THE ROYAL INSTITUTION OF NAVAL ARCHITECTS
AUSTRALIAN BRANCH

THE DESIGN OF PATROL BOATS FOR THE ROYAL AUSTRALIAN NAVY

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THE DESIGN OF PATROL BOATS FOR THE R.A.N.

INTRODUCTION

A modern warship is an excellent example of the application of advanced technology to the task of how to fit the proverbial quart into a pint pot.

In its design it requires the very close collaboration of Naval Architects Marine and Electrical Engineers, to fit within the smallest envelope the maximum fighting equipment, but must also provide adequate comforts, so that the men who man it may live in the ship and operate it efficiently at all times through all weathers and sea states, and in a very wide range of climates condition.

In this paper the intention is to give some detail of the design of the Patrol Boats currently being built for the Royal Australian Navy. It will be appreciated that much of the equipment and certain aspects of the design are Confidential.

The history of the Patrol Boat Design commenced about May 1963, with a request from the Naval Staff, for the preliminary feasibility study for a boat of simple characteristics, about 70-80 ft. in length with a speed of approximately 12 knots, and accommodation for a maximum crew of two officers plus 2 P.O.'s and 10 Junior rates.

From the preliminary studies; and resulting from more stringent requirements, a final design developed for a boat of about 100 ft. in length, with a service speed of 20 knots.

Quite a large amount of design data based on the American Coast Guard Cutters, together with tank tests reports, technical publications and official reports from the David Taylor Model Basin was studied, this information together with the final Draft Staff requirements was used as the basis for the final design.

REQUIREMENTS

The Staff requirements called for a Patrol Boat for General Duties, Harbour Defence, and for Pursuit and Interception Duties.

(1) The functions being:-

- (a) To carry out General Patrol Duties.
- (b) To act as Search and Rescue Craft.
- (c) To provide for Seaward and Harbour Defence.
- (d) To act as Training Vessels for Reserve Officers and Sailors.
- (e) To carry out Coast Watching Duties.
- (f) To act as Target Towing Vessels.

The Principal Hull Characteristics are:-

Length overall	107.5'
Length at datum G.L.	100.0'
Maximum Beam on datum W.L.	18.62'
Maximum Beam at deck	20.00'
Designed draft F.P.	4.88'
" " A.P.	6.67'
Designed rake of keel	1.83' in 100'
Half angle of Entrance	$12\frac{1}{4}^{o}$

Moulded L.C.B.

Fwd. of A.P. 46.7% L.

Co-efficients to Datum W.L. excluding skeg, are:-

Cp = 0.655

Cb = 0.48

Rates, Area/Mod. Area = $25\frac{3}{4}$%

MACHINERY INSTALLATION

The designed engine installation consists of twin Paxman 16YLCM diesels, with tropical ratings and transmission efficiencies giving the following rated DHP at each propeller:-

4 hr. pursuit 1560 h/s/675 r.p.m.

Continuous 1350 h/s/625 r.p.m.

Reverse/reduction gear bases of 2 to 1 rates were selected, together with twin fixed-pitch propellers with maximum allowable diameter of 4.0 feet and centre-line immersion from service N.L. of 4.12 feet.

RESISTANCE

The Resistances for the R.A.N. Patrol Vessel were extended from data on a round bilge, high speed, semi-displacement family of transom-stern models, corrected to agree with the test results on U.S. Coast Guard Patrol Boats - of somewhat similar hull form.

Rough-weather, fouled hull, service displacement resistance were equated to resistances of the clean hull in smooth water at a greater displacement, these permitting service condition propellers to be designed around an E.H.P. Curve obtained directly from model tests.

SPEED

The service speed estimates was made for the boats, with 2/3 liquids and stores, fouled hull, in rough water and with optimism wedges fitted to reduce trim and resistance at high speeds.

TANK CAPACITIES

Diesel Fuel (6 Main Tanks)	- 20 Tons
" " (2 Ferrying Tanks)	- 2.50 Tons
Fresh Water (Normal Capacity 4 Tanks)	- 6.50 Tons
" " (Maximum Capacity)	- 7.50 Tons

ENGINE ROOM EQUIPMENT

Generators - Two in number 50 KVA diesel driven generators were fitted at the forward end of the machinery space. Also one 24 volt/900 watt, auxiliary generator is attached to each main engine.

Pumps -	Fuel Oil Transfer Pump	- 500 GAL/HR.
	General Service Pump	- 20 TON/HR.
	S.W. Pump	- 9.0 TON/HR.
	F.W. Pump	- 0.75 TON/HR.
	Fuel Oil Standby Hand Pump	- 500 GAL/HR.
	S.W. Standby Hand Pump	- 1000 GAL/HR.

S.W., F.W. 4 FUEL SYSTEMS

Salt Water System

A salt water system 1" bore copper-nickel-iron 90/10 quality is fitted close up under the upper deck beams extending from Stn. 3 to Stn. 16 approximately, to supply salt water to the Officers, Senior and Junior rates showers, forward magazine spraying arrangements, galley A/C heat exchangers, etc. This system is served by a 9.00 ton/hr. salt water pump which draws sea water through a sea cock and strainer.

Cold Fresh Water Service

The fresh water tanks with a total capacity of approximately 7½ tons are built in as part of the hull. Each tank is fitted with a 2" air escape led to the upper deck with gooseneck bend and also a 2" bore sounding tube with standpipe and locked watertight screwed cap. Manholes for inspection and cleaning purposes are arranged in the tanks. For the purpose of filling from shore or waterboat a 2" filling cap is fitted on the upper deck. A 1¼" branch pipe, with a locked valve, is led from the tank to a pressure vessel in the engine room. Cold fresh water is supplied to all basins and showers by means of a ¾ ton/hr. fresh water pump and an automatic pressure system. Pressure vessel holds 25 gallons of water and is arranged to operate at pressures between 25 and 40 lbs/sq. inch. Main supply lines are 1" bore, with ½" bore branches to showers and ⅜" bore branches to wash-basins, galley sink and water heaters. In order to conserve fresh water (should the need arise) an alternative salt water supply is arranged to the Officers, Senior rates and Junior rates showers. All cold fresh water pipes and fittings are of plastic material. Screw down valves are of gunmetal.

Duties

It was required to have a total torque capacity (to operate two rudders) of 100 tons/inches.

DECK MACHINERY

Anchor Windlass

The anchor windlass comprises of one cable lifter and two warpends driven by 4½ H.P. electric motor through a totally enclosed worm reduction gearbox. The windlass is arranged for emergency hand operation.

The anchor consists of a 180 pound "Danforth" type and the cable used is 11/16" chain cable.

DOMESTIC EQUIPMENT

Galley

The (all electric) galley is fitted with the following equipment:

(1) One single oven range with four radiant hot plates and one grill plate.

(2) One 15 cub. ft. refrigerator.

(3) One hot cupboard.

(4) One 7½ gallon and one 2 gallon hot water urn.

(5) One portable mixer/mincer.

Provision Room

The provision room contains one 21 cub. ft. deep freeze unit which serves as storage for all meat, fish and dairy products, etc. Both mess spaces and the wardroom are fitted with 5 cub. ft. refrigerators and these serve as storage for ready use supplies.

CATHODIC PROTECTION

The stern area of the craft is cathodic protected with six R.A.N. type anodes. The anodes are secured by welding the steel strap, passing through the anode directly to the hull. The rudders, which carry no anodes, are bonded to the hull structure with a low resistance lead from the rudder stock to the rudder bridge.

SEA KEEPING

Sea keeping and Spray Conditions on trials were very satisfactory - and confirmed the results of tank test which indicated that spray strips were not necessary.

CONCLUSION

In concluding, it is considered that all the requirements for the design have been more than covered. Trials of the boats completed to date have been satisfactory.

APPENDIX

SHIP DESIGN

A request for ship design feasibility study usually stems from the staff requirement and/or Committees, these are made to support the development of approved characteristics for ships in the shipbuilding programme.

The approach taken in the development of feasibility studies is not an established or cut and dried process but varies from design to design.

The process for a single feasibility design study usually follows this pattern:

(a) A rough displacement figure is estimated.

(b) An approximation of the required ship length is made by summing up the principal functional requirements. Several lengths usually are studied.

(c) Midship section co-efficients are chosen for the various lengths to give the best possible values of presmatic co-efficients from a resistance standpoint.

(d) Drafts are selected suitable for the size and type of ship.

(e) Beam and Waterplane exerted co-efficients are selected to give adequate metacentric radius for satisfactory stability.

(f) Midship section and inboard profiles are outlined to small scales to determine depth of hull and assign rough scantlings. This involves consideration of the number of sections required, height of machinery spaces, freeboard and strength.

(g) Heights of centre of gravity are estimated by proportioning from previous designs or knowledge of type.

(h) Power estimates are made using various standards for similar ships and tank results.

(j) Fuel for endurance is estimated.

(k) Transverse intact stability is estimated.

(l) Upon completion of the above, the principal dimension usually becomes obvious, the minimum displacement which will meet the operational requirements, and criteria such as stability strength etc.

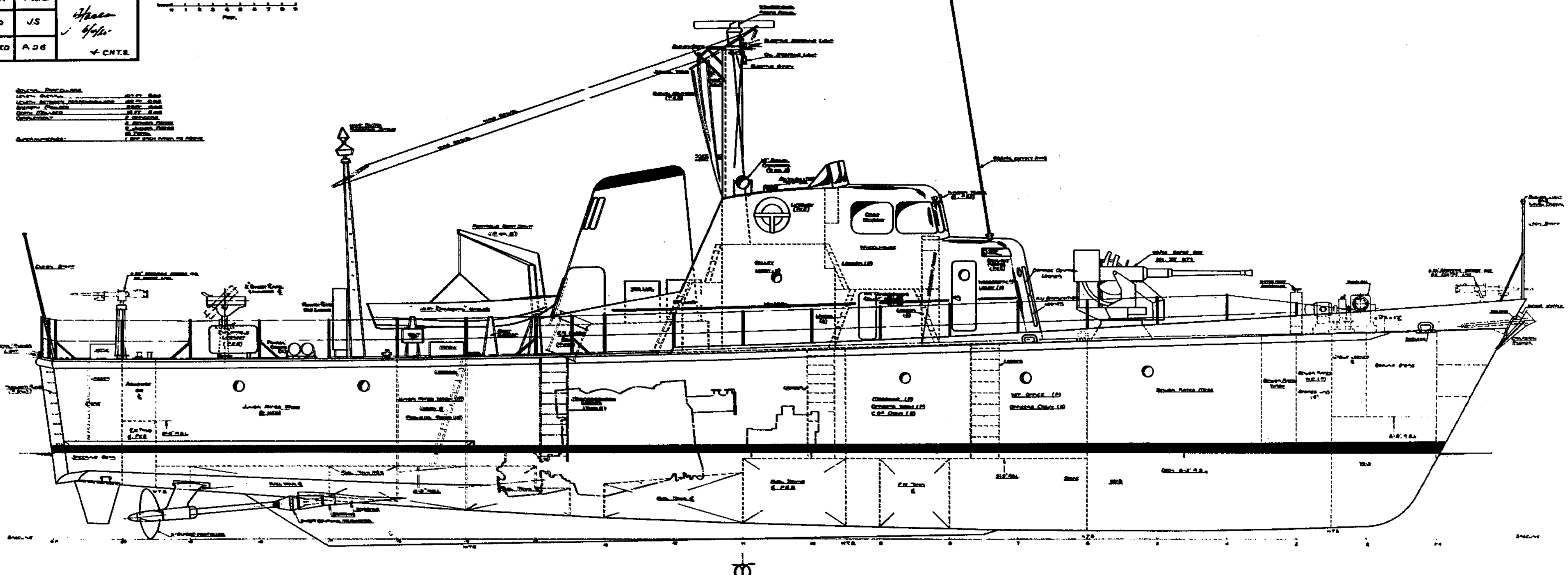
UNCLASSIFIED			
NAVY OFFICE CANBERRA.			
DRG Nº 249/11-1			
DATE: 12TH OCTOBER 1965			
TRACING Nº	2/	COPY Nº	
DRAWN	M.J.C.	APPROVED	
TRACED	J.S		
CHECKED	A.D.G		CNT.S.

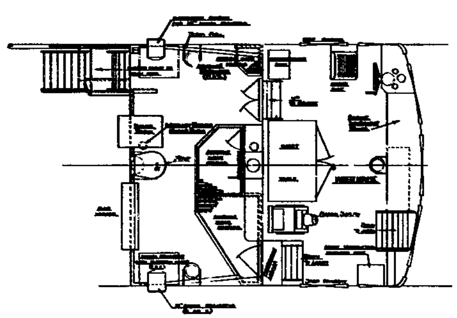
100'-0" PATROL VESSEL

GENERAL ARRANGEMENT

SHEET No. I

SCALE: = 1 FOOT





GENERAL ARRANGEMENT

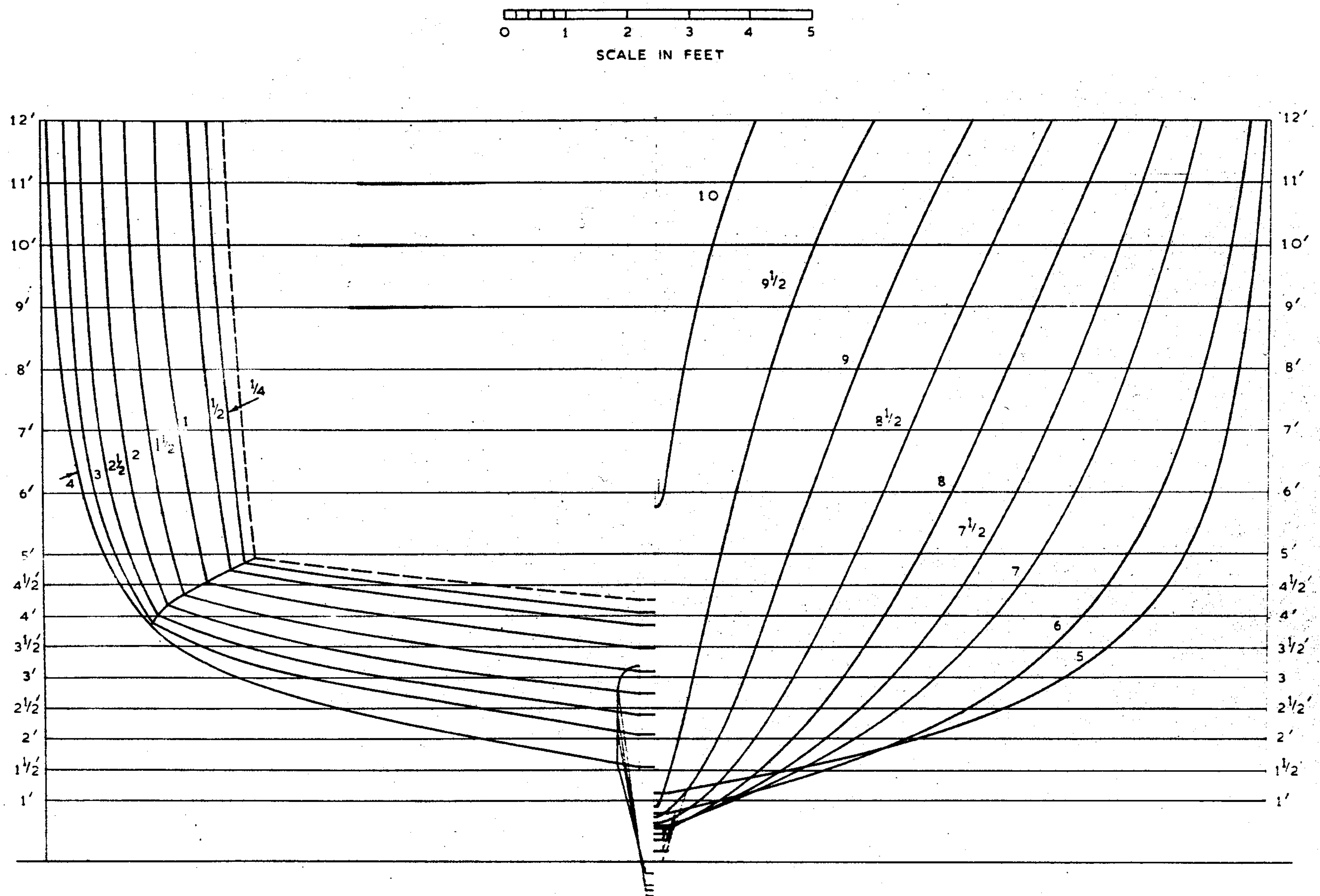
SHEET No. I

SHIP DIVISION – N P L

PROJECT Nº 40·8

REPORT ON EXPERIMENTS WITH MODEL Nº 4727

FIG. 1A. BODY SECTIONS



SHIP DIVISION — N.P.L.

PROJECT Nº 40·8

REPORT ON EXPERIMENTS WITH MODEL Nº 4727

FIG.1B. STERN CONTOUR AND WATERLINE ENDINGS

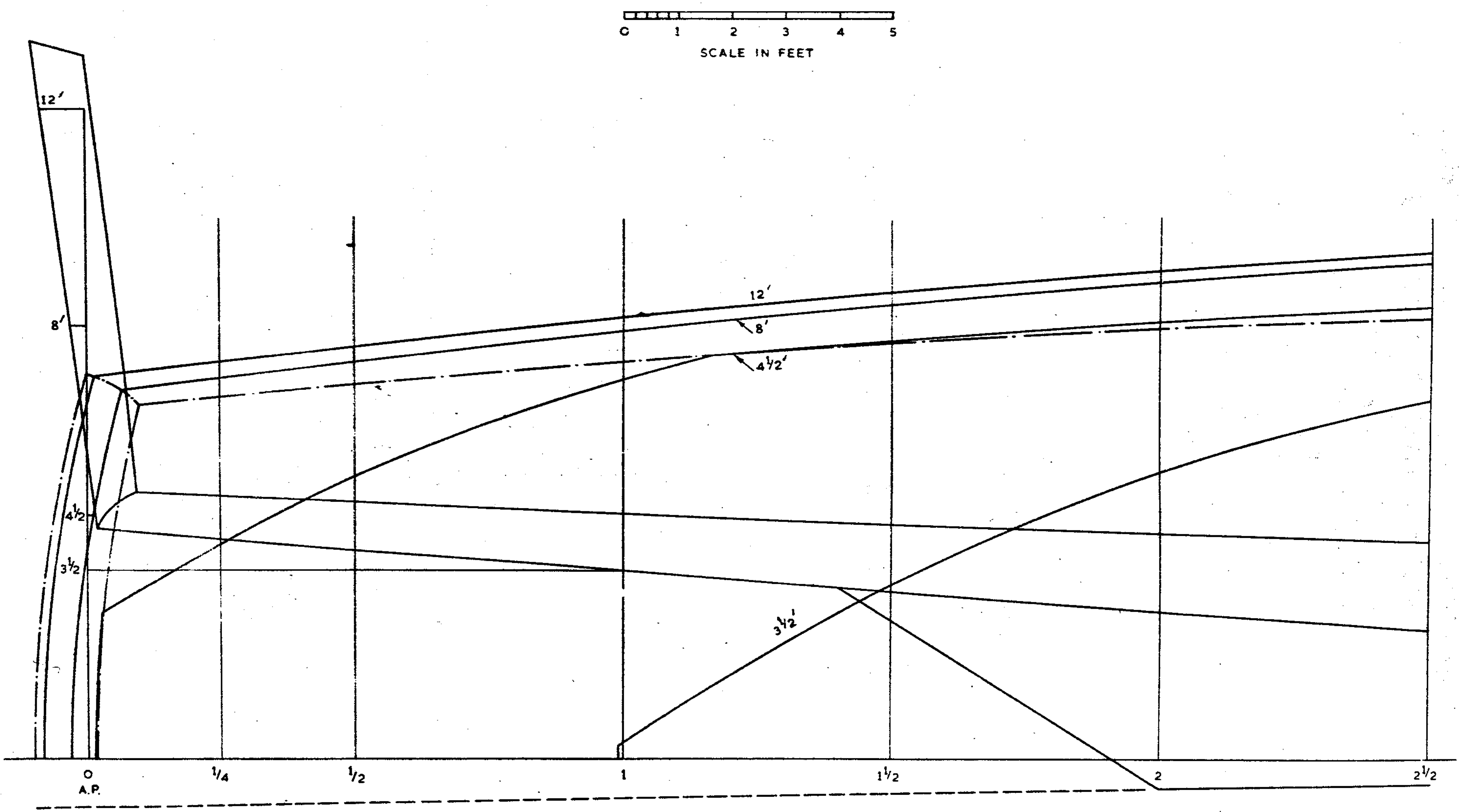


FIG. 6.

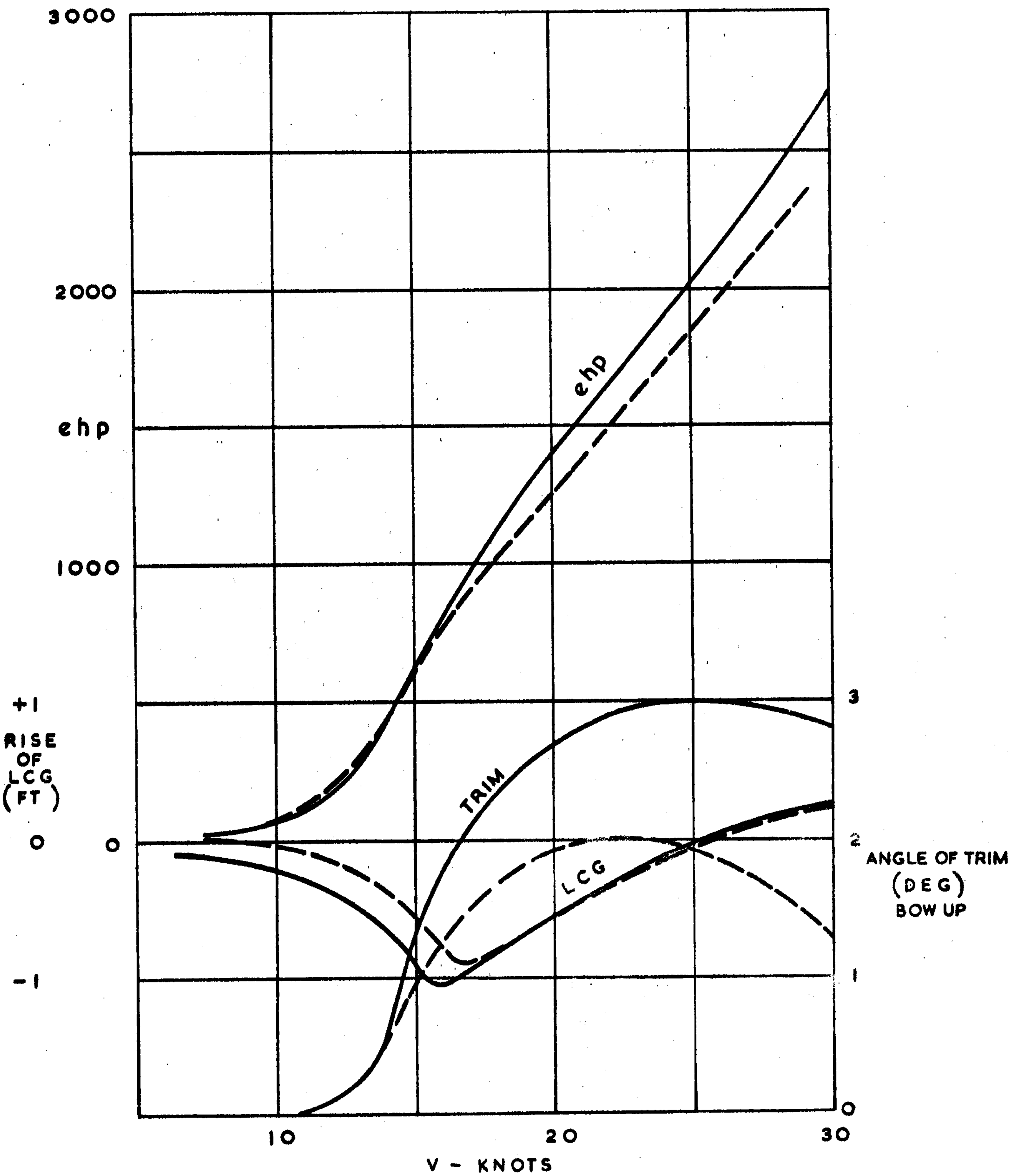
SHIP DIVISION — N.P.L.

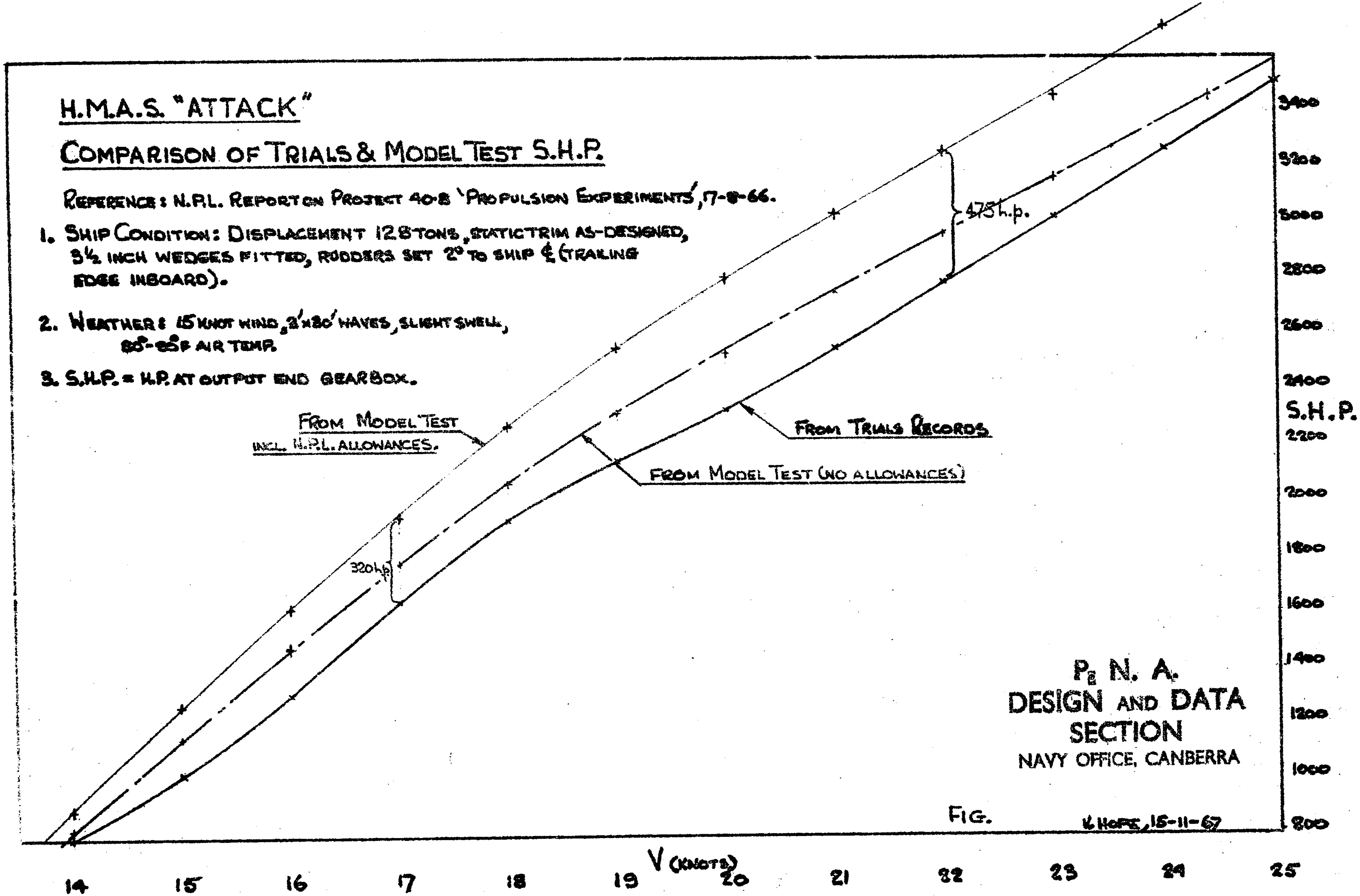
PROJECT Nº 40.8. MODEL HULL Nº 4727

RESISTANCE EXPERIMENT RESULTS

Δ = 133
TRIM :- 1% LWL BY STERN
WEDGES :- NOT FITTED ————
" FITTED – – – –
S.F.C. ACCORDING TO SCHOENHERR
(ROUGHNESS ALLOWANCE + 0·0002)

RESULTS CORRECTED TO TEMPERATURE :- 85° F




H.M.A.S. "ATTACK"
COMPARISON OF TRIALS & MODEL TEST S.H.P.
REFERENCE: N.R.L. REPORT ON PROJECT 40-8 'PROPULSION EXPERIMENTS', 17-8-66.
1. SHIP CONDITION: DISPLACEMENT 128 TONS, STATIC TRIM AS-DESIGNED, 3½ INCH WEDGES FITTED, RUDDERS SET 2° TO SHIP ℄ (TRAILING EDGE INBOARD).
2. WEATHER: 15 KNOT WIND, 2'×80' WAVES, SLIGHT SWELL, 80°-85°F AIR TEMP.
3. S.H.P. = H.P. AT OUTPUT END GEARBOX.
FROM MODEL TEST
INCL. N.P.L. ALLOWANCES.
FROM MODEL TEST (NO ALLOWANCES)
FROM TRIALS RECORDS
475 h.p.
320 h.p.
S.H.P.
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
V (KNOTS)
14
15
16
17
18
19
20
21
22
23
24
25
P. N. A.
DESIGN AND DATA
SECTION
NAVY OFFICE, CANBERRA
FIG.
K HOPE, 15-11-67

DESIGN FOR PATROL BOATS FOR R.A.N.

By Mr. J.J. FOLLAN

D I S C U S S I O N

Lt. V. FAZIO: NIRIMBA

I noticed earlier Mr. FOLLAN that you said you sprayed with aluminium up to the first Deck. Was this externally as well as internally?

Mr. J. FOLLAN:

Internally.

Lt. FAZIO:

You did not go below the waterline at all?

Mr. FOLLAN:

No, the main hull throughout is all mild steel and this is metal sprayed except for the external underwater area. The superstructure was built separately from the main hull in a shop, transferred, then lifted on board. The superstructure itself is huck bolted to a flat bar welded to the main deck separated by Densichrome tapes.

Lt. FAZIO:

We did some metal spraying on the yacht we built at NIRIMBA and we found it was unsatisfactory under water. We had failures in large areas.

Mr. FOLLAN:

Mr. BELL, have you known of any failures?

Mr. E.T. BELL: G.O.S.I.

There is no spraying externally on the hulls. It is not acceptable under the water. The weather decks are metal sprayed.

Mr. R. TUFT: University of New South Wales

What is huck bolting?

Mr. FOLLAN:

A huck bolt is a patterned fastening, something like a rivet, which is used quite frequently for fastening dissimilar metals, particularly aluminium to mild steel where you would not normally rivet. It has a screwed thread with a clamp nut. There is a machine which pulls it tight then clamps the

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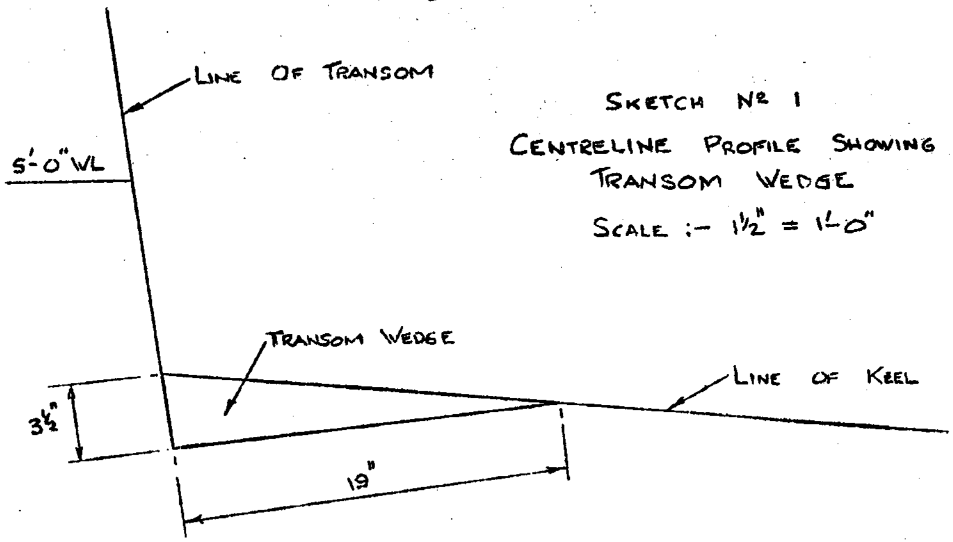

Mr. FOLLAN:

The wedge extends for some nineteen inches from Point 'A' at the aft end. The depth adopted by us as a result of extensive trials was three and half inches. (There were some 20 runs carried out.) We did fit a wooden wedge in the first instance with a series of layers and we sent divers down to modify these during the trials. We would take a number of runs at four and half inches depth then we would send a diver down and take off that layer then try it out at the next depth three and half inches then two and half inches and so on. Then we went back and from this we were able to plot what we thought was the optimum result but the wedge itself is shown in Sketch No. 1 is three and half inches and some nineteen inches long.

The wedge went the full width of the transom at that depth. This was the optimum size that we adopted. The first boat went up north and we had to send her away without a wedge but we have sent the fabricated steel structure up to Manus and this will be fitted up there. All boats now will have the wedges on them.

Mr. TUFT:

A remarkably simple addition to the hull.

Mr. FOLLAN:

Yes.

Mr. D.S. CARMENT:

I have heard that you cannot go slow.

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are under training at the present time.

LIEUT. B. SWAN: R.A.N.

You have not mentioned the stability characteristics of the vessel. Is this still Classified?

Mr. FOLLAN:

No, it is very good. There is a very large range of stability. We thought they would be rather stiff but their sea keeping qualities are quite good. You saw from the slides that turning at full speed there was hardly any angle at all and they stand up to it very well. They have a fairly high freeboard and this gives quite a big range.

Mr. N. RILEY: A.S.B.

I wonder could you tell me Mr. Follan, whether the tank has given any explanation why their predicted powers are so far above what you actually achieved on trials.

Mr. FOLLAN:

No, we have not returned to them.

Mr. RILEY:

Have you run trials on any but the first of class boat.

Mr. FOLLAN:

Yes, we do speed trials on all craft, but we have not done the same extensive trials that we did on the first two craft. With every boat that comes out of the Dockyard we do full power, and operational trials, steering, stopping, starting, manoeuvering - etc.

Mr. N. RILEY:

But you have not carried out any correlation of power trials between boats.

Mr. FOLLAN:

Yes. We did Attack and Aitape and just recently we were doing Advance. Results were very, very close.

Mr. TUFT:

I noticed that Schoenherr formulation was used for skin friction resistance with an allowance of 0.0002, where for ship work it is generally allowed as 0.0004. They have been very conservative with their allowance here which may explain, to some extent, the difference.

Mr. FOLLAN:

Yes, it could be the explanation. If you drew out the high resistance hump in the curve that would explain the difference.

Mr. R. GRANT: G.I.D.

Is the small boat carried of fibre glass?

Mr. FOLLAN:

The present one is fibre glass but this will probably be changed to an aluminium dinghy. There is considerable argument about the suitability of the particular boat supplied. Again this is a matter of opinion between staff officers who, like all of us, have their own opinions on suitability of different types of craft. We did carry out trials on a

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Mr. FOLLAN:

This has many complications. No doubt if you fit the controllable pitch propellor it means more costly equipment and perhaps you would not obtain the same results at full power on normal operational conditions. After all, the towing requirements are only spasmodic and we accept a reduction in efficiency and performance under the towing conditions. These propellors are what one would call a highly rated propellor, and when you use them for towing purposes you must, of necessity, have a big reduction in efficiency. We have accepted this. We did look at the question of controllable pitch propellors but because of cost and interchangability of the craft they were not fitted. If you have a vessel operating here and you may want to suddenly deploy her in another sphere so you want to have them all common. All propellors fit all craft. Everything is interchangable - shafting, engines and so on. This is one of the reasons that went against it.

COMMODORE MUSSARED:

There was a very valid reason for not fitting them. This was, for those craft working in New Guinea, there was too much likelihood of damage, and damage to a propellor of this nature means a very large expenditure to replace it, so, as we wanted this complete interchangability the general decision was for a standard propellor.

Mr. A. HUNTER: Nirimba.

How were these craft built. Were they built in sections then joined together?

Mr. FOLLAN:

Yes, they have been fuilt in sections.

Mr. HUNTER:

All in the same yard?

Mr. FOLLAN:

All the structural sections have been built in the same yard. Briefly, Evans Deaken and Walkers sub-let the structural components to Com-Eng. in Brisbane. Commonwealth Engineering prefabricated the hulls in sections, also they built the superstructures in aluminium. They did this under cover in the shops. These sections were then delivered to the shipyards where they joined them together and continued to fit out the craft. Commonwealth Engineering did only the structural work and did no fitting out. We had hoped that this method would accelerate the production but unfortunately this has not been so. Mr. Bell would you like to comment on trial results as the overseer.

Mr. E.T. BELL: G.O.I.S.E.A.

First, I would like to thank Mr. Follan for presenting this paper and the Department of the Navy for giving permission.

This project is unique in the history of the R.A.N. over the last 20 years. There are 20 such craft. It is the start of a new era as far as this type of craft is concerned in the R.A.N. These craft we need.

It was 1939 when they built something like 60 A.M.S. vessels and it has taken all these years to venture out on a project of this magnitude.

The boats are certainly up to the level required and the ships' officers are very happy with them. We have a few minor teething troubles but nothing very serious. At sea they

Mr. FOLLAN:

This applied to the Bridge structure and wheelhouse fitting out, positioning of the steering, gear, engine controls and compass repeats, voice-pipes and so on. This of course, in any naval craft where there is such a large quantity of equipment, it is absolutely essential to have a mock up. Most of these things look right on paper but I think the mock up more than pays for itself, particularly when you have a large number of craft. We do this with all our vessels, even our frigates. We have mock ups of the Operations room, mock ups of the Bridge etc. It is absolutely essential to do this. We have so much equipment to fit in, that it would be very difficult to get at it if you did not have a preliminary mock up.

Mr. R. GRANT:

There is one final point, Mr. Follan, which probably is worth mentioning. Mr. Carment mentioned the Vosper craft. Perhaps a number of people don't realise the pressure we are under to produce something equivalent to this, (Mr. Ted Bell will bear this out) in the design stages. The Naval Board at this time wondered what we were doing, why were we doing this, why were we not buying Vosper boats. We all took a risk to a very large extent by saying we could achieve a boat as good as the Vospers. In fact, we thought we could exceed it. On my assessment of the results, I think we have exceeded the Vosper boat.

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