THE TIGER LINE CONCEPT

by

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SUMMARY

Because its efforts to import freight carrying aircraft into Australia were continually frustrated by Government action, a major road freight company decided to investigate the possibility of providing a fast shipping service between mainland Australia and Tasmania as an alternative to air transport.

This paper describes the concept and the developement of it. The ship and its route between terminals on each side of Bass Strait were viewed as a link in the transport company's line haul, with that company owning and operating all units including terminals, cranes, containers and trucks.

Extensive model testing was carried out to ensure that satisfactory service reliability could be achieved in the Bass Strait environment.

The proposed service created great interest and some controversy, particularly in respect of the manning arrangements and the locations of the terminals.

The service has not been instituted for political and industrial reasons but in technological terms it could have been considerably successful.

1. INTRODUCTION

Until a few years ago, there were very few items which were classified as prohibited imports into Australia. Included in these were drugs of addiction, certain pornographic materials and freight aircraft having all-up-weights above 12,000 pounds. The IPEC Transport Group had been applying to the Commonwealth Government for some 14 years for permission to import aircraft to fly freight across Bass Strait. Governments of the day, of whatever political persuasion, steadfastly refused permission on the basis of defending the 2 airline agreement. The existing air freight capacity was, however, inadequate across the Strait.

The author suggested to IPEC that a fast ship able to cross Bass Strait in 8 to 9 hours would enable that company to provide the same speed of service avaliable from the very limited air freight capability i.e. freight collected by one of the Company's vehicles from around the suburbs of Melbourne by 5 p.m. would be delivered to an address in the suburbs of Hobart by noon the next day. The company commissioned a technical and financial feasibility study of the concept.

The study examined 2 types of vessels both having the same basic dimensions as follows:-

LOA	64.3 metres
LBP	56.0 metres
Beam	11.0 metres
Depth	4.0 metres
Draft loaded	3.0 metres
Deadweight	160.0 tonnes

The service speed required was 25 knots in normal Bass Strait weather. The estimated power requirement was 8500 BHP.

One of these vessels was arranged to carry 20 foot ISO containers on deck in one layer. The other vessel was arranged as a trailer ship, able to load 10 x 40 foot pantechnicons on deck via a stern ramp. In style, these vessels were very much like simple oil rig supply vessels as shown in Fig. 1.

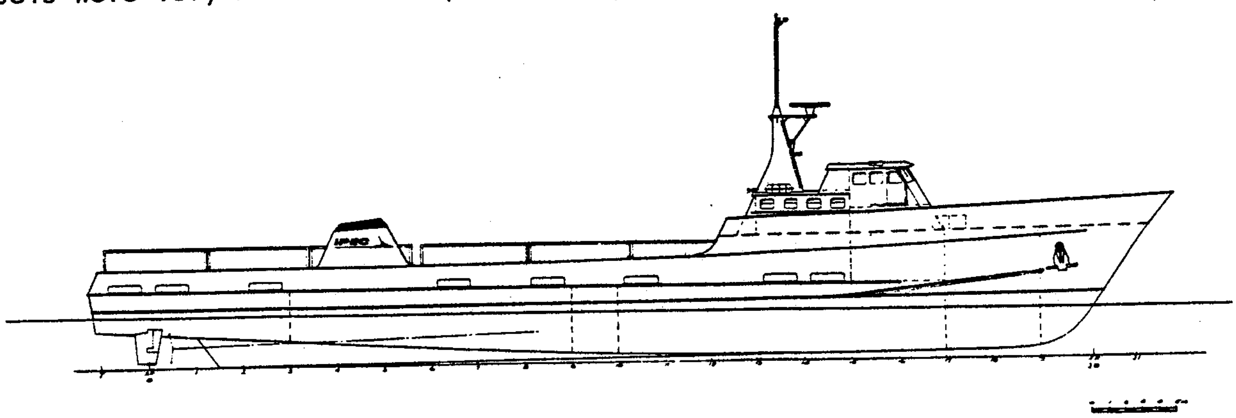
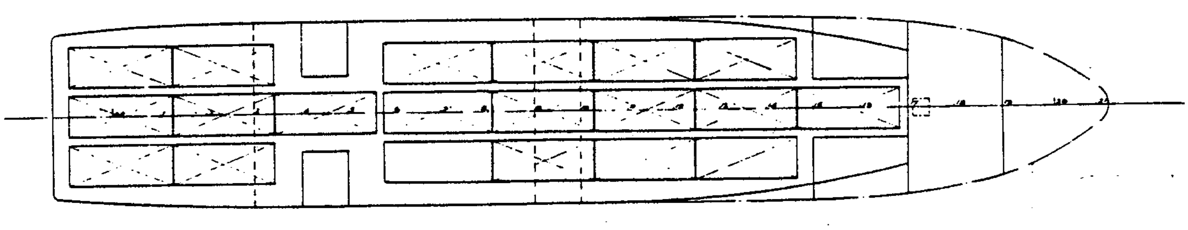


FIG. 1



The financial analysis showed that there was little to choose between the 2 types as far as the freight rate was concerned. The required freight rate was, however, some 65 percent of that required for an airfreight operation.

At this stage of development of the concept, the vessels were intended to carry only that freight which the company generated itself during its normal door-to-door road freight business. The crossing of Bass Strait was seen simply as part of the "line-haul"

Encouraged by the favourable freight rate, IPEC decided to develope the idea and to test market the proposed service.

2. BASS STRAIT WEATHER

Vital to the concept was the need for service reliability. The round trip time required was to be not more than 24 hours including cargo loading and unloading operations. A one way crossing time of 8 to 9 hours was therefore necessary.

At an early stage in the investigations, it was decided to operate from a terminal to be established in Westernport Bay on the Northern side of the Strait. The Southern terminal was to be established in one of the 3 major ports in Northern Tasmania, - Launceston, Devonport or Burnie. Depending on the final choice from these 3 and the location in Westernport, the one way voyage distance would be 180 to 195 nautical miles and the ship's speed would therefore need to be in the 23 to 25 knots range.

The ability of a relatively small vessel to maintain this high speed in what are said to be frequently rough waters required evaluation. Fortunately, a great deal of useful information about Bass Strait was available (1). This although theoretically derived, was believed to provide an adequate basis for evaluation, particularly as advice received from engineers employed on the design and installation of the platforms in the Eastern end of the Strait indicated that the method of deriving the sea state information tended to overestimate the population of a very large waves (significant height greater than 5.0 metres), based on measurements made of actual waves on completed platforms.

A desk study indicated that the vessels should be able to maintain the required speed for an adequately reliable service to be achieved but up to 3 round voyages per year (less than 1% of scheduled voyages) would need to be cancelled because the reduced speeds safely attainable on these voyages would preclude the 24 hour round voyage requirement being met. Having regard to the fact that the Bass Strait crossing was only part of the line haul, it was concluded better to cancel voyages than to delay excessively the remainder of the elements of that line haul.

A substantial proportion of the larger waves along the track connecting Westernport to the mid - North coast of Tasmania is generated by winds in the Southern Ocean. These waves travel in a North Easterly direction. It was to be expected, therefore, that the ships would experience seas on the starboard bow when Southbound to Tasmania and Port quartering seas when Northbound. The speeds of these waves are in the range of operating speeds for the ships and the possibility of steering difficulties and perhaps even broaching could not be neglected on Northbound voyages.

Southbound, in head seas and bow quartering seas, large vertical accelerations seemed certain to occur, potentially leading to extreme crew discomfort and ship and cargo damage.

An outline of a model testing program was, therefore, developed. Examination of the information given in Ref. 1 suggested that the rough water testing should be carried out in a number of scaled sea states, the largest having a significant height of 3.66 metres and a period of 11.0 seconds.

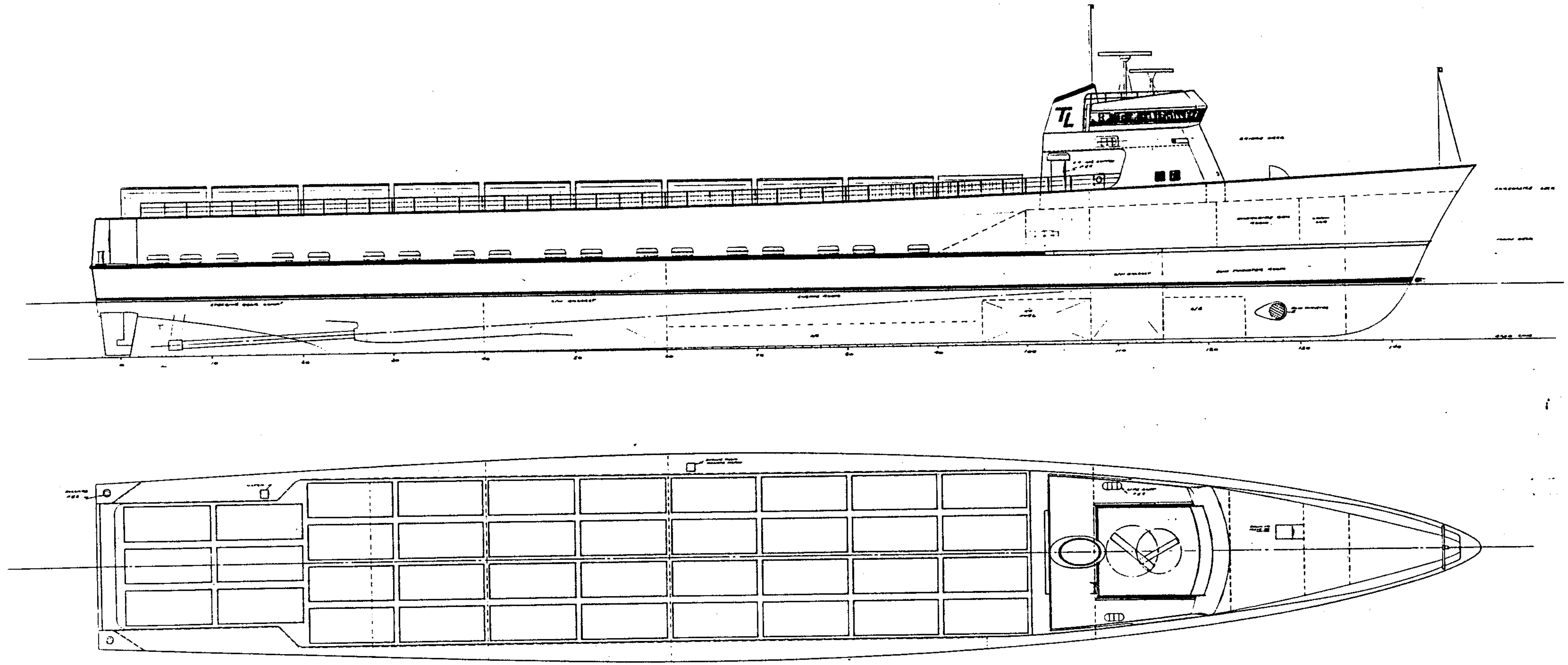
3. CONCEPT DEVELOPMENT

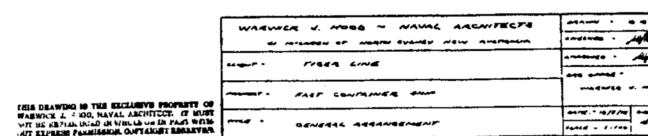
The owners came to believe that the service would generate more cargo than originally estimated. The design was accordingly developed in a number of stages, with ship dimensions increasing to the point where the GRT was approaching 1600 and the very real possibility of the need to carry a radio operator had to be faced. Further increases of size and consequently container capacity therefore ceased, the final design having the following dimensions.

L.A.	99.0 metres
LBP	92.0 metres
Beam	14.9 metres
Depth	6.7 metres
Draft loaded	3.8 metres
Deadweight	975.0 tonnes
Number of Containers	74

Fig. 2 shows the outline general arrangement. The vessel still retains the ORSV type of arrangement with wheelhouse and funnel structure forward above a raised forecastle but with containers stacked two high above deck.

Because of the relatively high speed requirement, a hull form very much like a patrol frigate but with increased beam (for stability and stowage

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TIGER LINE
FAST CONTAINER SHIP
GENERAL ARRANGEMENT

FIG. 2

reasons) was developed. (see Fig. 3) This hull shape was reproduced in model form at the Netherlands Ship Model Basin and a series of resistance and propulsion tests were undertaken. A number of minor modifications to the hull were required, notably in the forefoot area. A wedge of about 7 degrees included angle was added to the bottom just forward of the transom, this having the effect of reducing the power required by about 10%. Stream flow tests in the vicinity of the bow thruster tunnel forward and in the bilge keel area were performed as were wake surveys and shaft bracket alignment studies. Fig. 4 shows the horsepower-to-speed relationship in the fully loaded trials condition.

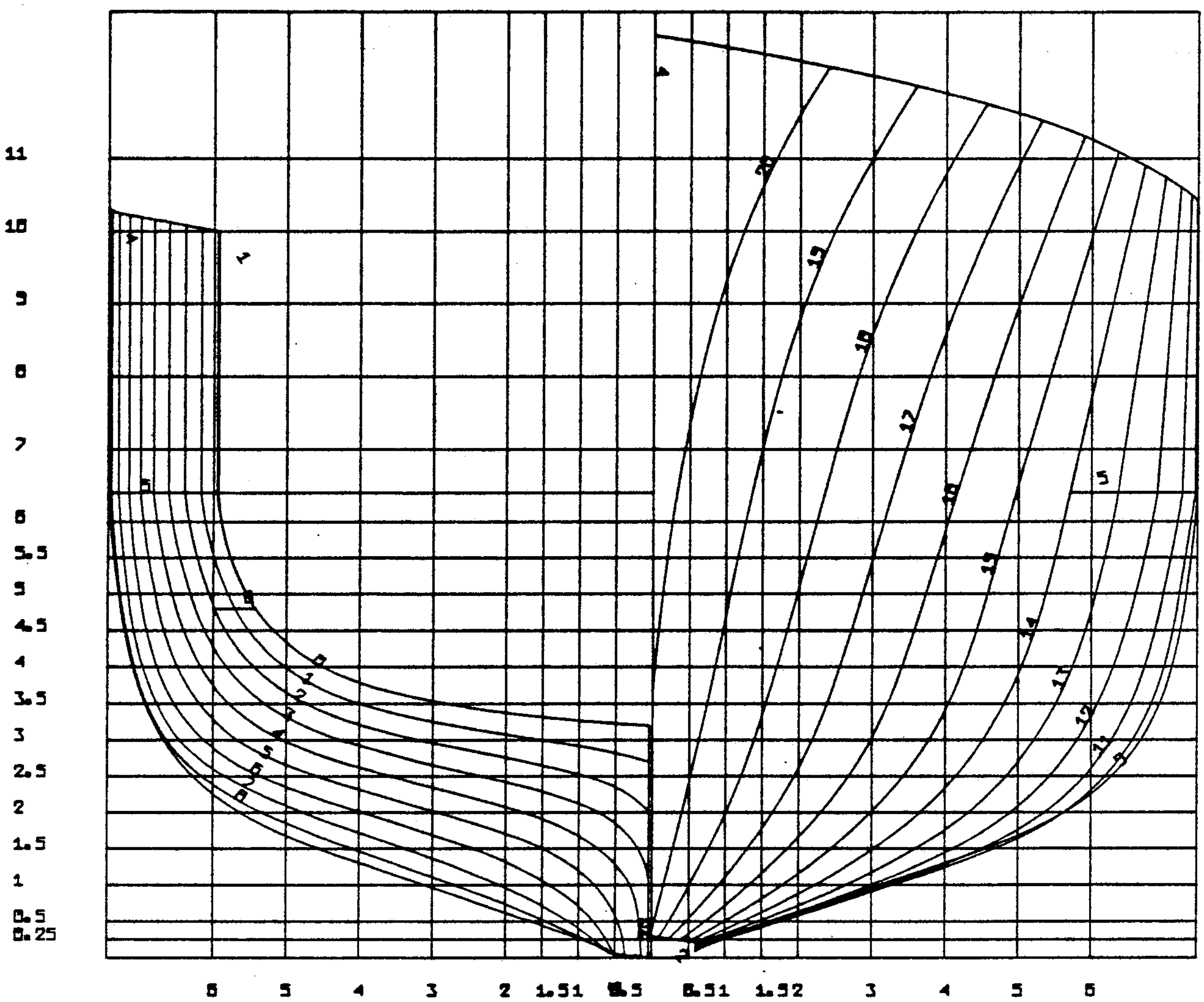


Fig. 3

PREDICTION

FIG. 4

SHIP MODEL 5365

PROPELLER MODEL 4155 R+L   P0.7/D = 1.265

TANK VALUES ARE BASED ON RESULTS OF PROPULSION TEST No 36323

DRAFT 4.00 m

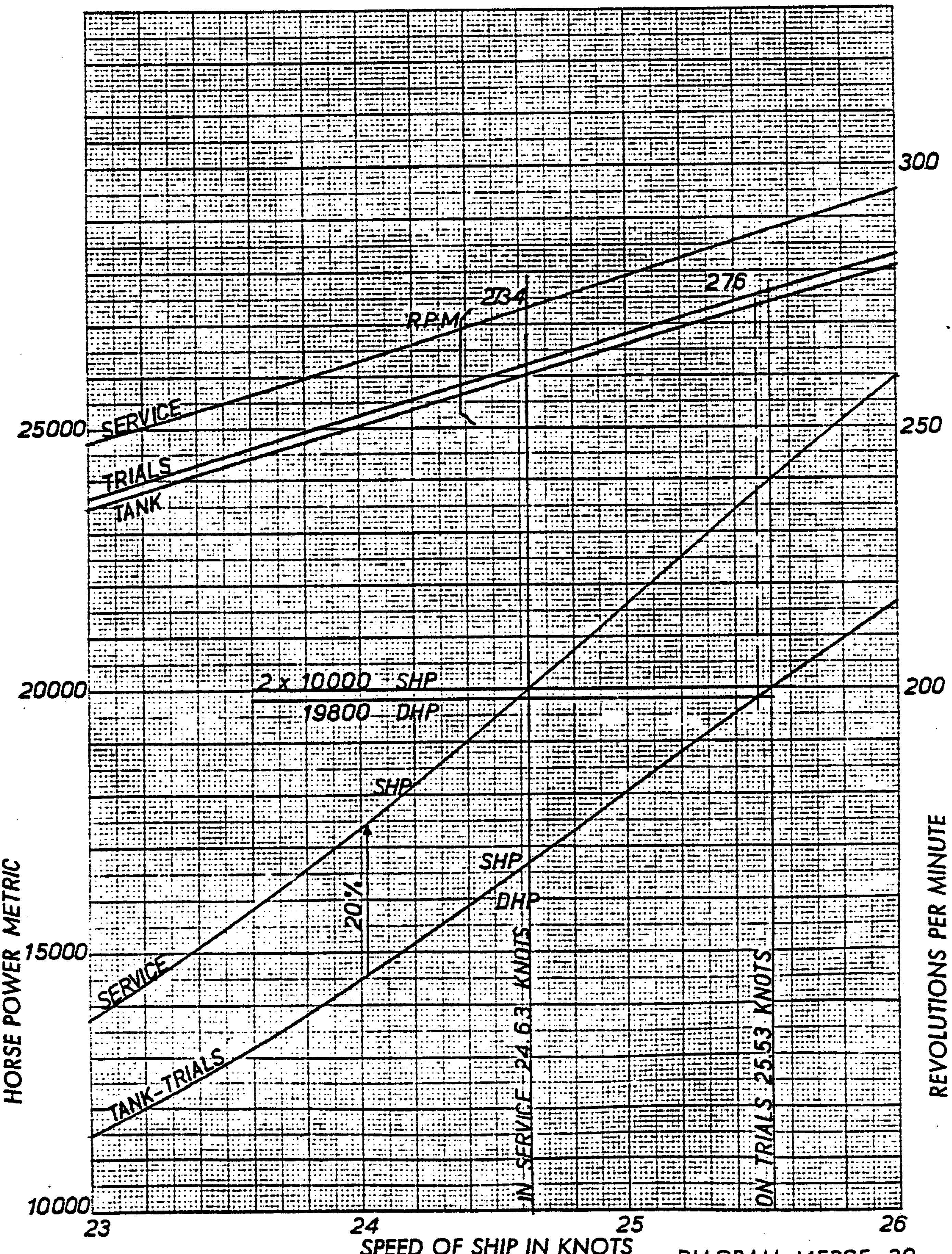


DIAGRAM M5365-20

4. SEAKEEPING TRIALS

When the final hull form had been fixed as a result of the trials in 3. above, another model at a scale of 1 to 15 approximately was constructed from wood. This model was self propelled and fitted with active rudders and steering gear. After it had been used for a series of bow, bow quartering and beam seas experiments in scale seaways, it was fitted with additional instrumentation including radio control and automatic pilot to enable a series of broaching experiments to be undertaken. Not a great deal is known about the phenomenon of broaching and even less about appropriate model testing methods. It was decided that the model should be tested without any restraint at all by the towing carriage which would merely follow the model and receive information from and transmit steering instructions to the model by radio. Very large deviations from the desired course and substantial velocity surges were to be expected. A very wide model tank was, therefore, selected. Control of the towing carriage speed was very difficult and considerable effort was expended in development of the model testing technique. Velocity surges of as much as 25% of the steady speed were experienced. Fig. 5 shows a broaching/no broaching envelope developed from these tests.

The conclusions reached from these seakeeping trials were

a) in head seas, the desired voyage times could be achieved in sea states up to the limits of the tests.

b) the pitching motions were occassionally excessive resulting in accelerations in the wheelhouse close to the limit for personnel exposed to them for 8 hours. Bottom slamming forward could be expected at the same time and an occassional "wetness event" (towing tank jargon for green water over the bow).

c) accelerations anywhere in the cargo stack would never approach 1.0 g and the possibility of damage was, therefore, remote.

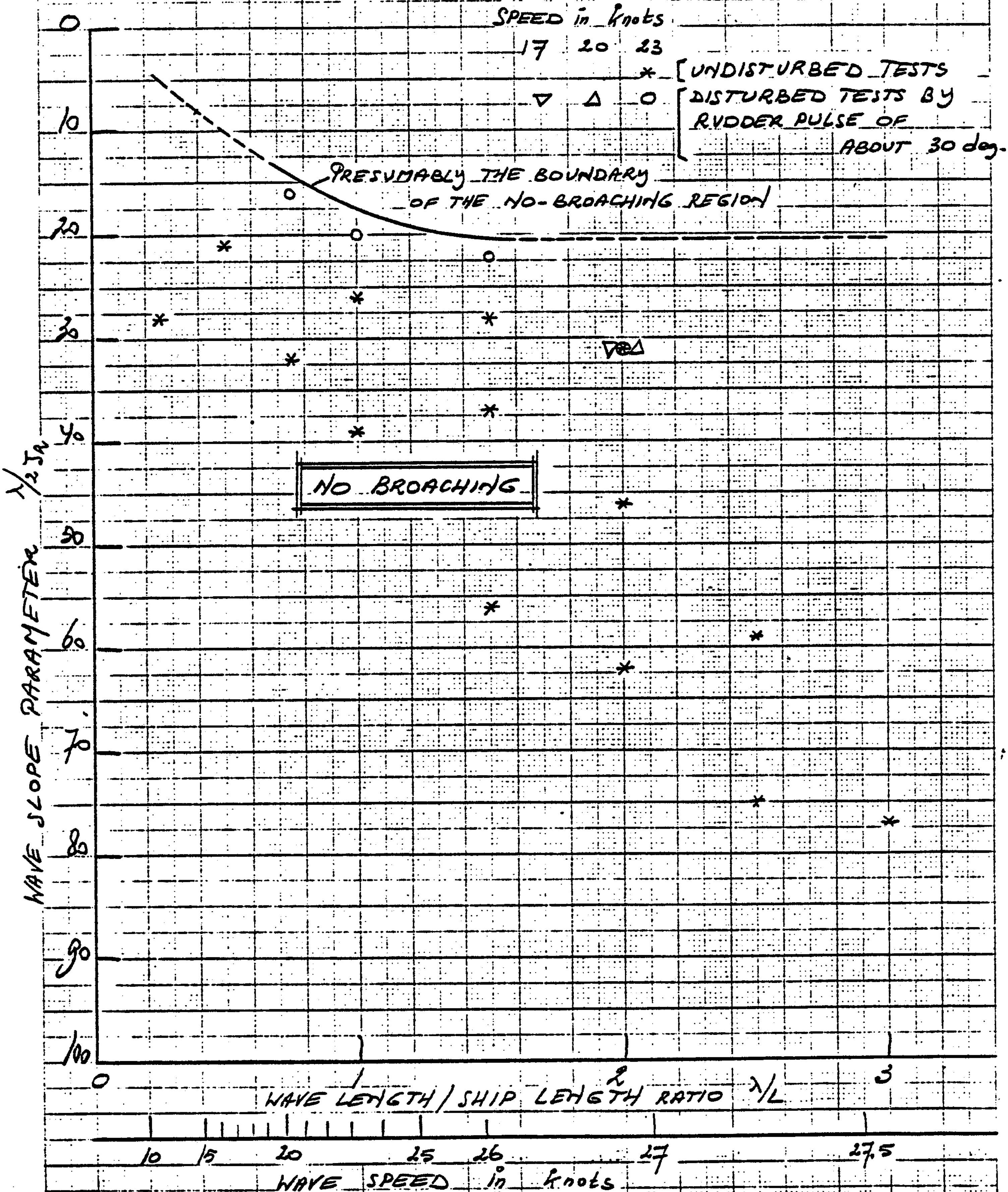
d) in following seas, serious directional stability problems were unlikely to occur and broaching, never.

BROACHING TESTS

FAST CONTAINERSHIP

FIG. 5

TEST REVIEW



5. TERMINAL SITES AND DESIGN

A number of sites were identified in Westernport Bay and preliminary engineering studies for wharves and container handling cranes were prepared. A decision had been made by IPEC that containers were more versatile than wheeled pantechnicons and in any case there was some doubt about the pantechnicon bodies, tyres and suspensions being capable of withstanding the ship motions.

Discussions with the 3 major port authorities in Northern Tasmania resulted in a decision to use Devonport as the Southern terminal site. An existing wharf was allocated in that port and design studies for modifications to it and installaltion of cranes were undertaken.

The container handling cranes were purpose designed for the berths and the ships and were capable of much shorter cycle times than the normal very large cranes seen at the usual container berths. By providing 2 cranes at each berth it was possible to reduce the loading and unloading times to such an extent that the ship's speed could be reduced and the voyage time increased. The reduction in speed was sufficient to permit a reduction in installed propulsive power of 50% - from 20,000 to 10,000 BHP.

6. MANNING AND AUTOMATION

Two factors were the main influence on deciding the manning level for the proposed ships.

a) There is nothing lacking in the available technology which would prevent the ships from safely operating the entire route including berthing operations without any crew at all.

b) The relatively short time required for a one-way voyage.

The first of these raised howls of rage in some quarters. Some minds capable of comprehending, indeed admiring, the technology which had demonstrated the capability to send space craft on voyages through hundreds of millions of miles with pin-point accuracy after years of voyage time, could not conceive of simple adaptations of this sort of technology to a ship operating on a route just a few hundred miles long and for 8 or 9 hours. There was never any intention, of course, to reduce the manning to zero. The concept did, however, set the scene for an examination of the functions of all ship operating personnel.

The second of these factors drew attention to the crewing arrangements of inter-continental, commercial aircraft, where highly trained small crews oversee the performance for a flight which might require up to about 12 hours to complete after which it will be replaced by a similar crew, fresh from a rest period.

The efforts of the design team lead to the conclusion that a crew totalling 5 only would be adequate safely to navigate the ship on a one way crossing of Bass Strait. This crew was to consist of the master, 2 navigating officers and 2 engineer officers. All crew members were to be located in the wheelhouse at carefully designed work stations with all navigating and machinery control equipment and functions coming readily to eye and hand. Those normal sea going functions of ships' crews other than those performed by the officers given above were either not required for the operation in question or were automated, including the berthing and unberthing. Automatic mooring arrangements were to be provided on the ships and their dedicated berths.

Current leave entitlements for members of the Australian sea-going unions are approaching 1 day's leave for each day's service. In order to allow for leave and the crew change requirement at the end of each one way voyage, up to 5 crews would be necessary for each ship.

7. RELIABILITY AND SAFETY

Because it is not possible to develope a concept such as this without a great deal of discussion with government and semi-government authorities, unions and private organisations and individuals who may be effected by it, it was not long before a large amount of informed and un-informed comment evolved. There were those who said that the ships would be unsafe and a danger to other vessels. There were those who wanted to become involved in the commercial decision making by the owners. There were those who were concerned about the environment of Westernport Bay which is a politically sensitive region of Victoria.

The reliability of complex machines (ships, aircraft, computers and so on) can, these days, be predicted. It was decided therefore, to undertake a reliability analysis of the ship design, including all critical components specified and a safety analysis of the voyages across Bass Strait. This work was commissioned from det Norske Veritas, the chosen classification society. Classification society records relating to machinery and structural faults and breakdowns are essential imputs to such an analysis. Additional inputs included weather data,tank testing reports and ship movement statistics in Bass Strait.

It is well known that the average ship has a high degree of redundancy of vital components built into it. For example, there is always more than one way of pumping the engine room bilges or in the event of failure of the main steering gear there is another available even though this may be suitable for hand operation only at reduced ship speed.

The reliability and safety analysis predicted, to give one example, that the possibility of a complete loss of main propulsive power was about once in 18 years of operation. This was considered to be satisfactory although it must be admitted that one cannot predict at what stage one enters the 18 year cycle. A number of recommendations of relatively simple nature, one relating to gear box stand-by lubrication arrangements, were adopted.

Perhaps the most interesting aspect of this type of analysis is in exposing what might be called "soft spots" in what might appear to be thoroughly reliable equipment. As an example, the radar equipment specified consisted of 2 transmitter/receivers, 2 displays and 2 antennae. An inter-switch allowed either transmitter/receiver to work with either display and either antennae. Each of these 6 major items was shown to have adequate reliability when properly installed but the weakness in the whole system was one of the least complex and cheapest components, namely the inter-switch.

The great value of this reliability and safety analysis lies in providing the ability to give proper answers based on sound engineering principles to those conservatives who ask 'What happens if such and such stops?". The cost of the analysis was found to be quite reasonable and it may be recommended to any ship designer. It is just as likely to expose an element of over-design as it is a "soft spot".

8. STRUCTURE AND MACHINERY ARRANGEMENTS

Having regard to the characteristics of the commodities to be carried in the containers, the average mass of each including the container had been set at 12.5 tonnes giving a cargo deadweight of 925 tonnes. Budget masses were then set for structure, machinery and outfit as well as the remaining components (fuel, water, crew and effects) of the deadweight. There was obviously no profit in continuously transporting excess fuel backwards and forwards across the Strait. Although the fuel tank capacity was considerable, fueling installations were to be provided at each terminal and no more fuel than for 3 round voyages was to be carried. The masses of fresh water, crew and effects were obviously fairly small.

A detailed structural design was carried out using the facilities of DNV in Oslo, Norway. This resulted in a light and elegant structural arrangement, partly transversely and partly longitudinally framed which provided a saving of 50 tonnes of steel mass as compared to the budget. This was fortunate as further promotion of the service was resulting in heavier and heavier commodities being offered for transport.

The structure required fairly substantial stiffening in the forefoot and in the bridge front. The bridge front windows were to be double-glazed. Large quantities of water in the wheelhouse would have played havoc with the electronic equipment installed there.

A pressure transducer was to be installed in the forefoot area to provide an alarm in the wheelhouse indicating that a reduction in speed was necessary.

The high bulwarks, of a box-type structure, were considered as part of the main hull girder. They also protection for the containers and support for the container cell - guide structure.

The selection of the main propulsion engine was made fairly simple because there were only 2 or 3 types having the required power, low weight and low fuel consumption that were essential. A further restraint was the low headroom in the engine room which was entirely below the deck supporting the container stack. There could be no casing or skylight through the deck.

The engines selected were manufactured by MTU in Southern Germany. They were of the 1163 Series, having vee form and 20 cylinders. The maximum continuous rating for commercial application of this engine is 5000 HP. Two engines were required, each coupled to a controllable pitch propeller via a reduction gearbox and flexible coupling.

The engine room was also to contain 2 diesel-driven alternators plus the usual pumps and auxiliaries. An emergency generator was to be installed in a separate space within the forecastle while a bow transverse thruster of 3 tonnes thrust, driven by a diesel engine was specified.

The steering gear was to provide for tandem operation of the twin rudders while in the normal operational mode and for independent operation while manoeuvring. With a control system combining the functions of the rudders, propellers, bow thruster and engines, the ships would be able to inch ahead or astern, to move bow or stern to Port or Starboard or to combine any of these movements under the control of "joy-stick" type levers mounted on the bridge wings.

9. SERVICE IMPLEMENTATION

The concept appeared to be soundly based. Nimmo[2] had recommended a fast service across Bass Strait with a round voyage time of 24 hours. Detailed design and cost estimates had shown satisfactory reliability adequate safety and good profitability at ruling freight rates. Tenders were therefore called for the construction of 2 ships, for the necessary containers, cranes, wharves and additional trucks for the road transport sections of the line haul. The total capital cost at 1978 prices was of the order of $40 million.

The company's aspirations may have, to this stage, been treated with a certain lack of seriousness by its potential competitors although the concept had been well publicised. Furthermore, committees appointed by the Governments of both Victoria and Tasmania had investigated the concept in some depth and had reported favourably.

A public meeting held in Hobart had, however, soundly condemned the idea. The opposition came from almost all quarters including seagoing unions, waterfront unions (Hobart branches), freight forwarders and existing shipping companies. IPEC decided at that stage to delay the project, in spite of a large investment in investigations and promotion.

10. CONCLUSIONS

The Tiger Line concept attracted much interest in Australia and overseas. There are a number of sea transport routes of similar distance where a small, fast vessel providing a service having a round trip time of 24 hours appears to be attractive particularly where valuable commodities are involved.

The technical problems relating to service reliability and low manning levels can be solved and, at ruling freight rates, the service is financially viable.

This type of shipping service may, however, never be seen in operation. The most important reason for this in the case of Tiger Line is the very high consumption of expensive fuel. All forms of marine transport are looking for ways of reducing the cost of fuel by such means as slow steaming, coal firing and the use of wind power. The cost of the fuel for one round trip of a Tiger Line type vessel of less than 1000 DWT is very roughly equal to the daily cost of heavy fuel for a much larger, slower vessel transporting 50 times that deadweight.

At the time, the main reason for delaying of the project was opposition from maritime unions and potential competitors which resulted in some official support of the concept being withdrawn. The need for better shipping services to Tasmania continues to exist and the Tiger Line idea may be revived. The passage of time may assist in reduction of the opposition to the concept of manning and propulsion engines capable of running on heavy and cheaper fuels may be developed.

11. REFERENCES

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