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THE COLLEGE OF AERONAUTICS

CRANFIELD

SOME PRELIMINARY SUGGESTIONS ON THE STANDARDISATION OF DATA COLLECTION PROCEDURES FROM U.K. COMMERCIAL HOVERCRAFT OPERATORS AND AN INITIAL STUDY INTO THE DERIVATION OF A STANDARD METHOD FOR ESTIMATING THE OPERATING COSTS OF HOVERCRAFT

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Much of the data collected during the work on this pilot study was released on the understanding that it would be treated with the utmost commercial confidence. It has therefore not been the policy of this report to acknowledge specific data sources. This, of course, makes the justification of many of the standard values impossible. It is however expected that when the stage is reached when it becomes viable to publish a detailed and widely applicable Standard Method for Estimating Operating Costs, the data used in the formulation of such a method will be by then largely made available for general inspection to justify the conclusions reached.

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Hovercraft Service Report 1. Operations Record. Opposite Page 6.

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INTRODUCTION

This report is a summary of the ground covered during a 6 month pilot study encompassing a number of aspects of hovercraft operations. It is hoped that the experience gained during this period of study will enable more specific tasks involving much more detailed analysis of particular aspects of operations to be carried out.

A number of possible areas of study were considered for the initial 6 month period. The final choice was governed by several factors, the most significant of which were;

a) the nature of data available on past operations;
b) expected future data;
c) topics expected to yield the greatest benefits to all parties concerned (i.e. Cranfield, Mintech., the Operators and the Manufacturers, present and prospective) both in the short and long term;

and d) manpower available.

Unfortunately the latter restriction proved more severe than had been initially envisaged.

Fields of study considered were as follows:

(i) A study of the Problems involved in the derivation of a Standard Method for Estimating the Operating Costs of Hovercraft.
(ii) An attempt to Standardise the data collection proceedures from the various current U.K. Operators.
(iii) An analysis of all currently available data.
(iv) An investigation into the possible use of Automatic Data Processing techniques for the collection and analysis of operating data.
(v) An analysis of the causes and effects of delays and cancellations in current scheduled operations.
(vi) A study of the traffic carried on and the demand for current scheduled services, and the effect of varying fare structures on this.

Clearly any study in any given field of operations would depend largely on the availability and clarity of the data available. It was largely for this reason that (ii) was given priority. Once data could be standardised a sound basis would be founded from which further studies could be made. However, the successful derivation of a Cost Estimation method was considered to be the most widely beneficial outcome possible over the coming years. Such an exercise would again depend largely on the data available, and so study areas (i) and (ii) were selected as the two most appropriate. Clearly some analysis of current data would be necessary, but this was not singled out as a task in itself. Finally, some preliminary investigation into the possible use of Automatic Data Processing techniques would be made, time permitting. Thus the aims of the study were decided.

From the onset it was evident that the current state of A.C.V. technology was not sufficiently settled to permit the use of any Standard Costing Method which could be applied realistically to all current craft. The study was limited to craft in or shortly to be in commercial use in the U.K. Included therefore were SR-N6, SR-N4, HM2 and VT 1. Only one of these craft, SR N6, had sufficient operating hours accumulated for its Direct Operating Costs, particularly maintenance costs, to be considered as having settled to a reasonably constant level. Certainly experience with SR N6's has shown that D.O.C.'s can be expected to fall unpredictedly during the first few years of operations with a new craft. This process is happening now with SR N4's in Cross-Channel service, and will no doubt be experienced also by early HM-2 and VT.1 Operators.

The implications of these facts on any Standard Method are clear. One simply cannot formulate at this early stage in the development of the commercial A.C.V. a universally applicable formula, for the information necessary for such a task is not only not available, but in many cases is not yet known. Furthermore the four craft studied are very diverse animals. SR-N6 and SR-N4 are of basically aircraft type construction, with all round flexible skirts giving them amphibious capability and powered by gas turbine engines, driving air propellers. Conversly, HM-2 is of boat like construction, with immersed rigid sidewalls making it a strictly marine vehicle, and powered by marine diesel engines driving water screws. Between these two extremes we have VT-1 with all round flexible skirt and gas turbines, but driving water screws making the craft non-amphibious, though nose ramp loading is feasible. The operating economics of the amphibian and the sidewall are very different, and VT-1 is itself unique. In this light then, it might appear foolish to begin work on a Standard Costing Method.

However, so long as some fairly reliable N6 data exists, and so long as we recognise that the true costs of the other craft will not be known for some time yet, a start can be made. If we can successfully apply the Method to the N6, and if we can obtain figures for the other craft which appear feasible, then providing we recognise the scanty basis and informed guesswork on which the latter figures are estimated, we can have reasonable cause for satisfaction. Certainly, no more could be done at this juncture The real benefits will it is hoped be felt in years to come when the information from Standardised Data Sheets can be applied to test the formula and to update it progressively, until such time as a fairly stable stateof the art exists. The immediate value of any formula must be recognised as being severely limited. It is the contacts made, the channels of information opened, the groundwork covered which provides the necessary basis for future work.

We see then the severe limitations within which we can work on Operating Costs at present, even assuming data to be freely available, which unfortunately it has not as yet been. The ground covered in Section 2 of this report must be considered as a mere scratching at the surface, which it is hoped will prove more penetrable in the months ahead. Finally, the whole report must be looked upon as simply setting the wheels in motion for future work.

Section 1. DATA COLLECTION

101) Past Data and associated difficulties

It will be noted that all data currently available on past operations concerns SR-N5 and SR-N6 craft, and covers the period 1966-1968 inclusive. These craft were the first A.C.V.'s used for commercial services, and throughout this period the N6 can be said to have undergone a continual development programme. This development has enabled its operating costs to be gradually reduced to a level which may now be regarded as being fairly static. Thus this data gives a guide as to where the principal cost reductions have been made, and while we must draw more recent data from other sources to estimate current operating costs, this operating data from the development period will provide a useful yardstick when we are in a position to compare N4, HM2 and VT1 early years cost reductions with the comparable period for the N6. Only then may we be able to estimate, with some basis for confidence, the expected fall in operating costs during the early years of operations of a new craft.

The biggest contributors to maintenance costs, i.e. engines and skirts, were the principal sources of cost reductions over the years of N6 operations. As skirt design improved and new materials were introduced so Time Between Overhaul figures increased and direct maintenance costs fell. Similarly as engine Time Between Overhaul figures increased, maintenance costs fell.

The point to be noted here about past N6 data is that this was the first craft to be commerically used to any significant degree, and was thus somewhat of a guinea pig upon which new equipment was tested. Maintenance cost data reflect this, together with the fact that the operation of hovercraft on a commercial basis was and still largely is an art still to be mastered. Large cost fluctuations for many items of maintenance costs can be seen, and these cannot of course be taken as being representative of the craft performance today. Thus the available N6 data gives us a very unsettled picture of D.O.C.'s which is not truly representative of the current craft.

The second major point to be made about this data is that its diverse nature makes comparison an extremely strenuous and long winded task. Much of this data was supplied under contract to Mintech. The actual form and layout of the data was left to the individual suppliers, with the result that each batch of information received was of different form and layout to the others. It was this fact which led to the realisation that if a continuing stream of operating data was to be supplied by the Operators, something needed to be done about its form to make analysis easier, and to cut down on important manhours.

102) The Concept of Standardised Data Sheets.

The obvious way to make any data analysis exercise as simple as possible is of course to have all the data coming in a common form. Therefore it was decided that work should begin on designing some Standard Data Sheets. The eventual success or failure of this exercise will depend largely upon the degree of availability of the desired information from the Operators, and the co-operation received in the setting up and operation of the data collection process.

103) What do we want to know?

First of all it was necessary to decide just what sort of information would be required. This in turn depended upon who was going to use the information, and for what purposes. This latter question could not be definitively answered, as future areas to be studied could not be positively defined.

Certainly, however, information would be needed in detail on D.O.C.'s and I.O.C.'s to aid the formulation of a workable Standard Cost Estimation Method. Also information would be required to provide a picture of the performance of the various craft from an engineering point of view. Together with this information it was decided that details of traffic handled and reliability of services would be useful items to have on record, and that they provided possible areas of future investigation.

Thus the field of operations to be covered by the Data Sheets was established. The sheets had to give sufficient detail for the analysis to follow yet it was attempted from the outset to keep them as few in number and as simple as possible. As the bulk of work to be done during the study period would be on the Standard Method, clearly time would not permit detailed discussion with the Operators on the form of the Data Sheets. This was not seen as a major handicap however, as the timescale would not allow the introduction of such sheets before Summer 1970 at the earliest. Therefore the details could be hammered out in the Winter months following the current study period.

In the light of what was required, 3 Data Sheet Layouts were designed. They were given the title "Hovercraft Service Reports", and headed respectively:-

1. Operations Record.
2. Maintenance Record.
3. Operating Costs.

104) The Proposed Data Sheets

The 3 Data Sheets can be seen on pages 6a, 7a and 8a. At this early stage in their development, when they are still in provisional form and bound to be subject to some modification as a result of consultation with the Operators, a detailed item by item description with definitions etc. is considered to be inappropriate and premature. A brief general description will suffice.

The Operation of any given sector would be covered by each of the data sheets. That is to say each sheet refers to the operation of a particular sector, be that sector part of a more complex route pattern or a route in itself with just two terminals.

HOVERCRAFT SERVICE REPORT	1. OPERATIONS RECORD	WEEK NUMBER YEAR
OPERATOR ROUTE	BLOCK DISTANCE N.M. CRAFT TYPE:	CONFIGURATION PASS. CARS LBS. OTHER
FREQUENCY: PEAK PER HOUR, OFF PEAK PER HOUR	DURATION OF PEAK HRS. OPERATING DAY HRS.	NUMBER OF CRAFT: PEAK OFF PEAK
CRUISE SPEED: NORMAL KTS., ROUGH SEAS KTS.	BLOCK TIME: NORMAL MINS. ROUGH SEAS MINS.	TOTAL SECTORS OPERATED: CRAFT HOURS
SEA STATE: CRITICAL > FT. %. PERMISSABLE %. GOOD < FT. %	WIND: CRITICAL > KTS. %. PERMISSABLE % GOOD < KTS. %	VISIBILITY: CRITICAL < YDS. % PERMISSABLE %. GOOD > YDS. %

OVERALL WEATHER CONDITIONS: CRITICAL PERMISSABLE GOOD

SERVICE INTERRUPTIONS		OPERATIONAL				WEATHER						ENGINEERING							
						En - Route			Terminal			Late Maintenance		Unserviceability					
		Late Arrival	Insufficient Traffic	Traffic Handling	Terminal Area Control	Sea State	Wind	Visibility	Sea State	Wind	Visibility	Turnround	Check	Powerplant	Skirt/Wall	Lift/Drive	Props. Fans.	Equipment	Hull
CANCELLATIONS																			
DEPARTURE DELAYS	5 - 15 mins.																		
	15 - 30 mins.																		
	> 30 mins.																		

TOTAL SECTORS SCHEDULED % ON TIME % CANCELLED % DELAYED

TRAFFIC		CAPACITY OFFERED								TRAFFIC CARRIED												LOAD FACTOR %		
		SCHEDULED				CHARTER				PEAK HOUR SCHEDULE				DAILY SCHEDULE				CHARTER				SCHEDULE		CHARTER
		Sectors	Pass.	Cars	Lbs. other	Sectors	Pass.	Cars	Lbs. other	Sectors	Pass.	Cars	Lbs. other	Sectors	Pass.	Cars	Lbs. other	Sectors	Pass.	Cars	Lbs. other	Peak	Day	
SUNDAY	Out																							
	Return																							
MONDAY	Out																							
	Return																							
TUESDAY	Out																							
	Return																							
WEDNESDAY	Out																							
	Return																							
THURSDAY	Out																							
	Return																							
FRIDAY	Out																							
	Return																							
SATURDAY	Out																							
	Return																							

REVENUE		TRAFFIC CARRIED								REVENUE											
		Pass. Only	Child	Pass. with car	Car	Coach or Caravan	2-Wheeler	Animal	Freight	Pass. Only	Child	Pass. with car	Car	Coach or Caravan	2-Wheeler	Animal	Freight	Other	Total	On Craft Extra	Off Craft Extra
NORMAL FARE	1 Way																				
	Return																				
OFF PEAK FARE	1 Way																				
	Return																				
CHEAP DAY RETURN																					
SEASON																					
IT./BLOCK BOOKING	1 Way																				
	Return																				
CHARTER	On Route																				
	Off Route																				

TOTAL REVENUE £	PER CRAFT HOUR PER SECTOR			TOTAL	UK. GENERATED OTHER GENERATED		TOTAL	STERLING OTHER CURRENCY	

6a.

1. Operations Record.

This would give a weekly record of the service interruptions, traffic carried against capacity offered, and revenue generated, by a given type of craft on a particular sector or route. This means that if during a week a route was operated by 3 craft, 2 of type A and one of type B, then 2 operations records would be required, one covering the B craft, the other the 2A craft. Thus the performance of different types of craft could be compared in terms of susceptibility to adverse weather conditions, and engineering reliability. The type of traffic being attracted could be studied, and the principal sources of revenue noted. Also, some miscellaneous items of interest would be logged, e.g. Weather conditions, (sea state, wind, visibility), cruise speeds, block time, sectors operated, craft hours, etc.

HOVERCRAFT SERVICE REPORT	2. MAINTENANCE RECORD	WEEK NUMBER YEAR
OPERATOR ROUTE	CRAFT CRAFT HOURS	POWER HOURS IDLING HOURS
NO. OF CREWS/CRAFT TYPE OF FUEL	NO. IN CREW: DAY NIGHT	CREW SHIFTS OPERATED: DAY NIGHT
FUEL USED I.G. OIL USED I.G.	MTCE. STAFF / SHIFT: DAY NIGHT	MTCE. SHIFTS OPERATED: DAY NIGHT
NO. OF MTCE. STAFF: SKILLED SEMI-SKILLED	MTCE. MANHOURS: PAID ATTENDED	PAID MTCE. HRS./CRAFT HR. FUEL I.G./CRAFT HR.

Date	Craft Operating Hours	Symptom/ Defect/ Scheduled Inspection	System No.	Scheduled or Unscheduled	Rectification Repair Details	U/S Item	Category of U/S Item			Cost of Replacement & or Repair £		Man Hour Cost	Remarks
							Repairable	Scrap	Total Loss	Component	Other Materials		
									Total £				

Unshed. Mtce./Craft Hour manhrs. / Snag Elapsed Time/Craft Hour hrs.	Engines 1	Engines 2	Engines 3	Engines 4	Props. 1	Props. 2	Props. 3	Props. 4	Structure	Skirt Trunk	Skirt Fingers Av.	Fans 1	Fans 2	Fans 3	Fans 4	Transmission	Main G' Boxes	Primary G' Boxes	Others
Operating Hrs. since Major Overhaul																			
Operating Hrs. since Replacement																			

Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Systems Key	Engines	Electrical	Instruments	Radar & Radio	Props. & Fans	Gearboxes Primary/ Ancillary Components	Gear Boxes Main / Ancillary Components	Transmission Shafts / Couplings	Structure	Skirt [Trunk]	Fingers / Attachments	Safety Equipment	Furnishings

2. Maintenance Record

Again a weekly sheet applied to a given sector, but this time applying to an individual craft. Two craft of the same type on the sector would need separate maintenance records. This sheet would record all reported defects, and give details of their rectification. As well as such unscheduled maintenance, scheduled maintenance and inspections would be logged also. This information would be related to craft operating hours, and each entry would be classified according to a craft system number indicating which of the 13 systems listed was involved. Materials and labour costs would be recorded for each entry. Also a continual record of the achieved Time Between Overhaul figures for each major system/component would be maintained, in addition to operating hours since replacement. Other miscellaneous data would include power hours, idling hours, fuel consumed, oil consumed, etc.

HOVERCRAFT SERVICE REPORT

3. OPERATING COSTS

MONTH YEAR

OPERATOR ROUTE CRAFT

COST HEADINGS	WEEK	WEEK	WEEK	WEEK	WEEK	MONTHLY TOTAL	PER SECTOR	PER CRAFT HOUR
NUMBER OF CRAFT OPERATED							—	—
NUMBER OF SECTORS OPERATED							—	
CRAFT HOURS							—	—
FUEL AND OIL COST £								
MAINTENANCE STAFF PAY £								
MTCE. MATERIALS AND CONTRACTS £								
INC. POWERPLANT ONLY £								
INC. SKIRT ONLY £								
CRAFT MAINTENANCE £								
VARIABLE D.O.C. £								
CREW COST £								
PASSENGER INSURANCE £								
CRAFT AND SPARES FIXED COSTS £								
FIXED DIRECT OPERATING COSTS £								
TOTAL DIRECT OPERATING COSTS £								
TERMINALS AND EQUIPMENT FIXED COSTS £								
TERMINAL OPERATION-STAFF AND ASSOCIATED COSTS £								
TERMINAL COSTS £								
SALES, TICKETING AND ADVERTISING COSTS £								
ADMINISTRATION- STAFF AND ASSOCIATED COSTS £								
TOTAL STAFF- NIGP, PENSIONS, S.E.T. AND UNIFORMS £								
RATES AND TAXES £								
MISCELLANEOUS EXPENSES £								
ADMINISTRATION AND OVERHEAD COSTS £								
CREW TRAINING HOURS @ £/HOUR £								
OTHER INTRODUCTORY COSTS £								
TOTAL INTRODUCTORY COSTS £								
NAVIGATION AND HARBOUR DUES £								
TOTAL INDIRECT OPERATING COSTS £								
TOTAL OPERATING COSTS £								

CAPITAL ASSETS	Col. 1. Craft	Col. 2. Spares	Col. 3. Terminals	Col. 4. Equipment	Col. 5. Other
NUMBER OWNED OR HIRED		—		—	—
INITIAL COST £1,000s					
CURRENT VALUE £1,000s					
MONTHLY HIRE CHARGES £					
PROPORTION ALLOCATED TO ROUTE					
MONTHLY ROUTE CHARGES FOR	—	—	—	—	—
INTEREST ON CAPITAL £					
INSURANCE £					
AMORTISATION/DEPRECIATION £					
HIRE CHARGES £					
FIXED MONTHLY COSTS £					

INDIRECT STAFF AND ASSOCIATED COSTS	Col. 6. Sales and Advertising	Col. 7. Terminal Operation	Col. 8. Administration and Services
NUMBER OF STAFF			
MONTHLY STAFF COSTS £			
PROPORTION ALLOCATED TO ROUTE			
MONTHLY ROUTE CHARGES FOR	—	—	—
STAFF £			
AGENCY/LICENCE COSTS £			
TICKETS AND OFFICE SUPPLIES £			
TOTAL MONTHLY COSTS £			

REVENUE £ COST £

PROFIT/LOSS ON CRAFT OPERATION £

PROFIT/LOSS FOR YEAR TO DATE £

3. Operating Costs

This time a monthly record, listing and totalling all D.O.C. and I.O.C. items, for a given sector and type of craft. These would be related to craft hours and other information, for whatever particular comparison was needed. This sheet would indicate any long term and seasonal fluctuations in the overall operation being considered. Some statement of profit/loss here would be useful also.

The Data Sheets will, it is hoped, provide a sufficiently accurate and detailed picture of the various operations to make various analyses possible without the collection of further information. Their contents should provide plenty of scope for other investigation, in addition to providing the data necessary for the Standard Costing Method and for craft engineering assessments.

105) Work still to be done.

As has been emphasised, the layout of the sheets illustrated is a first attempt made without detailed consultation with the Operators Before any such Standardised Data Collection procedures can be instigated, the next step must necessarily be a period of detailed discussion with Operators aimed at finalising the exact form the sheets will take. Agreement here is essential to the success of the operation Only when the final form of the data sheets is agreed can the contractual details be hammered out and the operation begun Unforeseen difficulties may arise, but the importance of this task must not be diminished. The successful operation of this unique exercise would bring benefits to all concerned with hovercraft operations.

106) Automatic Data Processing.

It is certain that the type of exercise envisaged could be adapted to include the use of a computer for analysis of the data. Tentative enquiries and discussions on this subject suggest strongly that the eventual establishment of an Automatic Data Processing analysis would be a worthwile, and economically justifiable aim. Compared with what we might call phase 1 of the data collection exercise, involving the manual processing of sheets 1,2 and 3, a computer orientated operation would be both time and labour saving, as well as yielding a greater degree of accuracy and reliability in the actual processing of the collected data.

Similar types of operations to the one envisaged, involving the acquisition of accurate and relevant information from a given population, and the analysis of this data to suit various ends, have been and are at present being carried out. The technique that is frequently employed in such operations is known as Survey Analysis. Typical applications currently being carried out in the assessing of market conditions and reactions by various organisations, are in the fields of sociological research, and traffic surveys carried out by Local Authorities.

Survey Analysis involves the processing of large amounts of data and is therefore a suitable application for the digital computer. The advent of computer aided Survey Analysis has meant that this technique is now an economic proposition for many research bodies and organisations that previously could not afford to process data on a large scale.

A computer aided Survey Analysis of U.K. commercial hovercraft operations would consist of a series of 3 main activities:-

1. Collection of basic data.
2. Analysis of this basic data.
3. The interpretation of the co-ordinated data.

1. Collection of the basic data:-

The basic data would be obtained from questionnaires answered by the Operators. It would consist of a number of sets of answers to the questionnaires In order to facilitate the extraction of useful information from the basic data the questionnaires would be designed in such a way that the answers would be concise and unambiguous, and if possible would be in a form ready to be transferred directly to punch cards or paper tape. The design of these questionnaires would be made much easier by having the relevant data already collected in different form from past analyses, i.e. Sheets 1,2,3. The use of these sheets over a period of time would enable the precise contents of the data as a whole to be finalised before the detailed design of the questionnaires for the computer based operation was instigated. Thus the manual collection and analysis would form a useful precedent to the automatic process, making the inauguration of the latter much easier than would be the case if it were begun from scratch.

2. Analysis of Basic Data:-

The basic data, now in the form of punch cards or paper tape would be input to the computer for analysis. The analysis would possibly consist of the formulation of tables showing the interrelation between various sub-sections of the basic data, and comparisons with past throughputs.

3. Interpretation of Co-ordinated Data:-

The results of the analysis would then be examined to discover the precise information required from the survey. This may range from a cumulative tabulation of unscheduled maintenance carried out on various craft systems to a comparison of achieved D.O.C.'s of a given craft on a given route, with those predicted by the Standard Method.

The particular information required by the various organisations concerned could be detatched and dispatched individually. The possibilities of such an exercise are limitless. Once the survey was begun, a flexibility would be maintained to cope with changes in conditions and output required.

Section 2. INITIAL ATTEMPT TO DERIVE A STANDARD METHOD FOR ESTIMATING OPERATING COSTS

201) Breakdown of cost items.

A conventional breakdown into fixed and variable D.O.C.'s and I.O.C.'s has been adopted. The constituents of each category were agreed upon at the Hovercraft Symposium, Cranfield, 25th and 26th February, 1969. Ref. 1.

Direct Operating Costs.

Fixed.

1. On board crew.
2. Interest on capital.
3. Insurance (Hull, passenger and third party).
4. Depreciation/Amortisation.

Variable

5. Fuel and Oil.
6. Maintenance.

Indirect Operating Costs.

1. Sales, ticketing, advertising
2. Terminal costs.
3. Administration and Overheads.
4. Navigation and Harbour fees.
5. Introductory costs.

No investigation was made into possible short-comings of or alternatives to the D.O.C., I.O.C. convention. Possible future investigation on this subject is suggested in Section 3.

202) Difficulty in fixing Standard Values

Any standard method must be representative of as wide a range of vehicles as possible. The fixing of realistic standard values to aid D.O.C. calculation can only be done when some years of experience in the operation of a number of craft representing many ranges of the spectrum has been achieved. This state of affairs is of course still some years ahead. Therefore the first qualification to the validity of the values chosen is that they are in many cases dependent largely on manufacturers' and Operators" estimates and informed guesswork. This is certainly almost entirely the case when considering SR N4, VT 1 and HM2.

Secondly, we have the inherent difficulty of fixing any Standard value to be applied to different craft, namely that one can only estimate figures for what we might call the "average case". The greater the number of actual operations and craft types that can be studied, the more confidently can we say what the "average case" is likely to be. With the A.C.V. industry still in its infancy, we can only again hypothesise on what this "average case" may be.

Thirdly, it is clear that we have two very different types of A.C.V., namely the amphibian and the sidewall. VT.1 falls between the two. One could reasonably attempt to produce a separate Standard Method for each of these types. However, there are some items in the costings which depend little on the craft types, few though they may be. It was decided to base the Method on the amphibious craft, of the N6,N4 type, with modifications where appropriate to suit the sidewall, and the unique VT.1. The reasons for this are twofold. Firstly the only craft which has had any appreciable length of time in service is SR N6, an amphibian, and secondly this type of craft is by far the most common today. It may be the case that in years to come the sidewall might prove to be the more commonly used craft, but this is currently not the case, nor is it likely to be so in the near future.

The problems concerning I.O.C.'s are dealt with separately in (220).

203) Fixed D.O.C.'s   <u>On board crew.</u>

Crew costs will depend upon a number of factors, the prime ones being:-

a) Utilisation.
b) Size and complexity of craft.
c) Configuration of craft.
d) Fleet size.
e) Wage rates.
f) Location of operation.
g) Shore based facilities, i.e. radar.
h) Peak or off peak operation.

Clearly a high level of utilisation will demand more crews/craft than a low one. Based on estimates from manufacturers and data from Operators the number of crews/craft can be calculated from Fig. 1. for any given utilisation. Obviously a 1000 hr. utilisation could be operated by one crew in many circumstances. The scale is not a rigid one, but taking account of all influences it appears to give a reasonable estimate. Other influences here will be fleet size and location.

The assumed annual craft utilisation used in the examples in 216-219 is 2000hrs/annum. This is taken as a generally representative figure, as data from operators has tended to be between 1000 and 2000 hrs but expectations are that utilisation will increase as craft get over development problems. This has been the case with N6.

Having decided then on the number of crews/craft, we must now calculate their cost. This will depend on wages paid to each individual crew member and the make-up of the crew. The number of members in the crew of a craft will depend on factors b),c),g),h) mainly. Figure 2 shows some achieved and projected total crew complements. Included here are cabin crew, e.g. stewardesses. Excluded are any lashing crew for car deck operations, who may travel on the craft. The yard-stick used for total crew make up is craft A.U.W.

For current ACV configurations, the convention shown in Fig. 3(a) is suggested. This is based on a passenger/car mix for the craft above 20 tons A.U.W. For all passenger operations 3(b) is recommended. The passenger/car mix is based on VT1 and SR N4 layouts 5 and 7 respectively, with one car equivalent to approximately 12 passengers. The increase in crew for an all passenger version against passenger/car configuration is taken up solely by cabin crew. Figure 3 is intended to give an indication of crew size. Whether an 80 ton passenger/car ferry has 5 or 6 crew will depend on the actual passenger-car mix. If this were 164 passengers + 8 cars, 6 would be most appropriate. However, if it were 124 passengers + 12 cars, then 5 would be better.

The exact make up of the crews in Fig 2 is shown in table 1.

TABLE 1

Crew Make Ups From Fig. 2.

	SR.N6		HM. 2		VT. 1.		SR.N4	
	1	2	3	4	5	6	7	8
COMMANDER	1	1	1	1	1	1	1	1
FIRST OFFICER (co-driver, navig)					1	1	1	1
NAVIGATOR/RADAR OP.		1		1			1	1
ENGINEER							1	1
LEADING HAND			1				1	1
CHIEF PURSER					1	1	1	1
STEWARDESSES				1	3	6	4	9
TOTAL	1	2	2	3	6	9	10	15

Clearly crew size must be selected according to the particular operation the craft is to be on. For example, VT 1 in example 5 would probably carry a 3rd cockpit crew member on a bad weather trip at night. Some flexibility in these figures is intended.

Recommended salary scales are shown in Table 2.

TABLE 2

RECOMMENDED SALARIES £ p.a.

A.U.W. TONS.

	Up to 25	25 - 75	75 - 150	OVER 150
COMMANDER	2000	2250	2600	3000
1ST. OFFICER	1750	1900	2150	2500
NAV./RADAR OP.	1500	1600	1700	1800
ENGINEER	-	1250	1400	1600
LEADING HAND	1150	1200	1250	1300
CHIEF PURSER	-	1200	1350	1500
STEWARDESS	1000	1025	1050	1075

Thus we have the necessary information for the calculation of crew costs for any craft of given A. .W. and passenger/car capacity. Crew costs in £/block hr. will be:-

$$\frac{(\text{Sum of crew salaries}) \times (\text{No. of crews/craft})}{\text{utilisation.}} \text{ £/ block hr.}$$

Taking SR.N6 as an example. With a 2000 hr. utilisation this gives 2.5 crews/craft, from Fig. -1. At an A.U.W. of 10.7 tons approximately, No. in crew is between 1 and 2 from Fig. 3. Assuming day operation with no radar on board, no. in crew will be 1. From Tab. 1 he will be a commander and from Table 2 he will be paid £2000 p. a.

∴ sum of crew salaries = £2000.

$$\therefore \text{crew cost} = \frac{2000 \times 2.5}{2000} = \text{£}2.5/\text{block.hr.}$$

It is possible that the salary scale may in fact prove to be lower for sidewall commanders and first officers than that for amphibious craft, due to the simpler controls and less training needed for the former craft. However, the scale on Fig. 2. is recommended for both craft until this hypothesis can be tested against fuller information.

Any crew costs above actual salary paid e.g. uniforms, accommodation allowances are considered to be I.O.C.'s Cabin crew are included in D.O.C.'s, as was decided at the Symposium. Ref. 1. They travel on the craft, their job is on the craft, they are necessary for operations with larger numbers of passengers or over long routes. In some cases, a car deck lashing/loading crew may travel on the craft. However, as their job is done at the terminals, they are considered to be part of I.O.C.'s. Whether such a crew travels on the craft or is stationed at terminals will depend on the number of terminals, the number of craft and the frequency of services. This will not affect D.O.C.'s.

204) Interest on Capital

One can really say very little about this component of D.O.C. The financial arrangements made by each particular Operator will determine the rate he pays. One can only take as generally representative a value as is possible.

On the basis of current quotes available from some Operators, it is proposed that 5% of 1st. cost of vehicle + spares should be a sufficiently representative figure at this stage.

Thus, $\dfrac{(\text{1st. cost of vehicle + Spares}) \times (\text{Interest rate})}{\text{Utilisation.}}$ = Cost £/block.hr.

For spares holding. see. 206.
For 1st. Cost convention. see 214.

205) Hull, Passenger and 3rd. party Insurance.

The insurance of the vehicle itself will be based on the initial investment, but will depend also on local operating conditions and past experience. In U.K. coastal waters and short range international routes the operating environment should not significantly affect hull insurance.

From data available a figure of 3% of first cost of craft + spares seems a reasonable average figure for the depreciation period.

Passenger and 3rd party insurance may be assessed as so much per vehicle or per seat offered, depending on the liability being covered. Here, 1% of craft 1st. cost + spares appears to tally reasonably with available data.

Thus 4% p.a. is the suggested figure to cover hull, passenger and 3rd. party insurance.

We have $\dfrac{(\text{1st cost of vehicle+ spares}) \times (\text{Annual premium})}{\text{Utilisation.}}$ = Cost £/block.hr.

206) Amortisation/Depreciation

This will be dependent on the expected life of the craft concerned and its residual value at the end of the depreciation period. Craft useful life may be considerably longer than that considered as the amortisation period in reality, but again experience has yet to be gained in this field.

Aircraft depreciation is primarily governed by obsolescence, and when the aircraft becomes obsolete it has a substantial residual value. Ref. 2 recommends 8 years to 10% for aircraft. Ships on the other hand tend to have their depreciation based more directly on useful life, with 20 plus years to zero residual value a more likely measure.

Hovercraft appear to fall somewhere between these two extremes. The limited data available at present would suggest that for amphibious craft of aircraft type construction the 8 years to 10% of the S.B.A.C. method may not, however be far wrong. The somewhat simpler construction of the A.C.V. compared with the aircraft is counterbalanced by the more hostile operating environment. The residual value is principally accounted for by the engines. It is recommended that for sidewall craft, constructed of largely G.R.P and diesel powered, that 10 years to 5% may be more realistic. The former figure is recommended for VT.1 also. (8 years to 10%).

Depreciation costs will be in £/block hr.

$$\frac{(\text{First cost of vehicle + spares})-(\text{Residual value})}{(\text{Depreciation period}) \times (\text{Utilisation})}$$

The craft systems for maintenance cost analysis are split into 5 groups.

(i) Equipped Hull
(ii) Engines
(iii) Lift/Drive
(iv) Skirt
(v) Props.

These 5 systems could be used separately to calculate depreciation charges, but providing the depreciation period is consistent for all systems, this practice seems to involve useless labour.

Spares Holding

A figure for spares holding must be decided upon. This will obviously depend on a wide range of factors, including:-

a) Fleet size.
b) Location of operations.
c) Stage in craft development.
d) Maintenance contracts.

To quote a fixed figure for spares holding is therefore a rather meaningless concept. However, for U.K. coastal operations, 10% of 1st. cost of vehicle was decided at the symposium, ref. 1 . It is recommended that in the absence of fuller data, this figure be retained.

The recommended split of this 10% between the 5 craft systems is shown in Table 3. Also shown is a suggested standard breakdown of craft 1st cost according to these 5 systems.

This breakdown may be modified in the light of more information and may well need alterations to suit side-wall craft. At this stage, however, it should be a sufficiently accurate general breakdown for all craft.

TABLE 3.

Spares holding and Craft 1st. cost by systems

SYSTEM	System cost as % of Craft 1st. cost.	Spares holding as % of system 1st. cost.
EQUIPPED HULL	55	5
ENGINES	20	20
LIFT/DRIVE	15	10
SKIRT, FINGERS, ATTACHMENTS.	5	10
PROPS.	5	25
TOTAL	100	

Example:-

For a craft of first cost £100,000 systems costs and costs of spares holdings are shown in Table 4.

TABLE 4

Example - Spares holding, craft 1st. cost £100,000

SYSTEM	System Costs £	Spares holding £
EQUIPPED HULL	55,000	2,750
ENGINES	20,000	4,000
LIFT/DRIVE	15,000	1,500
SKIRT, FINGERS, ATTACHMENTS	5,000	500
PROPS.	5,000	1,250
TOTAL	100,000	10,000 or 10% of 1st cost.

Clearly these figures can be wildly out when compared with some actual operations. e.g. An operator with 2 single engine craft could reasonably hold 1 spare engine. So engine spares would be 50%. However, any figures decided upon could be criticised simply by looking at various operations. The 10% overall holding and the recommended split of this are felt to be adequate estimates at this stage.

It is possible that the depreciation period for the craft may in the future prove not to be common to all systems. e g. Possibly Operators may wish to amortise skirts or engines over a shorter period than that for the craft structure. Only time will tell, but here is another area for future research.

207) Fuel and Oil Costs. Variable D.O.C.'s

a) Fuel Costs:- Any accurate estimation of fuel costs must be related to a particular operation. Cost/block hour will vary with load factors, sea state, wind conditions, etc., as well as relative times spent at maximum power, cruise power, idling power, etc.

In the light of current information, a detailed breakdown into various power settings is not considered to be practical. The recommended method simply differentiates between cruise power and idling power.

Fuel cost. £/block hr. =

$$\left(\frac{(\text{Block fuel consumed}) + (\text{Idling fuel consumed})}{(\text{Block time})} \right) \times (\text{Fuel cost})$$

considering each item individually:-

1) Block time:- is defined as total elapsed time on cushion for a given sector. For the proposed method this is simplified into cruise time and manoeuvre time. The latter will vary according to particular terminal area conditions and size of craft. It is not felt that differentiation between amphibious and sidewall craft is justified here until more operating experience is gained. The simple rule suggested in Table 5 is recommended.

TABLE 5

Manoeuvre time/sector related to craft A.U.W.

CRAFT A.U.W.	MANOEUVRE TIME PER SECTOR.
Less than 10 TONS	2 min.
10-50 TONS	3 min.
More than 50 TONS	4 min.

Block time (hrs) will therefore be:-

$$\frac{\text{(Block Distance)}}{\text{(Cruise speed)}} + \frac{\text{(Manoeuvre time)}}{60}$$

Due to the sidewall or water screw craft being dependent on a minimum depth of water to operate successfully, this may or may not effectively increase the block distance for such craft. Whether any diversion will be needed, or how extensive this will be, will depend on the particular characteristics of the route and craft. It is felt, however, that some form of differentiation in favour of the amphibious craft is justified here, especially when considering coastal and estuary type routes. It is therefore recommended that a 10% addition be made to the point to point block distance when considering sidewall or any water screw powered craft.

2) Fuel Cost:- This again will vary with location of the operation; also whether tax rebate is claimable, and quantity purchased. Further, type of fuel used, i.e. diesel or kerosene will affect cost.

The recommended standard fuel charges are shown below.

Kerosene - 15 d. /I.G. incl. tax. = £0.0625

Diesel Oil - 13 d /I.G. incl. tax. = £0.05417

Tax Rebate for Operations in International waters 2d/I.G.

3) Block fuel consumed:- This will simply be

(Block time) x (Fuel consumption at cruise power).
S.F.C. quoted by manufacturers may be used here, but in the absence of any available figure, the following guideline is suggested.

S.F.C. at cruise power (cruise power = max. cont. rating)
= 0.08 I.G./H.P./hr. for gas turbines.
and
0.06 I.G./H.P /hr. for diesels.

4) Idling fuel consumed.

This again is a very difficult concept to standardise.
Idling fuel consumed =
(Idling time) x (Idling fuel consumption).

Idling time will depend primarily on turnround time, but also on the sophistication of the terminal, the craft type, and arrangements over engine maintenance made by individual operators.

Just how long a turnround must be to justify shutdown rather than idling is difficult to pinpoint. It seems reasonable to assume that the longer the block time, the longer will be t e turnround time in the majority of cases, and therefore the longer the idling time, if any. Current limited experience would suggest that the times suggested in Table 6 may not be unreasonable.

TABLE 6

Min. length of turnround to justify shutdown.

CRAFT A.U.W.	MIN. TURNROUND FOR SHUTDOWN.
Less than 10 TONS	5 MIN.
10-50 TONS	10 MIN.
More than 50 TONS	15 MIN.

Again no differentiation between sidewall and amphibian is recommended at this time. Further operating experience may modify this view.

In the light of the figures recommended in Table 6 it is suggested that for the standard method idling time will be negligible in most cases. (i.e. Time during starts only). Only if a high frequency service is envisaged within the turnround times of Table 6 should idling fuel consumed be included as a positive figure. Idling time per turnround would be estimated from Table 6. Idling fuel consumption may be taken from manufacturers' estimates; in the absence of these a figure of 20% of cruise consumption is suggested.

(Note:- As each sector operated will include ½ x Idling time for each of 2 terminals, assuming a fast turnround justifying idling, the ½ x Idling times for each terminal must then be added together to form idling time for the sector. This would be necessary if a particular route with given turnround times was being examined, if the two turnround times were unequal. If they were equal, or were assumed to be equal in a hypothetical case, then the single total idling time for one terminal would be sufficient for the whole sector.)

b) Oil Costs. It is recommended that oil costs simply be added on as a percentage of fuel costs. Current experience suggests that actual oil consumption may not account for all oil used due to substantial leakage experienced on some craft. However, assuming that this can be minimised, the following percentages are recommended.

Gas Turbines:- Oil cost 3% of fuel cost.
Diesels:- Oil cost 5% of fuel cost.

208) Maintenance Costs. Introduction.

In maintenance costs we have undoubtedly the most crucial and difficult area in the whole D.O.C. make up. The technical advances in design, and materials, which have been made, and which are still being made in the A.C.V. field, are reflected more directly in maintenance costs than anywhere else.

Whereas fixed direct costs, crew costs, insurance, interest on capital, and depreciation have been reasonably stable and are fairly straight forward to predict, within the known limitations, variable costs are not so straight forward. Fuel and oil consumption figures, however, have not shown any large unexpected fluctuations, as engines currently used have all achieved considerable hours of operation in other vehicles or applications.

Maintenance costs on the other hand, have been the subject of constant fluctuations during these early years. Significant improvements in skirt design and materials have been made, and this pattern, unpredictable though it may be, is expected to continue, and will be reflected in skirt maintenance costs. The novel operating environment for the gas turbine engines and propellers led to extremely short Time Between Overhaul figures initially, and in these areas costs are still very unsettled also.

These facts make the formulation of Standard Values in the Maintenance Costs section of any Standard Method very difficult to assess. For SR N6, the craft to which available data almost exclusively applies, we can now be reasonably confident of the level of maintenance costs we expect, yet even here the matter is by no means straight forward. Life expectancy of N6 fingers is still rising to give a single example. Even if we accept that we can fairly accurately predict N6 maintenance costs for a given route and location, a Standard Method cannot be built on the operation of one type of craft only. When we consider the vastly different scale of the SR N4, the unique VT.1 hybrid, and the sidewall HM 2, the fact that VT 1 has yet to make its debut, and the short period of operations of N4 and HM2, which has still to yield much needed data, we realise that the formulation of detailed standard cost formulae for maintenance of the above named craft and others is simply not on at present. Time Between Overhaul figures even expected Time Between Overhaul figures, are just not known or available for many components. What then can be done at this stage?

As stated in 206, the craft are split into 5 major items for maintenance analysis. These are:-

1. Equipped Hull.
2. Skirt.
3. Engines.
4. Lift/Drive.
5. Props.

The maintenance of each system may be split into labour costs and materials costs, and will include regular inspections, replacement and repair of components, both scheduled and unscheduled, and major overhauls. It has become clear, however, that such an analysis of the 5 systems including labour and materials costs for all types of maintenance carried out is not viable at this stage of the work. Certainly this will be the long term aim, to relate the maintenance costs in terms of labour and materials for each system, to Time Between Overhaul , wt. of craft, 1st cost of system, installed h.p. expected life or whatever combination of parameters is most relevent to the particular system. To make such a thorough analysis worthwhile and the end product useful, certainly as far as any standard method is concerned, means commencing with at least a certain minimum amount of relevant data, relating to a certain minimum number and type of craft. All available data for the purposes of this pilot study could only be said to meet these requirements for SR N6.

However, if the recommendations of Section 1 can be followed up and a data analysis operation be successfully instigated, the information needed during the next few years to build a reliable model from which a realistic standard Method can emerge, will be made available in a form most suitable for the task.

Having said this then, let it be made clear that the conclusions drawn and formulae suggested in the remainder of this section on maintenance costs are intended to provide only an approximate guide to current maintenance costs, and will undoubtedly be superceded by more accurate and realistic formulae based on more relevant parameters in future years. The lack of and nature of available data, much of which is based on Manufacturers' and Operators estimates, makes these qualifications inevitable, and no claim is laid that the small amount of work done by the author to date provides any more than an approximate estimate of N4, VT.1 and HM.2 maintenance costs, costs which will no doubt be subject to various changes as the craft are developed.

209) Equipped Hull

The suggested formula here for maintenance labour manhours for amphibious craft with light alloy airframe type construction, eg. SR N6, SR N4, is:-

$$\text{Manhours/block hour} = 0.114\ (\text{A.U.W.}) + 1.516.$$

To bring this into cost per block hour a standard labour rate must be applied. In the light of present information it is recommended that this be taken as £0.75/man hour.

Thus equipped hull labour costs per block hour will be:-

$$(0.114\ (\text{A.U.W.}) + 1.516)\ 0.75 \quad \text{or:-}$$

$$0.086\ (\text{A.U.W.}) + 1.137.\ \text{£/ block hour.}$$

Figure 4 shows this labour cost plotted against craft A.U.W. As far as can be ascertained from present data, materials costs will be approximately ½ labour costs at 15/- per man hour standard rate. Thus materials costs will be given by the formula:-

$$0.043\ (\text{A.U.W.}) + 0.5685\ \text{£/block hr.}$$

Hence total equipped hull maintenance costs will be given by:-

$$0.129\ (\text{A.U.W.}) + 1.706\ \text{£/block hour.}$$

For sidewall craft, such as HM2 with marine type construction, employing predominantly GRP, hull maintenance will be somewhat lower. It is recommended that a factor of 4 be applied to bring down hull maintenance costs from the level indicated by the formula for equipped hull maintenance for amphibians to a level more realistic for sidewalls. As more data becomes available this reduction will be sophisticated and modified. The reduction is due largely to the more robust and simpler construction of the sidewall of HM2 type, employing mainly G.R.P in the structure itself. Thus Sidewall equipped hull maintenance costs will be:-

$$\frac{0.129\ (A.U.W.) + 1.706}{4} \qquad £/\text{ block hr.}$$

No differentiation has yet been made here between labour and materials. Although it is expected that they will prove to be in approximately the same proportions as for the amphibian.

For V.T.1, the question is virtually unanswerable at this stage. Due to a slightly more simple construction than the amphibious craft, and a lesser degree of sophistication on some systems, a factor of 1.2 is recommended as a first estimate. Therefore for hybrid craft of V.T.1 type, equipped Hull maintenance costs will be given by.

$$\frac{0.129\ (A.U.W.) + 1.706}{1.2} \quad £/\text{block hr.}$$

When detailed analysis becomes possible on a number of different craft in the future, it is anticipated that hull maintenance will be related to weight of equipped hull alone, and its first cost, with some incorporation of the relative proportions of G.R.P./light alloy/wood etc. employed in the structure.

When records of equipment failures and details of rectification costs become available for a number of craft these constituents of equipped hull maintenance costs will likewise become more readily predictable.

210) <u>Skirt</u> (<u>Trunk, fingers & attachments</u>).

Flexible skirts have been the singularly most common source of escalations in A.C.V. maintenance costs. Improvements in skirt design and in the durability of materials used, are improving costs steadily, but there is still some way to go before many skirt maintenance costs can be considered acceptable.

Current skirts consist of an upper "trunk" section, with a large number of "fingers" attached, the latter making any surface contact.

Again a simple formula is recommended as a sufficient approximation at this stage. This gives total skirt maintenance costs as.

$$0.147\ (A.U.W.) + 3.529\ £/\text{block hr.}$$

This may be split into approximately 80% materials costs and 20% labour costs. See Fig. 5.

For sidewall craft a reduction factor of 4 is again recommended. The sidewall's skirt will only traverse the beam at bow and stern, and will also need no amphibious capability. Thus sidewall skirt maintenance costs will be:-

$$\frac{0.147\,(\text{A.U.W.}) + 3.529}{4} \quad \text{£/block. hr.}$$

For hybrid craft of V.T. 1 type, again any reduction factor is extremely difficult to assess. It is felt that some reduction should be justified due to the VT.1 being powered by water screws, this leading to an inherently more stable condition than the amphibian and therefore slightly lower wave impacts, over a period of time, on the perimeter of the skirt as a whole. Furthermore, all round amphibious capability is not needed, although bow loading is provided for on a ramp. In the absence of information here, a factor of 1.25 is suggested at this time. So, hybrid skirt maintenance costs will be:-

$$\frac{0.147\,(\text{A.U.W.}) + 3.529}{1.25} \quad \text{£/block hr.}$$

Particularly in this area of maintenance costs, it is recognised that much more work is needed when more information becomes accessable. Costs which constitute total skirt maintenance will be a) Regular Inspections, b) Replacement / repair materials costs of damaged fingers, c) Replacement trunk materials costs, d) Labour costs for b) and c). It should be possible to relate inspection time to possibly skirt depth and perimeter, together with operating environment. When achieved trunk and finger lives become known, progress can rapidly be made here. SR.N6 expected life of trunk is now 3,000 hrs, and fingers 600 and increasing, figures which are incomparable with the early fingered skirts used.

The type of formula eventually used may have the following general form.

Skirt maintenance. £/block hr =

$$\left(\frac{f\,(\text{Skirt perimeter, depth, \% time on water/land})}{\text{Utilisation.}} \times \text{Wage Rate} \right) +$$

$$\left(\frac{\text{Cost of Finger} \times \text{No. Fingers}}{\text{Life of finger}} \right) + \left(\frac{\text{Trunk cost.}}{\text{Trunk life}} \right) +$$

$$\left(\frac{f\,(\text{No. of fingers, ht., width})}{\text{Utilisation}} \times \text{Wage rate} \right) + \left(\frac{f(\text{Trunk dim})}{\text{Utilis.}} \times \text{Wage Rt.} \right)$$

+ (Finger/trunk repair labour & materials costs) This represents:-

(Inspection labour) + (Finger materials) + (Trunk materials) +

(Finger replacement labour) + (Trunk replacement labour).

+ (Repair costs).

Analysis on these lines will prove viable when more data is available on craft other than SR N6.

211) Engines

As yet, the only reliable Time Between Overhaul figures available are for N6 Gnomes, which currently have major overhaul after 1250 hrs and complete overhaul after 3750 hrs. The concept of Time Between Overhaul makes overhaul cost fairly easy to calculate, the accuracy depending entirely on quoted Time Between Overhaul figures being achieved. For the Lycoming TF 20's in VT.1, no Time Between Overhaul figures are available. N4's may be estimated. It is felt that at this stage a formula incorporating all relevant parameters cannot be reliably estimated. The constituents of such a formula might be:-

(Inspection labour) + (Major overhaul labour) + (Major overhaul materials) + (Repairs labour) + (Repairs materials) + (A.P.V. allowance).

Relevant parameters' will include. i) Time Between Overhaul ii) Utilisation. iii) Labour rate. iv) Installed S.H.P./Max. cont. rating. v). First cost of engine. vi.) Stage length. vii). S.H.P./A.V.W.

Until such time as sufficiently reliable Time Between Overhaul data is available, and more operating experience gained, the following convention is suggested as an interim approximation.

Gas turbine engine maintenance costs:-
(0.001 (M.C.R.) + 7) x (Number of engines) £/block hr.

M.C.R. = Max. continuous rating. See Fig. 6A.

Labour costs will here be of the order of only 5-10% of materials costs.

No justification is found for any reduction factor for VT.1 engines in the absence of relevant data.

For Diesel engines, as in H.M.2 maintenance costs will be considerably lower. The recommended formula is:-

$$\left(\frac{0.0025\ (\text{M.C.R.}) + 8.5}{20} \right) \times \left(\text{No. of engines} \right) \text{ £/block hr.}$$

See Fig. 6B.

Of course, if like HM_2 a craft has engines of different capacity, these must be treated separately. HM_2 has 2 propulsion engines of 320 b.h.p. and one lift engine of 185 b.h.p. Maintenance costs from the temporary formula will be:-

$$\frac{(0.0025(320) + 8.5)}{20} \times (2) + \frac{(0.0025(185) + 8.5)}{20} \times (1) \text{ £/block.hr.}$$

It is hoped that these temporary formulae will provide adequate approximation until the more sophisticated method is finalised.

212) Lift/Drive

Included here will be fans, transmission shafts, couplings, gearboxes etc Costs here should be related to engine power basically, with T.B.O.'s bearing some relationship to T.B.O. of the engines. Number of engines will be significant, as will be method of propulsion i.e. Water screws or air propellers Considerably more operating data is needed here before detailed analysis is viable.

Recommended approximatäon here relates costs to total max. continuous power rating. Total lift/drive maintenance costs for amphibians will be given by.

$$0.00091 \text{ (T.M.C.R.)} + 1.292 \text{ £/block hr.}$$

T.M.C.R. = Total max. continuous rating. See Fig. 7.

For Sidewall craft, due to simpler drive mechanism through water screws, costs will be somewhat lower. Recommended formula here is:-

$$\frac{0.00091\text{(T.M.C.R.)} + 1.292.}{2} \text{ £/block hr.}$$

i.e. a reduction factor of 2.

For the hybrid, again the drive mechanism is somewhat less sophisticated, but not to the same extent as that of the diesel. A reduction factor of 1.5 is recommended here.

Thus for the hybrid, lift/drive total maintenance costs will be.

$$\frac{0.00091\text{(T.M.C.R.)} + 1.292}{1.5} \text{ £/block hr.}$$

213) Props.

Again here, one of the most dominant factors will be engine power. Fig. 8 relates air propeller maintenance cost to M.C.R. for one engine and prop. Total Prop. maintenance costs in £ per block hour will be:-

$$\left(\frac{0.006\text{(M.C.R.)} + 34}{20} \right) \times \left(\text{No. of props.} \right)$$

As more information becomes available and T.B.O. figures settle, prop. maintenance costs will become more predictable. More sophisticated formula may include the following variables.

$$(\text{Number of props}) \times \left(\frac{\text{Overhaul cost}}{\text{T.B.O.}} + f(\text{First cost, engine H.P., wt., speed, operating environment}) \right)$$

In the absence of sufficiently reliable data, the temporary convention of Fig. 8 is suggested.

For the sidewall and hybrid, driving water screws, t e costs will be somewhat lower. The following are recommended as approximations:-

Sidewall and hybrid craft:-

Total prop. maintenance costs:-

$$\left(\frac{0.006(\text{M.C.R.}) + 34}{20 \times 6} \right) \times \left(\text{No. of props.} \right) \quad \text{£/block hr.}$$

M.C.R. will be for propulsion engines only where these are different to lift engines.

214) Other useful Standard Values.

In evaluating a projected or hypothetical craft, certain information which would normally be available when considering current craft, may not be so. For this reason, certain other conventions may prove useful. They are of necessity only intended to provide an approximate guide when information is lacking.

A). Craft 1st. Cost.

Craft 1st cost/ton A.U.W. is shown in Fig. 9 for Amphibious, hybrid and sidewall craft. This convention does assume similar construction methods and materials to current craft, being used in any projected craft being studied, i.e. Amphibians of airframe type light alloy construction, sidewalls of mainly G.R.P. as in HM_2 and hybrids of VT.1 type construction in light marine alloys.

B). Max continuous power/ton. A.U.W.

This gives a total power figure including lift and propulsion engines where these are separate identities. Recommended approximations are:-

Air propeller, amphibians:- 80 H.P./ton A.U.W.
Water screw, sidewall/hybrid:- 45 H.P./ton. A.U.W.

C). Max. continuous rating.

For gas turbines, this is recommended as 90% of maximum rated power. For Diesels, no differentiation is needed.

215) Summary of D.O.C. estimation.

Annual Utilisation = 2000 hrs.

Fixed D.O.C.'s.

1) On Board Crew:- 203.

$$\frac{(\text{£ Sum of crew salaries}) \times (\text{No. of crews/craft})}{(\text{Utilisation. hrs.})} \quad \text{Cost} = \text{£/block. hr.}$$

Sum of crew salaries:- See Figs. 2 and 3 and Tabs. 1 and 2.

No. of crews/craft:- See Fig. 1.

Utilisation:- 2000 hrs. p.a.

2). Interest on Capital:- 204

$$\frac{(\text{£ 1st. cost of vehicle + spares}) \times (\text{Interest rate})}{(\text{Utilisation})} \quad \text{Cost} = \text{£/block.hr.}$$

1st. cost of vehicle + spares:- Spares holding 10% of 1st. cost. See 206. 1st. cost convention, see. Fig. 9.
Interest rate:- 5%

3) Hull, Passenger & 3rd party Insurance:- 205

$$\frac{(\text{£. 1st cost of vehicle + spares}) \times (\text{Annual premium})}{(\text{Utilisation}).} \quad \text{Cost} = \text{£/block.hr.}$$

Annual premium = 4%

4) Amortisation/Depreciation:- 206

$$\frac{(\text{£ 1st. cost of vehicle + spares}) - (\text{Residual value})}{(\text{Depreciation period yrs.}) \times (\text{Utilisation}).} \quad \text{Cost} = \text{£/block.hr}$$

Residual value:- 10% 1st. cost of vehicle + spares, amphibians. and hybrid. 5% Sidewall.

Depreciation period:- 8 yrs. amphibians and hybrid. 10 years Sidewall.

Variable D.O.C.'s

5) Fuel & Oil Costs:- 207

Fuel cost =

$$\frac{\left(\text{(Block fuel consumed. Ig.)} + \text{(Idling fuel consumed)}\right) \times \frac{\text{(Fuel cost d/I.g)}}{240}}{(\text{Block time})} \quad \text{Cost} = \text{£/block hr.}$$

Block fuel consumed = (Block time. hrs) x (Fuel consumption at cruise power Ig./hr.) I.g.

Block time =

$$\frac{\text{(Block Distance. [illegible] s.)}}{\text{(Cruise speed m.p.h.)}} + \frac{\text{(Manoeuvre time. mins.)}}{60} \text{ Hrs.}$$

Manoeuvre time/sector:- See tab. 5.

Idling fuel consumed =
(Idling time hrs.) x (Fuel consumption at Idling power Ig.hr).Ig.
Idling time:- See Tab. 6.
Block Distance:- Add 10% for Sidewall/Hybrid craft, if diversion allowance not included. See p. 19 .

Fuel Consumption at Cruise power:- If no figures available assume:-
0.08 I.g./H.P./hr for Gas Turbines.
0.06 I.g./H.P./hr for Diesels.

Fuel Consumption at Idling power:- If no figures available assume 20% of cruise consumption.

Fuel cost:- Kerosene = 15 d /I.g.
Diesel Oil = 13 d /I.g.

6) <u>Maintenance Costs</u>:- 208-213.

a) <u>Equipped Hull</u>. 209

Manhours/block hr. = 0.114(A.U.W.)+1.516 for Amphibians
Labour rate = £0.75/ man hour.
Total labour cost = (0.114(AU.W.)+1.516) 0.75 £/block hr.
= 0.086 (A.U.W.) + 1.137 £/block hr.

Materials cost = 0.043 (A.U.W.) + 0.5685 £/block hr.

∴ Tot. equipped hull maintenance costs are:-

0.129 (A.U.W.) + 1.706 £/block hour.

See Fig. 4.

Sidewall total equipped hull maintenance costs are:-

$$\frac{0.129 \text{ (A.U.W.)} + 1.706}{4} \text{ £/block hr.}$$

Hybrid total equipped hull maintenance costs are:-

$$\frac{0.129 \text{ (A.U.W.)} + 1.706}{1.2}$$

b) Skirts. 210

Total skirt maintenance costs:-

Amphibians:- 0.147 (A.U.W.) + 3.529 £/block hr. See Fig.5.
Sidewall:- Factored down by 4.
Hybrid:- Factored down by 1.25.

c) Engines. 211

Total Engine Maintenance costs:-

Gas turbines:- (0.001(M.C.R.) + 7) x(No. of engines)£/block hr.

See Fig. 6A.

Diesel Engines:- $\frac{(0.0025(M.C.R.)+8.5)}{20}$ x(No. of Engines) £/block hr.

See Fig. 6B.

d) Lift/Drive 212

Total Lift/Drive maintenance costs:-

Amphibians:- 0.0091 (T.M.C.R.) + 1.292 £/block hr.
Sidewall:- Factored down by 2. See Fig. 7.
Hybrid:- Factored down by 1.5

e) Props. 213

Total. prop. maintenance costs:-
Air props:- $\left(\frac{0.006(M.C.R.)+34}{20}\right)$ x (No. of props.) £/block hr. See Fig. 8.

Water screws:- $\left(\frac{0.006(MCR)+34}{20 \times 6}\right)$ x(No. of props.) £/block hr.

Total Fixed D.O.C.'s (On board crew costs)+(Interest on Capital) + (Hull, passenger and 3rd. party insurance) + (Amortisation/Depreciation). £/block hr.

Total Variable D.O.C.'s = (Fuel & Oil Cost)+ (Maintenance cost) £/block hr.

Tot. Maintenance cost. = (Tot. equipped hull maintenance costs) + (Total skirt maintenance costs) + (Total engine maintenance costs) + (Total Lift/Drive maintenance costs) + (Total prop. maintenance costs). £/block hr.

Total D.O.C.'s = (Total Fixed) + (Total Variable) £/block hr.

216) Worked Example No. 1. SR.N6.

First Cost = £150,000
Configuration = 38 passengers
A.U.W. = 10.72 tons.
Utilisation = 2000 hrs p.a.
Engine max. cont. rating = 900 s.h.p.
Fuel consumption at M.C.R. = 65 I.g./hr.
No. of engines = 1.

Sector direct distance = 10 mls.
Cruise speed = 40 m.p.h.
Turnround = ≯ 10 min.

Fixed D.O.C.'s	COSTS.
1) On Board crew:-	
$\text{Cost} = \frac{(2000) \times (2.5)}{2000} = 2.5$	£2.500/block hr.
Sum of crew salaries = £2000 No. of crews/craft = 2.5	
2) Interest on Capital:-	
$\text{Cost} = \frac{(165,000)\times(5\%)}{2000}$	£4.125/block hr.
Spares holding = 10% 1st. cost = £15000 Interest rate = 5% 1st. cost vehicle + spares.	
3). Hull, passenger & 3rd. party ins.	
$\text{Cost} = \frac{(165,000)\times(4\%)}{2000} = 3.3$	£3.300/block hr.
Annual Premium = 4% 1st cost vehicle + spares	
4) Amortisation/Depreciation	
$\text{Cost} = \frac{(165,000)-)16,500)}{8 \times 2000}$	£9.281/block hr.

Total Fixed D.O.C.'s = 2.500+4.125+3.300+9.281

= 19.206 £19.206/block.hr.

Variable D.O.C.'s

5) Fuel & Oil

$$\text{Block time} = \frac{(10)}{(40)} + 3/60 = 18/60 \text{ hrs.}$$

Manoeuvre time = 3 min.

$$\text{Block fuel} = \frac{18}{60} \times 65 = 19.5 \text{ I.g.}$$

Idling fuel consumed = 0.
Fuel cost = 15d. /I.g.

Total Fuel costs = $\frac{(19.5 + 0) \times 15/240}{18/60} = 4.063$

Oil Cost = 3% fuel cost = 0.122

∴ Tot. fuel and oil cost = 4.185 £4.185/block hr.

6) Maintenance costs

Equipped Hull
Total, labour + materials = 0.129(10.72)+1.706
= 3.089
£3.089/block hr.

Skirt
Total = 0.147(10.72) + 3.529
= 5.105 £5.105/block hr.

Engine
Total = (0.001 (900) + 7) x 1
= 7.900 £7.900/block hr.

Lift/Drive
Total = 0.00091(900) + 1.292
= 2.111 £2.111/block hr.

Props.
Total = $\left(\frac{0.006(900) + 34}{20}\right) \times 1$

= 1.970 £1.970/block hr.

Total Maintenance costs: = 3.089+5.105+7.900+2.111+1.970
= 20.175
£20.175/block hr.

Total Variable D.O.C.'s = 20.175 + 4.185
= 24.360 £24.360/block hr.

TOTAL DIRECT OPERATING COSTS

= 19.206 + 24.360
= 43.566 (£43.566/block hr)

217) Worked Example No. 2. SR. N4

First Cost = £1,750,000.

Configuration = 254 pass + 30 cars.

A.U.W. = 177 tons.

Utilisation = 2000 hrs.

Engine Max. cont. rating = 3400 s.h.p.

Fuel consumption at M.C.R. = 250 Ig./hr/engine.

No. of engines = 4.

Sector direct distance = 40 mls.
Cruise Speed = 55 m.p.h.
Turnround = ≯ 15 min.

Fixed D.O.C.'s	COSTS
1) On board crew Cost = $\frac{(16,000)x(2.5)}{2000}$ = 20 Sum of crew salaries = £16,000.	£20.000/block hr.
2) Interest on Capital Cost = $\frac{(1,925,000)x(5\%)}{2000}$ = 48.125	£48.125/block hr.
3) Hull, passenger & 3rd. party ins. Cost = $\frac{(1,925,000)x(4\%)}{2000}$ = 38.500	£38.500/block hr.
4) Amortisation/Depreciation Cost = $\frac{(1,925,000)-(192,500)}{8 \times 2000}$ = 108.281	£108.281/block hr.
Tot. fixed D.O.C.'s = 20.000+48.125+38.500+108.281 = 214.906	£214.906/block hr.

Variable D.O.C.'s

5) Fuel & Oil

Block Time = $\frac{(40)}{(55)} + \frac{4}{60} = \frac{47.637}{60}$ hrs.

Manoeuvre time = 4 min.

Block Fuel = $\frac{47.637}{60}$ x 1000 = 793.833 I.g.

Idling fuel consumed = 0.

Fuel cost = 15d./I.g.

Total Fuel costs = $\frac{(793.833)x15/240}{47.637/60}$

= 62.5

Oil cost = 62.5 x $\frac{3}{100}$ = 1.875

∴ Tot. Fuel & Oil costs = 64.375 — £64.375/block hr.

6.) Maintenance costs

Equipped Hull

Total, labour + materials =
0.129(177)+1.706 = 24.536 — £24.536/block hr.

Skirt

Total = 0.147(177) + 3.529
= 29.549 — £29.549/block hr.

Engine

Total = (0.001(3400)+7) x 4
= 41.600 — £41.600/block hr.

Lift/Drive

Total = 0.00091(13600) + 1.292
= 13.672 — £13.672/block hr.

Props.

$$\text{Total} = \left(\frac{0.006(3400)+34}{20}\right) \times 4$$

= 10.889 — £10.889/block hr.

Total Maintenance Costs:-

24.536+29.549+41.600x13.672+10.889
= 120.246 — £120.246/block hr.

Total Variable D.O.C.'s:-

120.246+64.375
= 184.621 — £184.621/block hr.

TOTAL DIRECT OPERATING COSTS

= 214.906 + 184.621
= 399.527 — (£399.527)

218) Worked Example No. 3. HM.2.

First Cost = £85,000

No. of engines
(Propulsion = 2
(Lift = 1.

Configuration = 60 pass.

A. .W. = 18.53 tons.

Sector Direct Distance = 10 mls.

Utilisation = 2000 hrs. p.a.

Cruise Speed = 35 mph.

Engine Max. cont. rating(320 bhp propulsion)
(185 bhp lift.)

Fuel Consumption at M.C.R.
(18.5 I.g./hr. propulsion.)
(8.5 I.g./hr. lift.)
Turnround = $\geqslant$ 10 min.

Fixed D.O.C.'s	COSTS
1) On board crew:- $\text{Cost} = \frac{(3150) \times (2.5)}{2000} = 3.938$ Sum of crew salaries = £3150.	£3.938/block hr.
2) Interest on Capital:- $\text{Cost} = \frac{(93,500) \times (5\%)}{2000} = 2.338$	£2.338/block hr.
3) Hull, pass. & 3rd party ins.:- $\text{Cost} = \frac{(93,500) \times (4\%)}{2000} = 1.875$	£1.875/block hr.
4) Amortisation/Depreciation:- $\text{Cost} = \frac{(93500)-)4675)}{10 \times 2000} = 4.441$ Amortisation Period = 10 yrs. Residual Value = 5%.	£4.441/block hr.
Tot. Fixed D.O.C.'s :- = 3.938 + 2.338+ 1.875+4.441 = 12.592	£12.592/block hr.

Variable D.O.C.'s

5) Fuel & Oil

Block distance =
10 miles + 10% diversion allowance.
= 11 miles.

Block Time = $\left(\frac{11}{35}\right) + \frac{3}{60} = \frac{48}{140}$ hrs.

Manoeuvre Time = 3 min.

Block fuel = $\frac{48}{140} \times 45.5 = 15.600$ I.g.

Idling fuel consumed = 0.
Fuel cost = 13d/I.g.
Total Fuel costs = $\frac{(15.6 + 0) \times 13/240}{48/140} = 2.464$

Oil cost = $2.464 \times \frac{5}{100} = 0.123$

∴ Tot. fuel & oil costs = 2.587 — £2.587/block hr.

6) Maintenance costs

Equipped Hull

Total, labour+ materials =
$\frac{0.129\ (18.53) + 1.706}{4}$

= 1.024 — £1.024/block hr.

Skirt

Total = $\frac{0.147(18.53)+3.529}{4} = 1.563$ — £1.563/block hr.

Engine

Total=
$\left(\frac{0.0025(320)+8.5}{20}\right) x(2) + \left(\frac{0.0025(185)+8.5}{20}\right)$

= 1.378 — £1.378/block hr.

Lift/Drive

Total = 0.00091(825)+1.022 — £1.022/block hr.

Props.

Total = $\left(\frac{0\ 006(320)+34}{20 \times 6}\right) \times 2 = 0.599$ — £0.599/block hr.

Total Maintenance costs
= 1.024+1.563+1.378+1.022+0.599 = 5.586 — £5.586/block hr.

Total Variable D.O.C.'s= 5.586+2.587
= 8.173 — £8.173/block hr.

TOTAL DIRECT OPERATING COSTS
= 12.592 + 8.173
= 20.765 — (£20.765/block hr.)

219) Worked Example No. 4. V.T.1.

First Cost = £500,000

Configuration = 148 pass + 10 cars

A.U.W. = 79 tons.

Utilisation = 2000 hrs. p.a.

Engine max. cont. rating = 1850 s.h.p.

Fuel consumption at M.C.R. = 162 I.g./hr.

No. of engines = 2.

Sector direct distance = 25 mls
Cruise speed = 45 m.p.h.
Turnround => 15 min.

Fixed D.O.C.'s	COSTS
1) On Board crew:- Cost = $\frac{(9250) \times (2.5)}{2000}$ = 11.563; Sum of crew salaries = £9250.	£11.563/block hr.
2) Interest on Capital. Cost = $\frac{(550,000) \times (5\%)}{2000}$ = 13.750	£13.750/block hr.
3) Hull, pass. & 3rd. party ins. Cost = $\frac{(550,000) \times (4\%)}{2000}$ = 11.000	£11.000/block hr.
4) Amortisation/Depreciation:- Cost = $\frac{(550,000)-(55,000)}{8 \times 2000}$ = 30.938	£30.938/block hr.
Total Fixed D.O.C.'s = 11.563 + 13.750 + 11.000+ 30.938 = 67.251	£67.251/block hr.

Variable D.O.C.'s

5) Fuel & Oil

Block time = $\frac{27.5}{45} + \frac{4}{60} = \frac{30.5}{45}$

Block distance = 25 + 10%
= 27.5 mls.

Manoeuvre time = 4 min.

Block fuel = $\frac{30.5}{45} \times 324$

Idling fuel consumed = 0.

Fuel cost = 15 d/I.g.

Total fuel costs = $\dfrac{\left(\dfrac{30.5}{45} \times 324\right) \times \dfrac{15}{240}}{30.5/45} = 20.25$

Oil cost = $20.25 \times \dfrac{3}{100} = 0.608$

Total fuel & oil costs = 20.858 £20.858/block hr.

6) Maintenance costs

Equipped Hull:-

Total. lab. + materials

$= \dfrac{0.129(79)+1.706}{1.2}$

= 9.913 £9.913/block hr.

Skirt:-

Total = $\dfrac{0.147(79)+3.529}{1.25}$ = 12.110 £12.110/block hr.

Engine:-

(0.001(1850) + 7) x 2 = 17.700 £17.700/block hr.

Lift/Drive:-

Total = $\dfrac{0.00091(3700)+1.292}{1.5}$ = 3.106 £3.106/block hr.

Props:-

Total = $\left(\dfrac{0.006(1850)+34}{20 \times 6}\right) \times 2$ = 0.750 £0.750/block hr.

Total Maintenance Costs =

9.913+12.110+17.700+3.106+0.750

= 43.579 £43.579/block hr.

Total Variable D.O.C.'s =

43.579 + 20.858 = 64.437 £64.437/block hr.

TOTAL DIRECT OPERATING COSTS

= 67.251 + 64.437

= 131.688 (£131 688/block hr)

220) Indirect Operating Costs

The small amount of work done during the Study on Indirect Operating Costs has led to the following conclusions:-

1) The basic concept of I.O.C.'s is not well defined.

2) The current practice of adding I.O.C.'s as a percentage of D.O.C.'s is basically wrong.

3) Much more information and investigation is called for before the main parameters influencing I.O.C.'s can be identified and any attempt made to quantify them.

4) The incorporation of I.O.C.'s in any Standard Method of Estimating Operating Costs, may prove eventually to be an impractical task.

For the collection of data on I.O.C.'s via Service Report sheet 3, costs have been split into 5 main groups:-

1) Sales, Ticketing, Advertising.
2) Terminal Costs.
3) Administration & Overheads.
4) Navigation & Harbour fees.
5) Introductory Costs.

Terminal costs would include manning, and the cost of the facilities, including interest on capital, insurance, amortisation, etc. Administration and Overheads would include rents and rates, cost of any operating licences, building maintenance etc.

Introductory costs would include crew training, modifications to craft, and other costs not already classified.

The precise definition of the constituents of these components of I.O.C.'s would be made after discussion with the Operators on the exact form of the Data Sheets.

The very fact that certain costs are considered by some Operators to be D.O.C.'s and by others to be I.O.C.'s illustrates the lack of definition of the overall concept, which is admittedly not easy when one is attempting to define in terms of costs being dependent directly on the running of the craft or otherwise. A rigid convention would be difficult to establish here.

Most openly quoted data from Manufacturers on their craft operating costs, add on I.O.C.'s as a percentage of D.O.C.'s. Although this practice may provide a very speedy approximation, for more detailed analysis it should be discarded. Indirect costs would appear to be highly dependent on the specific type of service being operated, the marketing of this service and the overheads involved. The actual craft involved affects the picture only in a minor way. Therefore, I.O.C.'s warrant completely separate treatment to D.O.C.'s, and much investigation is needed before any more firm conclusions can be reached.

It is clear, however, that due to their very nature, any standard Method for calculating I.O.C.'s may prove very difficult to devise. The following may constitute some of the major influences on I.O.C.'s.

a) Size of Operation, i.e. Amount of capacity offered.
b) Nature of this capacity:- i.e. Passengers, vehicles, freight.
c) Level of service provided.
d) Route distance, and nature:- This will affect shore facilities.
e) Size of fleet.
f) Size of company:- Whether company is part of larger parent company.
g) Whether Hovercraft operates on new route or replaces or augments other transport modes:- This affects the need to "market" the service.

Thus in conclusion it may be said that much more work is needed here before any useful picture emerges, and whether any clearly quantifiable parameters can be identified to make some form of estimation viable seems doubtful at present.

Section 3.

Summary and conclusions with recommendations for future study.

The main work carried out during the Study is summarised in Sections 1 and 2. Section 1, Data Collection, basically sets up a starting point from which it is hoped progress can be made fairly rapidly towards the finalisation and distribution of Service Reports 1,–,5. for future collection of data. Section 2, preliminary work on a Standard Method, emphasises the need for more data and more operating experience with various craft before any reliable Standard Method can be formulated. An approximate method with application in the current state of the art is laid down, but is essentially only an interim measure, and must be extensively modified, particularly the sections on Maintenance Costs, before any attempt to produce a more accurate and relevant estimation method is made. A brief mention of I.O.C.'s is made in the final section.

Main Conclusions reached.

1) Any attempt to produce a Standard Method for Estimating Operating Costs will necessarily be dependent on the data available. Before a realistic and widely applicable formula can be devised, more operating experience with a wider variety of craft is needed. This may take a number of years.

2) Data currently available relates almost exclusively to SR.N6 craft. This data is in varying forms which makes analysis a laborious task. Data of more recent operations, particularly involving other craft has proved difficult to obtain, and some parties are reluctant to release information on certain aspects of Operating Costs or Craft details, although it was made clear that all data made available for the study would be treated with the utmost commercial confidence.

3) The most immediate priority should be given to attempting to standardise data collection. The basis for this is laid down in Section 1. If such an exercise can be successfully initiated, the benefits should be felt immediately by all parties concerned.

4) If this task were given priority, it would be feasible for such an exercise to be instigated by the beginning of the Summer schedules in 1970.

5) The success of such an operation, would depend largely on the co-operation of all the Operators, and the Manufacturers, in releasing the required data.

6) The adaption of such a data collection and processing exercise to include the use of a computer for the processing of the data is both a feasible and logical step.

From a go ahead given when the manual exercise was in operation, (possibly Summer 1970), such an adaption to Automatic Data Processing should be technically feasible within a 6-9 month period, i.e. (by the commencement of the following Summer schedules).

7) Even allowing for the successful operation of the data collection and processing exercise, it may take several years before a Standard Method for Estimating Operating Costs can be brought into general use. This is primarily due to the small number of craft operating at present, and their diverse nature. No real pattern has yet emerged as to where the main applications for commercial hovercraft may lie, and what types of craft may eventually emerge.

8) At this juncture, a realistic Standard Method is simply not feasible. The approximation suggested is based on sparse information on craft which are still in their development period, and some of the parameters used are not wholly justifiable. An approximate guide to current costs is all that is intended at this stage.

9) Indirect Operating Costs warrant separate investigation and bear no logical correlation with D.O.C.'s. Any Standard Method incorporating I.O.C.'s is a very long way off, if indeed this proves feasible at all.

Possible Areas of Future Study.

1) As has already been mentioned, the finalisation of the exact form of the data sheets and the initiation of data collection via such a common medium is recommended as the first priority.

2) The eventual formulation of a workable and accurate Standard Method for estimating D.O.C.'s will clearly be a very useful exercise, although the conclusion of this task may be some years distant.

3) The analysis of data which would be collected via the Standardised sheets would enable progress to be made with the Standard Method, and also make an understanding of the behaviour of the various craft and their systems more easily achievable. Also various other areas might be studied with the aid of the data received, including possibly an analysis of traffic carried, delays and cancellations, revenue sources.

4) A survey of an existing route or routes (e.g. Cross-Channel) or a proposed future route could be made with particular emphasis on the most suitable transport modes. i.e. Road, rail, hovercraft, ship, aircraft, etc. Hence the particular factors favouring hovercraft above other transport modes might be identified, and the particular advantages and disadvantages of this mode of travel to the customer brought to light.

5. An investigation into I.O.C.'s would be useful at a future date, but this would involve a lengthy analysis, with the outcome still dubious. (The Boeing, Douglas and Lockheed Aircraft Companies in the U.S.A. planned to publish a joint technique to enable a Standaridsed calculation of Indirect Operation Expense to be made for certain types of aircraft. It became immediately apparent, however, that such a Standard Method was not viable at the present time, due largely to the lack of definition of I.O.C.'s,their seemingly minor dependence on the particular aircraft in question, and the highly individualistic accounting systems of the various airlines. The first two of these reasons would almost certainly hinder any investigation on hovercraft I.O.C.'s aimed at devising some sort of Standard I.O.C. calculation method).

6) A most useful investigation might look into the overall usefulness of the current D.O.C. and I.O.C. convention. Could this be improved upon? Would not a better classification be of Fixed and Variable Costs, the latter indicating the performance of the craft via maintenance, fuel, oil and possibly crew, all other costs currently in DOC's and I,O.C.'s being classified as Fixed costs? Such an investigation at an early date might save much unnecessary future work if some changes in the D.O.C., I.O.C. convention were recommended.

List of Abbreviations

A.C.V. = Air Cushion Vehicle

D.O.C. = Direct Operating Cost.

I.O.C. = Indirect Operating Cost.

T.B.O. = Time Between Overhauls.

A.U.W. = All Up Weight.

G.R.P. = Glass Reinforced Plastics.

S.F.C. = Specific Fuel Consumption.

M.C.R. = Max. Continuous Rating. (1 engine).

T.M.C.R. = Total Max. Cont. Rating (sum for all engines).

Props. = Propellers (Air propellers or water screws).

I.g. = Imperial gallons.

A.P.U. = Auxiliary Power Unit.

s.h.p. = Shaft Horse Power.

b.h.p. = Brake Horse Power.

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Hoverwork. "Expo '67 Hovercraft Operation". Mintech Contract No. KC/3A/132/C.B.5(b).

19.
Hoverwork. "Traffic Study Report SR.N6. Hovercraft Operations. Solent 1966/1967. Mintech Contract No. KC/3A/201/CB5B.

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Fig. 6B. Diesel Engine Maintenance Costs.

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NUMBER OF CREWS / CRAFT / ANNUAL UTILISATION.

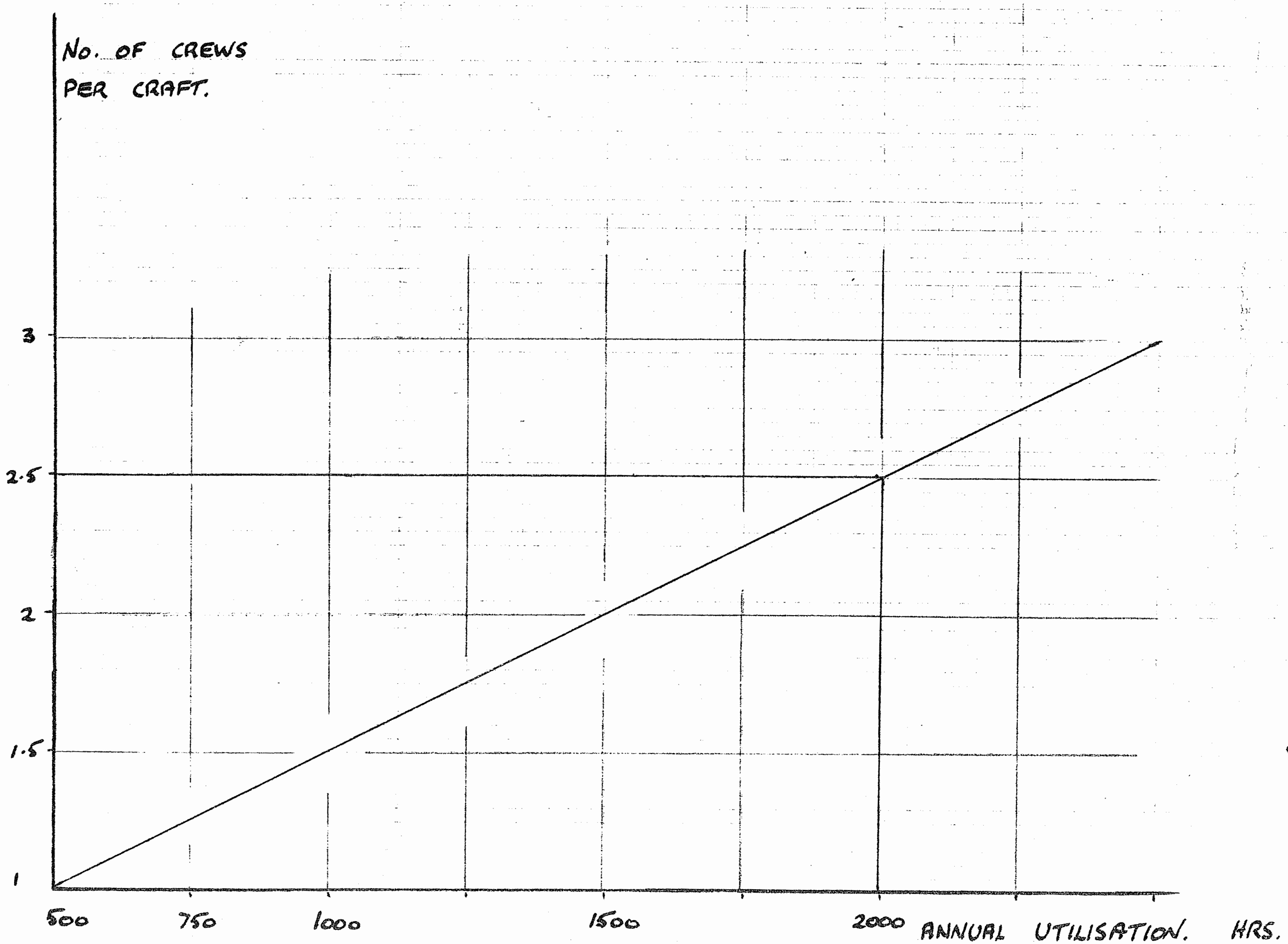


Fig. 1.

TOTAL MEMBERS IN CREW / CRAFT A.U.W. Some Examples.

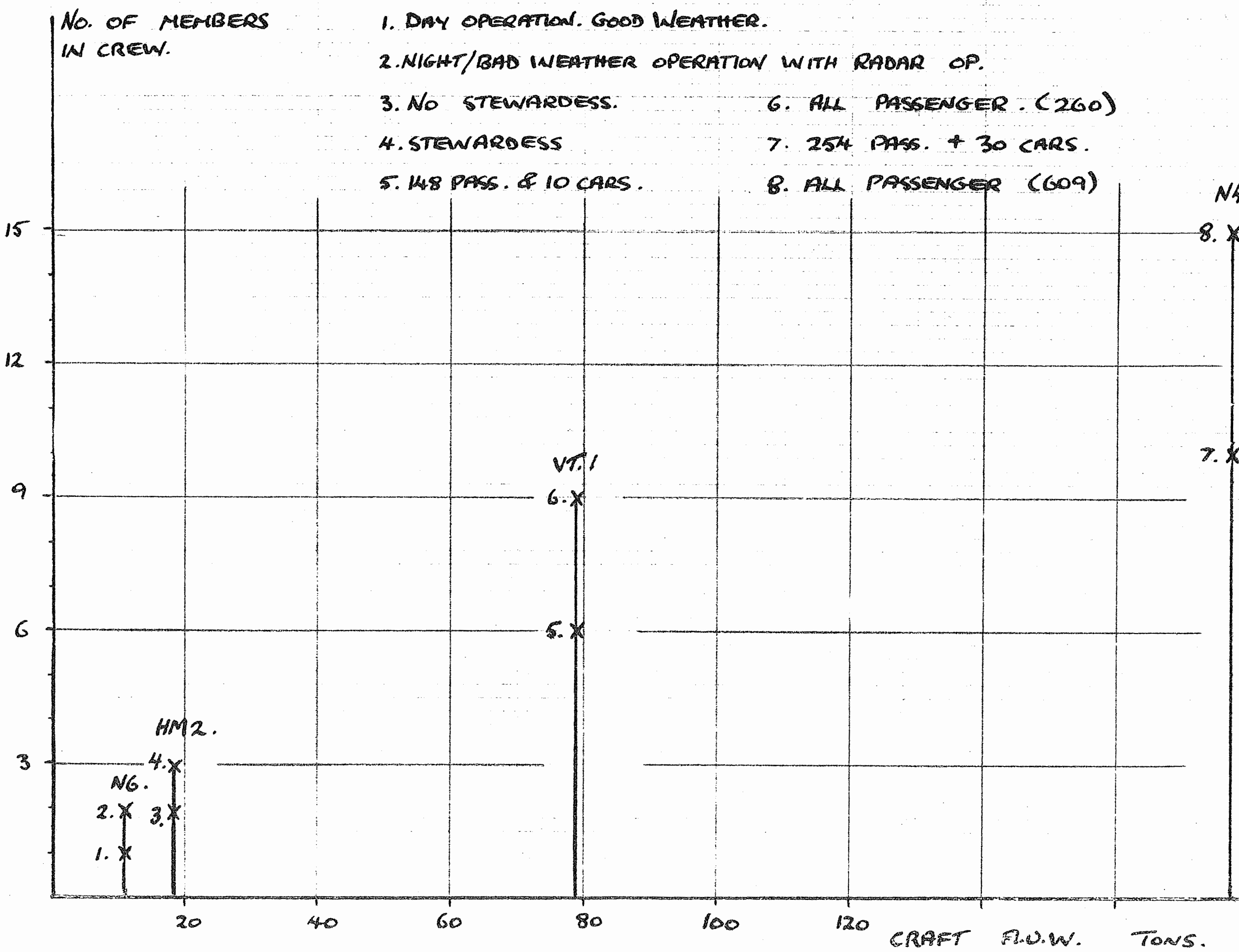


Fig. 2.

TOTAL MEMBERS IN CREW / CRAFT A.U.W. & CONFIGURATION.

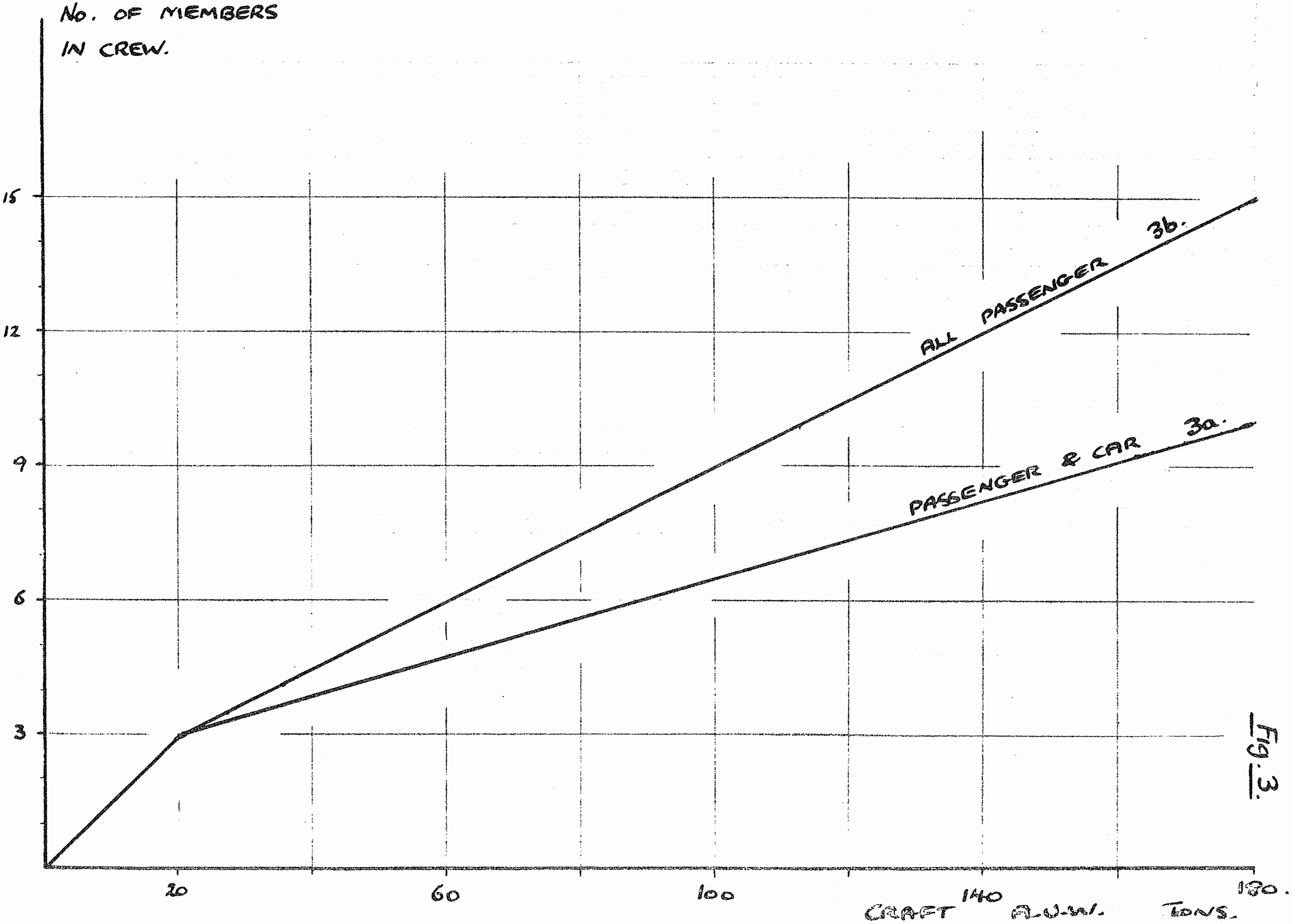


Fig. 3.

EQUIPPED HULL MAINTENANCE COSTS.

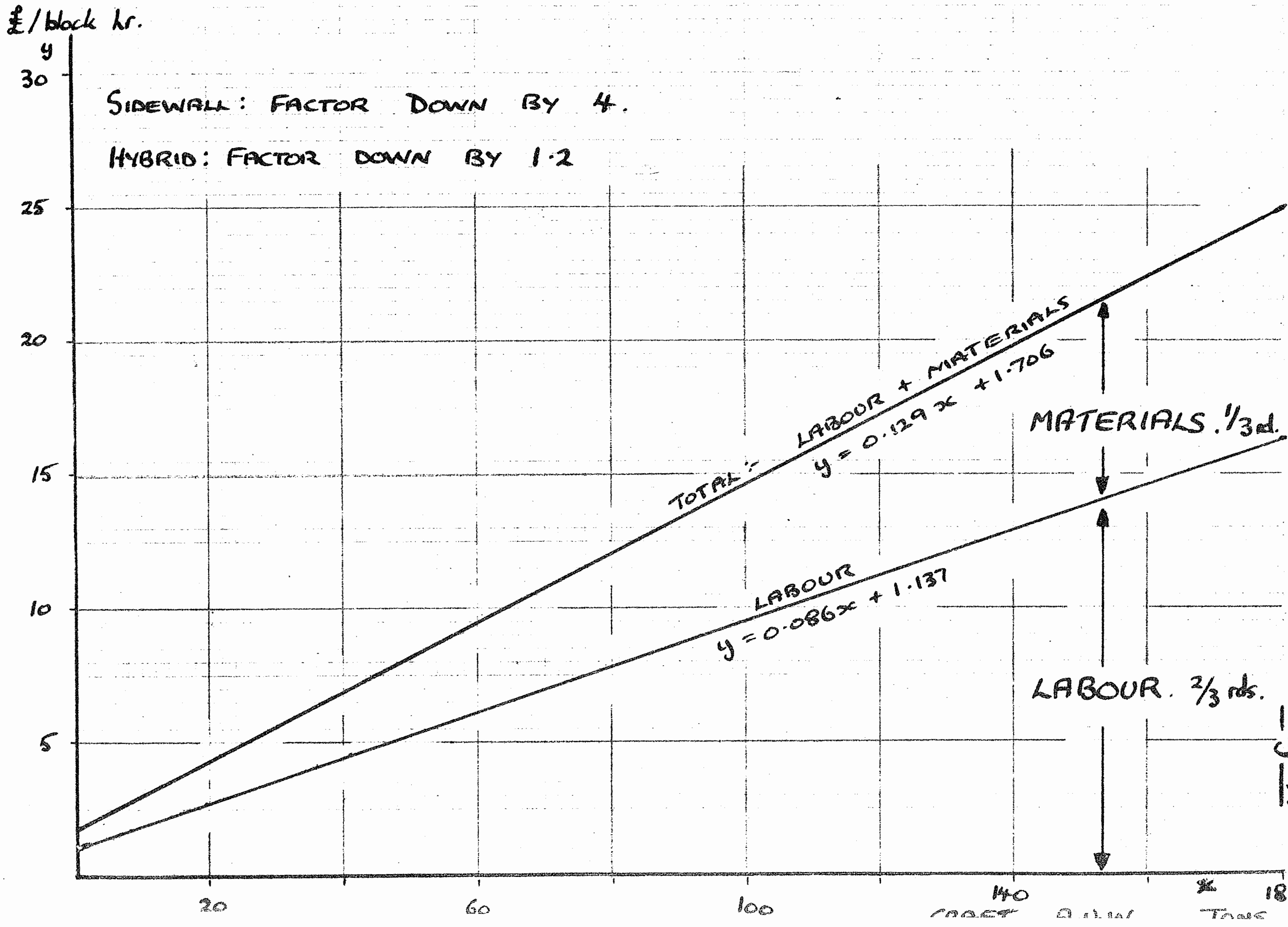
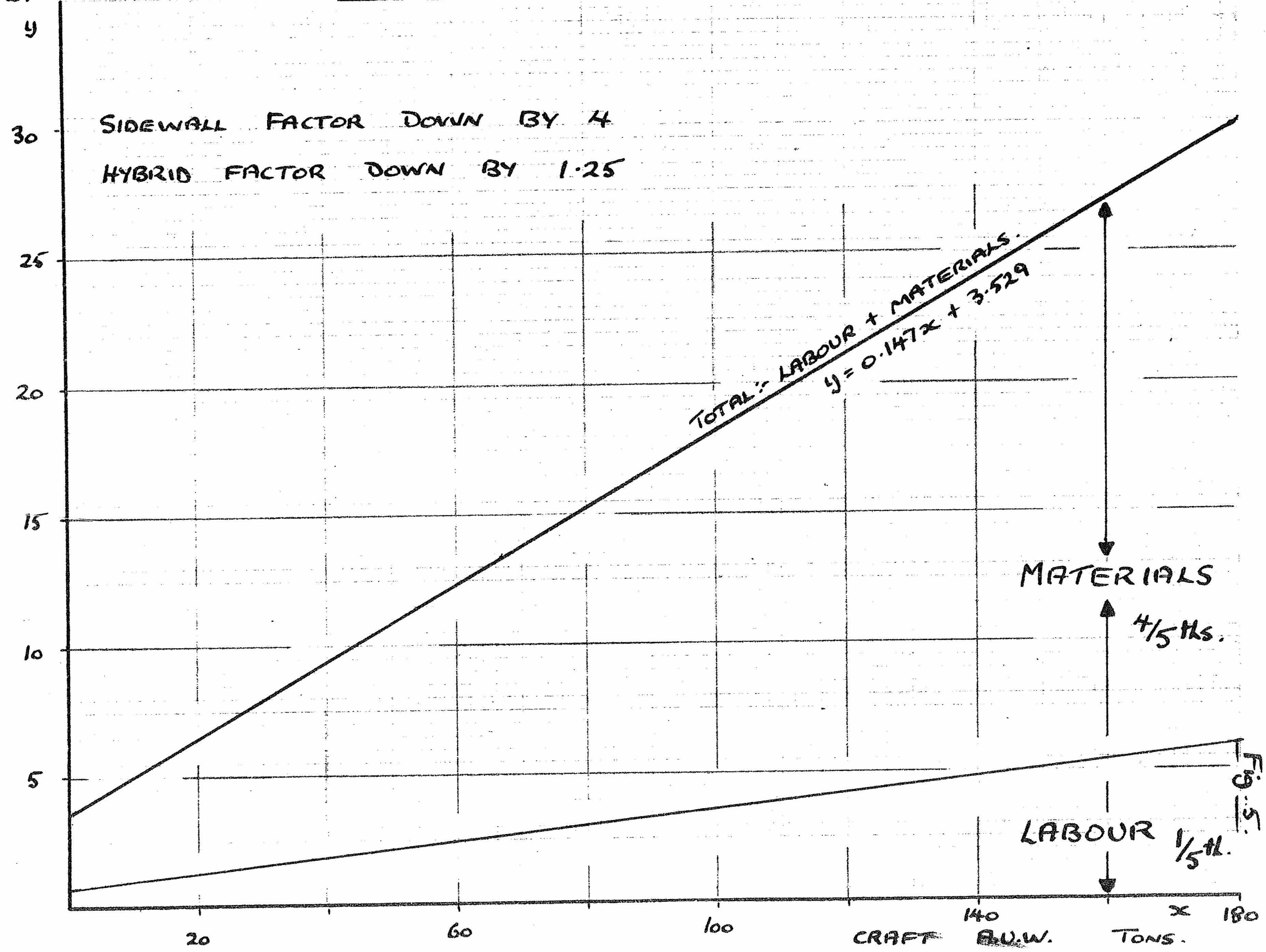


Fig. 4.

SKIRT MAINTENANCE COSTS.



ENGINE MAINTENANCE COSTS :- GAS TURBINES.

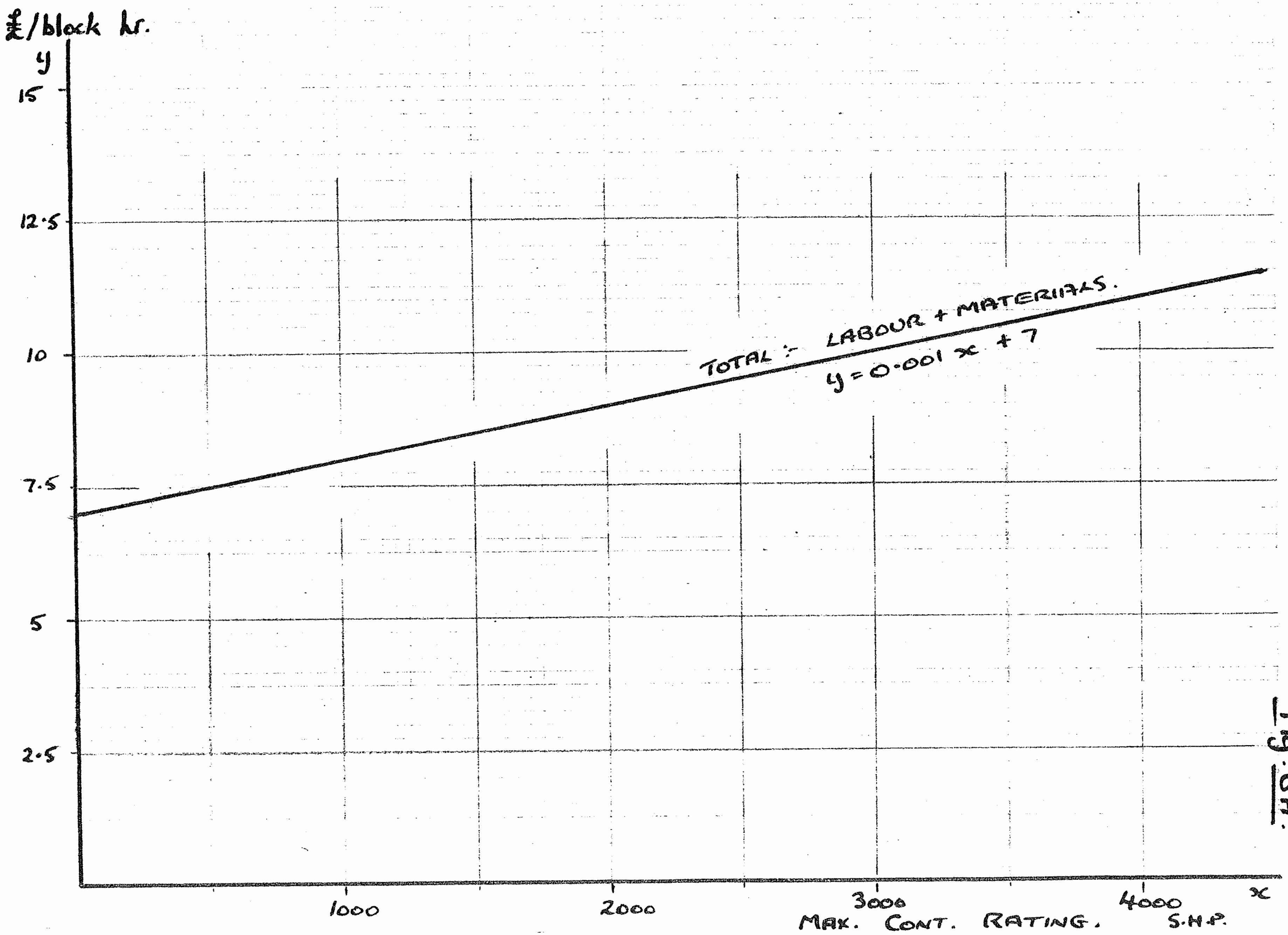


Fig. 6A.

ENGINE MAINTENANCE COSTS :- DIESELS.

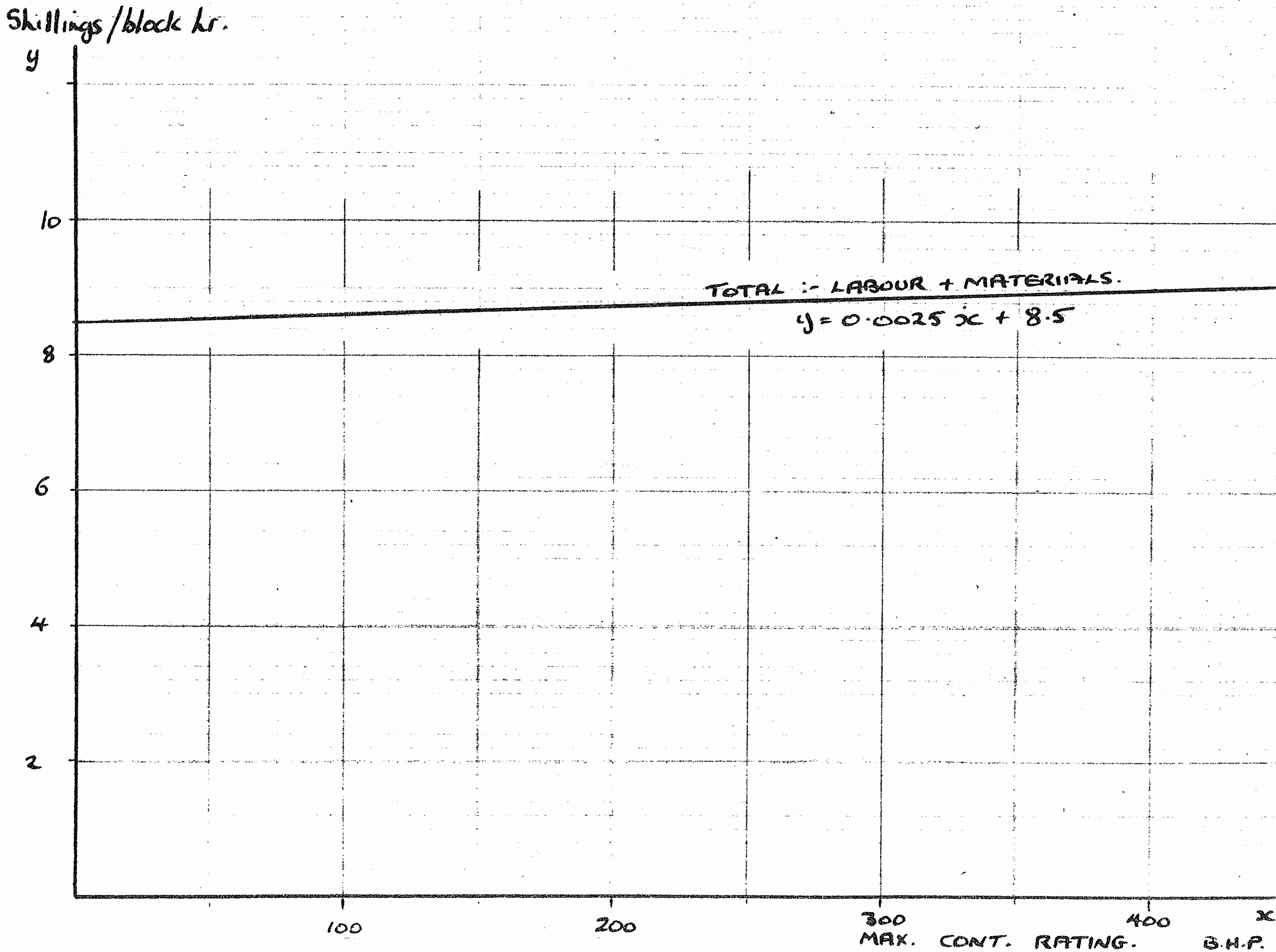


Fig. 6B.

LIFT/ DRIVE MAINTENANCE COSTS.

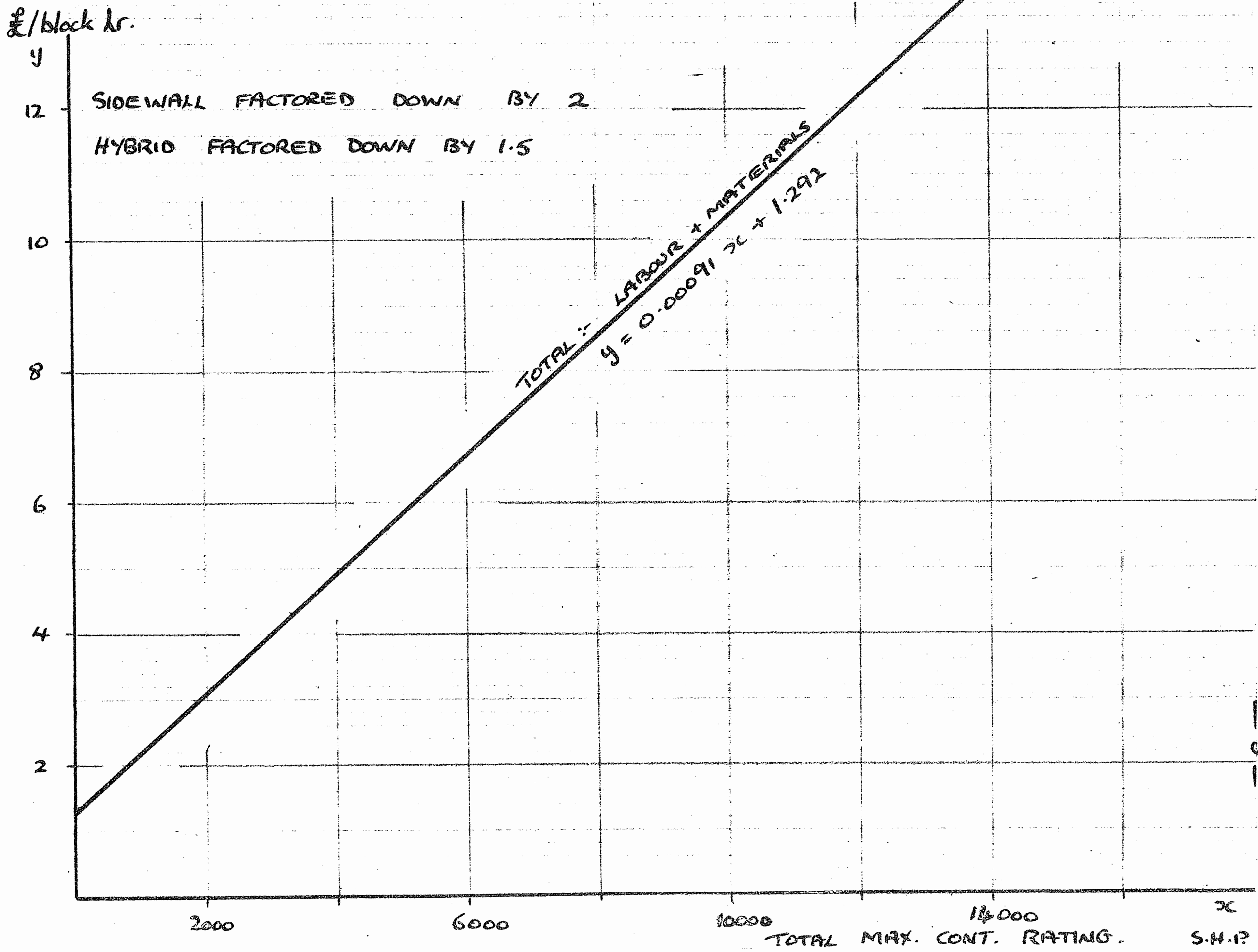


Fig. 7.

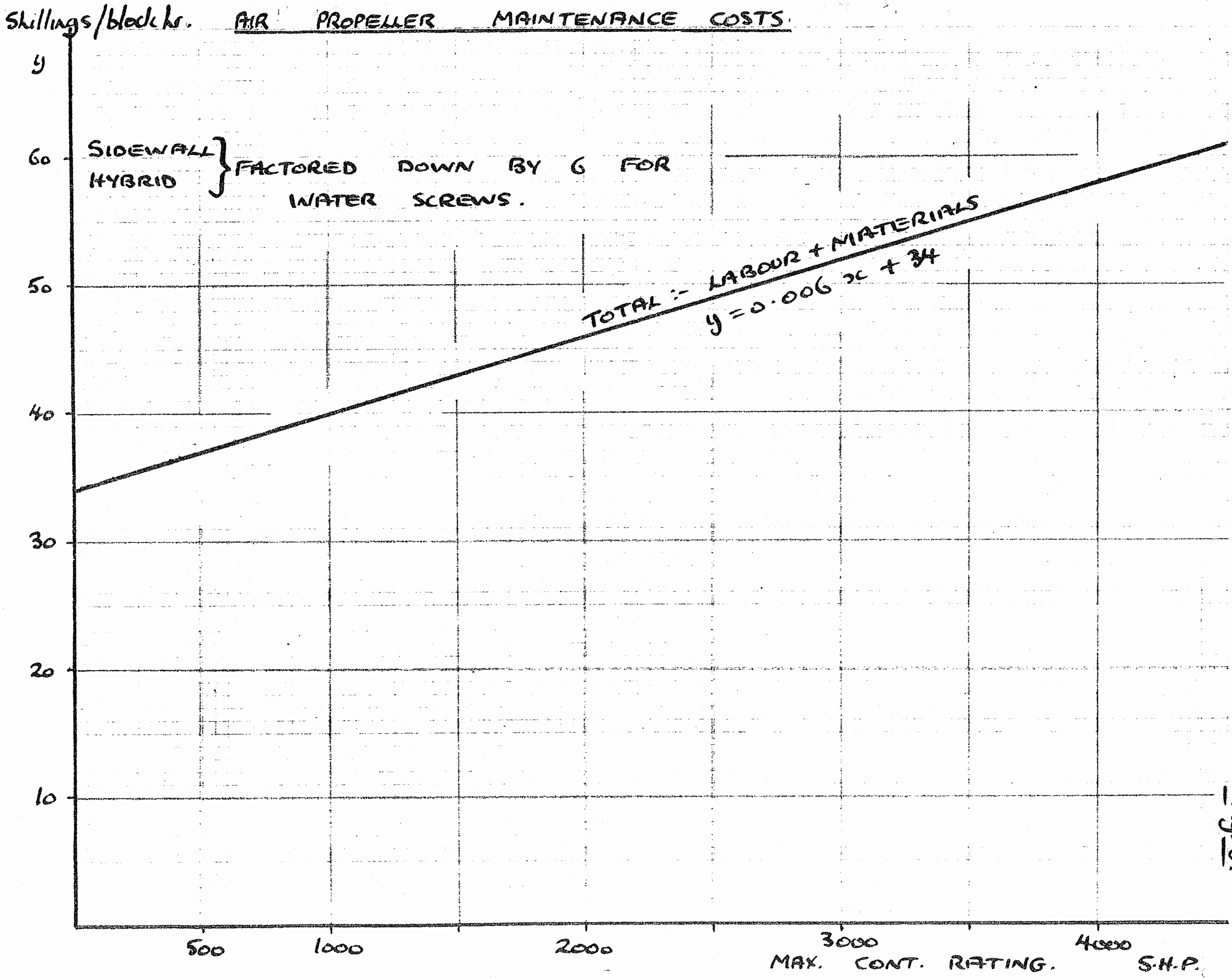

Shillings/block hr.
AIR PROPELLER MAINTENANCE COSTS.
y
60
50
40
30
20
10
SIDEWALL
HYBRID
FACTORED DOWN BY 6 FOR WATER SCREWS.
TOTAL :- LABOUR + MATERIALS
y = 0.006 x + 34
500
1000
2000
3000
4000
MAX. CONT. RATING. S.H.P.

Fig. 8.

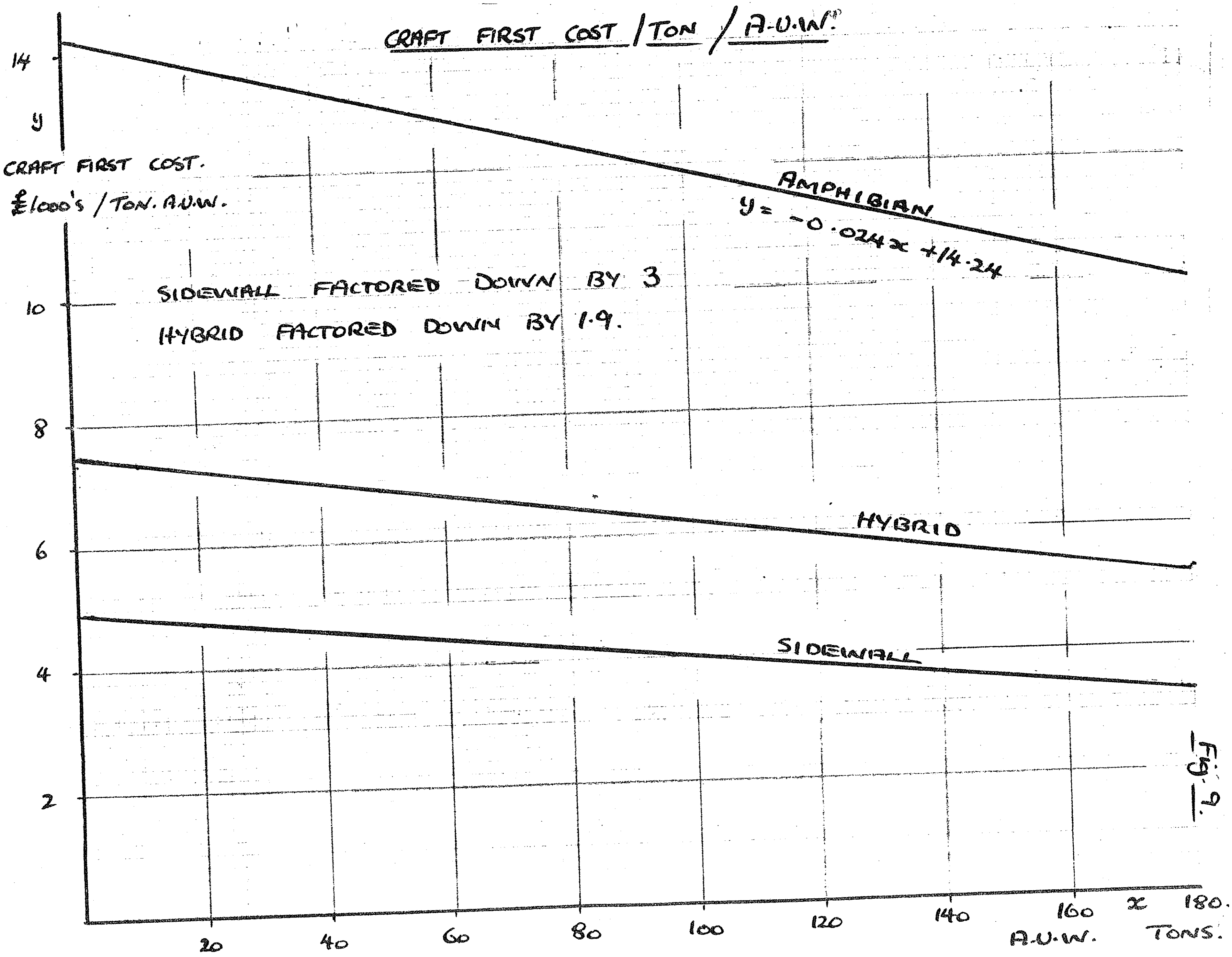

CRAFT FIRST COST / TON / A.U.W.
14
y
CRAFT FIRST COST.
£1000's / TON. A.U.W.
10
8
6
4
2
SIDEWALL FACTORED DOWN BY 3
HYBRID FACTORED DOWN BY 1.9.
AMPHIBIAN
y = -0.024x +14.24
HYBRID
SIDEWALL
20
40
60
80
100
120
140
160
x
180.
A.U.W. TONS.

Fig. 9.