuel Consumption

Fig. 9

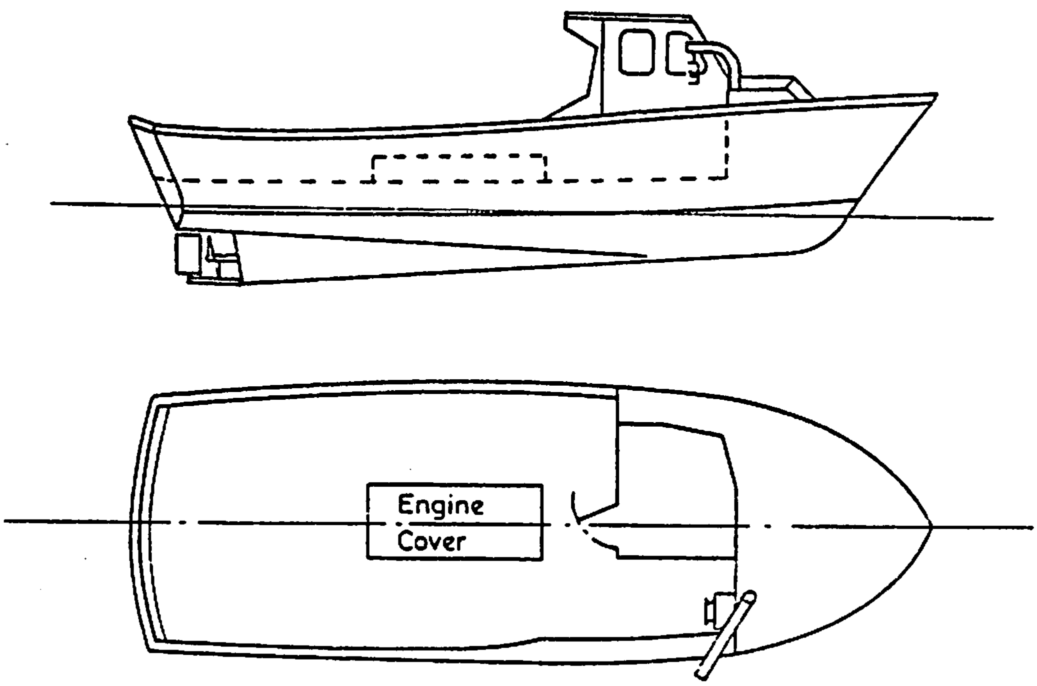
APPENDIX I

PRINCIPAL PARTICULARS, SPECIFICATIONS AND ARRANGEMENTS

1. **Sea Jade**

Vessel (Port)	'Sea Jade' (Padstow)
Hull Form	Hard Chine
Length Overall	10.1 metres
Engine	Volvo 184 H.P.
Engine Layout	Midships, Straight Shaft
Engine Compartment	Engine box on deck
Crew	2/3
Deck Gear	Hydraulic Hauler
Fuel Capacity	640 litres
Hull Condition	Clean

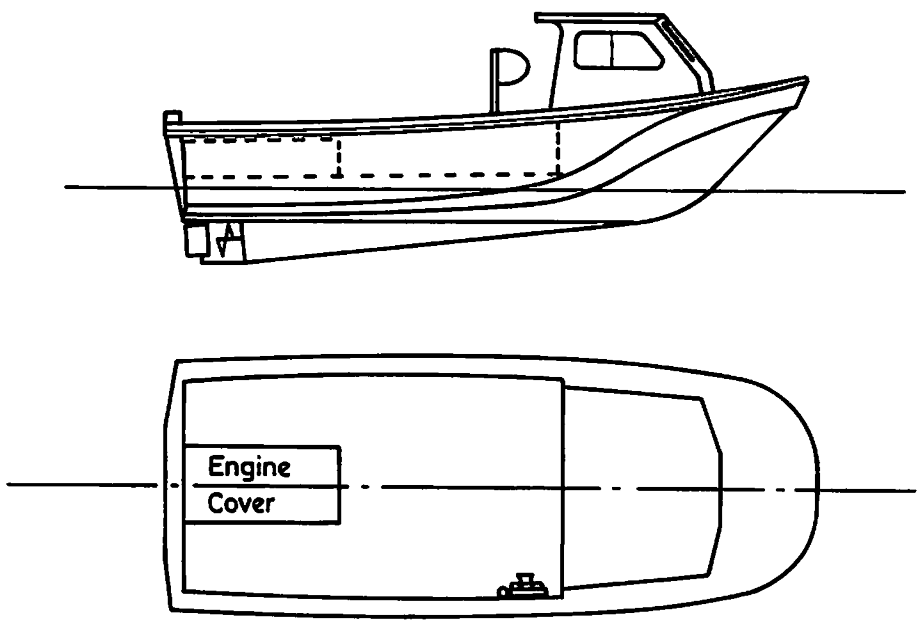
'Sea Jade'



2. **Vixen**

Vessel (Port)	'Vixen' (Oban)
Hull Form	Trihedral Dory
Length Overall	8.3 metres
Engine	Sabre 190 H.P. (212 H.P. Derated)
Engine Layout	Aft, 'V' Drive
Engine Compartment	Engine box on deck
Crew	2
Deck Gear	Hydraulic Hauler
Fuel Capacity	450 litres
Hull Condition	Heavy weed on waterline

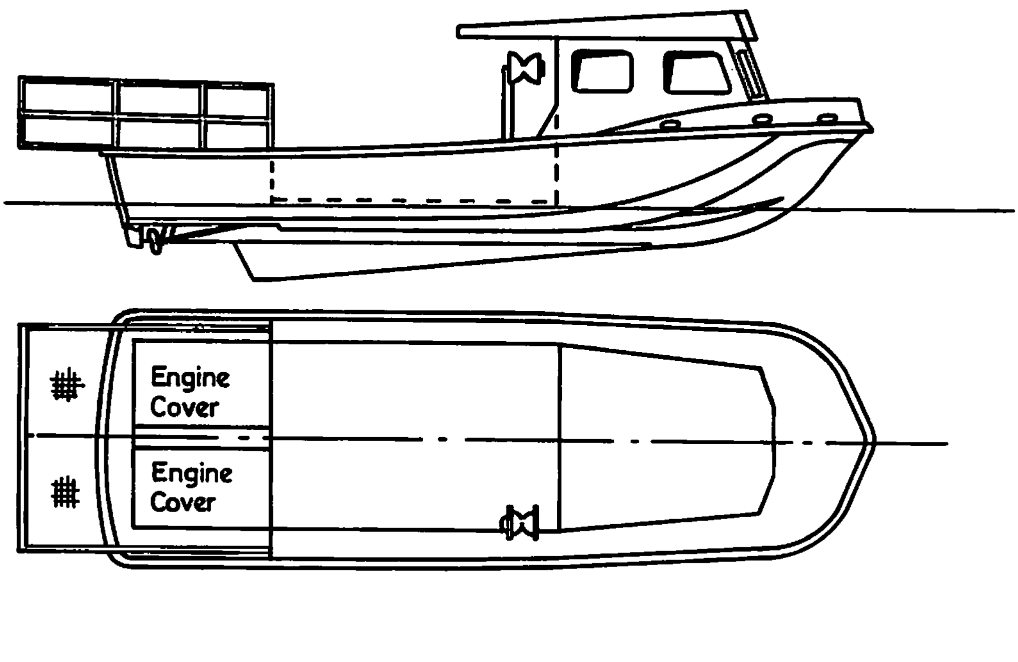
'Vixen'



3. **Nautilus**

Vessel (Port)	'Nautilus' (Oban)
Hull Form	Trihedral Dory
Length Overall	10.0 metres
Engine	2 x Sabre 212 H.P. Each
Engine Layout	Aft, 'V' Drive
Engine Compartment	Below Raised Deck Aft
Crew	2
Deck Gear	Hydraulic Hauler
Fuel Capacity	1360 litres
Hull Condition	Clean

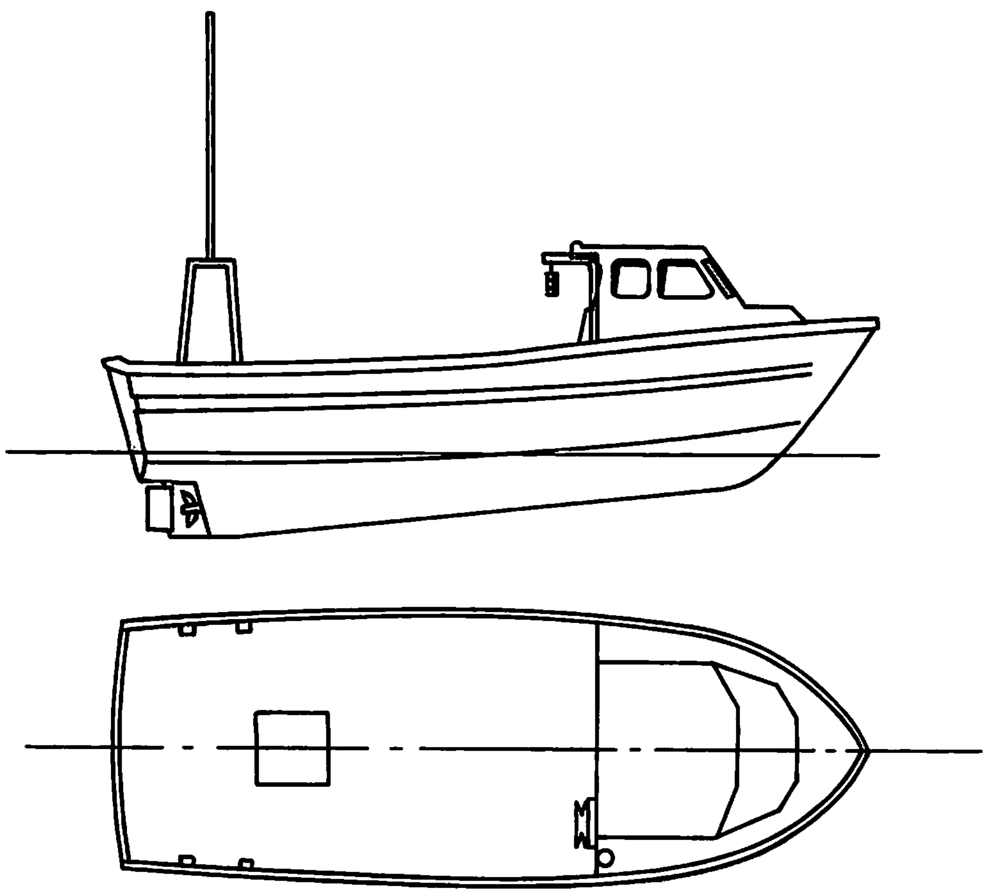
'Nautilus'



4. **Sweet Promise**

Vessel (Port)	'Sweet Promise' (St. Ives)
Hull Form	Hard Chine
Length Overall	10.3 metres
Engine	Volvo 320 H.P. (Intermittent)
Engine Layout	Midships, Straight Shaft
Engine Compartment	Below Deck
Crew	2
Deck Gear	Hydraulic Hauler, Stern Gantry
Fuel Capacity	1000 litres
Hull Condition	Clean

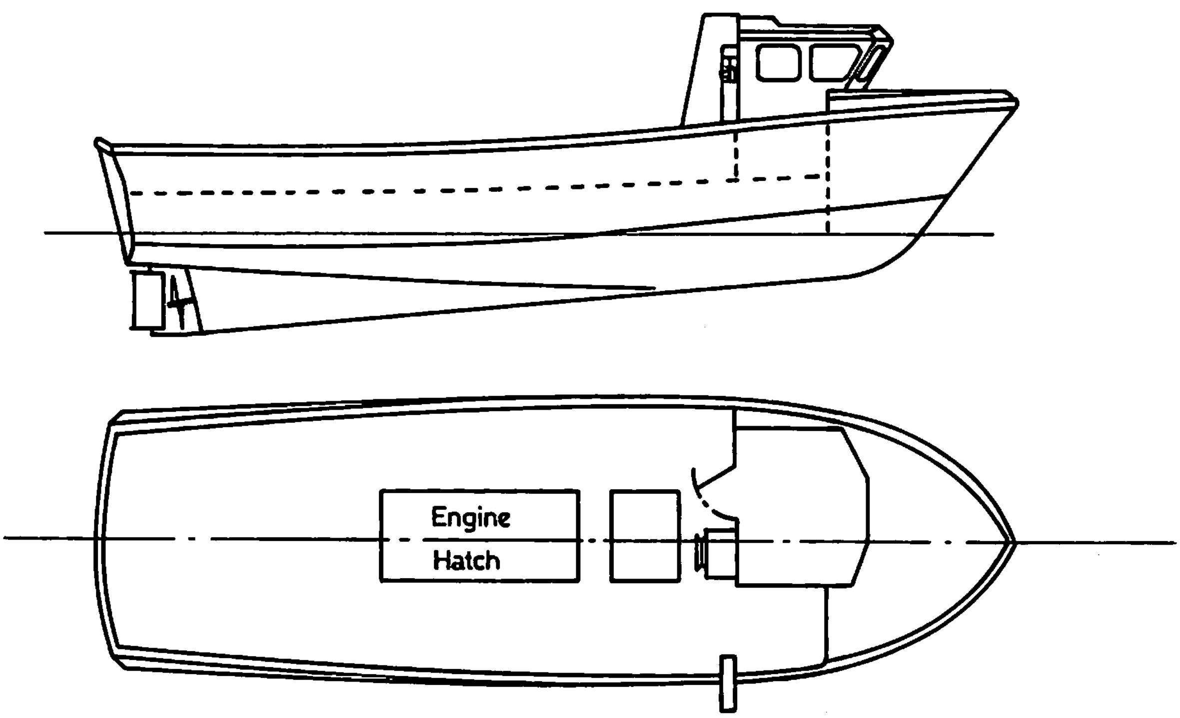
'Sweet Promise'



5. **JNP**

Vessel (Port)	'J.N.P.' (Weymouth)
Hull Form	Hard Chine
Length Overall	12.0 metres
Engine	Volvo 270 H.P.
Engine Layout	Midships, Straight Shaft
Engine Compartment	Below Deck
Crew	3
Deck Gear	Hydraulic Hauler
Fuel Capacity	1360 litres
Hull Condition	Heavy Weed on Waterline

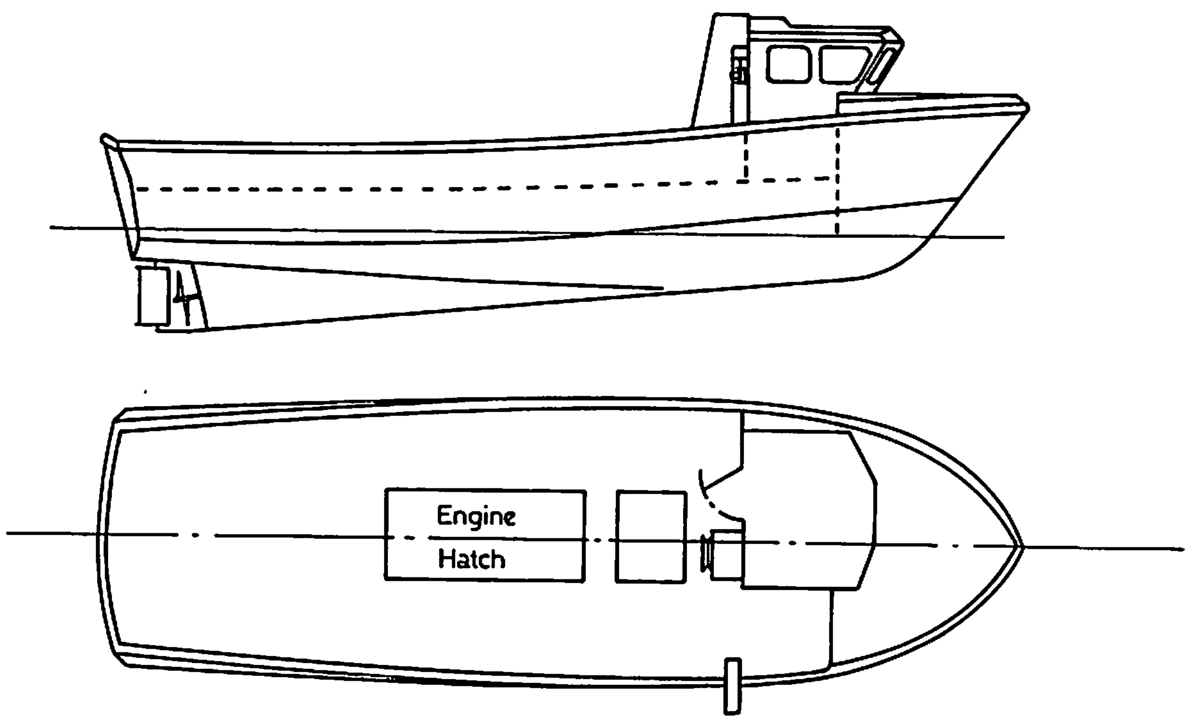
'J.N.P.' and 'Plus Two'



6. **Plus Two**

Vessel (Port)	'Plus Two' (Weymouth)
Hull Form	Hard Chine
Length Overall	12.0 metres
Engine	Volvo 270 H.P.
Engine Layout	Midships, Straight Shaft
Engine Compartment	Below Deck
Crew	3
Deck Gear	Hydraulic Hauler
Fuel Capacity	1360 litres
Hull Condition	Clean

'J.N.P.' and 'Plus Two'



APPENDIX II

TRIALS RESULTS

"SEA JADE"

RPM	SPEED KNOTS	FUEL FLOW LITRES/ HOUR	FUEL LITRES/ MILE	FUEL MILES/ GALLON	LOAD TONNES
1300	7.10	8.40	1.18	3.84	0.63
1600	8.56	14.65	1.71	2.66	0.63
2000	11.08	26.80	2.42	1.88	0.63
2200	12.54	32.50	2.59	1.75	0.63
2200	12.71	32.55	2.56	1.77	0.63
2390	14.71	37.80	2.57	1.77	0.63
1500	7.77	12.35	1.59	2.86	1.12
1750	9.24	19.15	2.07	2.19	1.12
2000	10.81	27.00	2.50	1.82	1.12
2100	11.34	29.85	2.63	1.73	1.12
2200	12.10	32.70	2.70	1.68	1.12
2300	13.10	36.50	2.79	1.63	1.12
1500	7.75	12.80	1.65	2.75	1.76
1750	9.06	20.00	2.21	2.06	1.76
2000	10.52	27.65	2.63	1.73	1.76
2100	10.99	30.80	2.80	1.62	1.76
2200	11.89	34.20	2.88	1.58	1.76
2290	12.63	36.80	2.91	1.56	1.76

LOAD: The loads quoted include weight of fuel. The lowest load quoted represents full fuel capacity but no deck load.

"VIXEN"

RPM	SPEED KNOTS	FUEL FLOW LITRES/ HOUR	FUEL LITRES/ MILE	FUEL MILES/ GALLON	LOAD TONNES
1500	7.49	10.6	1.42	3.21	0.50
1750	8.16	16.8	2.06	2.21	0.50
2000	9.12	25.2	2.76	1.65	0.50
2250	10.39	35.4	3.41	1.33	0.50
2250	10.19	36.5	3.58	1.27	0.78
2250	9.77	37.1	3.80	1.20	1.06
2250	9.35	36.50	3.90	1.16	1.34
2300	11.31	39.4	3.48	1.30	0.46
2330	11.51	38.7	3.36	1.35	0.30

"NAUTILUS"

RPM	SPEED KNOTS	FUEL FLOW LITRES/ HOUR	FUEL LITRES/ MILE	FUEL MILES/ GALLON	LOAD TONNES
900	6.00	7.4	1.23	3.69	1.25
1200	7.60	16.4	2.16	2.11	1.25
1500	9.10	29.6	3.25	1.40	1.25
1550	9.40	32.4	3.45	1.32	1.25
1800	11.25	53.2	4.73	0.96	1.25
2100	15.65	70.4	4.50	0.99	1.25
900	6.10	-	-	-	1.73
1170	7.50	17.4	2.32	1.96	1.73
1530	9.50	38.80	4.08	1.11	1.73
1810	11.50	63.6	5.53	0.82	1.73
2140	15.90	86.0	5.40	0.84	1.73
1150	7.20	15.6	2.17	2.10	2.49
1490	9.10	32.6	3.58	1.27	2.49
1810	10.10	63.6	6.30	0.72	2.49
2100	14.60	89.2	6.10	0.74	2.49
2120	14.60	87.8	6.01	0.76	2.49

"SWEET PROMISE"

RPM	SPEED KNOTS	FUEL FLOW LITRES/ HOUR	FUEL LITRES/ MILE	FUEL MILES/ GALLON	LOAD TONNES
1620	9.35	22.6	2.42	1.88	0.74
1800	10.44	29.8	2.85	1.59	0.74
2000	11.40	37.0	3.25	1.40	0.74
2230	13.25	52.9	3.99	1.14	0.74
2420	14.30	67.7	4.73	0.96	
1210	7.20	8.7	1.21	3.76	0.74
1420	8.65	16.0	1.85	2.46	0.74
1600	9.70	22.6	2.33	1.95	0.74
1800	10.45	28.4	2.72	1.67	0.74
2000	12.10	38.6	3.19	1.43	0.74
2200	13.30	50.0	3.76	1.21	0.74
2420	14.70	65.3	4.44	1.02	0.74
2470	14.90	67.8	4.55	1.00	0.74

"J.N.P."

RPM	SPEED KNOTS	FUEL FLOW LITRES/ HOUR	FUEL LITRES/ MILE	FUEL MILES/ GALLON	LOAD TONNES
1500	8.65	17.3	2.00	2.27	0.95
1810	10.22	32.0	3.13	1.45	0.95
2100	12.84	48.4	3.77	1.21	0.95
1500	8.72	17.5	2.01	2.26	1.43
1710	9.51	25.6	2.69	1.69	1.43
1820	10.19	31.1	3.05	1.49	1.43
1950	11.18	38.7	3.46	1.31	1.43
2080	12.50	47.4	3.79	1.20	1.43
1500	8.59	17.5	2.04	2.23	2.05
1700	9.45	25.7	2.72	1.67	2.05
1900	10.39	36.5	3.51	1.29	2.05
2030	11.53	46.4	4.02	1.13	2.05

"PLUS TWO"

RPM	SPEED KNOTS	FUEL FLOW LITRES/ HOUR	FUEL LITRES/ MILE	FUEL MILES/ GALLON	LOAD TONNES
1710	9.50	19.70	2.07	2.19	1.08
1900	10.57	27.55	2.61	1.74	1.08
2110	11.75	36.35	3.09	1.47	1.08
2250	12.80	43.30	3.38	1.34	1.08
2410	13.97	52.70	3.77	1.21	1.08
2100	11.55	37.00	3.20	1.42	1.82
2250	12.70	45.25	3.56	1.28	1.82
2380	13.45	52.15	3.88	1.17	1.82
1500	8.57	14.70	1.72	2.65	2.57
1750	9.70	22.00	2.27	2.00	2.57
2030	11.07	34.20	3.09	1.47	2.57
2120	11.45	38.05	3.32	1.37	2.57
2220	12.05	44.35	3.68	1.23	2.57
2300	12.67	48.95	3.86	1.18	2.57
2350	12.90	51.70	4.08	1.13	2.57