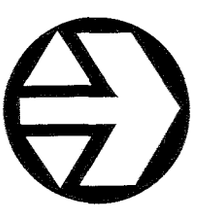
JANE'S SURFACE SKIMMER SYSTEMS

THIRD EDITION

EDITED BY
ROY McLEAVY

1969-70



JANE'S YEARBOOKS

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Dr. Alfred Skolnick and Z. G. Wachnik (JSESPO), *Jets, Props and Air Cushions,* ASME, Gas Turbine & Products Show, Washington, March 1968.

Glossary of Terms Relating to Air Cushion Vehicles, British Standards Institution.

Dictionary of Marine Engineering and Nautical Terms, by G. O. Watson, Newnes.

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Robert D. Waldo, Aerojet-General Corporation, *Some Special Problems in Surface Effect Ships;* Journal of Hydronautics, Vol. 2, No. 3. July 1968.

A. Skolnick, JSESPO, *Transoceanic Surface Effect Ships,* Proceedings of the IEEE, Vol, 56, No. 4, April 1968.

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CONTENTS

HYDROFOILS in 1969 NEW CRAFT, NEW OPERATORS

The De Havilland FHE-400 HMCS Bras D'Or—photographed during her first foilborne run off the Halifax coast on April 9th 1969

Overall, the past twelve months have been the hydrofoil industry's busiest and most successful yet. Orders for established designs continued to grow: "new generation" craft were being designed, built or tested in at least eight countries; around the world commercial operators, old and new, appeared to be flourishing.

Highlights of 1969 included the launching in Canada of the world's second biggest hydrofoil—the 212 ton De Havilland FHE-400 ocean-going all-weather ASW warship; the opening of new services in the Caribbean, and the inauguration of the first hydrofoil ferry service in the United Kingdom. The Soviet Union, as busy as ever developing this fast form of water transport, announced two completely new gas-turbine powered ferries; in France, Sud Aviation issued details of its SA 800 passenger/car ferry project, and the prototype Sea Ranger, first hydrofoil passenger ferry of more than $4\frac{1}{2}$ tons displacement to be built in the United Kingdom, began manufacturer's trials.

Half-a-century after Alexander Graham Bell and "Casey" Baldwin set-up their world water speed record of 61.5 knots in the HD-4, a Canadian hydrofoil is once again stimulating the interest of the world's navies. The objectives of the FHE-400 programme are first to evaluate the feasibility of a 200-ton, oceangoing, surface-piercing hydrofoil capable of 50 knots in sea state 5, and secondly, to assess the vessel's capabilities in ASW operations.

If successful, the craft, which has been commissioned as HMCS Bras d'Or, will operate at double the speed of comparable displacement vessels, have greater manoeuvrability, cost less and require a crew only one-tenth the size of that of a destroyer.

In much the same way as hunter/killer ASW aircraft, it will cruise at low speed for maximum search range, and close-in to "kill" at high speed. Hence it has low and high speed propulsion systems—a 2,000 hp diesel providing a range of upwards of 2,000 miles at 12 knots in displacement mode, and a 25,000 hp gas turbine to enable it to sweep into the attack at speeds up to 65 knots. Towed, variable-depth sonar is employed to detect submarines, and the ASW armament consists of lightweight homing torpedoes.

During its initial calm water trials in Halifax harbour, it surpassed expectations by attaining speeds in excess of the 60 knots required by the RCN specification.

Another military hydrofoil on the North American continent which has been performing consistently well is Boeing's Tucumcari. The 60-ton craft has been operating out of San Diego with the US Pacific Fleet Amphibious Command for more than a year, and during this time it has been handled and maintained entirely by its crew. By May 1969 it had logged 300 foilborne hours without a single control failure, either electronic or hydraulic. The gunboat is operated by a 12-man crew, plus one officer, on a three shift basis. Each of the four man duty shifts is able to operate the craft hullborne or foilborne. At no time since the craft has become operational has its movement been terminated or cancelled because of bad weather.

The success of the craft is due in no small measure to Boeing's philosophy that the best hydrofoil control system is the simplest one that will meet the performance requirements. Accordingly the designers have dispensed with a number of the controls found in earlier craft, including the turn-mode selector, manual trim control and the platform-contour selector. In the case of the latter, studies showed that it was undesirable that the operator should continually have to evaluate sea conditions in order to decide whether to contour or platform. The

design choice is based simply on the conclusion that contouring is impracticable. It has been found that, except at preferred headings or in old swells, the motions associated with pitching and heaving to maintain wave clearance are more disturbing than those associated with crests that exceed the strut length. Under conditions of low wave encounter frequency, for which contouring would be acceptable, the control system provides automatically for "natural" contouring. By tailoring the craft's dynamic response characteristics, the control system provides automatically for partially contouring the low frequency waves and platforming the higher frequency waves.

Recently praise for the Tucumcari came from the US Navy, which said in a press statement that the craft "continues to set unprecedented prototype performance and reliability records".

As the US Navy continues its evaluation of hydrofoils in various military roles, there are increasing signs of renewed American interest in the hydrofoil's commercial potential.

In the past, despite the full encouragement of the Maritime Administration, which contributed handsomely towards the cost of the Denison test craft and offered operators direct subsidy funding or mortgage insurance, surprisingly few US companies showed any enthusiasm for the concept. This attitude is gradually changing. Judging from its present rate of growth, one new company, International Hydrolines Inc., of New York, is likely to become the biggest commercial hydrofoil operator outside the Mediterranean by 1970.

The company is at present concentrating on developing a network of routes in the Caribbean and has recently inaugurated a service off the coast of California. The rapid strides made by this company to date are not altogether surprising, since its senior executives include three of the best known names in American hydrofoil circles: Ira Dowd, founder of the American Hydrofoils, which operated the World's Fair hydrofoil service; William Niedermair, founder of Northwest Hydrofoil Lines and owner of the HS Victoria, and Helmut Kock, designer of the Albatross, the first American hydrofoil to be given approval by the US Coast Guard.

Through its subsidiary Trinidad & Tobago Hydrolines Ltd., IHI operates a 60-seat Raketa on three trips a week between Port-of-Spain, Trinidad and Guira, Venezuela, and a 116-seat Kometa, with a seagoing, hoop-type bow foil which makes two round trips daily between St. Thomas and St. Croix.

As we go to press, the 250-seat PT 150 prototype is being towed across the Atlantic to St. Thomas, where it will operate three round trips a week for IHI between St. Thomas and Antigua, with calls at Tortola, Virgin Gorda and St. Martin.

The Victoria hydrofoil has been operating since July with the company's Western Division between San Pedro and Catalina Island, a distance of some 30 miles. IHI is now planning to open services to other South American countries. It has formed Mexico Hydrolines which will operate initially between Baja, California and Mexico, and it will open several new services in the Caribbean. To implement these it has ordered nine additional Kometas.

Two more American companies which are now active in the Caribbean are United States Hydrofoils Corporation and Bahamas Hydro Lines. Until recently, United States Hydrofoil Corporation has been concerned primarily with the operation of three 22-seat Albatross craft in the Fort Lauderdale, Miami and Biscayne Bay areas. It is now the joint owner, with Aliscafi SpA, of the Golden Arrow Hydrofoil Company, which operates a 125-seat Rodriquez-built PT 50. The craft, the Sun Arrow, leaves San Jaun, Puerto Rico each morning for St. Thomas in the US Virgin Islands, then offers two round-trips daily from St. Thomas to Tortola in the British Virgin Islands before returning to St. Juan in the evening.

Bahamas Hydro Lines Ltd operates the Blohm & Voss-built Grumman Dolphin prototype, now named Gulfstreak, between Freeport, Grand Bahama Island, and Miami Beach. Passengers say they have been impressed by the comfort and performance of the craft, which completes the 87-mile run in less than two hours. The craft carries 80 passengers and a crew of five, including two hostesses.

On the opposite side of the Atlantic, Red Funnel Line, of Southampton, assured itself of an entry in the annals of British maritime history when, somewhat courageously, it set a Seaflight H.57 to work in what had previously been considered a hovercraft preserve.

The fact that it was the first hydrofoil ever to operate commercially within the United Kingdom seemed to escape general notice, but not many people were surprised by this. What does matter is that the craft soon proved that it can provide a fast, comfortable, reliable and convenient service between Southampton and Cowes, and this is of greater importance to the average passenger than the vital differences between the two "rival" marine vehicle concepts. Few can tell one vessel from the other, but none are likely to lose any sleep because of it.

Once reconciled with the intruder, which moves across the Solent with impressive, almost swanlike, grace, many of the hovercraft "progressives" took the opportunity to inspect the craft and meet the manufacturer, and a useful exchange followed on propeller life, cavitation effects and other matters. Between May 5th and August 30th, the craft operated eleven return trips daily, six days a week and carried a total of 42,877 passengers.

One nation which has absolutely no doubt about the future of the hydrofoil is the Soviet Union. By January 1969, nearly 1,200 were in operation on practically all the major rivers, lakes, canals, and reservoirs from the Soviet Danube in the West, to Central Russia, Siberia, and the Far East. In 1968 they carried three million passengers—only 2% of the 150 million who travel by Soviet river boats annually—but it is forecast that hydrofoils will eventually oust displacement passenger ships on all inland waterways, and the conventional passenger ferries will be converted into holiday cruise vessels.

Two new hydrofoil passenger ferry designs were announced in 1969—the Voskhod (Sunrise), a Raketa replacement, and the Cyclone, a gas-turbine powered craft with seats for 250 passengers and capable of 38 knots.

The Voskhod will provide greater comfort and improved facilities for passengers and crew and air-conditioning will be installed. As with the Raketa, a family of variants will be available to suit a wide variety of operating and traffic conditions. Fastest of the series will be the Voskhod 3, powered by a gas-turbine and capable of 43 knots.

Raketa variants have given excellent service over the past twelve years and have the advantage of extremely low operating costs, which are stated to be lower than that of either displacement-type passenger ferries or buses. Similar low-cost operation is demonstrated by the 260-passenger Sputnik on the Moscow-Astrakhan route. It has been found that the cost of running a Sputnik on this service is only 8% of that of the latest displacement ferry of the United Volga Steamship Line. The Voskhod, like the Raketa and Kometa, is likely to find a useful market abroad.

To date the world's most popular sports and recreational hydrofoil is the 6-seat Volga, which is based on Dr Alexeyev's original testcraft. The shipyard at Batumi, which specialises in the production of this type, exported its first craft to Australia in August. The yard has built "several thousand", and has supplied these craft to buyers in 36 countries. It is now working on orders from East Germany, Kuwait and Rumania. In 1969 Volgas

were also delivered to the West Indies and to two operators in the United Kingdom, Taurus Yacht Services of Bournemouth, and Speed Hydrofoils, which operates tourist trips with the craft on the Thames from Greenwich.

Similar export successes are likely to be achieved by the new Nevka, a 12-14 seat fibreglass-hulled V-foiled craft which is available as a water-taxi, sightseeing craft or private cabin cruisers. Export models are likely to be available in 1970.

At the same time the Soviet Union has not failed to explore the military potential of the hydrofoil. The Soviet Navy has recently taken delivery of twenty-five Pchela-class fast patrol vessels, a type which has evidently been derived from the Strela design. The craft has an almost identical hull to that of the commercial ferry, and a similar vee-type foil system, which now incorporates stabilising sub-foils. The wheelhouse superstructure and deck arrangements have been revised, and an external piloting position, forward of the wheelhouse, is provided for use during offensive action, manoeuvring or in an emergency.

Another maritime nation clearly interested in entering the hydrofoil field is France, where both the Navy and the merchant marine authorities have expressed enthusiasm for these craft. Details of the first French design study were revealed in March. The craft is the joint project of a study group formed by Bassin d'Essais de Carènes (BEC), Ministry of Marine, Sud Aviation and Chantiers Mecanique of Cherbourg.

The foil system will be of aeroplane type, with two fully submerged foils located forward and one fully submerged foil aft. Beneath the aft foil is a SOGREAH waterjet, driven via shafts and bevel gears by two 1,300 hp Turmo 111C free-turbines mounted above the waterjet in the extreme stern. The two bow foils are incidence controlled and the rear foil has trailing edge control flaps. Accommodation is on two decks—as a passenger ferry it will seat 116 on the upper deck and 84 on the lower, and as a mixed traffic craft it will carry 8-10 cars on the upper deck, with the lower deck seating capacity remaining at 84.

Trials conducted with dynamic models have been successful and preliminary design studies are now complete. Further capital is needed, Sud Aviation states, before advancing from this stage to making a prototype. If the French Government gives the consortium the green light to go ahead, the first commercial and military craft could be ready two years from now.

It appears that, like Boeing, Sud Aviation is making use of its vast experience in the development of aircraft and missile components in designing the SA 800's sonic/electronic control system. The hydrofoil control designer is nowadays able to base a foil control system on a large assortment of reliable, proven components which have been developed in the aerospace industry. For a hydrofoil's inertial sensor and controller, aircraft and missile equipment can be used with only minor modification.

Across from Cherbourg, on the opposite side of the English Channel, at Dartmouth, Devon, the first British designed and built commercial hydrofoil, the Southern Hydrofoils' Sea Ranger, has successfully completed the first phase of its manufacturer's trials. It achieved 33 knots in moderately rough sea conditions and at the end of August was being prepared for the second phase of its trials. The prototype is powered by two 283 hp General Motors Detroit 8V53 diesels. The standard craft will seat up to 25 passengers, but alternative versions will be offered for a variety of applications ranging from fast naval, police and customs patrol to ambulance duties. The craft has a mechanically operated submerged foil system, with wave sensing arms controlling the incidence angle of the submerged bow foils.

The company plans to start production of the Sea Ranger 1 early in 1970 and is currently designing a 'stretched' version, the gas-turbine powered Sea Ranger 11, with seats for 35. The company has received many enquiries for the craft, especially from South America and the Middle East.

Established hydrofoil builders have been busier than ever. Westermoen, the first Supramar licencee to build a 165 ton Supramar PT 150, is now building two more craft of this type for Joh. Presthus Rederi, of Bergen, which plans to operate both vessels in the Canary Islands. Hitachi, Supramar's licencee in Japan, is currently building PT 50s and conducting a market survey into the potential sales of the PT 150 in the Pacific; and Rodriquez, which is looking into the prospects of the PT 150 in the Mediterranean, is building additional PT 50s and PT 20s for operators in this area.

In Lucerne, the Supramar team is concentrating on the development of the Schertel-Sachsenburg fully-submerged air-stabilised foils and further design refinements for the PT 150 series.

The next entirely new design to be launched in the Mediterranean will be Seaflight's L 90, the prototype of which is due to be completed in the summer of 1970. Developed from the H 57, the craft will have a maximum take-off displacement of 55 tons and cruise at 34 knots (63 km/h). The standard version will have a crew of 3-4 and accommodate 125 passengers in three large saloons. The bow foil, of W type, incorporates Seaflight's mechanically operated incidence control system which on the L 90 has been revised and simplified. The foil pivots around the axis of a single supporting tube between positions of maximum and minimum incidence, unlike the split bow foil of the H 57 which has separate port and starboard supporting tubes. The foil operates on the principle that the lift and drag generated tends to rotate it backwards, particularly during take-off and in rough seas, but this movement is opposed by a spring attached to an arm on the foil assembly shaft. The system is designed to produce the same amount of lift, irrespective of speed and foil depth in a wave crest or cavity.

The company was formed in 1961 and has built and sold eight 30-seat P 46s, and six 60-seat H 57s. Under construction at the yard, in addition to the L 90 is a second production batch of six H 57s.

To meet requirements in the Mediterranean, Arabian Gulf and elsewhere for fishery protection vessels and fast counter-insurgency craft, Seaflight is offering military derivatives of all three of its current designs. The company is at present concentrating its research on the development of its new W-type foil system and a new form of hollow-bladed propeller which will improve take-off performance. It plans to provide prompt after-sales assistance for Seaflight operators and intends to have technical staff on call ready to fly anywhere at a moments notice, taking replacement components with them if necessary.

Hydrofoils utilise to the utmost the main economic advantage of water transport over other forms of conveyance—its cheapness. Passengers are attracted to them since, unlike displacement craft, they can carry them at speeds equal or comparable to buses and trains with similar or greater comfort. Dozens of operators around the world were reaping the benefits in 1969.

The up-and-coming new generation hydrofoils like the PT 150, a seagoing craft which is faster, bigger and potentially far more profitable, makes their prospects look better than ever.

CANADA

De Havilland

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In 1947-49, a 45 ft craft powered by a 1,200 hp Rolls-Royce Merlin was designed by Phillip Rhodes for Cdr D. M. Hodgson RCNR of Montreal for an attempt on the existing water-speed record. At about this time, the Canadian Defense Research Board became interested in the potential operational employment of hydrofoils and Cdr. Hodgson's craft, named the R-100 Massawippi (after Lake Massawippi, Quebec, the site of its construction and initial tests) was built under the Board's direction. Success of the Massawippi, which displaced 7·5 tons and could reach 55 knots, led to an extensive experimental programme involving Massawippi and two subsequent craft, the Bras d'Or and RX. The Bras d'Or, designed and built by Saunders Roe for the Defense Research Board, was delivered in 1957 and has since been renamed Baddeck. The RX is a fully instrumented test bed for testing a wide range of new foil designs. De Havilland have used the craft extensively during their design development programme for the FHE-400.

The extensive test experience, together with that gained from the US programmes, led the Naval Research Establishment to prepare proposals for a 200-ton ASW hydrofoil capable of all-weather operation in the North Atlantic. At a tripartite conference in January 1960, a group of specialists from the US and Britain reviewed these proposals and concluded that the extension of NRE's work to a prototype craft was desirable. This led to the design and construction of the FHE (fast hydrofoil escort) 400 by De Havilland Aircraft of Canada as design agent for the Canadian Government.

FHE-400

In early 1961 the Canadian Department of Defence contracted De Havilland Aircraft of Canada Ltd for a feasibility and engineering study, based on the NRE ASW hydrofoil report, which could lead to detailed design and construction of a full-scale craft. The company's recommendations were approved in April 1963. The FHE-400 programme has two fundamental objectives: (a) to establish in practice the feasibility of an ocean-going hydrofoil of the proposed size and characteristics (b) to evaluate the prototype as an ASW system.

It is intended that the prototype shall be capable of being developed into a warship. For operational evaluation the fighting equipment is likely to include variable depth sonar for submarine detection, homing torpedoes for armament and the necessary facilities for navigation, communication, radar, command and control. Tactical use of the FHE-400 is based upon variable depth sonar as the prime means of submarine detection.

Launching was planned for mid-1968 and completion by mid-1970 after contractor's sea trials, weapon systems installation and systems evaluation.

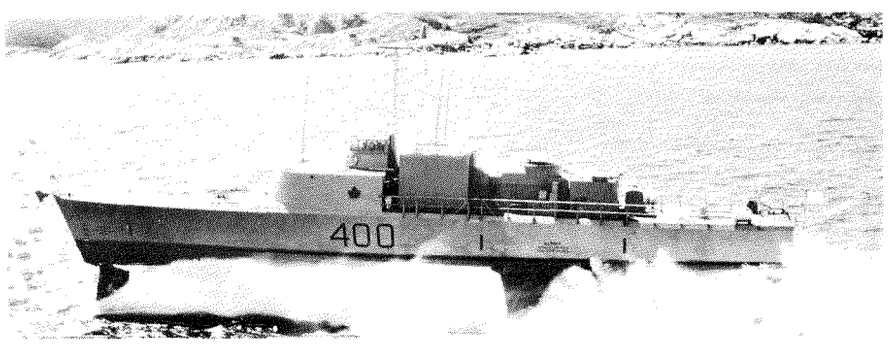
FHE 400 was commissioned as HMCS Bras d'Or in Halifax and was tested in brief displacement mode trials in September 1968. The foilborne transmission was fitted during the winter of 1968 and the first foilborne trial took place on April 9, 1969. An RCN crew will operate the ship during contractor's acceptance trials. Rough water and operational trials will then be conducted by the Hydrofoil Evaluation team at Halifax, N.S.

FOILS: The foil system is a canard configuration of the surface piercing type and non-retractable. The steerable foil is supercavitating and designed for good response in a seaway. The subcavitating main foil carries 90% of the static weight and is a combination of surface-piercing and submerged foils. The centre high speed foil section is protected from ventilation by the struts and the dihedral foils have full-chord fences to inhibit ventilation. Anhedral foils provide reserve lift at take-off and their tips provide roll restoring forces at foilborne speeds.

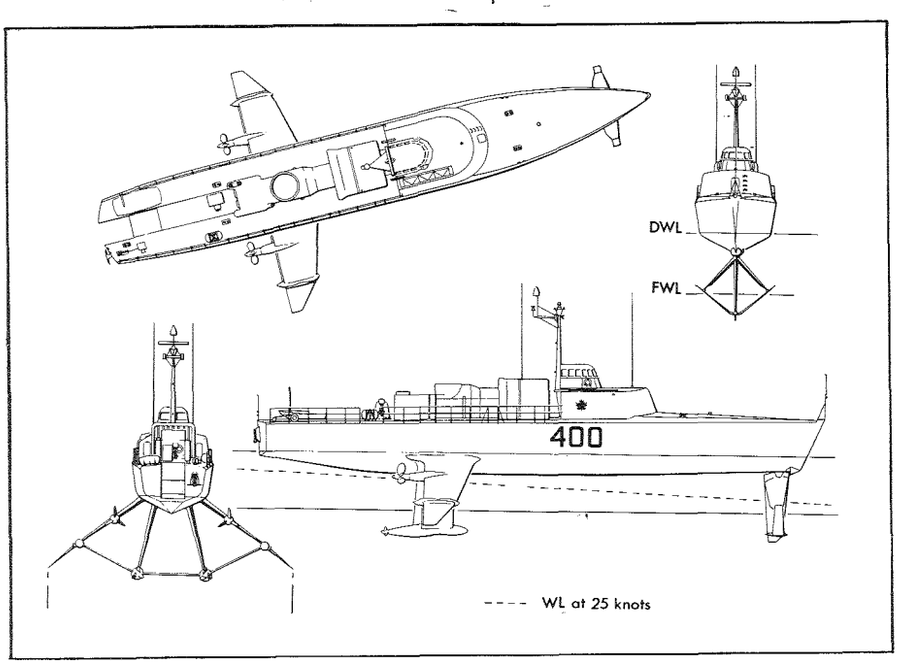
The struts are a compromise to provide the optimum fin effect in yaw in conjunction with the steerable bow foil. The foils are constructed in maraging steel.

HULL: Hull and superstructure are fabricated from ALCAN D54S, and extensive use is made of large extrusions with integral stringers for the plating.

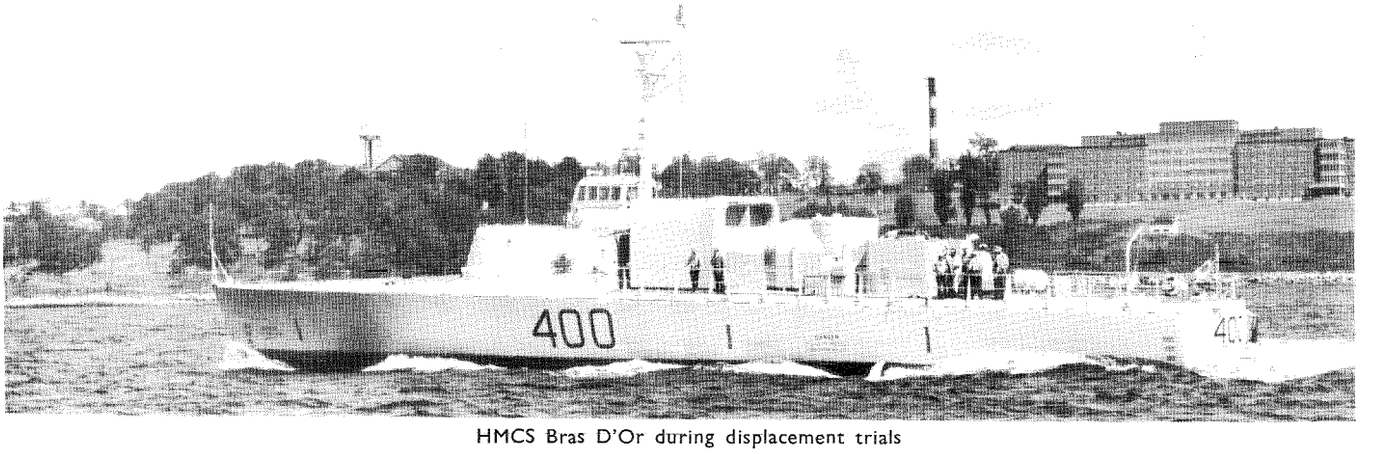
Strain gauges are attached to critical points in the hull and foil system so that predicted



The De Havilland FHE-400 HMCS Bras D'Or—photographed during her first foilborne run off the Halifax coast on April 9th 1969



De Havilland FHE-400 ocean going ASW warship



HMCS Bras D'Or during displacement trials

stress levels can be monitored and recorded on oscillograph charts or magnetic tape for analysis ashore.

A crew of twenty will be carried, comprising eight officers and twelve men. In order to maintain crew alertness at all times, comfortable crew quarters and good messing facilities were considered essential features. Both were intensively studied by the Institute of Aviation Medicine. The study included the testing of crew bunks on a motion simulator at NCR Ottawa, and the use of a simulator to assess crew efficiency under foilborne conditions.

POWER PLANT: Continuous search for a useful period demands economical operation in any sea state at displacement speeds and the ability to attack at high speeds. For this reason there are two propulsion systems —the foilborne "free" marinized gas-turbine, a 22,000 shp Pratt & Whitney FT4A-2, and a 2,000 bhp Davey-Paxman 16YJCM diesel engine for hullborne power. The maximum foilborne speed is expected to be about 60 knots and the hullborne speed about 14 knots. The KWM controllable-pitch displacement propellers of 7 ft (21·33 m) diameter are novel, since they will be feathered when the craft is foilborne so as to minimize the appendage drag penalty. Slow speed manoeuvring will be effected by a control of individual propeller pitch settings.

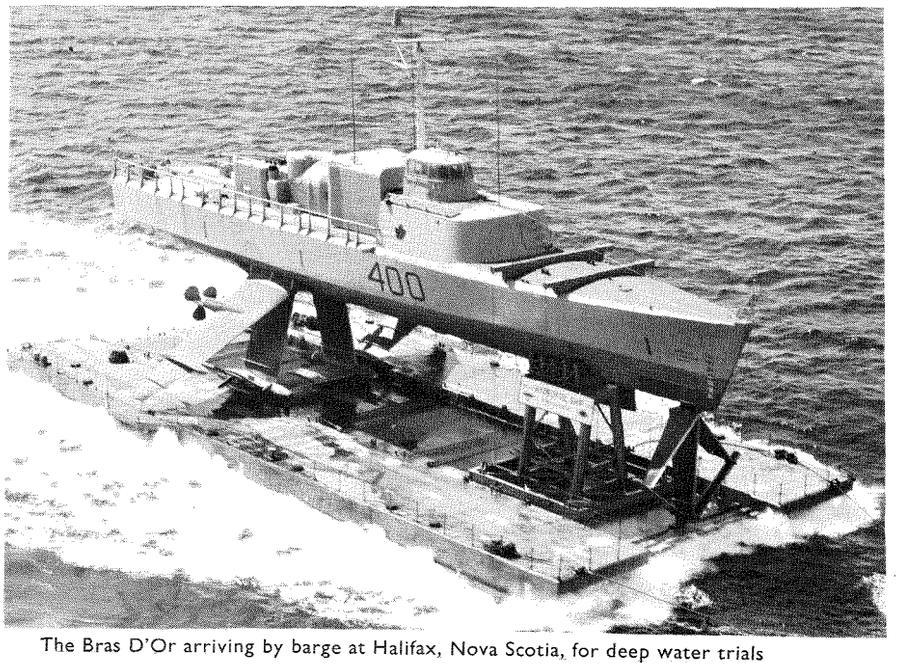
Thrust is provided by twin 4 ft (1·22 m) diameter supercavitating propellers fitted in pods at either end of the main foil's fully submerged centre section.

The FT4A-2, a marine version of the shaft-turbine engine developed from the JT4 and 5 gas turbine, is enclosed by a protective cowling aft of the bridge.

Shaft power is transmitted to the inboard gearbox directly aft of the engine exhaust elbow and is then transmitted via dual shafts through each of the two inner struts to the outboard gearboxes in the streamlined pods at the intersection of the struts and foils. The dual shafts are combined at the outboard gearboxes into a single drive, taken through an over-running clutch to each of the two fixed-pitch supercavitating propellers.

A governor prevents overspeed if the propellers leave the water in rough seas.

A Paxman Ventura 16YJCM diesel-engine is sited in the engine room, on the ship's centreline. Power is transmitted to the variable pitch hullborne propellers through a dual output gearbox and thence through shafts to gearboxes located in the pods.



The Bras D'Or arriving by barge at Halifax, Nova Scotia, for deep water trials

CONTROLS: Diesel power, propeller pitch, main gas turbine speed and individual displacement propeller pitch are all normally controlled by lever from the bridge. Dual wheels are provided to steer the bow foil. An engineer's console is located in the operation room and starting and stopping of all engines is undertaken from this position. Engine and propeller pitch controls duplicating those on the bridge are provided on the console.

SYSTEMS

AUXILIARY POWER: An auxiliary gas turbine, A United Aircraft of Canada ST6A-53 rated at 390 hp continuous at 2,100 rpm is used to power electric generators, hydraulic pumps and a slat-water pump. It can also be used to increase the available displacement propulsion power and for emergency propulsion power at reduced speed.

EMERGENCY POWER: The emergency power unit is an AiResearch GTCP-85-291 shaft-coupled turbine rated at 190 hp continuous. In the event of the auxiliary gas turbine becoming unserviceable or being in use for the displacement propulsion, this turbine will power the ship's system. Alternatively bleed air may be drawn from the compressor for main turbine starting.

ARMAMENT: The FHE 400 will be equipped with a specially designed detection, data processing and weapon delivery system. Primary sensor will be a towed sonar and the armament consists of lightweight homing torpedoes. Canadian Westinghouse Co is the main contractor to the RCN for the weapons system which will be installed on the completion of sea trials. The sonar towed body is being built by Canadian Westinghouse to a design developed as part of the Naval Research Establishment's long term high speed towed sonar programme. Handling gear is a compact, lightweight mechanism developed by Fleet Manufacturing.

DIMENSIONS, EXTERNAL:

Length overall, hull	151 ft 0 in (45·9 m)
Length waterline, hull	147 ft 0 in (44 m)
Hull beam	21 ft 6 in (6·5 m)
Beam across foils	66 ft 0 in (20 m)
Draft afloat	23 ft 6 in (7·16 m)
Freeboard	11 ft 0 in (3·3 m)

WEIGHTS:

Gross tonnage (normal)	212 tons
Light displacement	165 long tons
Max take-off displacement	235 long tons
Useful load (fuel, crew and military load)	over 70 tons

PERFORMANCE:

Cruising speed, foilborne
50 knots rough water 60 knots calm water
Cruise speed, hullborne over 12 knots
Sea state capability
Sea State 5 significant wave height 10 ft

Water Spyder

WATER SPYDER MARINE LTD

HEAD OFFICE AND WORKS:
157 Richard Clark Drive, Downsview, Ontario

TELEPHONE:
244 5404

DIRECTORS:
J. F. Lstiburek, President
G. A. Leask, Secretary/Treasurer
A. Lstiburek, Vice President

SENIOR EXECUTIVES:
L. Civiera, Sales Manager
J. F. Lstiburek, Designer

Water Spyder Marine Ltd is a wholly-owned Canadian company operating under charter issued by the Government of the Province of Ontario. It produces two fibreglass-hulled sports hydrofoils, a two-seat sports model and a six-seat family model. Both are available either ready-built or in kit form. Canadian Department of Transport plates were issued in 1966 for both models.

WATER SPYDER 2-B

The Water Spyder 2-B is a two-seat sports hydrofoil powered by a long-shaft outboard of 20-35 hp.

FOILS: The foil system comprises a split W-type surface piercing main foil supporting 98% of the load and an adjustable outrigged trim tab which supports the remaining 2%. The foils and the trim tab assembly are retracted manually for docking and beaching. The main foils are of polished 65ST aluminium and the trim tab is of steel.

HULL: This is a two-piece (deck and hull) moulded fibreglass construction and incorporates buoyancy chambers. Standard fittings include a curved Perspex windshield and regulation running lights, fore and aft.

ACCOMMODATION: The craft seats two in comfortably upholstered seats. Foils and the trim tab assembly are adjustable from inside the cockpit.

POWER PLANT: Any suitable outboard engine of 20-35 hp (Mercury 200L or 350L Chrysler Evinrude) with long-shaft extension. Total fuel capacity is 5 gallons.

CONTROLS: Controls include steering wheel with adjustable friction damper, single-lever throttle and gearshift control, and trim tab control.

DIMENSIONS:

Length overall, hull	12 ft 0 in (3·6 m)
Beam overall, foils retracted	5 ft 4 in (1·6 m)
Beam overall, foils extended	7 ft 4 in (2·2 m)

WEIGHTS:

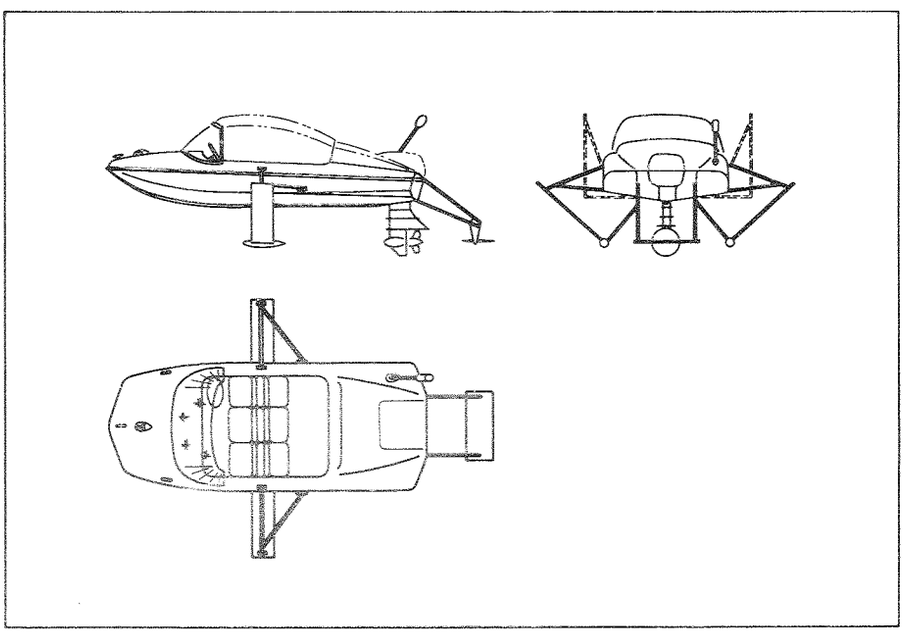
Weight empty	220 lb (99·7 kg)

PERFORMANCE:

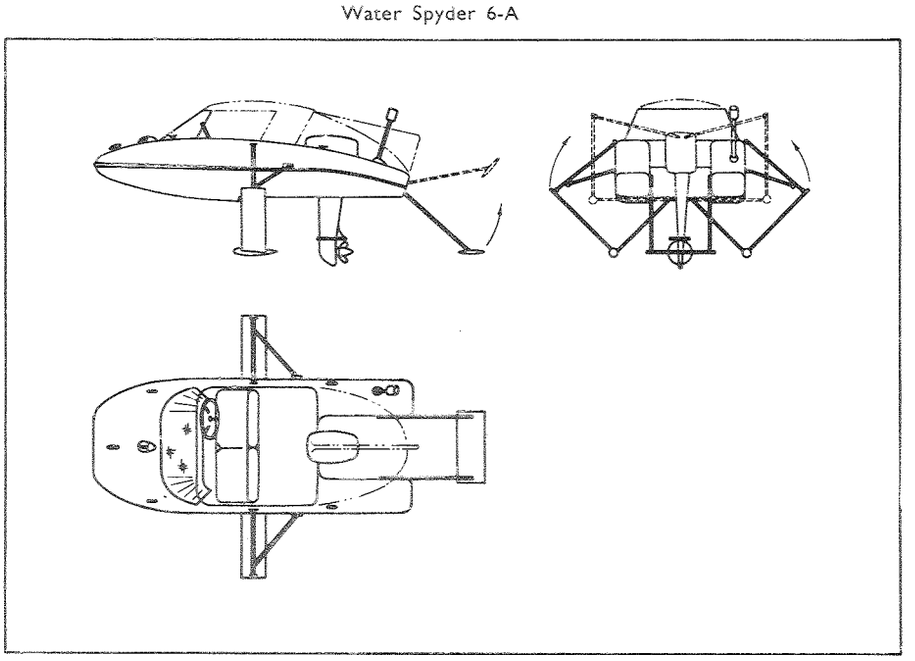
Max speed	up to 40 mph (64 km/h)
Max permissible wave height in foilborne mode	1 ft 6 in
Turning radius at cruising speed	10 ft (3 m) app
Number of seconds and distance to take-off (theor app)	4-6 sec, 15 ft (4·5 m)
Number of seconds and distance to stop craft (theor app)	4-6 sec, 15 ft (4·5 m)

Cost of standard craft and terms of payment: US$970. Terms: Cash. Delivery: 3 weeks from date of order, fob Toronto.

Water Spyder 2-B, a two seat, fibreglass-hulled hydrofoil pleasure craft powered by a 20-30 hp long-shaft outboard motor. The retractable W main foil system carries 98% of the total load



Water Spyder 6-A



Water Spyder 2-B

WATER SPYDER 6-A

An enlarged version of the Water Spyder 2, Model 6-A is a six-seat family pleasure hydrofoil boat, with a two-piece moulded fibreglass hull. The foil system is identical to that of the earlier craft except that the foils are retracted with the aid of a crank and winch.

The seats, located immediately over the main foil, are arranged in two rows of three abreast, one row facing forward, the other aft.

Power is supplied by a long-shaft outboard motor of 60-115 hp. Total fuel capacity is 15 gallons.

DIMENSIONS:

Length overall, hull	19 ft 0 in (5·79 m)
Beam overall, foils retracted	8 ft 3 in (2·5 m)
Beam overall, foils extended	13 ft 0 in (3·96 m)
Height overall, foils retracted	4 ft 6 in (1·37 m)
Floor area	30 sq ft (2·78 m²)

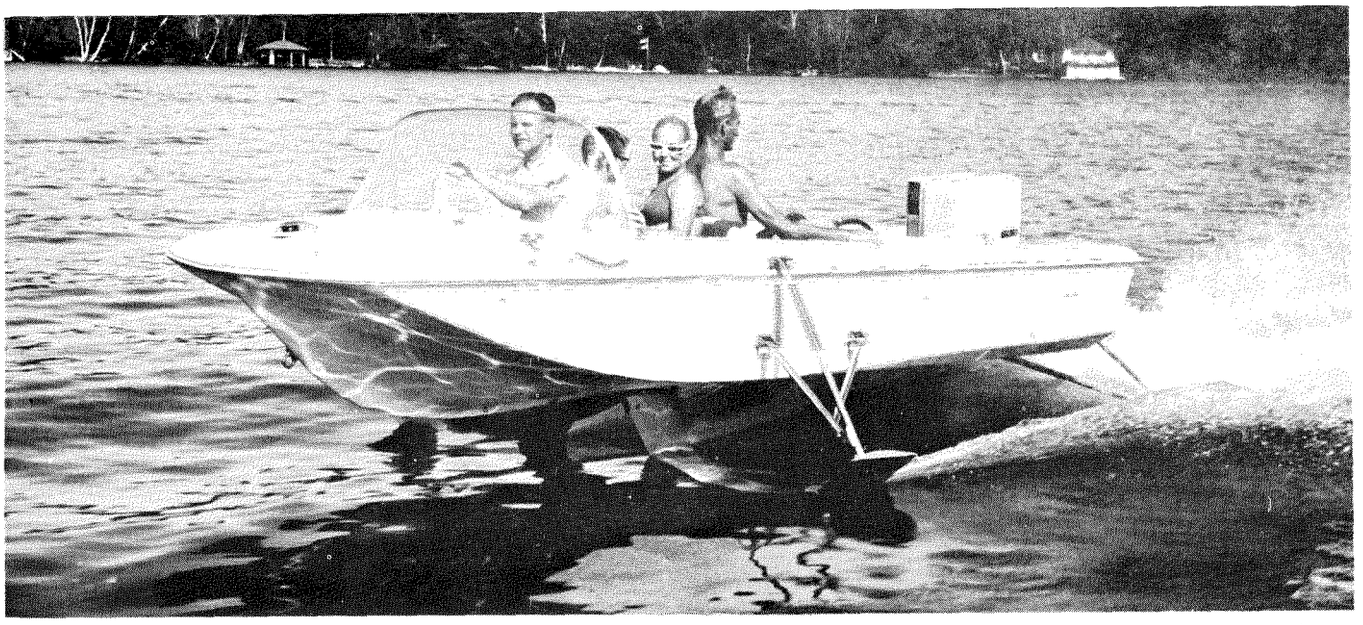
WEIGHTS:

Gross tonnage	1 ton app
Weight empty	980 lb (444 kg)

PERFORMANCE:

Max speed	35-40 mph (56-64 km/h)
Cruising speed	32 mph (51 km/h
Max permissible wave height in foilborne mode	2 ft 6 in (0·76 m)
Turning radius at cruising speed	20 ft (6·09 m)
Number of seconds and distance to take-off (theoretical, app)	4-6 sec, 15 ft (4·57 m)
Number of seconds and distance to stop craft (theoretical, app)	4-6 sec, 15 ft (4·57 m)

Cost of standard craft and terms of payment: $US2,200. Terms: cash. Delivery: Three weeks from date of order f.o.b. Toronto.



Water Spyder 6-A is a six-seat hydrofoil. The main foil, trim-tab support and engine fold upward so the craft can be floated on and off a trailer

GERMANY

Blohm & Voss

BLOHM & VOSS AG

HEAD OFFICE:
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TELEPHONE:
0411-3061
DIRECTORS:
Joseph H. Van Riet
Ernst Christian Frh v. Werthern
Dr. Heinricht V. Prinz Reuss
SENIOR EXECUTIVES:
Erich Schneider, General Manager
Albert Schütt, Shipbuilding Manager
Egbert Müller, Engineering Manager

Under partnership arrangement with Grumman Engineering Corporation, Blohm & Voss undertook the final development and construction of the Grumman Dolphin.

From January 1965 the company's engineers have worked together with Grumman's design staff. The Dolphin prototype was completed in October 1966 and has entered service with Bahamas Hydro Lines on the route Miami-Freeport, Grand Bahamas. The second Dolphin was due for completion in the autumn of 1968 and has also been sold to an operator in the United States. A description of the Dolphin appears under Grumman (United States).

The company is now planning to build the 325-ton Neptune, a passenger/car ferry similar in design and construction to the AG(EH) experimental hydrofoil designed by Grumman.

NEPTUNE

The Neptune is a design for a fast, seagoing passenger/car ferry, capable of operating in up to Sea State 6. It will have a maximum take-off displacement of 325 tons and a cruising speed of 50 knots (93 km/h).

The standard design will accommodate 302 passengers on the saloon deck and 37 cars on the vehicle deck beneath, but all-passenger layouts will be available.

Foilborne power will be supplied by two General Electric LM 1500 marine gas turbines each rated at 14,200 hp continuous.

FOILS: The foil system is fully submerged and of "aeroplane" configuration, with 90% of the weight supported by the two bow foils and 10% by the rear foil. The foils are subcavitating and of medium aspect ratio. The stern strut rotates for steering and all three foil struts retract completely clear of the water. Incidence of the three foils is controlled by an autopilot system. Struts and foils will be built in steel.

HULL: The hull will be almost completely built of aluminium and will be of predominantly welded construction. Most of the deck, side and bottom plating will be made from integrally stiffened, aluminium extruded planks.

ACCOMMODATION: The wheelhouse, located forward, provides a 360° view. The first officer and engineer are seated side-by-side, with a third seat for the captain. Immediately aft of the wheelhouse is a chart room/radio cabin. Normally the crew will have ten members, a captain, a first officer, an engineer, an assistant engineer, two deck hands and four stewards.

Passengers are accommodated in three well glazed saloons, a fore compartment seating 68, a central compartment seating 142 and an aft compartment seating 92. Passenger and crew compartments are air-conditioned.

Access to the compartments is through two doors in the forward saloon, port and starboard, or two doors in the aft saloon, port and starboard. Separate doors, port and starboard, are provided for the crew. Four emergency exits are provided, two port, two starboard.

A full range of safety equipment is carried, including fire extinguishers and approved life rafts sufficient for the crew and 302 passengers. Life jackets for adults and children are also provided.

The vehicle deck, designed for up to 37 cars, has two wide doors at the stern which become access ramps for loading and unloading. A turntable at the forward end permits the vehicle to be turned round so that they can be driven straight off.

POWER PLANT: Foilborne propulsion is supplied by two General Electric LM1500 marine gas turbines of 14,000 bhp continuous rating, connected by Z-drives through the main struts to two stainless-steel, supercavitating fixed propellers of 4 ft 4 in (1·3 m) diameter at the end of the propulsion pods on the main foils. The air intake is at the top of the deckhouse. Four integral fuel tanks will give a total fuel capacity of 35 tons. Oil tank capacity will be 4 tons.

Hullborne propulsion is supplied by two MB 835 BB, or equivalent diesels, rated at 1,650 hp at 1,500 rpm, driving two waterjet pumps with moveable nozzles.

NAVIGATION AND COMMUNICATIONS: Radio and radar are standard equipment.

SYSTEMS:

AIR CONDITIONING: Type not yet determined.

ELECTRICAL: Diesel generator 100 kW, 125kVA at 0·8 P.F. for auxiliary power, lighting system, master warning and monitoring system and autopilot.

HYDRAULICS: 210 atu for strut retraction, foil incidence control and auxiliary power.

APU: 1 emergency gas turbine generator, 30kW.

DIMENSIONS, EXTERNAL:

Length overall, hull	212 ft 8 in (64·85 m)
Length waterline, hull	198 ft 7 in (60·9 m)
Length overall, foils retracted	219 ft 8 in (67·0 m)
Length overall, foils extended	223 ft 0 in (67·97 m)
Hull beam, maximum	41 ft 6 in (12·65 m)
Beam overall, foils retracted	82 ft 9 in (25·2 m)
Beam overall, foils extended	70 ft 9 in (21·57 m)
Draft afloat, foils retracted	7 ft 8 in (2·33 m)
Draft afloat, foils extended	26 ft 1 in (7·95 m)
Draft foilborne	6 ft 7 in (2·0 m)
Freeboard	14 ft 1 in (4·3 m)
Height overall, approx	62 ft 6 in (19·0 m)

DIMENSIONS, INTERNAL:

Superstructure interior, including wheelhouse, chart room, radio cabin, passenger cabins, galley, toilets and air conditioning compartment:

Length	167 ft 5 in (51·0 m)
Max width	33 ft 0 in (10·0 m)
Max height	7 ft 5 in (2·3 m)
Floor area, approx	4,951 sq ft (460 m²)
Volume, approx	37,432 cu ft (1,060 m³)

BAGGAGE HOLDS:

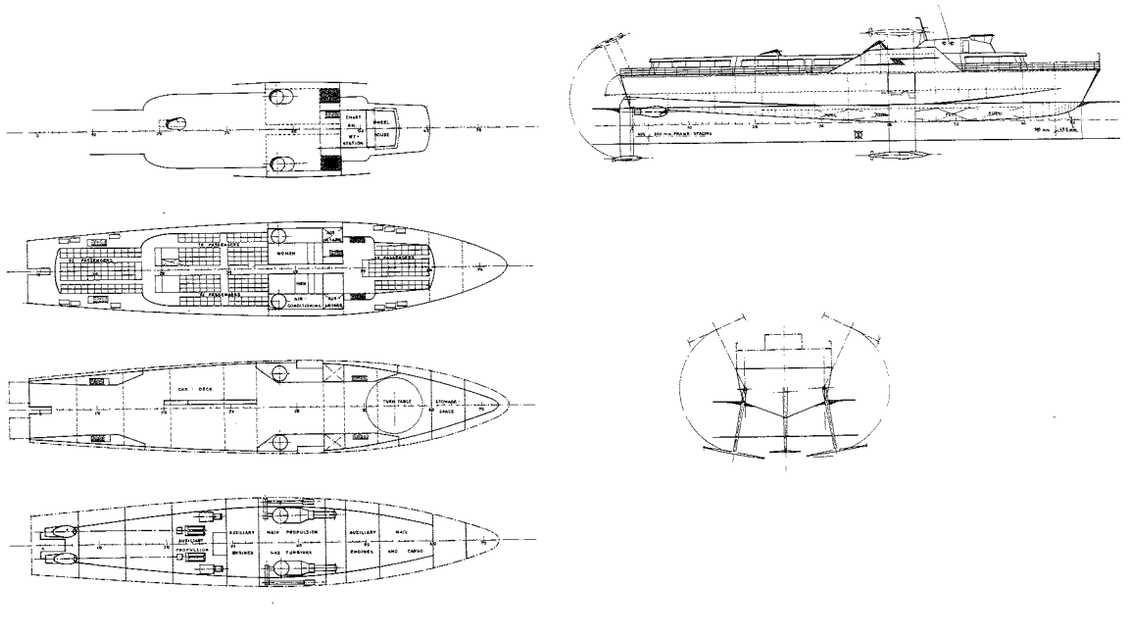
Racks for hand luggage in passenger cabin; baggage holds in forepeak.

WEIGHTS:

Light displacement	205 tons
Normal take-off displacement	320 tons
Max take-off displacement	325 tons
Normal deadweight	115 tons
Max deadweight	120 tons
Normal payload	73 tons
Max payload	78 tons

PERFORMANCE:

Max speed foilborne	58 knots (106 km/h)
Max speed hullborne	20 knots (38 km/h)
Max permissible wave height in foilborne mode	14·7-16·4 ft (4·5-5 m)
Cruising speed foilborne	50 knots (93 km/h)
Cruising speed, hullborne	18 knots (32 km/h)
Design range at cruising speed	325 n.m. app
Turning radius at cruising speed	1,148 ft (350 m)
Number of seconds and distance to take-off	35 sec/1,312 ft (400 m)
Number of seconds and distance to stop craft	16 sec/656 ft (200 m)
Fuel consumption at max speed	250·5 gallons per hour
Fuel consumption at cruising speed	255 gallons per hour



General arrangement of the Neptune hydrofoil passenger/car ferry showing outboard profile, passenger and car decks

Schlichtingwerft

SCHLICHTINGWERFT

HEAD OFFICE:
Mecklenburger Landstrasse, Lubeck-Travemunde
MANAGING DIRECTOR:
Alnwick Harmstorf

Schlichtingwerft is constructing the prototype of a 160-ton hydrofoil patrol craft of Supramar design for the Federal German Navy (Bundesmarine). It is generally similar in construction to the proposed gas-turbine powered version of the PT 150.

Details of the gas-turbine version of the PT 150, a 300-seat passenger ferry for routes up to 250 nautical miles, were released by Supramar in 1963. To facilitate calls at smaller ports, the crossing of shallows, docking and slipping, the foils, rudders and propellers are retractable.

A combined surface piercing and submerging foil configuration is employed with two surface piercing foils forward and two submerged foils aft. Initially the gas turbine powered PT 150 was to be fitted with hydraulically-operated stability augmentation flaps on the front foils to give improved performance in a seaway, and the new Supramar air stabilisation system was to be fitted at a later stage.

The two 4,250 bhp Marine Proteus turbines are located aft, and each transmits power through a mechanical right-angle drive transmission to a propeller at the aft end of a strut-and-pod assembly. For manoeuvring in displacement condition there is an independent 200 hp gas-turbine with its own propeller.

Designed maximum speed of the craft was given as 48 knots, and the cruising speed 45 knots.

ITALY

Advance Marine Systems

ADVANCED MARINE SYSTEMS—ALINAVI S.p.A.

HEAD OFFICE:
Via Gramsci 24, Rome, Italy
TELEPHONE:
879 204
DIRECTORS:
Dr. Publio Magini (Boeing), President
Airo M. Gonnella (Boeing)
W. J. Kane (Boeing)
Brantz Mayor (Boeing)
Ing. Riccardo Baldini (Finmeccanica)
Ing. Giorgio Bettini (Finmeccanica)
Cav. del Lav. C. Rodriquez (Rodriquez)
EXECUTIVE:
Ing. Francesco Cao, Chief Engineer

This company was formed in 1964 to develop military and commercial advanced marine systems, primarily in Europe and the Mediterranean areas. Local manufacturing and marketing support will be given to technology from Boeing. At present the company's major activities are confined to the sale and production of military hydrofoil boats and research into hydrofoil design, and advanced marine propulsion systems. The company is jointly owned by The Boeing Company (60%), Finmeccanica (30%) and Carlo Rodriquez (10%).

Leopoldo Rodriquez

LEOPOLDO RODRIQUEZ SHIPYARD

HEAD OFFICE:
Molo Norimberga 24, Messina
TELEPHONE:
44801 (PBX)
TELEX:
98030 Rodrikez
DIRECTORS:
Cav Del Lavoro Carlo Rodriquez, President
Leopoldo Rodriquez
Franco Rodriquez
SENIOR EXECUTIVES:
Dott. Ing. Leopoldo Rodriquez, General Manager
Capt. Franco Rodriquez, Sales Director
Dott. Ing. Giovanni Faizea, Yard Director
Ing. Frederick Leobau, Design Office Director

The Leopoldo Rodriquez Shipyard was the first in the world to produce hydrofoils in series, and is now the biggest hydrofoil builder outside the Soviet Union. On the initiative of the company's president, Carlo Rodriquez, the Aliscafi Shipping Company was established in Sicily to operate the world's first scheduled seagoing hydrofoil service in August 1956 between Sicily and the Italian mainland.

The service was operated by the first Rodriquez-built Supramar PT 20, Freccia del Sole. Cutting down the port-to-port time from Messina to Reggio di Calabria to one-quarter of that of conventional ferry boats, and completing 22 daily crossings, the craft soon proved the commercial viability of Supramar designs. With a seating capacity of 75 passengers the PT 20 has carried between 800-900 passengers a day and has conveyed a record number of some 31,000 in a single month.

The prototype PT 20, a 27-ton craft for 75 passengers, was built by Rodriquez in 1955 and the first PT 50, a 63-ton craft for 140 passengers, was completed by the yard in 1958.

Since 1956 the company has built forty-three PT 20s and twenty-six PT 50s. Sales have been made to 21 countries. Under construction at the yard at the time of going to press are seven PT 20s, six PT 50s and one PT 150. Apart from building the standard range of Supramar designs (*see Supramar, Switzerland*) the company also produces a number of variants. These include the PAT 20 fast naval and police patrol craft, the PT 20 Caribe and PT 50/S, and mixed passenger/freight models of the latter craft, specially adapted for servicing offshore drilling platforms.

PAT 20

Two PAT 20 fast patrol hydrofoils, Camiguin 72 and Siquijor 73, have been built by Rodriquez for the Phillipine Navy. The craft carry one bow-mounted 12·7 machine gun and have been employed on contraband patrol and coastguard duties since June 1965. Their main patrol area is between the island of Mindanao and the NW coast of Borneo.

FOILS: Bow and rear foils are of surfacing piercing V configuration and identical to those of the standard PT 20. About 59% of the total weight is borne by the bow foil and 41% by the rear foil. The foils are of hollow ribbed construction and made from medium Asera steel.

Total foil area is 112 sq ft (10·4 m²). The angle of incidence of the forward foil can be varied during flight by means of a hydraulic ram acting on the foil strut supporting tube.

HULL: The hull is of riveted light alloy construction with Peraluman (aluminium and magnesium alloy) plates and Anticorrodal (aluminium, magnesium and silicon alloy) profiles.

ACCOMMODATION: The crew comprises a captain, two officers and eight NCO's and ratings. The pilot's position is on the left of the wheelhouse, with the principal instrumentation; and the radar operator sits on the right with the auxiliary instrumentation. The pilot is provided with an intercom system connecting him with the officer's cabin, engine room and crew cabin. The internal space has been divided as follows:

(a) The forward or bow room, subdivided into two cabins, one for the captain, the other for two officers, and including a WC with washstand and a storeroom with a refrigerator.
(b) The stern room, with eight berths for the NCOs and ratings, a WC with washstand and a galley equipped with a gas stove and an electric refrigerator.
(c) The deck room, aft of the wheelhouse, with tilting sofa and table for R/T equipment.

Air conditioning is installed in the captain's and officer's quarters.

POWER PLANT: Power is supplied by a supercharged 12-cylinder Mercedes-Benz MB820 Db with a max continuous output of 1,350 hp at 1,500 rpm. Engine output is transferred to a 3-bladed bronze aluminium propeller through a Zahnradfabrik BW 800/S reversible gear. Fuel (total capacity 2,800 kg) is carried in ten cylindrical aluminium tanks located in the double bottom beneath the bow room and the stern room. Dynamic and reserve oil tanks in the engine room give a total oil capacity of 120 kg. An auxiliary engine can be fitted in the stern for emergency operation.

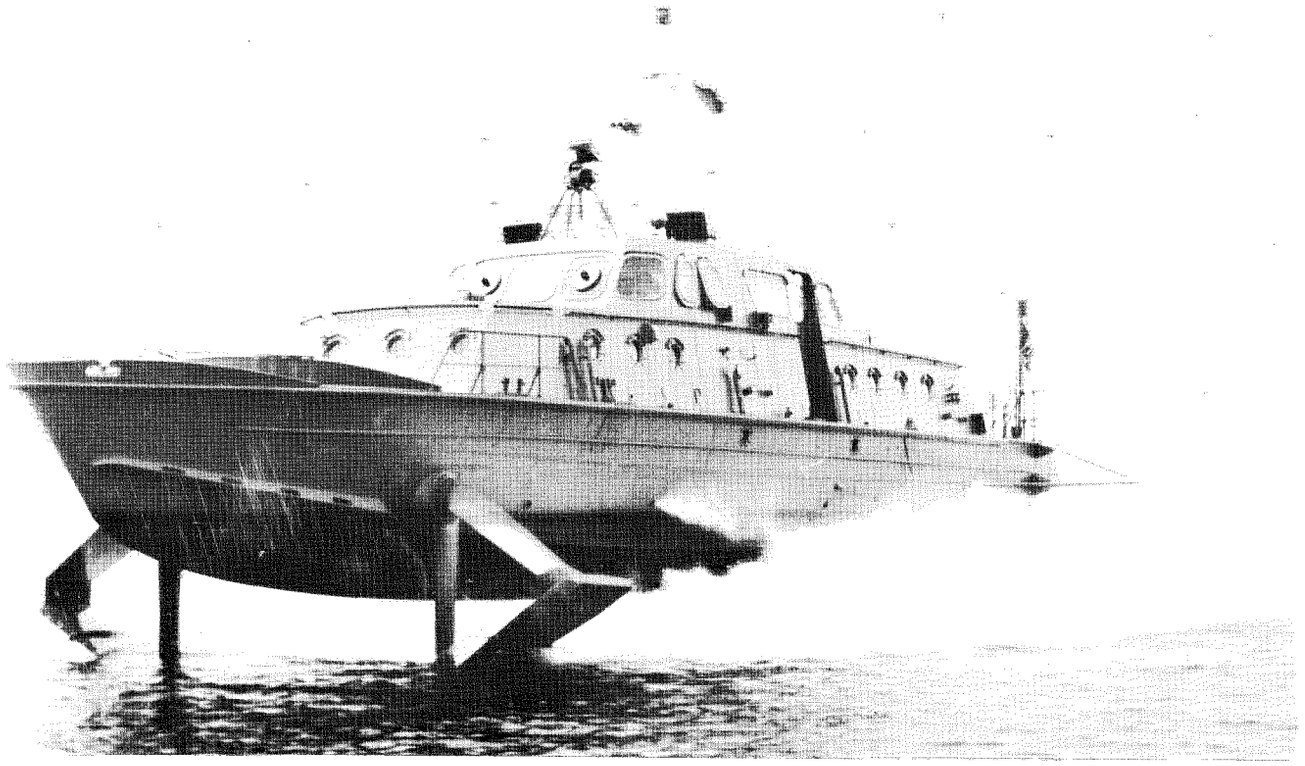
ARMAMENT AND SEARCH EQUIPMENT: Single 12·7 machine-gun mounted above well position in bow, and two searchlights.

SYSTEMS:

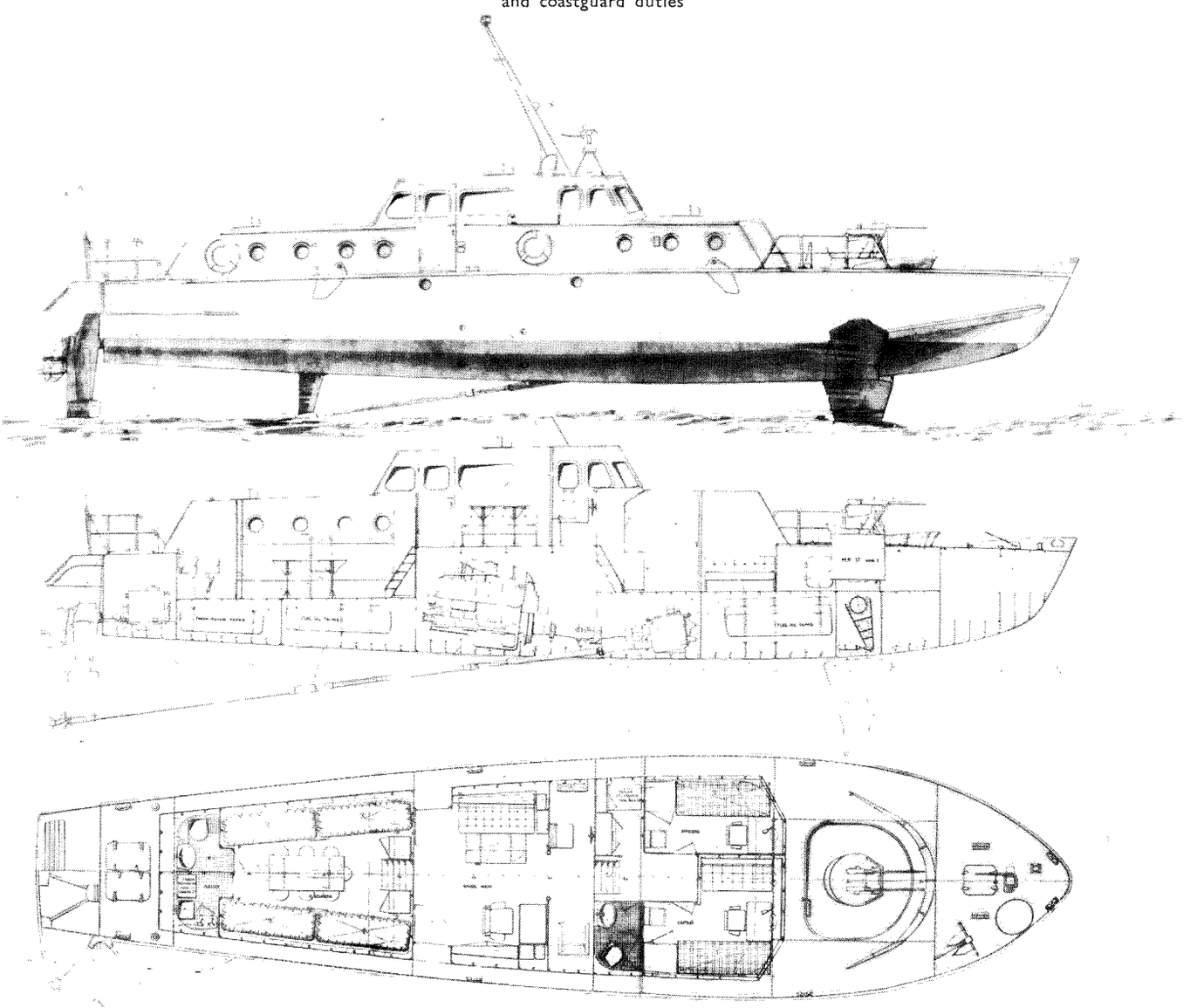
ELECTRICAL: 220v, 10 kW, diesel generator with batteries. Supplies instruments, radio and radar and external and internal lights, navigation lights and searchlights.

HYDRAULICS: 120 kp/cm² pressure hydraulic system for steering and varying forward foil incidence angle.

APU: Onan engine for air conditioning when requested.



A Rodriquez PAT 20 fast patrol hydrofoil during tests off Messina. Two of these craft are employed by the Philippine Navy on contraband patrol and coastguard duties



Rodriquez PAT 20

DIMENSIONS:

Length overall, hull	68 ft 6 in (20·89 m)
Hull beam	15 ft 8¾ in (4·79 m)
Beam overall	24 ft 4 in (7·4 m)
Draft afloat	9 ft 1 in (2·76 m)
Draft foilborne	4 ft 0 in (1·20 m)
Height overall:	
hullborne	21 ft 0 in (6·44 m)
foilborne	26 ft 3 in (8·00 m)

WEIGHTS:

Net tonnage	28 tons
Light displacement	26 tons
Max take-off displacement	32·5 tons
Useful load	7·6 tons
Max useful load	8·1 tons

PERFORMANCE:

Max speed foilborne	38 knots
Max speed hullborne	13 knots
Cruising speed foilborne	34 knots
Cruising speed hullborne	12 knots
Max permissible sea state foilborne mode	Force 4
Designed range at cruising speed	540 miles (869 km)
Number of seconds and distance to take-off	20 secs, 328 ft (100 m)
Number of seconds and distance to stop craft	12 secs, 164 ft (50 m)
Fuel consumption at cruising speed	145 kg/h
Fuel consumption at max speed	180 kg/h

PT 20/59 CARIBE

This version of the PT 20 was designed originally for services in tropical waters. The bridge and engine room have been arranged in the foreship to give maximum forward vision in areas where there is an influx of driftwood. Tropical conditions have also been taken into consideration in the design and installation of the powerplant.

FOILS: Bow and rear foils are of standard Schertel-Sachsenburg surface-piercing Vee configuration, with about 66% of the weight supported by the bowfoil and 34% by the rear foil. Submerged foil area when foilborne is 67 sq ft (6·2 m²). Each foil, together with its struts and horizontal girder forms a rigid framework which facilitates the exchange of the foil structure. The foils are of hollow-ribbed construction and fabricated from medium Asera type steel. The incidence angle of the forward foil can be adjusted hydraulically during operation to counter the effect of large variations in passenger loads.

HULL: The hull is of riveted light metal alloy and framed on a combination of longitudinal and transverse formers. Watertight compartments are provided in the bow and stern and beneath the passenger decks. Some are filled with foam plastic which makes these boats practically unsinkable.

POWER PLANT: The engine is a supercharged Mercedes-Benz MB 820 Db, with a maximum continuous output of 1,100 hp at 1,500 rpm. Engine output is transferred to a 3-bladed, 27·5 in (700 mm) diameter bronze aluminium propeller through a Zahnradfabrik BW 800 H reversible gearbox.

ACCOMMODATION: Fifty-one passengers can be accommodated in the main cabin and fifteen in the small forward cabin. Access to the forward and main compartment is through either of two doors, located port and starboard, to the rear of the wheelhouse superstructure. Steps from the forward compartment lead down to the main cabin. At the aft end of the main cabin is a WC and an emergency exit.

A mixed passenger/cargo version is available, with seats for 19 in a cabin immediately aft of the wheelhouse and a cargo deck in place of the main passenger cabin.

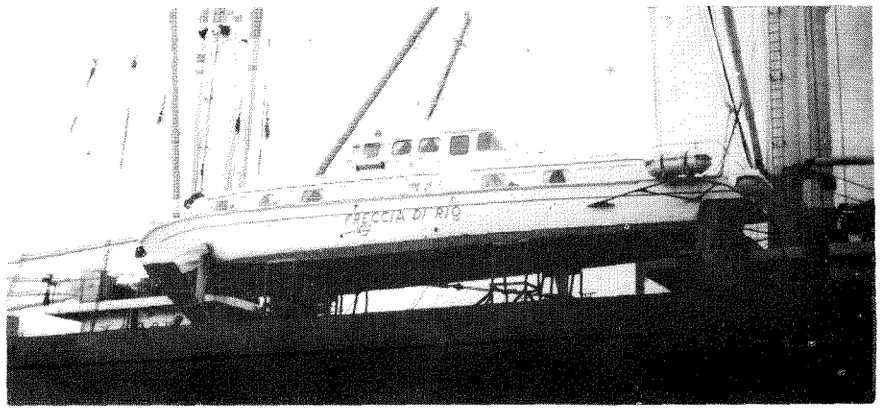
SYSTEMS:

ELECTRICAL: Single phase generator 220 volts, 7·1 kW, 50 c/s and batteries. Supplies instruments, radio, radar and internal and exterior lights.

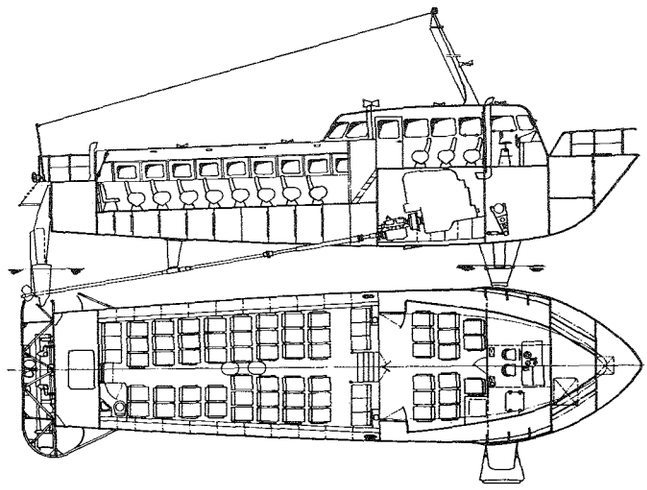
HYDRAULICS: 120 kp/cm² pressure hydraulic system for rudder and varying incidence angle of bow foil.

APU: Onan engine for air conditioning, when specified.

COMMUNICATIONS AND NAVIGATION:
Radio: VHF radio-telephone, to customer's requirements.
Radar: Decca, Raytheon, etc., to customer's requirements.



Freccia di Rio, a Rodriquez PT 20, en route to Rio de Janeiro. The craft is now operating the route Rio-Niteroi-Rio-Itila Grande. Forty-three PT 20s have been built by Rodriquez since 1956



Inboard profile and plan of the Rodriquez PT 20 Caribe

DIMENSIONS:

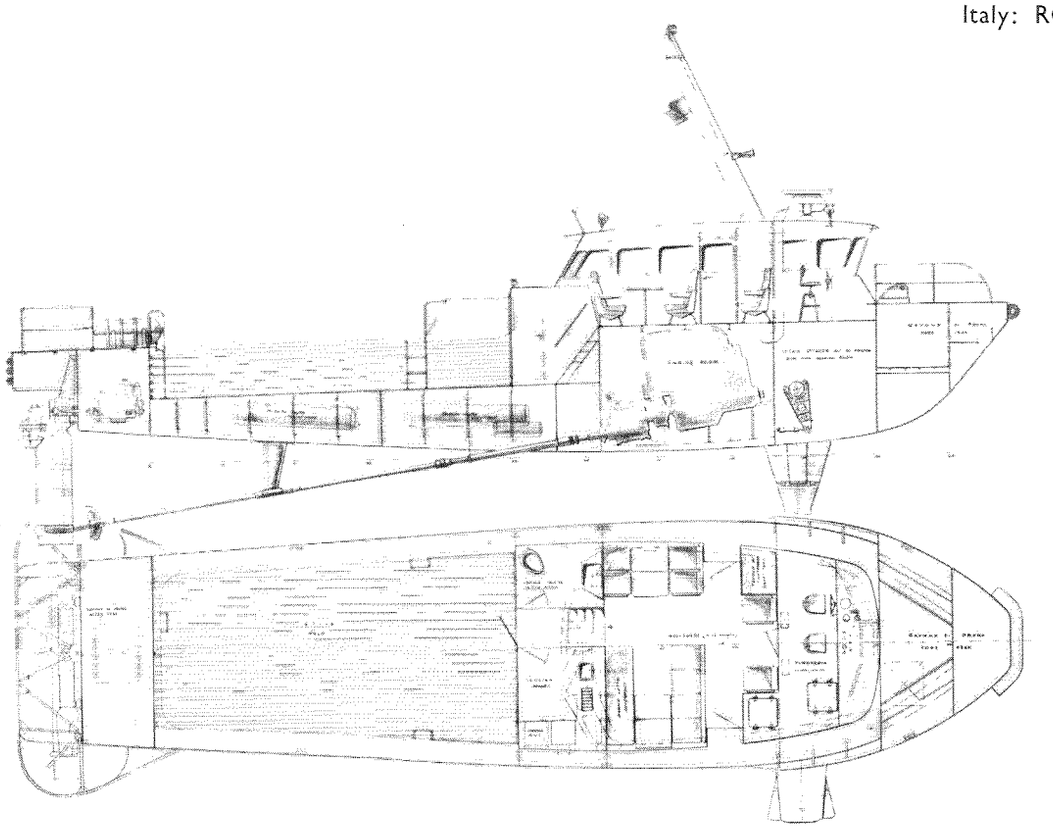
Length overall, hull	64 ft 0 in (19·5 m)
Hull beam	16 ft 7 in (5·06 m)
Width over foils	24 ft 2 in (7·38 m)
Draft afloat	9 ft 1 in (2·77 m)
Draft foilborne	3 ft 10 in (1·16 m)
Height overall, hullborne	20 ft 4 in (6·18 m)
Height overall, foilborne	27 ft 11 in (8·5 m)

WEIGHTS:

Net tonnage	43·31 tons
Light displacement	25·8 tons
Normal take-off displacement	33 tons
Max take-off displacement	33·5 tons
Useful load (fuel, water, passengers, baggage and crew)	7·2 tons
Max useful load	7·7 tons

PERFORMANCE (with normal payload):

Max speed, foilborne	34·5 knots
Max speed, hullborne	12 knots
Cruising speed, foilborne	31 knots
Cruising speed, hullborne	11 knots
Max permissable sea state in foilborne mode	State 5
Designed range at cruising speed	250 n miles
Fuel consumption at max speed	396 lb/h (180 kg/h)
Fuel consumption at cruising speed	320 lb/h (145 kg/h)



Rodriquez PT 20/59 hydroil

PT 20/59 HYDROIL

The first of the new series of PT 20/59 Hydroil offshore drilling platform supply vessels is being built for ENI Oil Corporation, which will employ the craft in the Adriatic. A mixed passenger/cargo version of the PT 20/59 Caribe passenger ferry, the Hydroil variant has an open cargo deck aft of the bridge superstructure in place of the Caribe's main passenger cabin. Dimensions of the cargo deck are: length, 24 ft 7 in (7·50 m); width, 11 ft 6 in (3·50 m) and height, 3 ft 5 in (1·05 m).

FOILS: Bow and rear foils are of standard Schertel-Sachsenburg surface piercing Vee configuration, with about 66% of the weight supported by the bow foil and 34% by the rear foil. Each foil, together with its struts and horizontal supporting tube, forms a rigid framework which facilitates the exchange of the foil structure. The foils are of hollow-ribbed construction and fabricated from medium Asera steel. The forward foil can be tilted within narrow limits by means of a hydraulic ram acting on the foil strut supporting tube. The angle of attack can therefore be adjusted during operation to assist take-off and counteract the effect of large variations in loading.

HULL: The hull is of riveted light metal alloy (Peraluman) and framed on a combination of longitudinal and transverse formers. Watertight compartments are provided in the bow and stern, and a double-bottom runs from immediately aft of the engine room, beneath the full length of the cargo deck, to the after peak. Contained within the double-bottom are six cylindrical aluminium fuel tanks with a total capacity of 495 gallons (2,250 litres). Access to the fore and aft compartments is via removable deck hatches. The deck is of 0·196 in (5 mm) Peraluman, suitably reinforced to withstand heavily concentrated loads. Two 4·9 in (125 mm) diameter scuppers are provided aft for rapid drainage. Heavy rubber fenders are provided at the bow and stern.

POWER PLANT: Power is supplied by a 12-cylinder supercharged MB 820 Db with a maximum output of 1,350 hp at 1,500 rpm. Engine output is transferred to a 3-bladed 27·5 in (700 mm) bronze-aluminium propeller through a Zahnradfabrik BW 800 H20 gearbox. The propeller shaft is 3·5 in (90 mm) in diameter, and supported at three points by seawater lubricated rubber bearings. In an emergency, hullborne propulsion is provided by a 105 hp Mercedes OM 352 diesel with a Mercruiser Z-drive. The engine is installed in the aft peak and propels the craft at about 5 knots.

ACCOMMODATION: The PT 20/59 has a crew of two, and seats up to 12 passengers in a comfortably appointed saloon, immediately aft of the wheelhouse. Passengers have a choice of six armchairs and two three-place settees, one of which converts into a bed for transporting sick or injured personnel. All seats are equipped with safety belts. Aft of the saloon is a fully equipped galley, with refrigerator, a gas cooker with two gas rings, cupboards, plate rack and sink unit. Two folding wooden tables permit up to eight passengers to take meals at one sitting. A toilet/washbasin unit is provided opposite the galley on the port side. The engine room, wheelhouse and passenger saloon are fully heated and ventilated. A full range of safety equipment is carried including inflatable rafts and lifebelts for each passenger and crew member.

SYSTEMS: Electrical: 220 volt 50 H2 three-phase a.c., 24 volt dc; provision for 220 volt 50 H2 three phase shore supply. The dc supply is from a 24 volt generator driven by the main engine and feeding a 235 Ah battery. AC supply is derived from a four-stroke Onan diesel generator set, located in the engine room.

HYDRAULICS: One Bosch Hy/ZFR 1/16 AR 101 for steering and bow foil incidence control.

COMMUNICATIONS AND NAVIGATION: Radio; VHF radio-telephone to customers' requirements.

Radar: Decca, Raytheon etc., to customers' requirements.

DIMENSIONS:

Length overall, hull	68 ft 9 in (20·95 m)
Hull beam	16 ft 7 in (5·06 m)
Width over foils	24 ft 3 in (7·40 m)
Draft afloat	8 ft 10 in (2·70 m)
Draft foilborne	3 ft 9 in (1·14 m)

WEIGHTS:

Max take-off displacement	33·12 tons
Max load on open cargo deck	3 tons

PERFORMANCE (with normal payload)

Cruising speed	32 knots
Range	300 miles (480 km)

PT 50/S HYDROIL

Latest in the Rodriquez Hydroil range is a mixed passenger/cargo version of the 64-ton PT 50/S. As with the smaller PT 20/59 Hydroil, the main passenger saloon is replaced by a large open cargo deck for loads up to 6 tons. The deck is 31 ft 2 in (9·5 m) long, 15 ft 9 in (4·8 m) wide and 6 ft 4 in (1·9 m) high.

The craft will carry a crew of two and up to 14 passengers. Power will be supplied by two 12-cylinder supercharged MB 820 Dbs, with a maximum output of 1,350 hp.

DIMENSIONS:

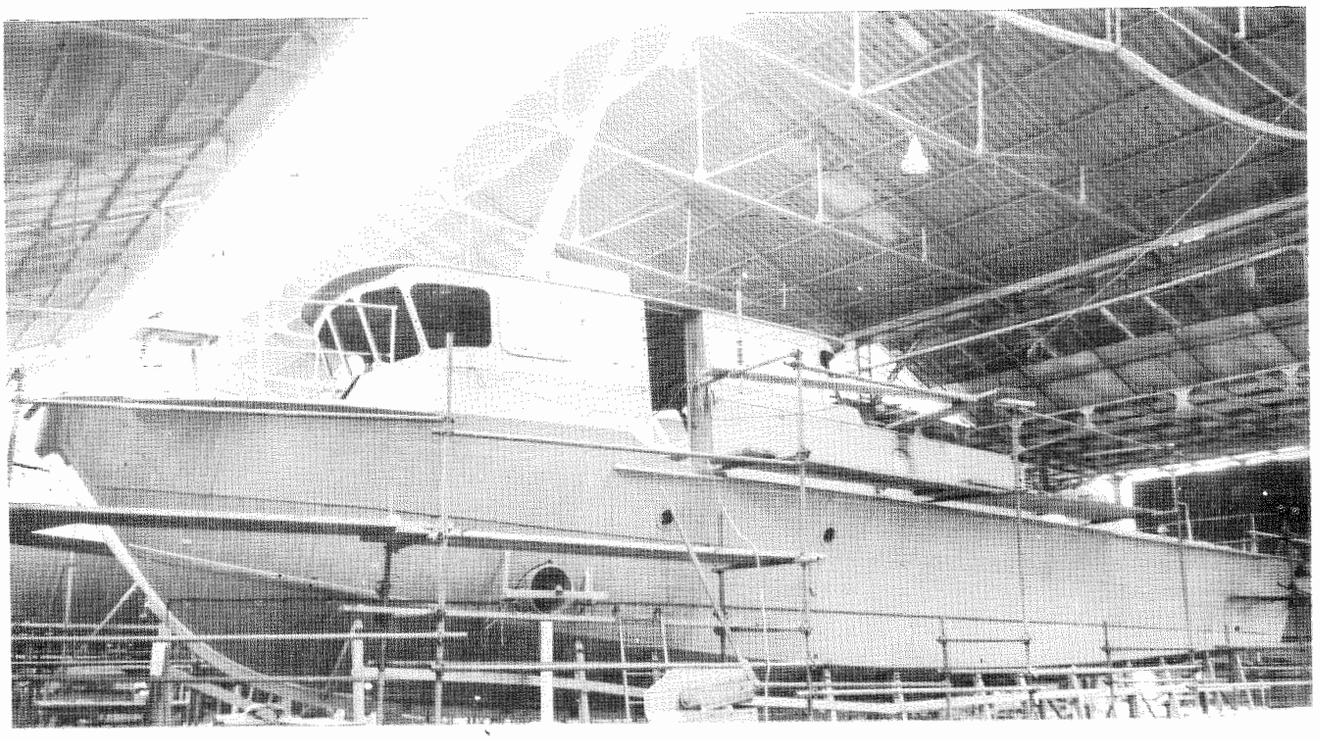
Length overall, hull	93 ft 6 in (28·50 m)
Hull beam	20 ft 0 in (6·10 m)
Width over foils	35 ft 2 in (10·72 m)
Draft hullborne	11 ft 6 in (3·50 m)
Draft foilborne	4 ft 11 in (1·50 m)

WEIGHTS

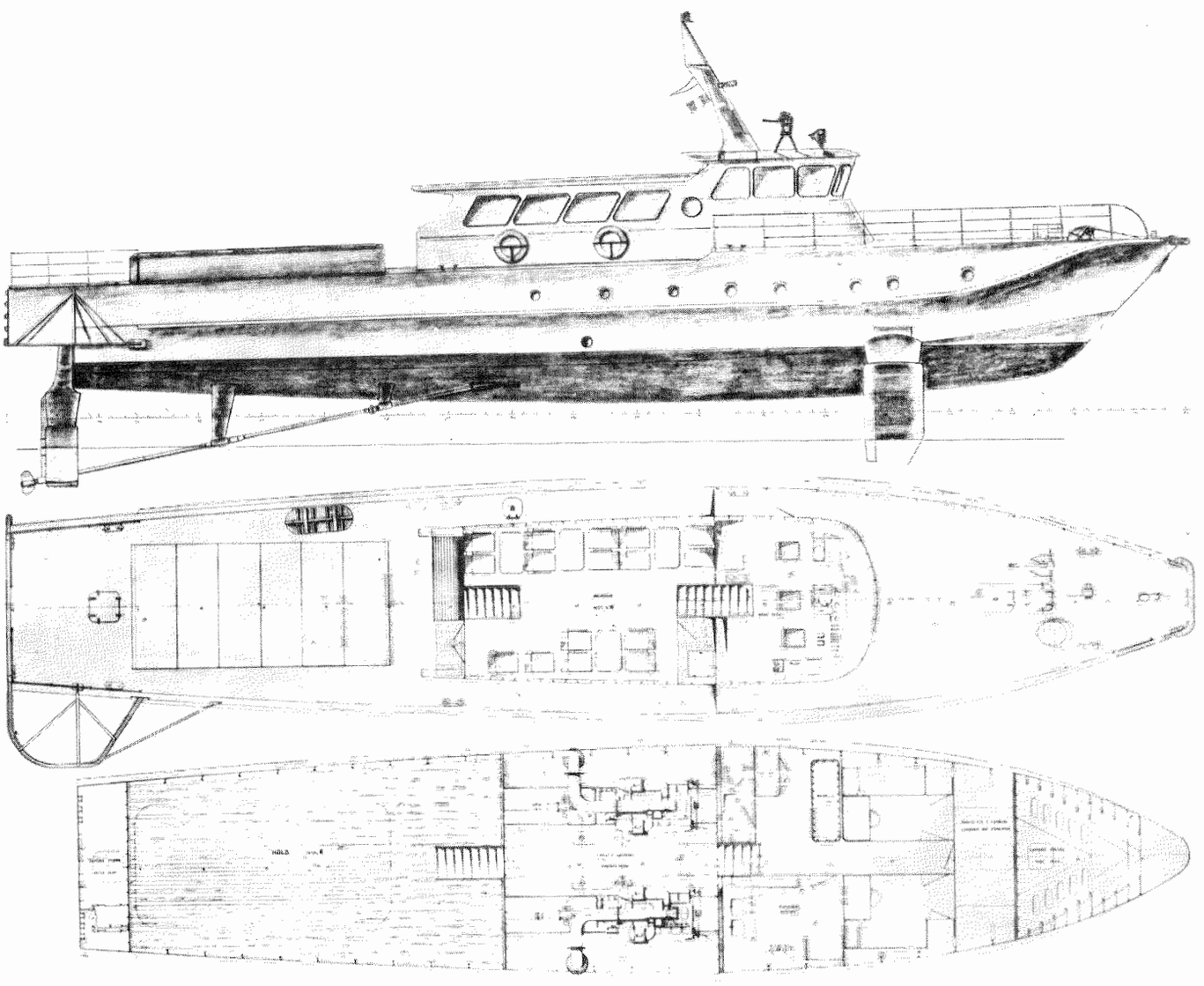
Normal take-off displacement	64 tons

PERFORMANCE

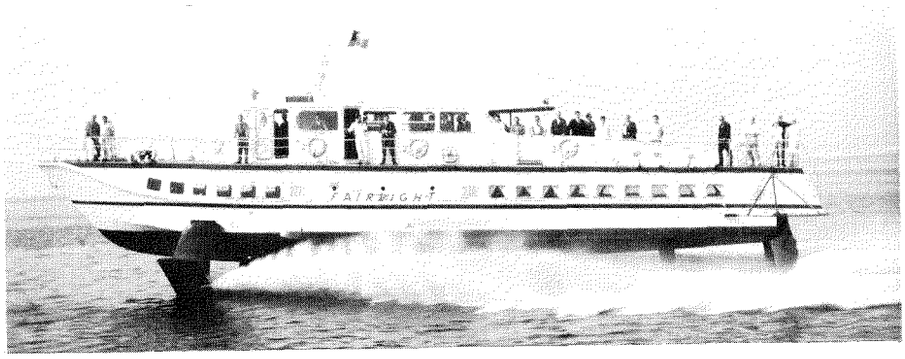
Cruising speed	32-34 knots
Range at cruising speed	300 miles (480 km)



The first PT 20/59 Hydroil under construction at the Rodriquez shipyard, Messina. The craft will be employed by ENI Corporation to service offshore drilling platforms in the Adriatic



Rodriquez PT 50 hydroil



Fairlight, a Rodriquez-built 125-seat PT 50/S operated across Sydney bay, Australia, by the Port Jackson and Manly Steamship Company, Sydney

PT 50/S

The PT 50/S differs from the standard PT 50 in having the bridge arranged in the foreship. Immediately aft of the wheelhouse is a belvedere (viewing) saloon with seats for 14 and a bar. Companies operating this particular variant include the Port Jackson and Manley Steamship Co of Sydney, Australia, and the Hong Kong-Macao Hydrofoil Co.

FOILS: Bow and rear foils are of surface-piercing vee configuration identical to those of the standard design. About 60% of the total weight is borne by the bow foil and 40% by the rear foil. Hydraulically-operated flaps are fitted at the trailing edge of the bow foil to balance out longitudinal load shifting, assist take-off and adjust the flying height.

HULL: This is of riveted light alloy construction and framed on a combination of longitudinal and transverse formers.

ACCOMMODATION: The PT 50/S carries a crew of 6 and 125 passengers. The main compartment, aft, seats 65, the forward compartment seats 46, and the belvedere saloon, located above the engine, seats 14. Either a dry ice or electric refrigerator of about 150 litre capacity can be fitted in the bar, together with a stainless steel wash basin served with running water. Both the forward and aft saloons have a WC/washbasin unit. Access to the passenger saloons is through either of two doors on the main deck, port and starboard. Separate doors, on either side of the wheelhouse, are provided for the pilot and crew.

POWER PLANT: Power is supplied by two 12-cylinder supercharged MB 820 Dbs, with a maximum output of 1,350 hp at 1,500 rpm. Reverse and reduction gears are manufactured by Zahnradfabrik. The reverse clutches are solenoid operated from the bridge.

SYSTEMS:

AIR CONDITIONING: Genefrigor Genoa, where requested.

ELECTRICAL: Air cooled MWM type AKD412E or similar diesel driving a single phase generator of 220 volts, with batteries. Supplies instruments, radio and radar and external and internal lights.

HYDRAULICS: System to operate rudder and flaps on bow foil, 120 kp/cm².

DIMENSIONS:

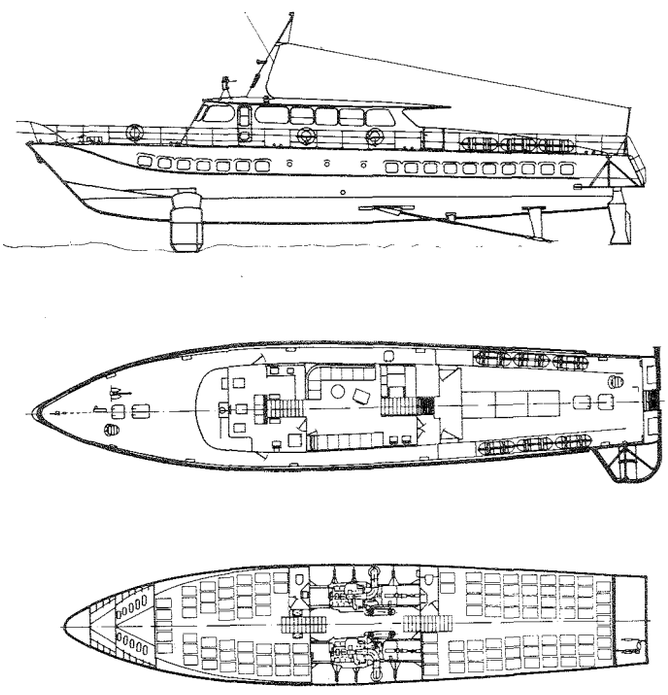
Length overall, hull	95 ft 2 in (29 m)
Length waterline, hull	80 ft 1 in (24·8 m)
Hull beam	20 ft 1 in (6·1 m)
Width over foils	33 ft 6 in (10·2 m)
Draft afloat	11 ft 6 in (3·5 m)
Draft foilborne	4 ft 11 in (1·5 m)
Height overall, hullborne	29 ft 7 in (9 m)
Height overall, foilborne	36 ft 2 in (11 m)

WEIGHTS:

Net tonnage	82 tons
Light displacement (with fuel, oil and water)	51·5 tons
Max take-off displacement	64·5 tons
Useful load (fuel, water, passengers, baggage and crew)	13·5 tons
Max useful load	14 tons

PERFORMANCE (with normal payload):

Max speed foilborne	37 knots
Max speed hullborne	18 knots
Cruising speed foilborne	34 knots
Max permissible sea state in foilborne mode	State 6
Designed range at cruising speed	250 n. miles
Number of seconds and distance to take-off (theor app)	25 secs, 164 yd (150 m)
Number of seconds and distance to stop craft	18 secs, 88 yd (80 m)
Fuel consumption at max speed	360 kg/h
Fuel consumption at cruising speed	330 kg/h



Rodriquez PT 50/S

Seaflight

SEAFLIGHT SpA Cantiere Navale

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Dott Ing Emanuele Midolo, Chief Designer

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The Seaflight series of hydrofoils use a variable-incidence foil system introduced by Giuseppe Giuffrida who formed this company in 1961. The company is backed by a group of Messina industrialists and currently employs a staff of about sixty.

Construction of the company's yard on the beach at Torre Faro, began in 1962, and the Seaflight P 46 prototype, the C 44, was launched in January 1965. The company has since built eight 30 seat P 46s and six H 57s, the latter being a larger and more powerful development of the P 46, seating 60 passengers. Under construction at the yard at the time of going to press is a second production batch of six H 57s and the prototype L 90, a 55-ton ferry seating up to 126 passengers. The company is at present conducting studies aimed at the further development of the Seaflight variable-incidence foil system and the design of a gas-turbine powered waterjet propulsion system for commercial hydrofoils.

SEAFLIGHT P 46

The Seaflight P 46, a 12-ton boat for 30 passengers, is designed for coastal and inter-island ferry services. The prototype, designated C 44, was completed at the Company's shipyard at Torre Faro, in January 1964 and a total of eight craft of this type have been built to date. Operators include ENIT, the Italian Government Tourist Organisation, who during the summers of 1967-8 chartered two of the craft for long-distance cruise routes around the Western Mediterranean, and the Hamburg municipality which operates two as passenger ferries.

FOILS: Foils are of standard Seaflight surface-piercing type arranged in aeroplane or conventional configuration. The bow foil is split and has a horizontal submerged centre section. About 63% of the load is supported by the bow foil and the remaining 37% by the rear foil.

A mechanically-operated system of incidence control is fitted to the bow foil so that it automatically assumes the best angle of incidence in relation to the water flow. Each half of the split bow foil is attached to a shaft which runs in an athwartships direction. By pivotting the foil assemblies around the axes of the two shafts, the angles of attack can be changed. The lift and drag generated by the foils tends to rotate them backwards, but this movement is opposed by a spring attached to an arm on the foil assembly shaft. The system is designed to produce the same amount of lift at any time, whether the speed varies or the foils' submerged surface varies in a wave crest or cavity.

The foils are of hollow, ribbed construction and fabricated in ERSC high tensile steel. Two shear points are provided which will give way in the event of violent impacts. The rudder is built in high tensile steel and is hydraulically operated.

HULL: The hull is of riveted light alloy construction; Anticorodal sections and Peraluman sheet and plate are used throughout. Watertight compartments in the forepeak, afterpeak and the double bottom are filled with expanded polystyrene to make the craft practically unsinkable.

ACCOMMODATION: The P 46 carries a crew of three, captain, engineer and seaman, and thirty passengers. The captain and engineer are seated in a raised wheelhouse in the foreship. Access is through two 2 ft 8 in (80 cm) wide doors in the centre of the superstructure. There is an emergency exit at the aft end of the passenger saloon. WC and washbasin units are located in the bow, together with closets for the crew.

POWER PLANT: Power is provided by two Cummins VT8-370-M diesels, each developing 370 bhp at 3,000 rpm. Output is transferred to two three-blade subcavitating high tensile bronze propellers through Capitol hydraulic reversing gears and inclined shafts. Propeller diameter is 1 ft 7 in (480 mm). Fuel is carried in two fuel tanks in the after peak with a total capacity of 176 gallons (800 litres).

SYSTEMS: Two generators driven by the main engines and two battery sets provide 24 volts for engine starting, instruments, lighting, etc.

DIMENSIONS, EXTERNAL:

Length overall	45 ft 11 in (14·00 m)
Length waterline (hull)	41 ft 2⅞ in (12·58 m)
Draft afloat	5 ft 10⅞ in (1·80 m)
Draft foilborne	2 ft 7½ in (0·8 m)
Hull beam	10 ft 6⅜ in (3·21 m)
Beam overall	18 ft 0½ in (5·50 m)
Freeboard	3 ft 3⅜ in (1·00 m)
Height overall	13 ft 3⅞ in (4·60 m)

DIMENSIONS, INTERNAL (incl wheelhouse and toilet):

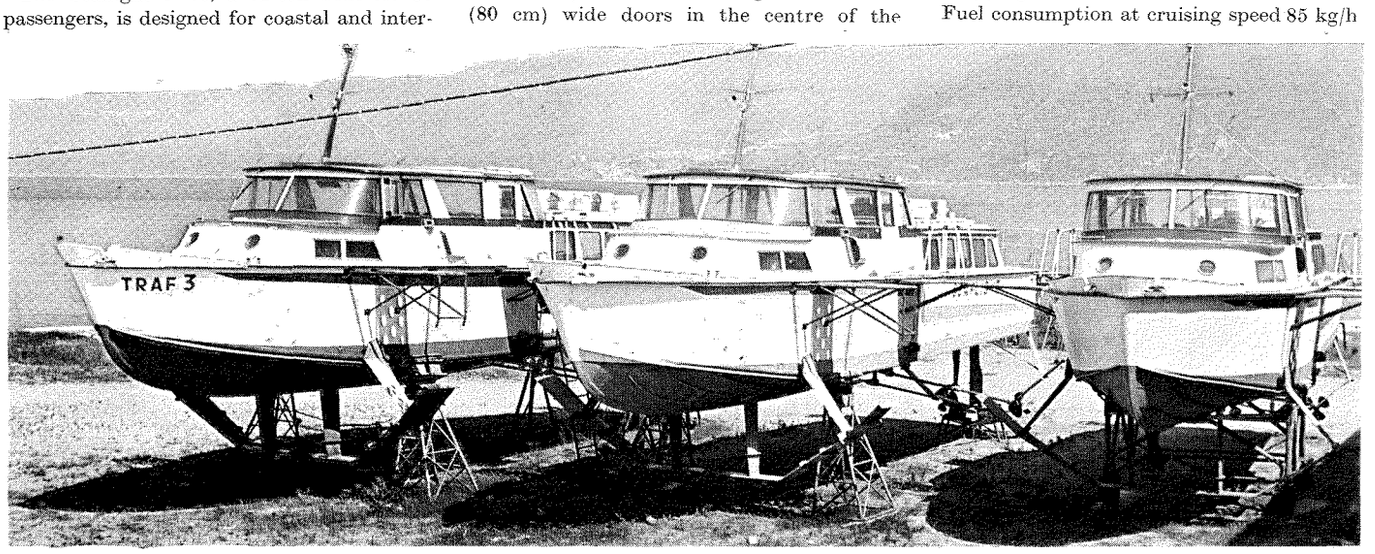
Length	32 ft 5¾ in (9·90 m)
Max width	8 ft 10¼ in (2·70 m)
Max height	6 ft 4¾ in (1·95 m)
Floor ares	285 sq ft (24 m²)
Volume	1,553 cu ft (44 m³)

WEIGHTS:

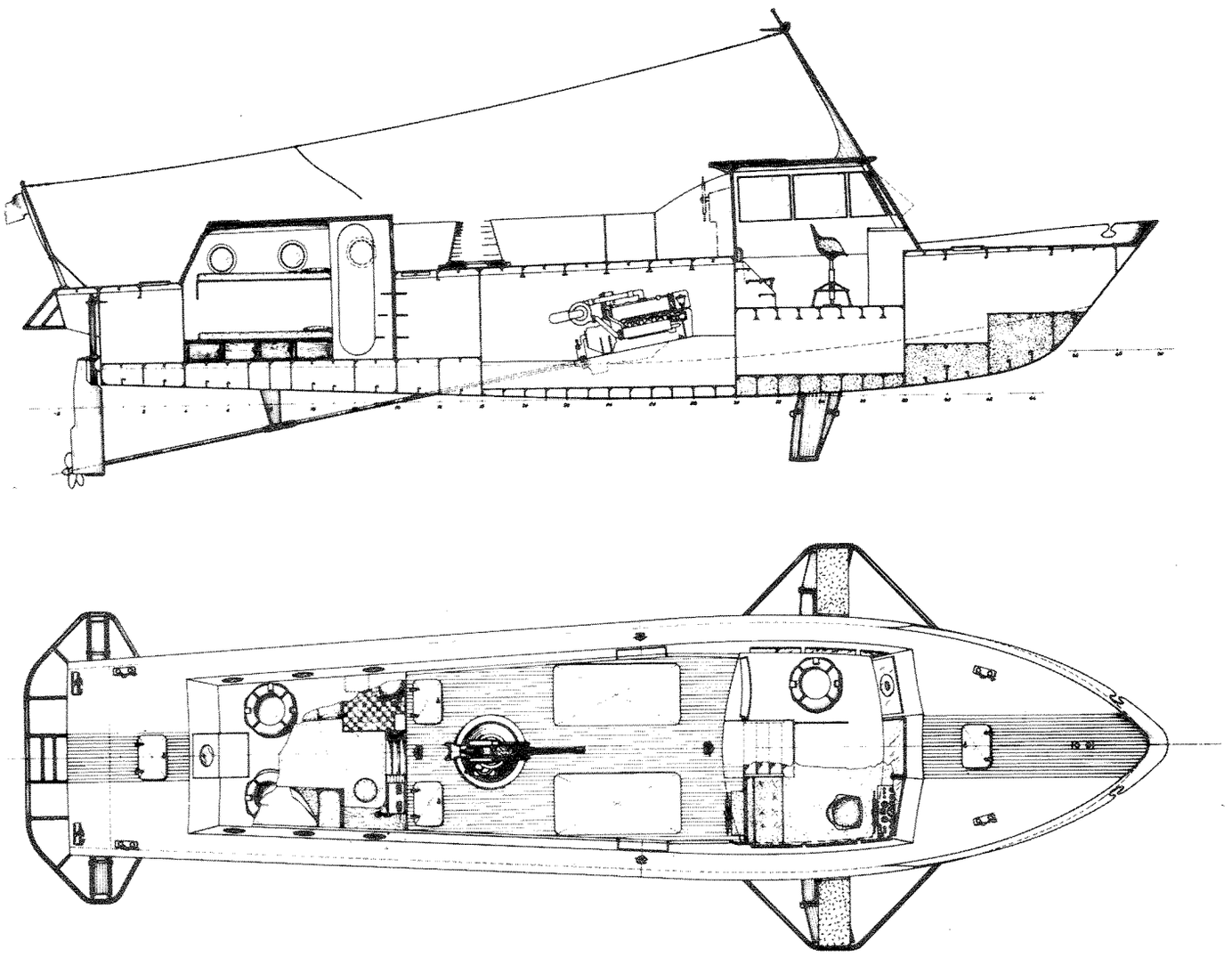
Light displacement	9·17 tons
Max take-off displacement	12·5 tons
Deadweight (incl fuel, water, passengers, crew)	3·3 tons
Payload	2·25 tons

PERFORMANCE:

Max speed foilborne	38 knots (70 km/h)
Cruising speed, foilborne	34 knots (63 km/h)
Max wave height in foilborne mode	2 ft 4 in (0·70 m)
Range at cruising speed	310 miles (500 km)
Turning radius at cruising speed	328 ft (100 m)
Take-off distance	393 ft (120 m)
Take-off time	25 sec
Stopping distance	164 ft (50 m)
Stopping time	8 sec
Fuel consumption at cruising speed	85 kg/h



Seaflight P46 (two Cummins VT8N-370-M) is available as a 30-32 seat passenger ferry, luxury yacht or fast coastal patrol boat. A mechanically operated system of incidence control is fitted to the bow foil



Inboard profile and deck plan, Seaflight M 16

SEAFLIGHT M 16

Derived from the P 46, the M 16 is a design for a fast military or police patrol vessel for use in sheltered waters. The hull has been lengthened by about 4 ft 11 in (1·5 m) to improve the performance in choppy seas, and the maximum speed is increased as a result of the reduction in deadweight.

FOILS: System is identical to that employed on the P 46.

ARMAMENT: The hull is basically that of the P 46, with a revised wheelhouse superstructure and deck arrangements. On the deck aft of the wheelhouse is a hand-operated machine-gun on a fixed mounting. Ammunition and portable weapons for the crew are stored close by in a small armoury. Estimated total weight of arms and ammunition is 600 kg, but this can be varied according to the radius of the patrol.

ACCOMMODATION: The number of crew members required will depend on the role for which the craft is employed. There is a saloon/cabin in the stern with two bunks and a toilet, and two more bunks can be fitted in the forecastle above the peak. There are two piloting stations. One is in the fully enclosed wheelhouse, and the other is located externally on the deck near the machine-gun mounting.

POWER PLANT: Power is provided by two Cummins VT8N-370-M marinised turbocharged diesels, each rated at 270 hp at 2,600 rpm continuous. Each engine is coupled directly to a Capitol reduction and reversing gearbox which transmits power through an inclined steel shaft to a three-blade, high-tensile bronze propeller. On the deck above the engine room are two hatches for the rapid removal and maintenance or replacement of the two engines.

SYSTEMS:

ELECTRICAL: Two 24 volt generators driven by the main engines and two battery sets, giving 24 volts for engine starting, instruments, lighting, radio, etc.

DIMENSIONS:

Length overall, hull	52 ft 6 in (16·00 m)
Length waterline, hull	44 ft 5¼ in (13·54 m)
Draft afloat	5 ft 10 in (1·78 m)
Draft foilborne	2 ft 7 in (0·78 m)
Hull beam	10 ft 6⅜ in (3·21 m)
Beam overall	18 ft 0½ in (5·50 m)
Freeboard	3 ft 6⅛ in (1·07 m)
Height overall	14 ft 9⅛ in (4·50 m)

WEIGHTS:

Light displacement	9·5 tons
Take-off displacement	11·6 tons
Deadweight (incl fuel, water, armament, crew)	2·1 tons

PERFORMANCE:

Max speed foilborne	39 knots (72 km/h)
Cruising speed	34 knots (63 km/h)
Max wave height in foilborne mode	2 ft 3⅝ in (0·70 m)
Range at cruising speed	373 miles (600 km)

Seaflight H57 operators include two Italian companies, Tourist Ferryboat Co and Lauro Navigation Co. and one in the United Kingdom—Red Funnel Steamers of Southampton

SEAFLIGHT H 57

This is a larger and more powerful development of the P 46 passenger ferry and seats 60 passengers. Work on the prototype started in November 1965, the craft was completed in August 1966, and trials ended in August 1967.

The craft has been approved by Registro Italiano Navale, Germanischer Lloyd and the Board of Trade.

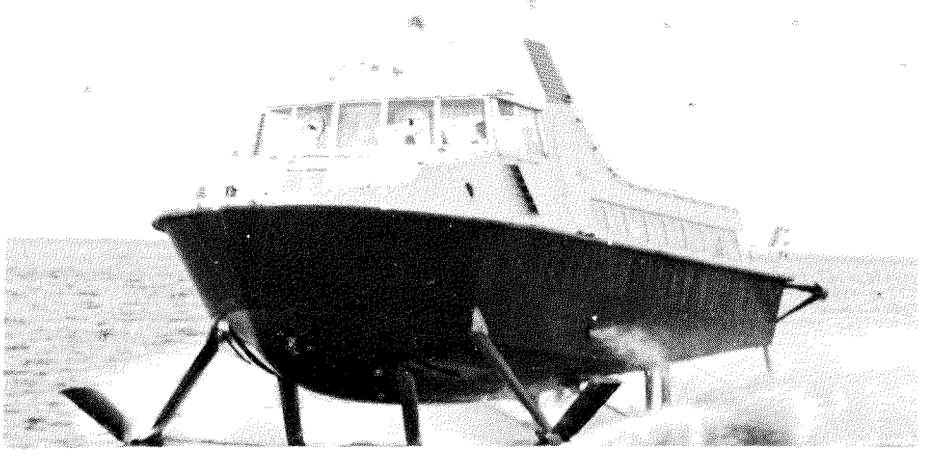
Six H 57s had been built by June 1968, and the company is now at work on a second production batch of six. H 57 operators include the Tourist Ferryboat Company, which operates one craft year-round on a high frequency passenger ferry service between Messina and Reggio Calabria; Lauro Navigation Co, with two employed on the routes Naples-Ischia, Naples-Capri, and Red Funnel, with one operating between Southampton and Cowes, Isle of Wight. The latter is the first hydrofoil to be employed on a scheduled passenger service in the United Kingdom.

FOILS: Foils are of standard Seaflight type, arranged in aeroplane configuration. The bow foil is split and has a horizontal submerged centre section. About 60% of the load is supported by the bow foil and the remaining 40% by the rear foil.

The mechanically operated system of incidence control on the bow foil is the same as that employed on the P 46. The foils are of machined, hollow-ribbed construction and fabricated in ERSC high tensile steel. Two shear points are provided which will give way in the event of violent impacts. The rudder is in high tensile steel and is hydraulically operated.

HULL: The hull is of riveted light alloy construction with transverse frames. Frame spacing is approximately 1 ft 0 in (300 m).

Anticorrodal Al-Mg-Si sections and Peraluman Al-Mg sheet and plate are used throughout. Keel sections are in 5 mm plate; the bottom is in 4 mm plate, the sides are in 3 mm plate, and the thickness of the deck plating is from 3 mm to 5 mm. The stem is built in steel. Protection against chemical and galvanic action is provided by three coats of epoxy resin paint and a zinc anodes undercoating. The hull is designed for two-compartment subdivision, i.e. it will remain afloat with any two adjacent compartments flooded. Watertight compartments in the forepeak, afterpeak and double bottom are filled with polystyrene foam.



Seaflight H57

ACCOMMODATION: The standard version accommodates a crew of 3-4 and 60 passengers. The main passenger saloon seats 54 in armchairs of modern design, arranged airliner-style three abreast with a longitudinal centre aisle. A further six seats, of folding type, are arranged at the aft end of the wheelhouse/observation deck by the entrance doors.

The pilot's position is on the starboard side of the wheelhouse with an instrument panel and all controls within easy reach. On the port side is the second crew member's position, together with radio communications equipment, a public announcement and taped music system.

The wheelhouse area is separated from the passenger area by aluminium luggage racks. Forward of the wheelhouse is a service area, with a large toilet/washroom unit for passengers, and a rest room with a settee and table for the crew.

Passenger access is through two doors, each 2 ft 7 in (80 cm) wide, one each side of the wheelhouse/belvedere deck. A third door, also 2 ft 7 in (80 cm) wide is provided aft in the main saloon, providing access or exit in an emergency.

POWER PLANT: Motive power is provided by two Fiat-Carraro V12SS water-cooled, supercharged 12-cylinder diesels, each with a normal service output of 650 hp at 1,500 rpm. Each engine drives via an AIFO hydraulically operated, directly coupled, reverse gear, its own inclined shaft. The shafts are of hardened tempered steel, and the propellers, which are of four-bladed, sub-cavitating design, are in high tensile NIBRAL bronze.

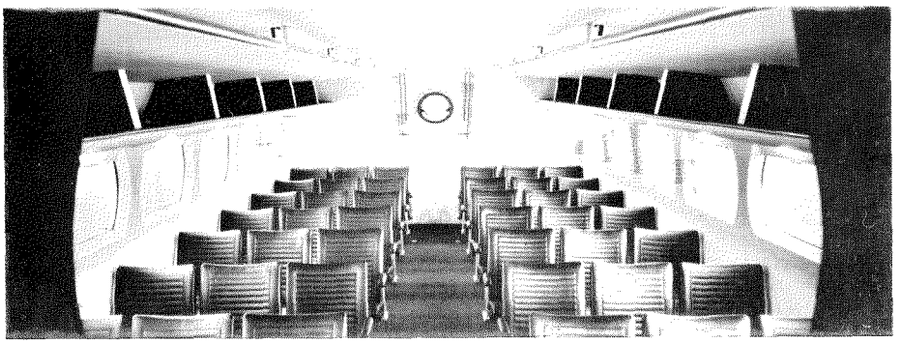
Fuel is carried in five cylindrical welded aluminium tanks, located in the after double bottom. Total capacity is 330 gallons (1,500 litres), providing a range in excess of 270 nautical miles (500 km).

SYSTEMS:
ELECTRICAL: Two 1 kW generators fitted to the main engine, and connected to two sets of batteries of 310 Ah each, provide a 24 volt supply for engine starting, instruments, lighting, etc.

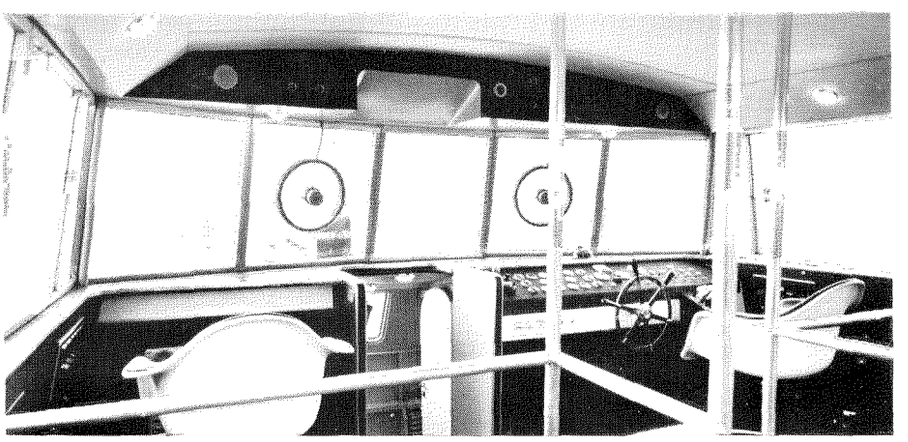
COMMUNICATIONS AND NAVIGATION: Radio and radar to customer's requirements.

DIMENSIONS:

Length overall	61 ft 0 in (18·60 m)
Length waterline, hull	50 ft 11½ in (15·52 m)
Draft afloat	8 ft 6⅜ in (2·60 m)
Draft foilborne	3 ft 8½ in (1·13 m)
Hull beam	15 ft 4¼ in (4·68 m)
Width over foils	26 ft 3 in (8·00 m)
Freeboard	4 ft 1⅜ in (1·26 m)
Height overall	22 ft 7⅜ in (6·9 m)



Seaflight H 57, showing a typical interior arrangement



Seaflight H 57 wheelhouse.

DIMENSIONS, INTERNAL:

Main passenger compartment:	
Length	24 ft 7¼ in (7.50 m)
Max width	12 ft 9½ in (3·90 m)
Max height	6 ft 4¾ in (1·95 m)
Floor area	310 sq ft (28 m²)
Volume	1,906 cu ft (54 m³)
Wheelhouse, including belvedere:	
Length	13 ft 9⅜ in (4·20 m)
Max width	12 ft 9½ in (3·90 m)
Max height	6 ft 4¾ in (1·95 m)
Floor area	182 sq ft (16 m²)
Volume	1,059 cu ft (30 m³)
Forward compartment (toilet and cabin):	
Length	7 ft 10½ in (2·40 m)
Max width	13 ft 5⅜ in (4·00 m)
Max height	6 ft 4¾ in (1·95 m)
Floor area	97 sq ft (9 m²)
Volume	565 cu ft (16 m³)

WEIGHTS:

Light displacement	20·65 tons
Max take-off displacement	27·3 tons
Deadweight (incl fuel, water, passengers, crew)	6·65 tons
Payload	4·5 tons

PERFORMANCE:

Cruising speed, foilborne	34 knots (63 km/h)
Max wave height in foilborne mode	5 ft 0 in (1·52 m)
Range at cruising speed	311 miles (500 km)
Turning radius at cruising speed	392 ft (120 m)
Take-off distance	427 ft (130 m)
Take-off time	25 seconds
Stopping distance	213 ft (65 m)
Stoppong time	10 seconds
Fuel consumption at cruising speed	150 kg/h

SEA TESTS

Successive tests have been held in the Straits of Messina in the presence of technicians from several registration authorities. During the last sea test, waves were 4 ft-4 ft 6 in (1·21-1·36 m) high, and these were crossed in all directions. Vertical and transverse accelerations were measured at the bows, stern and amidships. Max vertical acceleration recorded was 0·36 g and the maximum transverse acceleration was 0·33 g.

SEAFLIGHT H 57 (MILITARY)

Similar in construction and overall dimensions to the H 57 passenger ferry, this military variant is designed for fast naval patrol contraband and coastguard duties.

Power is supplied by two Fiat-Carraro V12SS watercooled, supercharged diesels, each with a normal service output of 650 hp at 1,500 rpm.

Crew accommodation includes a large cabin aft for the captain, a cabin with two bunks for the officers, a toilet and a galley. In the bow is a second cabin, with two bunks, a second toilet, and there is also provision for two bunks in the forepeak.

The pilot's position is on the starboard side of the wheelhouse, and the port side is occupied by the radio/radar operator. An external piloting station is provided at the aft end of the wheelhouse.

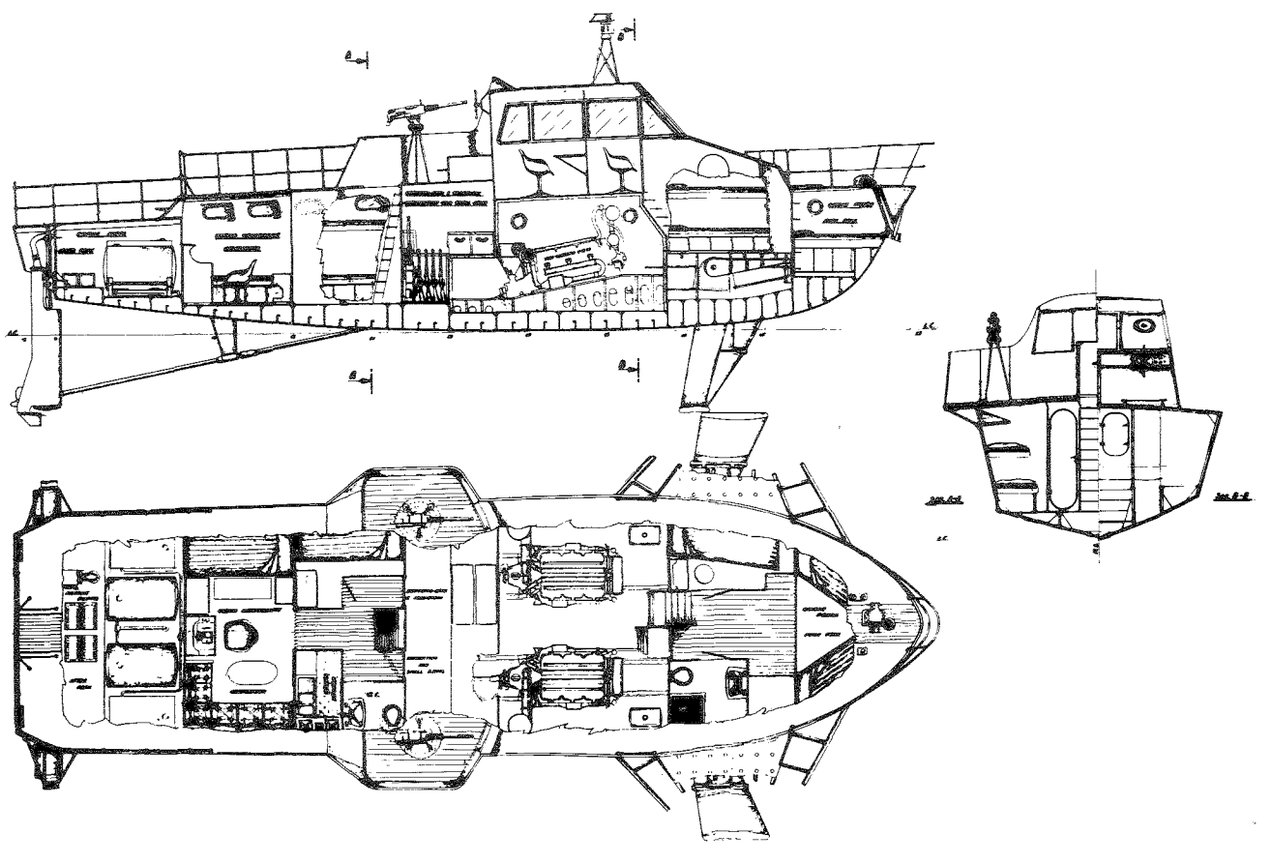
ARMAMENT: Armament will normally comprise two hand-operated machine guns mounted port and starboard on a gun platform aft of the wheelhouse. The deck is widened to permit the guns to be fired forward over the bows. Multiple-launch systems for guided missiles can be fitted if required. The weight allowed for arms and ammunition is 2,250 kg, but this can be varied according to the distance of the patrol.

WEIGHTS:

Light displacement	21 tons
Max take-off displacement	26 tons
Deadweight (incl fuel, water, armaments, crew)	5 tons

PERFORMANCE:

Max speed foilborne	38 knots (70 km/h)
Cruising speed foilborne	34 knots (63 km/h)
Max wave height in foilborne mode	5 ft 0 in (1·52 m)
Range at cruising speed	372 miles (600 km)



Seaflight H 57 (Military), for fast naval patrol and coastguard duties. Two hand-operated machine guns are located one each side of the widened deck area aft of the wheelhouse. A second piloting position is provided externally aft of the wheelhouse superstructure and is intended for use during offensive action, manoeuvring or in an emergency.

SEAFLIGHT H 57 CRUISER

This luxury cruiser version of the H 57 is identical in most respects to the passenger ferry apart from the revised interior. The only modification to the basic structural design is the raising of the main deck by about 18 in (45 cm) to increase the headroom below deck.

Main deck accommodation comprises the wheelhouse and radio cabin, a large saloon and living room with tables, settee, armchairs and bar and a kitchen. Below deck, from aft peak forward, is a compartment for batteries, ship's stores, and fuel and water tanks; a large cabin for the owner, with double-bed, settee, cupboards and private toilet; two cabins, one with a double-bed for guests and the other with a two-tier bunk for guests; a toilet for guests, and the forepeak with two bunks for the crew.

DIMENSIONS:

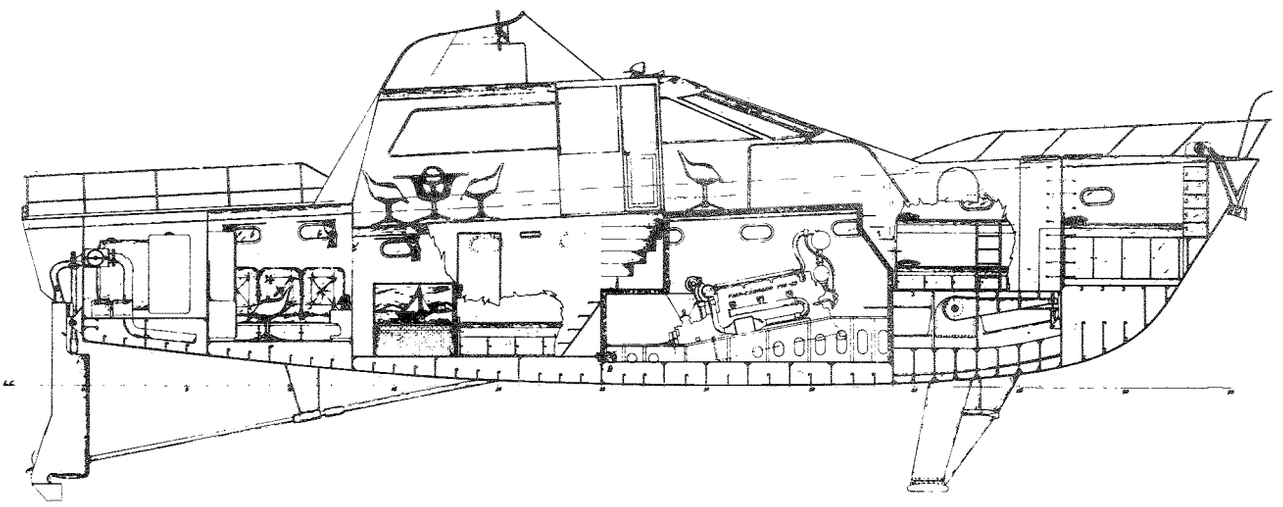
Length overall	62 ft 4 in (19·00 m)
Length waterline	50 ft 11½ in (15·52 m)
Draft afloat	8 ft 4½ in (2·55 m)
Draft foilborne	3 ft 8½ in (1·13 m)
Hull beam	15 ft 9 in (4·80 m)
Beam overall	26 ft 3 in (8·00 m)
Freeboard	5 ft 6⅞ in (1·70 m)
Height overall	23 ft 7½ in (7·20 m)

WEIGHTS:

Light displacement	21 tons
Max take-off displacement	26 tons
Deadweight (incl fuel, water, passenger and crew)	5 tons

PERFORMANCE:

Max speed foilborne	38 knots (70 km/h)
Cruising speed foilborne	34 knots (63 km/h)
Max wave height in foilborne mode	5 ft 0 in (1·52 m)
Range at cruising speed	373 miles (600 km)



Luxury cruiser version of the Seaflight H 57, showing a typical interior arrangement with a large saloon and living room on the main deck, and three cabins, toilet facilities and crew sleeping accommodation below

SEAFLIGHT L 90

The L 90, latest passenger ferry hydrofoil in the Seaflight series, seats 125 passengers and cruises at 35 knots. The craft is being built under the supervision of Registro Italiano Navale and Germanischer Lloyd and the prototype was due to be completed in the summer of 1970.

FOILS: The foil system is of aeroplane configuration with surface-piercing bow and rear foils. Approximately 60% of the load is supported by the bow foil and 40% by the rear foil.

The bow foil, of W type, is attached to a supporting tube inside the hull by a central and two lateral struts. The foil pivots around the axis of the supporting tube between positions of maximum and minimum incidence. The lift and drag generated by the foil tends to rotate it backwards, particularly during take-off and in rough seas, but this movement is opposed by a spring attached to an arm on the foil assembly shaft. The system is designed to produce the same amount of lift, whether the speed varies or the foil's submerged surface varies in a wave crest or cavity.

Foils, struts and the supporting tube are fabricated in steel. Four shear points are provided, two inside the hull at the attachment points of the support tube arm and the automatic incidence control system, and two externally, at the point of attachment of the two subfoils to the central strut. In the event of damage, the affected foils and their supporting structure can be quickly and easily repaired.

The rear foil combines a horizontal submerged centre section with inclined surface-piercing areas. It is attached to the hull by two struts and the two rudder supports and the angle of incidence is fixed.

HULL: Riveted light alloy construction is employed throughout. The structure is of the transverse type with frames spaced 1 ft 0 in (300 mm) apart. Full-length longitudinal members reinforce the hull bottom and the decks and run from stem to stern. All plates and sections are specially treated by the company for added protection against corrosion. Braking load of the plates is 30-35 kg/sq mm. The hull is designed for two-compartment sub-division and will remain afloat with any two adjacent compartments flooded.

ACCOMMODATION: The standard version accommodates a crew of 3-4 and 125 passengers, who are seated in three large saloons. Entry is through one of two sides door, one port, one starboard, in the central saloon, which provides access via a companionway to the aft saloon, the forward saloon and the wheelhouse. There are two WC/washbasin units in the aft saloon and one in the forward saloon.

The pilot's position, instruments and controls are on the starboard side of the wheelhouse and there is a crew member's observation position on the port side. Access to the engine room is from the wheelhouse via a watertight hatch.

POWER PLANT: Power is supplied by two supercharged 12 cylinder Mercedes-Maybach MB 820 Dc diesels, each with a maximum continuous output of 1,100 shp at 1,400 rpm. Engine output is transferred to two high tensile bronze propellers through Zahnradfabrik BW 800/s reversible gears.

SYSTEMS:

ELECTRICAL: Two engine driven generators coupled to two battery sets provide 24 volts dc for engine starting, instruments, lighting, radio, etc. Separate diesel ac

generating plant can be installed if required.

COMMUNICATIONS AND NAVIGATION: Ship-shore vhf and radar to customer's requirements.

DIMENSIONS, EXTERNAL:

Length overall	84 ft 4 in (25·70 m)
Length waterline, hull	69 ft 5 in (21·16 m)
Draft afloat	9 ft 8 in (2·95 m)
Draft foilborne	3 ft 11 in (1·20 m)
Hull beam	19 ft 0 in (5·80 m)
Width across foils	33 ft 6 in (10·20 m)
Freeboard	5 ft 4 in (1·63 m)
Height overall	25 ft 3⅛ in (7·70 m)

DIMENSIONS, INTERNAL:

Aft passenger saloon compartment, incl WC:

Length	27 ft 7 in (8·40 m)
Max width	16 ft 0 in (4·88 m)
Max height	6 ft 4 in (1·92 m)
Floor area	407 sq ft (37·7 m²)
Volume	2,532 cu ft (71·7 m³)

Main deck saloon, excl wheelhouse:

Length	15 ft 9 in (4·80 m)
Max width	16 ft 1¾ in (4·92 m)
Floor area	248 sq ft (23·6 m²)
Volume	1,660 cu ft (47·2 m³)

Forward passenger compartment, incl WC:

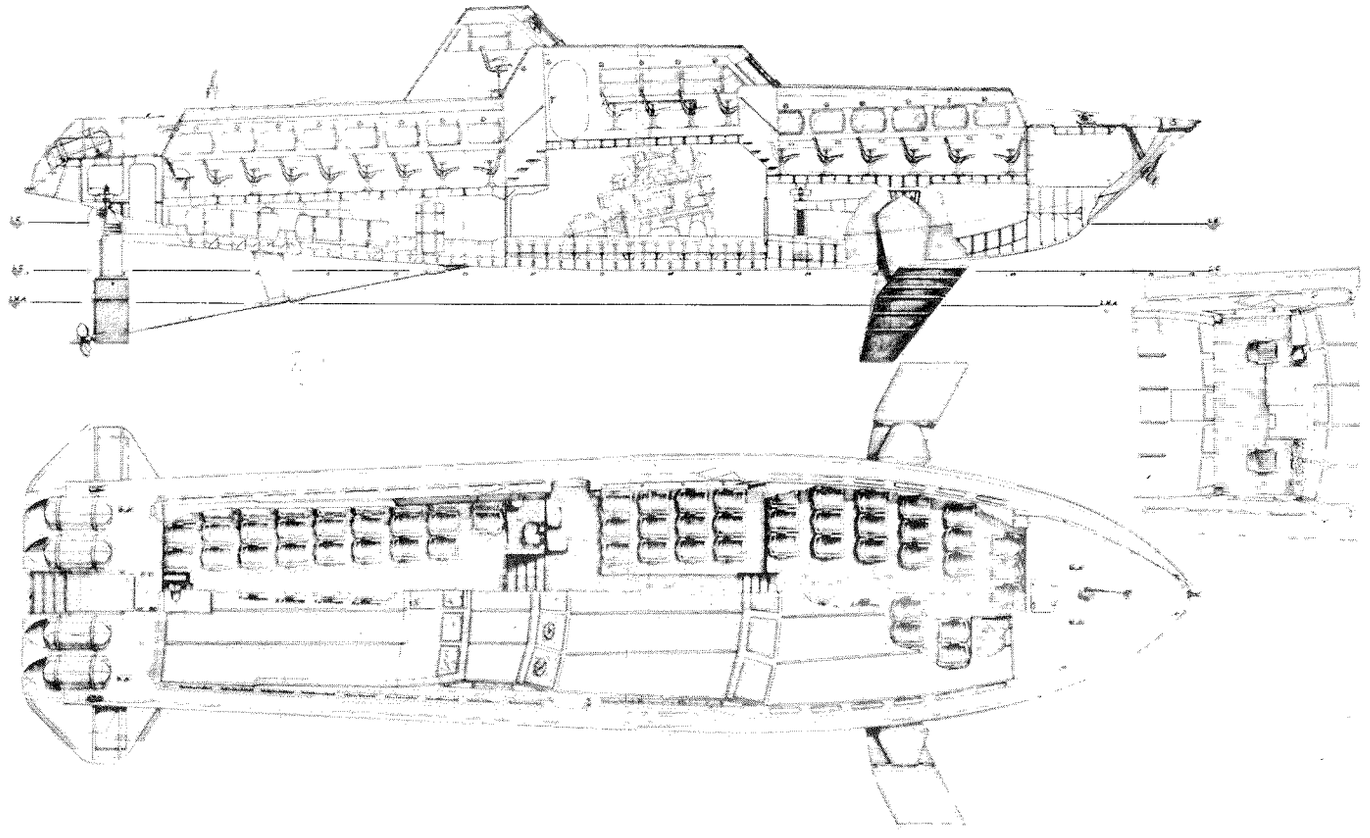
Length	18 ft 9 in (5·70 m)
Max width	16 ft 5 in (5·00 m)
Max height	6 ft 4 in (1·92 m)
Floor area	270 sq ft (25·1 m²)
Volume	1,680 cu ft (47·6 m³)

WEIGHTS:

Light displacement	41 tons
Max take-off displacement	55 tons
Deadweight (incl fuel, water, passengers, crew)	14·00 tons
Payload	9·4 tons

PERFORMANCE (Designed):

Cruising speed foilborne	34 knots (63 km/h)
Max wave height in foilborne mode	5 ft 3 in (1·60 m)
Range at cruising speed	311 miles (500 km)
Turning radius at cruising speed	328 yards (300 m)
Take-off distance	218 yards (200 m)
Take-off time	30 seconds
Stopping distance	87 yards (80 m)
Stopping time	10 seconds
Fuel consumption at cruising speed	300 kg/h



Inboard profile and deck plan of the Seaflight L 90

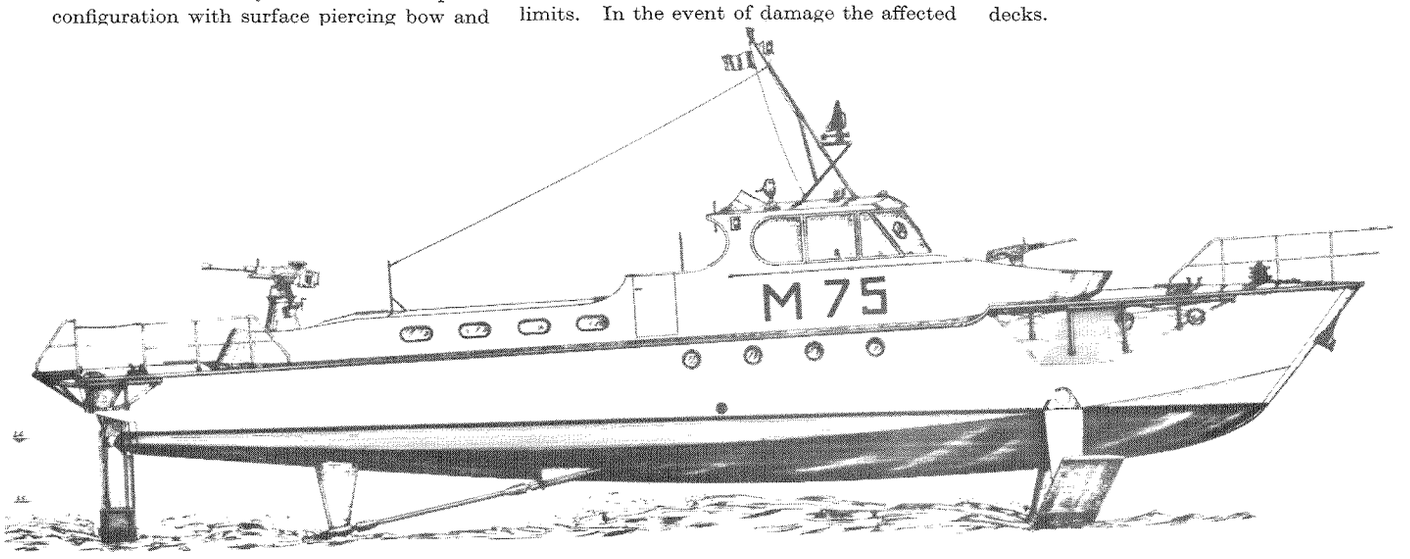
SEAFLIGHT M 75

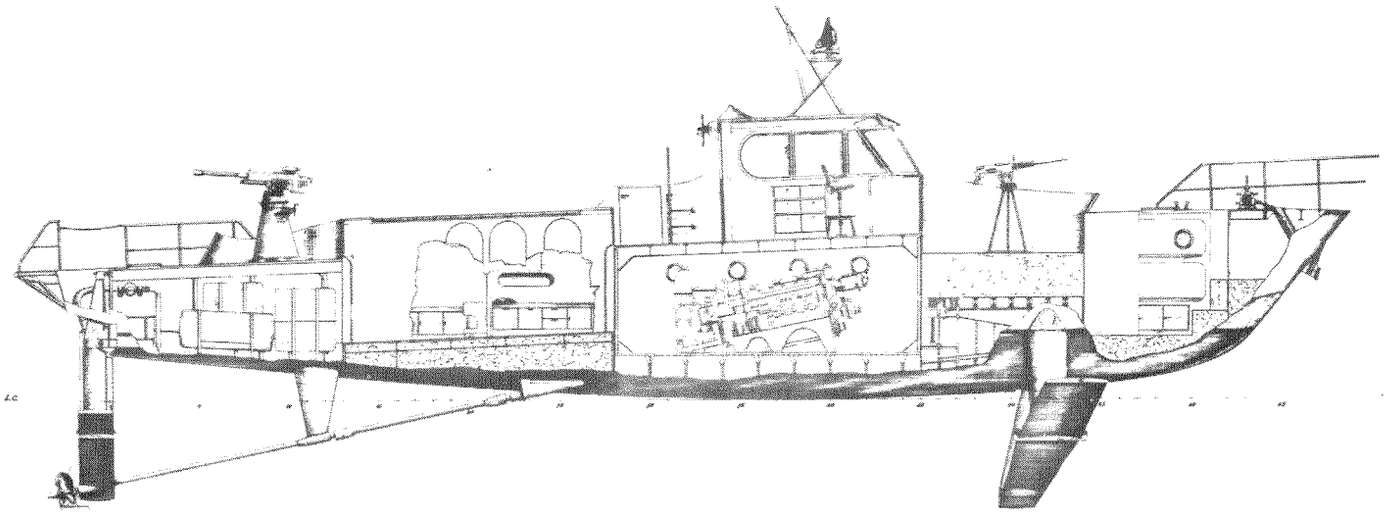
This craft is developed from the L 90 and has been designed for fast patrol in coastal waters. It is powered by two 1,040 hp CRM 18 Ds diesels and has a maximum speed of 40 knots (74 km/h).

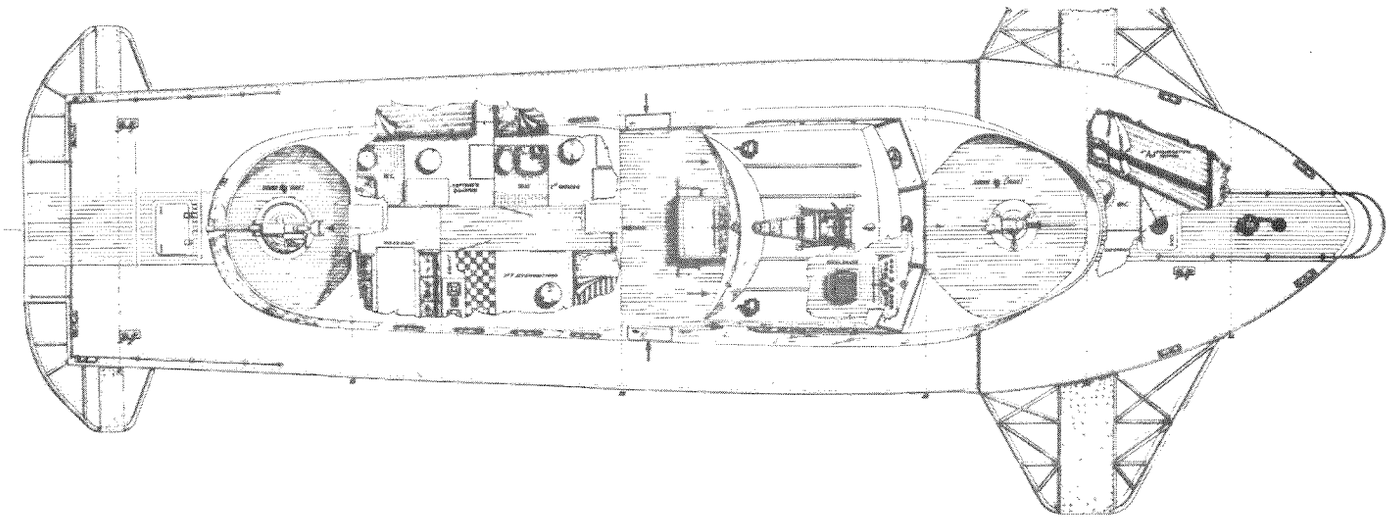
FOILS: The foil system is of aeroplane configuration with surface piercing bow and rear foils. Approximately 60% of the load is supported by the bow foil and the remaining 40% by the rear foil. Incidence of the bow foil, which is of 'W'-type, is controlled automatically by a mechanically operated system identical to that of the L 90.

Foils, struts and the bow foil supporting tube are in weldable steel with high fatigue limits. In the event of damage the affected foils and their supporting structure can be quickly and easily replaced.

HULL: The hull structure is of the transverse type, and built in riveted light alloy. Framing is spaced at 1 ft 0 in (300 mm). Full length longitudinal members running from stem to stern reinforce the hull bottom and decks.







Seaflight M 75 profiles and deck plan

HYDROFOILS
Italy: SEAFLIGHT

ACCOMMODATION: Living and sleeping quarters are provided for a crew of eight. Below deck, from aft peak forward, is a compartment for fuel and water tanks, batteries and ships stores; a large mess room, the captain's cabin with adjoining WC, a cabin with bed; a cabin with a two-tier bunk, a WC and a galley. Forward of the engine room there are four bunks for ratings and another WC.

The wheelhouse is above the engine room. The operating position with all controls and instruments is on the starboard side, and all auxiliaries—radio-telephone, radar—are on the port side. A second pilot's position is provided externally, aft of the wheelhouse superstructure and is intended for use during offensive action, manoeuvring or in an emergency.

ARMAMENT: Two gun positions are provided, one on the foredeck, the other on the after deck. Total weight of arms and amunition is estimated at 4,000 kgs. Main armament can comprise light or heavy machine guns, cannon or multiple-type missile launchers.

POWER PLANT: Two CRM 18 D/S supercharged 18-cylinder diesels, each developing 1,040 shp at 1,900 rpm continuous provide motive power. Each engine drives via a hydraulically controlled reduction and reverse gear its own inclined shaft. The shafts are in hardened steel and the propellers are in high tensile bronze.

SYSTEMS:
ELECTRICAL: 24 volt dc supplied by two engine-driven generators coupled to two battery sets for engine starting, instruments, lighting etc. A diesel generator set can be installed when an ac supply is necessary.

HYDRAULICS: Two engine driven hydraulic pumps, one operating, one in reserve, for rudder movement.

DIMENSIONS:

Length overall	74 ft 6 in (22·70 m)
Length waterline hull	62 ft 4 in (19·00 m)
Draft afloat	9 ft 8½ in (2·95 m)
Draft foilborne	4 ft 1¼ in (1·25 m)
Hull beam	17 ft 1⅞ in (5·23 m)
Beam overall	32 ft 10 in (10·00 m)
Freeboard	4 ft 3 in (1·30 m)
Height overall	21 ft 8 in (6·60 m)

WEIGHTS:

Light displacement	32 tons
Max take-off displacement	40 tons
Deadweight (incl fuel, water, armament and crew)	8 tons

PERFORMANCE:

Max speed foilborne	40 knots (74 km/h)
Cruising speed foilborne	35 knots (65 km/h)
Max wave height in foilborne mode	5 ft 3 in (1·60 m)
Range at cruising speed	373 miles (600 km)

JAPAN

HITACHI SHIPBUILDING & ENGINEERING CO

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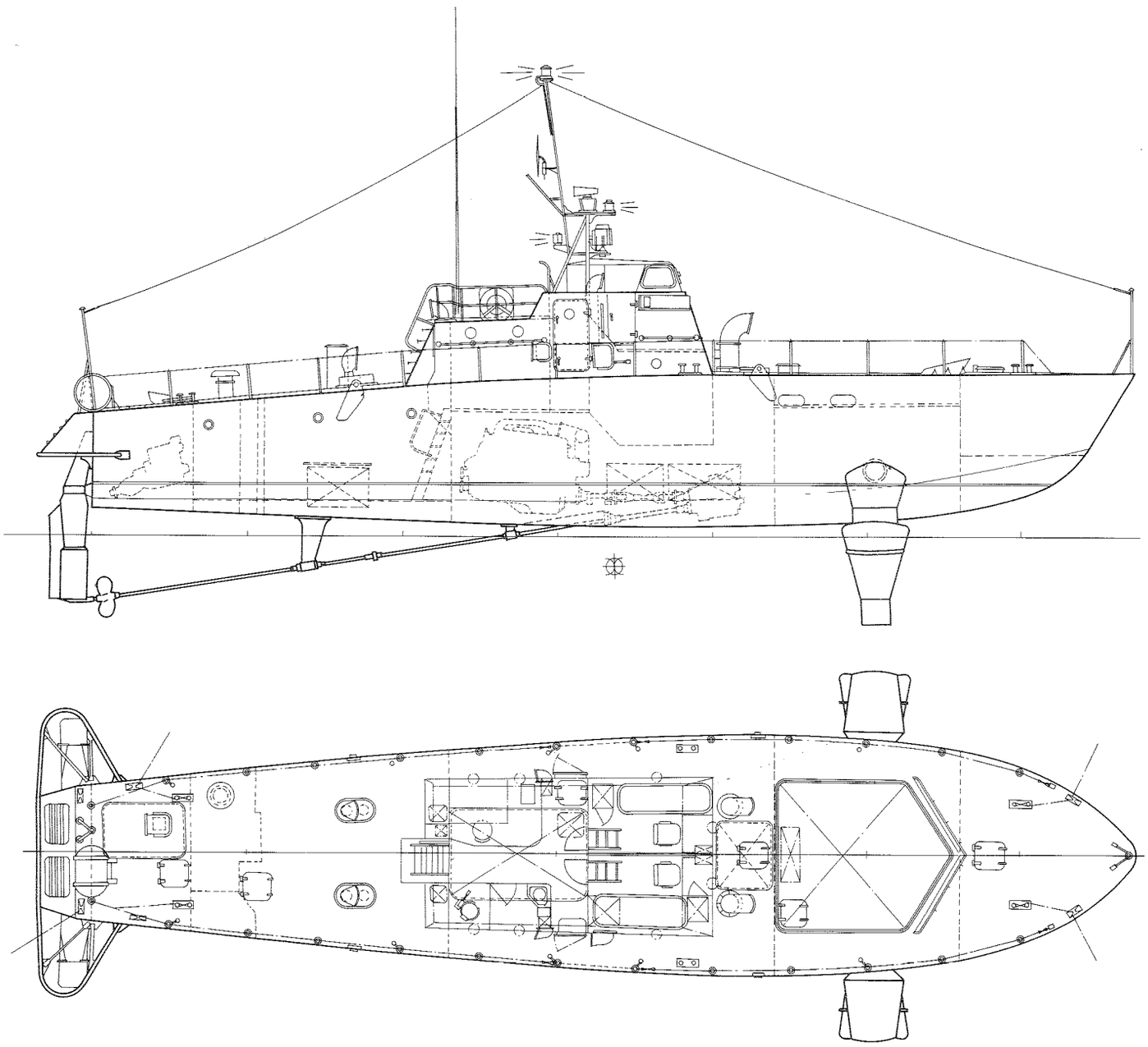
Takao Nagata, President
Hideo Fukuda, Managing Director and General Manager of Shipbuilding Division
Yoshio Kinoshita, Director and Manager of Product Development Department

Hitachi, the Supramar licencee in Japan, has been building PT 3, PT 20 and PT 50 hydrofoils since 1961. The majority of these have been built for fast passenger ferry services across the Japanese Inland Sea, cutting across deep bays which road vehicles might take two-to-three hours to drive round, and out to offshore islands. Other PT 20s and 50s have been exported to Hong Kong and Australia for ferry services.

Specifications of the PT 3, PT 20 and PT 50 will be found under Supramar (Switzerland). The Hitachi-built craft are identical apart from minor items.

In 1962 Hitachi, in conjunction with Eidai Sangyo Co Ltd, introduced two small hydrofoil runabouts equipped with Supramar



General arrangement of the PT 32 fast patrol hydrofoil developed for the Philippine Navy for contraband patrol and coastguard duties. Two craft of this type were delivered by Hitachi in November 1965. Armament comprises a twin .50 calibre machine gun mounted above the forward deck well and a single .50 calibre machine gun on the aft deck. Cruising range is 360 miles and the cruising speed is 32 knots

HYDROFOILS

Japan: HITACHI

foils. The foils can be retracted and folded close to the sides of the hull by means of a lever operated from the cockpit.

A special military hydrofoil, based on the Schertel-Sachsenburg foil system, and designated PT 32, has been designed and built by Hitachi for the Philippine Navy.

PT 32

This craft was specially designed as a fast patrol boat. Two have been delivered to the Philippine Navy for contraband patrol and general Coast Guard duties in coastal waters. The PT 32 is powered by a 1,350 hp Mercedes-Benz-Ikegai diesel, which gives a maximum speed of 35 knots. The hull is of light alloy, riveted construction and accommodation is provided for three officers and twelve NCOs and ratings. The armament comprises a twin ·50 cal machine gun mounted above the forward deck well, and a single ·50 cal machine gun on the aft deck.

DIMENSIONS:

Length overall	69 ft 0 in (21·0 m)
Length over deck	56 ft 9 in (20·0 m)
Beam over deck	15 ft 9 in (4·8 m)
Width over foils	25 ft 7 in (7·8 m)
Depth from top of keel to deck at side, amidships	9 ft 10 in (3·0 m)
Draft, hullborne, from base of foils	9 ft 2 in (2·8 m)
Draft, foilborne from base of foils	4 ft 3 in (1·3 m)

WEIGHT:

Fully loaded displacement	approx 32 tons

PERFORMANCE:

Cruising speed	approx 32 knots
Maximum speed	35 knots
Cruising speed	360 miles
Speed with auxiliary engine	approx 4 knots

Main engine Licence built:

Mercedes-Benz-Ikegai MB 820 Db supercharged diesel engine

MB 820 Db supercharged diesel engine

Maximum output	1,350 hp × 1,500 rpm
Continuous full output	1,100 hp × 1,400 rpm
Fuel consumption	0·364 lb/hp/h (165 g/hp/h)

Auxiliary propelling power:

Diesel engine	60 hp

Complement:

Officers	3 persons
Enlisted personnel	12 persons
Total	15 persons

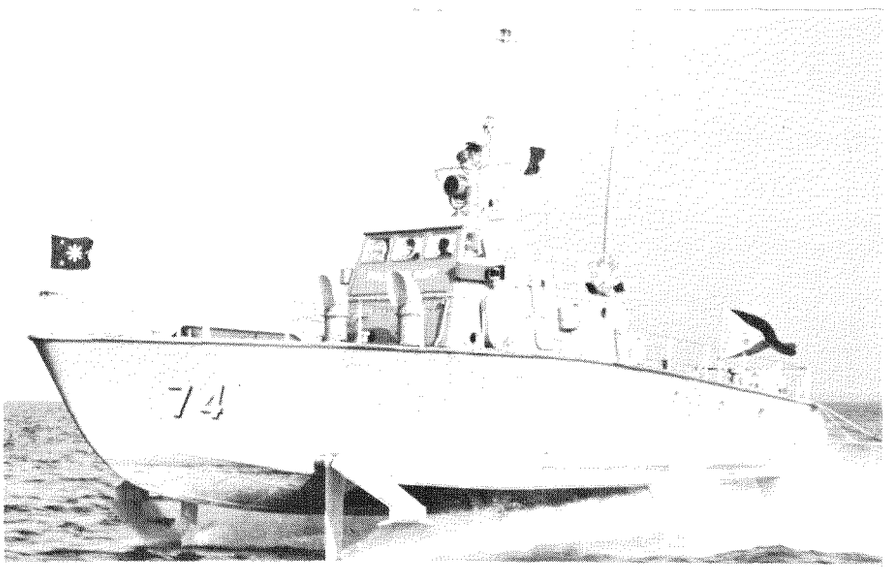
AT-FOIL

In addition to their range of Supramar-designed commercial passenger craft, Hitachi also manufactures retractable foils for the YODO-14 and -16 hydrofoil runabouts, substantial numbers of which have been sold throughout Japan and South East Asia.

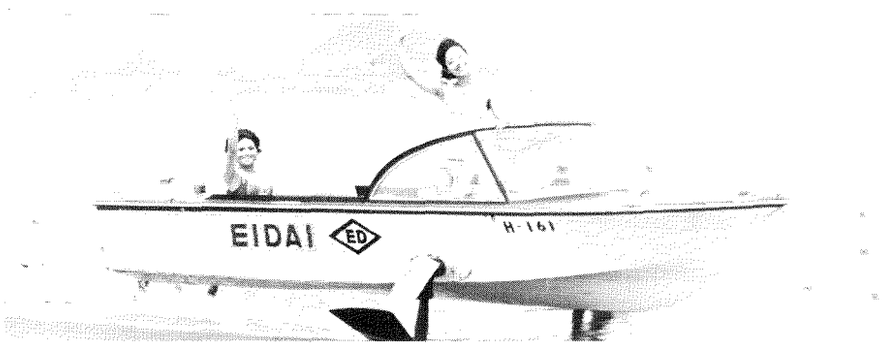
CONSTRUCTION: Built by Eidai Sangyo Co Ltd, of 33 Hirabayashi Minamino-cho, Sumiyoshi-ku, Osaka-City, and constructed in marine ply, the craft are powered by standard 40-70 hp marine outboards.

FOIL DESIGN: The front foil is of the surface-piercing split type, and the rear foil is a fully submerged type. Both front and rear foil systems fold upwards for retraction.

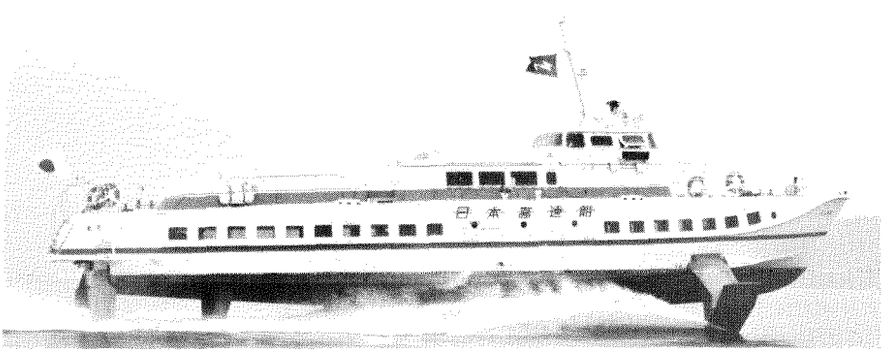
ACCOMMODATION: YODO-14 is a 14 ft craft seating 3-4 passengers, and uses AT-40 foils; YODO-16, a 16 ft craft. seats 5-6 and is fitted with AT-75 foils.



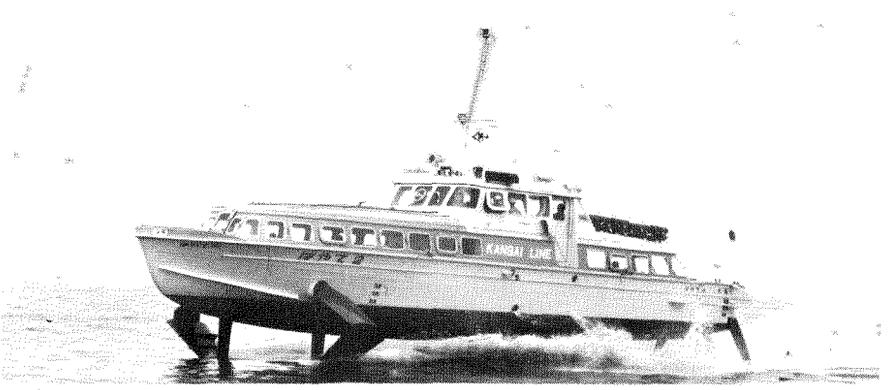
One of two Hitachi-built PT 32 fast patrol hydrofoils operated by the Philippine Navy



YODO-16, a 5-6 seat, 34 knot sports hydrofoil built by Eidai Sangyo Co. and fitted with Hitachi-Supramar retractable AT-foils



Hitachi -Supramar PT 50 "Wakashio"



Hitachi -Supramar PT 20 "Hayate"

Mitsubishi
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F. Yagi, General Manager
T. Kaneko, Sales Manager

Mitsubishi entered the hydrofoil field in 1960 and built the prototype of the 38-ton MH30, the first large Japanese-designed hydrofoil, in 1962. Five MH30s have so far been delivered for passenger services. The company has also built the MH03, a 20-passenger water-bus and has prepared designs for the 168-seat MH60. In 1964 Mitsubishi built the MH3 fully submerged foil test craft and in 1966 the company completed a waterjet propelled test craft which has reached a speed of 42 knots (77 km/h).

MH30

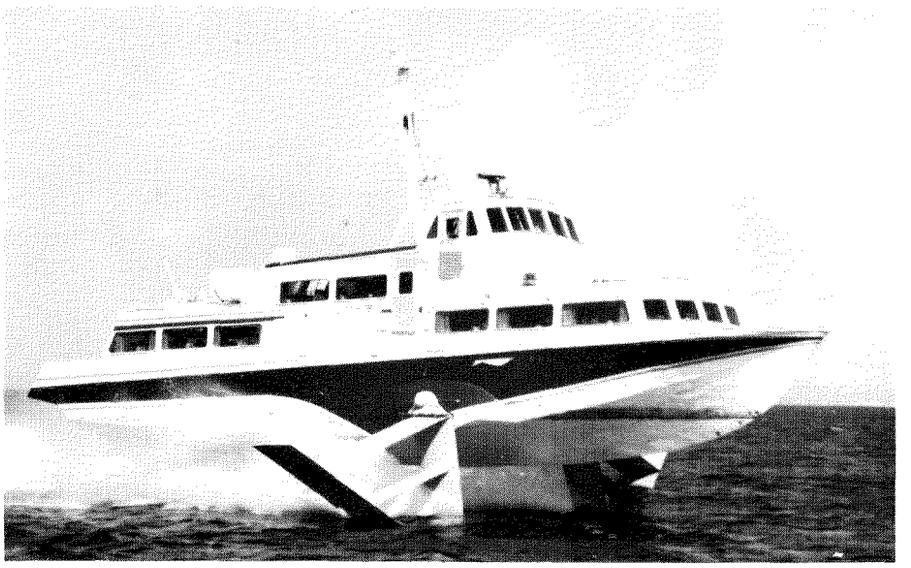
Designed for rough water operation around the Japanese Islands, the Mitsubishi MH30 seats eighty passengers and has a crew of four. Power is supplied by a Mitsubishi 12 WZ or Maybach MD655/18 high speed diesel. The cruising speed is 33 knots (61 km/h).

FOILS: The foil configuration is a combined surface-piercing and submerged system and is non-retractable. The split-Vee bow foil supports 65% of the load and the single, fully-submerged rear foil, which carries the propeller pod, supports the remaining 35%. The bow foil is in welded mild steel plate, and the rear foil is constructed in solid high tensile steel. Single rudders, which act individually for port or starboard turns, are fitted to the trailing edges of the aft foil struts.

HULL: The hull is an all welded, aluminium structure of the high speed type with hard chine sections for performance as a planing hull in waves.

ACCOMMODATION: Accommodation is on two levels. Passengers board the craft through single doors located amidships, port and starboard, leading to a 19-seat central saloon. Companion ladders lead down to the fore and aft saloons, with seats for 37 and 24 passengers respectively. Each cabin is fully air conditioned. Separate entrances, port and starboard, are provided for the pilot and crew. There is a toilet in the aft saloon. Two emergency exits are provided and a full range of safety equipment is carried, including life rafts.

POWER PLANT: Power is supplied by a Mitsubishi 12WK-AK high-speed diesel developing 1,500 hp at 1,600 rpm maximum; and 1,350 hp at 1,500 rpm normal. The output is transmitted through a mechanical right-angle drive transmission to an aluminium bronze, subcavitating propeller.



Powered by a Mitsubishi 12WZ-AK high-speed diesel developing 1,500 hp, the Mitsubishi MH30 seats 80 passengers and cruises at 33 knots. Five are in service with Japanese operators.

SYSTEMS:
AIR CONDITIONING: Daikin air conditioning unit.
ELECTRICAL: APU-driven 15 KVA 225 volt ac generator.
AUXILIARY POWER UNITS: Mitsubishi 22 Ps and 11.5 Ps diesels.
COMMUNICATIONS AND NAVIGATION: Marine radio-telephone and radar standard.
DIMENSIONS, EXTERNAL:

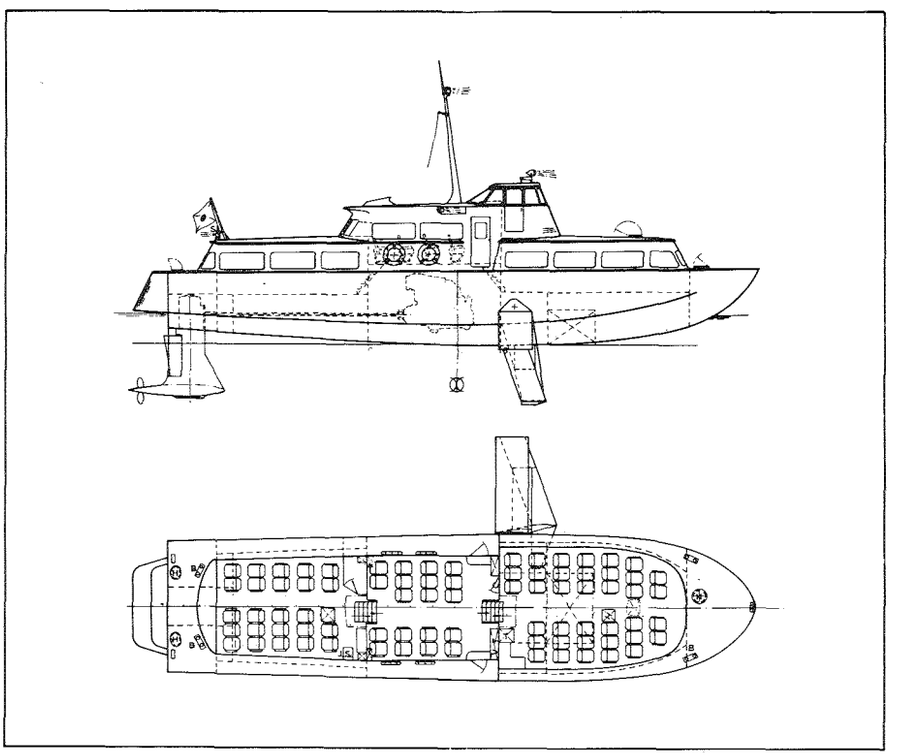
Length overall, hull	69 ft 0 in (21·0 m)
Length waterline, hull	64 ft 4 in (19·6 m)
Hull beam	15 ft 9 in (4·8 m)
Beam across foils	41 ft 6 in (12·66 m)
Draft afloat	10 ft 9 in (3·26 m)
Draft foilborne	4 ft 8 in (1·4 m)
Freeboard	*5 ft 0 in (1·45 m)*
Height overall	38 ft 5 in (11·7 m)

WEIGHTS:

Max take-off displacement	37 tons
Light displacement	27 tons
Net tonnage	30 tons
Max payload	7·2 tons

PERFORMANCE:

Max speed foilborne	38·2 knots (70·8 km/h)
Max speed hullborne	14 knots (25·7 km/h)
Cruising speed	33 knots (61·6 km/h)
Max permissible wave height in foilborne mode	6 ft 6 in (2 m)
Designed range at cruising speed	200 n. miles (37 km)
Turning radius at cruising speed	820 ft (250 m) app



Mitsubishi MH30

NORWAY

Westermoen

WESTERMOEN HYDROFOIL A/S

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TELEPHONE:

TELEX:
6514 Hydrofoil ML
SENIOR EXECUTIVES:
Toralf Westermoen, General Manager
Leif Hagaard, Sales Director
Rolf Hauke, Chief Designer

Westermoen Hydrofoils A/S was founded on August 1st 1961 by Toralf Westermoen and Kr Haanes with the object of building hydrofoils and fast naval patrol vessels. The company, a Supramar licencee, completed the first PT 150, a 150 ton mixed car/passenger ferry in June 1968.

The craft is now operating on the route Gothenburg, Aalenburg, Friedrikshaven.

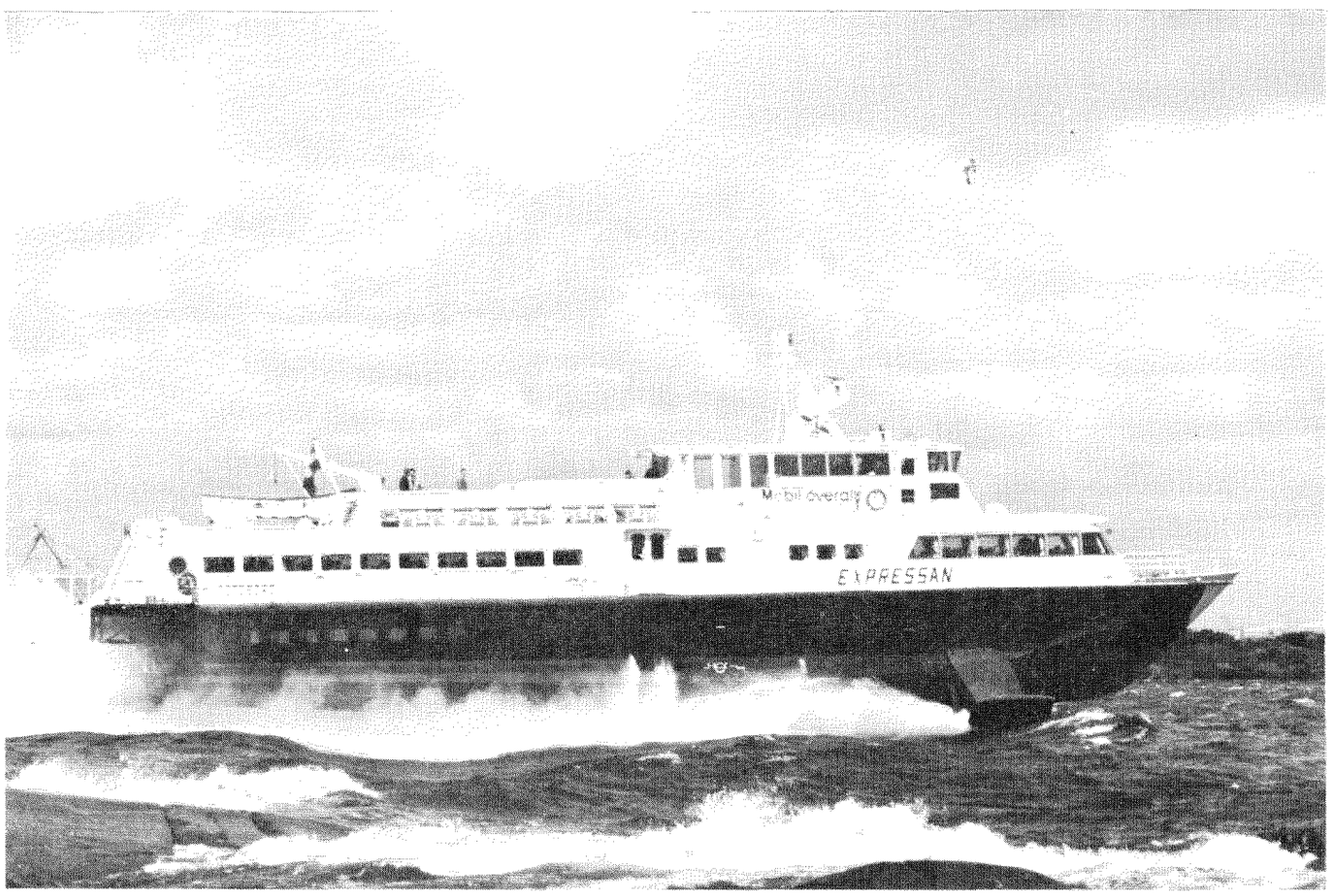
The PT 150 was the fifteenth craft to be built at the Westermoen shipyard, which employs a staff of 150. The company had previously built four PT 20 and three PT 50 hydrofoils.

An order for two further PT 150Ds (passenger version) was placed with the company in February 1969 by Joh Presthus Rederi, of Bergen.

Specifications for the PT 20, PT 50 and PT 150 will be found under Supramar (Switzerland).

At the end of 1966 a PT 50 (ex Westfoil) was returned to the yard to be fitted with a Schertel-Supramar fully submerged, air-stabilised rear foil in place of the normal surface-piercing unit. Renamed Flipper, it was the first craft to be fitted with an air stabilised foil and it was demonstrated to marine authorities in February 1967. Flipper is now operated by A/S Haanes Rederi, Kristiansand, Norway and is on charter in Scandinavian waters.

A description of the Flipper hydrofoil appeared in the 1967-8 edition of Jane's Surface Skimmer Systems.



Westermoen PT 150, a 36-knot passenger car ferry. The craft is the world's biggest seagoing commercial hydrofoil to date and has a fully loaded displacement of 165 tons. Two more PT 150s are now being built by the company

PT 150

In August 1966, Gothenburg-Fredrikshav-Line placed an order with Westermoen Hydrofoil A/S, Mandel, Norway, for a 165 ton Supramar PT 150 to operate a fast passenger/car ferry service between Sweden and Denmark, calling at Gothenburg, Aalborg and Fredrikshavn. Originally the PT 150 was intended purely as a 250 seat passenger ferry, but at the request of the operating company, the basic design was modified to allow an alternative payload of 150 passengers and 8 cars to be carried

Construction started in January 1967, the craft was completed in March 1968 and trials ended in June 1968.

The prototype PT 150, the world's largest seagoing commercial hydrofoil to date, was delivered at the end of June, 1968.

Building was superintended by Norske Veritas, and the craft was granted the class designation 1A2-Hydrofoil-K.

Two more PT 150Ds (passenger versions) are currently under construction.

FOILS: The foil configuration is a combined surface piercing and submerged system. The bow foil, which provides the necessary static lateral stability, is of the Schertel-Sachsenburg surface-piercing V design and carries 60% of the load. The rear foil, which bears about 40% is of the submerged, Schertel-Supramar air-stabilized type. In foilborne condition the boat is inherently stable.

Hydraulically-actuated flaps are fitted at the trailing edges of the bow foil to balance out larger longitudinal load shiftings, assist take off and adjust the flying height.

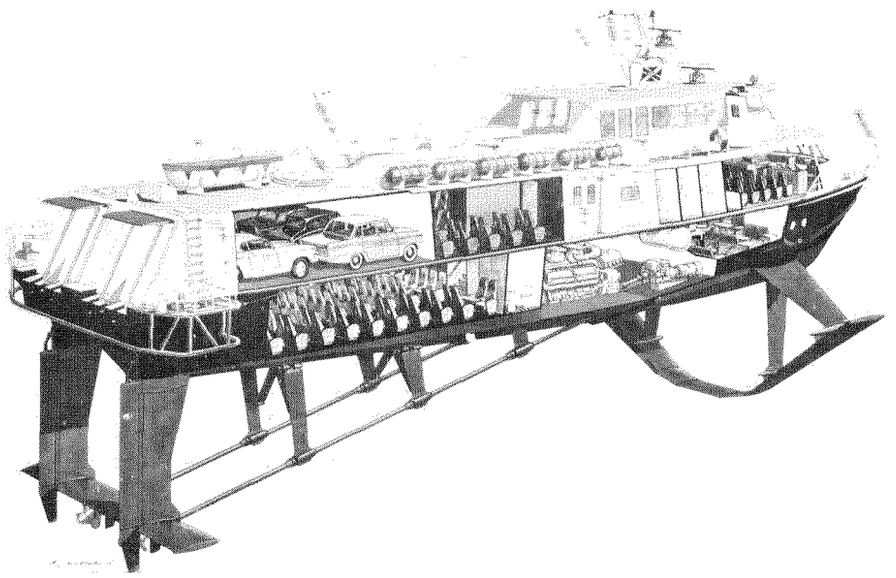
The rear foil is fully submerged and makes only a small contribution to lateral stability. It includes the lift-generating sections, rudders and the rear suspension structure which serves as a connecting element with the hull. Struts for the aftermost propeller bearings are also attached to the rear foil, the propellers being sited beneath the foil. The complete assembly is a framed structure which can easily be detached from the transom. The angle of attack of the rear foil can be controlled hydraulically both during take-off and in foilborne operation.

Air stabilisation is fitted to the rear foil for improved passenger comfort under heavy sea conditions. Separate port and starboard systems are installed to stabilise rolling and pitching.

The system feeds air from the free atmosphere through air exits to the foil upper surface (the low pressure region) decreasing the lift. The amount of lift is varied by the quantity of air admitted, this being controlled by a valve actuated by signals from a damped pendulum and a rate gyro. The stabilising moment is produced by decreasing the available air volume for the more submerged side and increasing that of the less submerged one.

The bowfoil centre section is also provided with submergence depth stablization, the quantity of air admitted being varied with the degree of submergence. The submergence depth control is only used in a following sea.

Foils and rudders are made of Naxtra-55. Front and rear foil are of hollow construction and by the extensive use of welding, the number of connecting parts requiring screws, bolts or similar means of attachment is reduced to a minimum.



Cutaway drawing of the first Westermoen-built PT 150

Passengers in the aft saloon of the PT 150. Provision is made for the serving of cold meals and drinks

HULL: This is of riveted light alloy construction and framed on longitudinal and transverse formers. It has fairly high dead-rise and hard chine sections for performance as a planing hull and for structural impacts in a seaway while foilborne. A step is provided to facilitate take-off. While the main or structure deck is continuous from bow to stern, the lower deck is interrupted by the engine room, sited amidships. The superstructure, which is also framed on longitudinal and transverse formers, is not included in the load bearing structure.

ACCOMMODATION: The forward part of the upper deck forms the forward upper passenger saloon, and seats 48. The aft saloon, which seats 100, is designed for rapid conversion to carry eight cars or the corresponding amount of palletised freight. Hydraulically-operated loading ramps at the rear of the superstructure are lowered for cars to roll on or off over the stern.

Passengers board the craft through double doors to the single centralized foyer, from which doors and companion ladders lead to the respective passenger saloons on the upper and lower decks.

The lower aft passenger saloon seats 70. A companion ladder at the centreline leads to the main deck foyer.

Provision is made for all passengers to be served in their seats with cold meals and drinks as in an airliner.

Passenger seats are of lightweight aircraft type. Floors and ceilings are covered with lightweight plastic material and the walls are clad in luxury plywood. Each passenger saloon has fitted carpets. Each room has an independent ventilation unit. Six toilets are provided.

The bridge, which is on a separate level above the main deck, slightly forward of midships, is reached by a companion ladder at the aft of the forward passenger compartment. The bridge itself has seating for another 5 passengers, but these are reserved for VIP guests of the shipping company. All passenger saloons have emergency exits.

The craft carries 12 inflatable RFD liferafts (for 110% of the classified number of

HYDROFOILS

Norway: WESTERMOEN

passengers and crew) which are stowed along both sides of the superstructure deck, aft of the wheelhouse extension. Lifebelts are arranged beneath the seats.

POWER PLANT: Power is supplied by two 20-cylinder Maybach MD 20V 538 TB8 supercharged and intercooled diesels each rated at 3,400 hp continuous at 1,790 rpm. To improve torque characteristics during take-off two engine mounted Maybach torque converters are provided.

Reverse and reduction gears are of the lightweight Zahnradfabrik BW 1500HS18 hydraulically-operated type, and incorporate the propeller thrust bearings. They have three shafts and two gear trains, one of which has an idler. The output shafts rotate either in the same direction as the input shaft or the opposite direction, depending upon the gear through which power is directed. Selection is by pneumo-hydraulic double-plate clutches on the input shafts. A mechanical lock-up is provided so that the gear can transmit full torque in the event of clutch slip while in service. This takes the form of a dog clutch which is effective in one direction, and can only be engaged in the "stop" condition. The gearboxes each have integral oil pumps for lubrication and clutch operation.

The inclined propeller shafts are made of high tensile stainless steel. The propellers, which are made by Radice, Italy, are 3-bladed and of approx. 41 inch diameter.

Fuel—total capacity is 1,979 galls (9,000 litres)—is carried in six tanks located in the aft peak and the engine room. Fuelling points are located aft, port and starboard.

CONTROL: Starting, manoeuvring and operation of the craft is controlled from the bridge, but in cases of emergency the main engines may be controlled from the engine room.

The two main engines are each controlled by an operating lever designed for single-handed control. Propeller reversal is also by means of these levers, the reverse gear being actuated by pneumatic remote control between bridge and main engines.

To start the boat both operating levers must be put in the "full ahead" position simultaneously. The engine mounted torque converter gear is actuated automatically. Foilborne speed can be regulated by fine adjustment of the operating levers. No other control devices are necessary for the main engines.

Levers for variation of the front foil flap angle and the angle of attack of the rear foil are actuated only before and after starting. During foilborne operation these can be used for trim compensation. All instrumentation and monitoring equipment is installed on the bridge.

SYSTEMS:

ELECTRICAL: The total electrical system is supplied by two diesel generators with an output of 44 KVA each. An emergency diesel generator of 32 KVA output is installed on the upper deck.

In the event of an electrical failure the emergency generator is switched on automatically by a STILL starter to operate the emergency lighting system as well as the services and communications system.

HYDRAULICS: Steering, variation of the front foil flap angle, the angle of attack of the rear foil and the capstan and windlass are all operated hydraulically. Each system has its own circuit which is monitored by a pressure controlled pilot lamp. Pressure is 120 kg/cm².

COMMUNICATION AND NAVIGATION: Standard navigation equipment of the PT 150 DC includes two Raytheon 2502-3 cm radar units with IP-33 display panels, one of which is north-stabilized; an Arma Brown gyro compass type Mk 1 Mod 5; a Plath T 12 magnetic compass and a Decca Navigator Mk. 12 with track plotter.

Communications equipment includes a Fisher F811 coast telephony station, a VHF telephony transceiver type ME-23C, produced by SRA Stockholm, and an intercom system to the engine room and office.

DIMENSIONS, EXTERNAL:

Length overall, hull	123·2 ft (37·55 m)
Length overall, deck	123 ft 0 in (37·13 m)
Hull beam, max	24·6 ft (7·50 m)
Deck beam, max	24·3 ft (7·40 m)
Width across foils	52·45 ft (16·0 m)
Draft afloat	18 ft 0 in (5·50 m)
Draft foilborne	8·9 ft (2·70 m)

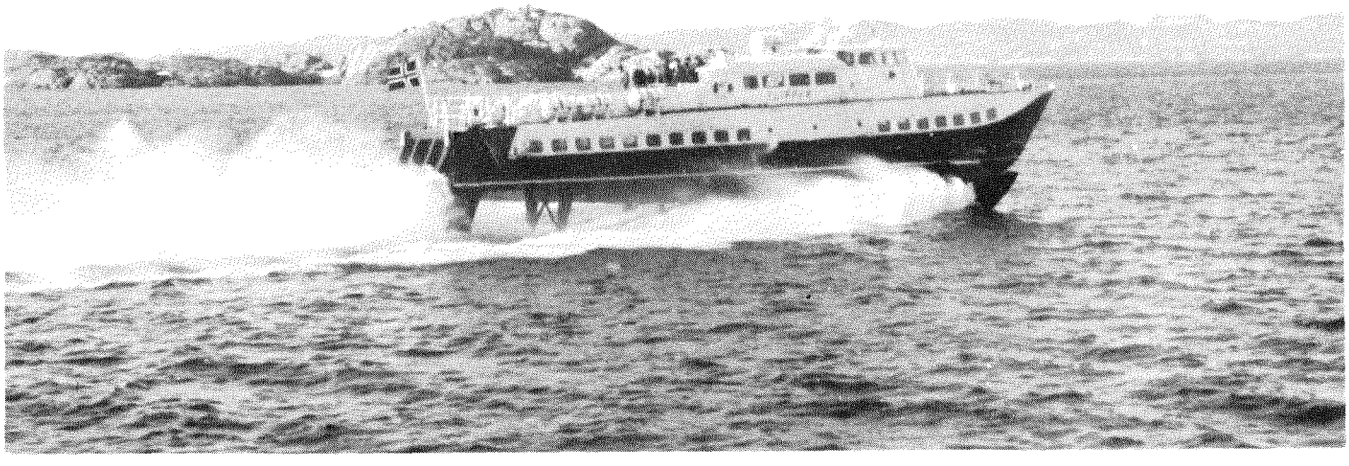
WEIGHTS:

Displacement, fully loaded	165 tons
Payload	23 tons
As passenger ferry	250 passengers
As passenger/car ferry	150 passengers + 8 medium size cars

PERFORMANCE:

Cruising speed at 6,880 hp	36 kt (66·5 km/h)
Cruising range	300 nautical miles (555 km)
Max permissible wave height in foilborne mode at full power	7 ft 6 in (2·28 m)
Approximate cost	$US 1,650,000

SEA TESTS: Location of the most recent test was in the Kattegat, between Mandal and Gothenburg. Conditions: Beaufort 6-7, speed of boat 32 knots, wave height 9·84 ft (3·0 m). Accelerometer locations: forward and aft saloons. Max vertical reading: 0·25 g.



The Westermoen-built PT 150 Flipper, first craft to be fitted with a Schertel-Supramar fully submerged, air stabilised rear foil in place of the normal surface-piercing unit

POLAND

Gdansk

GDANSK SHIP RESEARCH INSTITUTE

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Technical University, Gdansk
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41-47-12
DIRECTORS:
Prof Dr Lech Kobylinski
M. Krezelewski

Research on problems connected with hydrofoil design and construction have been conducted by the Department of Theoretical Naval Architecture at Gdansk Technical University since 1956.

Experience with various dynamic test models led to the construction of the K-3 four-seat runabout which, powered by an FSC Lublin converted auto-engine, has a top speed of 27 knots (50 km/h).

In 1961 the Department was invited by the Central Board of Inland Navigation and United Inland Shipping and River Shipyards Gdansk, to design a hydrofoil passenger ferry for service in the Firth of Szczecin. Designated ZRYW-1 the craft seats 76 passengers and cruises at 35 knots. It was completed in 1965. A second craft, the W-2, intended for passenger services in the Baltic, is under development.

During 1966 the Ship Research Institute designed two hydrofoil sports craft, the WS-4 Amor and the WS-6 Eros. The prototypes were completed in 1967 and both types will be put into series production during 1969.

ZRYW-1

The ZRYW-1 was completed in May 1965, and sea trials were initiated the following month. On scheduled passenger services between Szczecin and Swinoujscie, a distance of 36 nautical miles (67 km), the average operating speed has been in excess of 39 knots (73 km/h). The journey has been covered successfully in Sea States 2-4, with wave heights up to 5 ft 0 in (1·5 m).

FOILS: The foil configuration is a combined surface piercing and submerging type. The foils are welded assemblies fabricated from 0·2 to 0·28 in (5·7 mm) thick stainless steel. The configuration is subcavitating and is designed to be inherently stable in any expected combination of heave, pitch, roll and yaw.

HULL: This is a light alloy structure of almost fully welded construction, riveting being applied mainly to the joints of the longitudinal and transverse framings with the outer plating of the vessel's roof, and also the joining of steel elements, such as the foil foundations and stern tube, with light alloy members.

POWER PLANT: Provided by a single Russian-built M-50F4 diesel, rated at 1,000 hp continuous and 1,200 hp maximum, driving a fixed-pitch, three-blade propeller.

The engine room, sited amidships, houses the main engine together with reversible gear, auxiliary set, tanks, and pumps serving the engine room system.

ACCOMMODATION: Forty passengers are carried in the forward passenger saloon, and thirty-six passengers in the aft saloon.

Comfortable, upholstered seats are fitted and the floors are covered with vinyl.

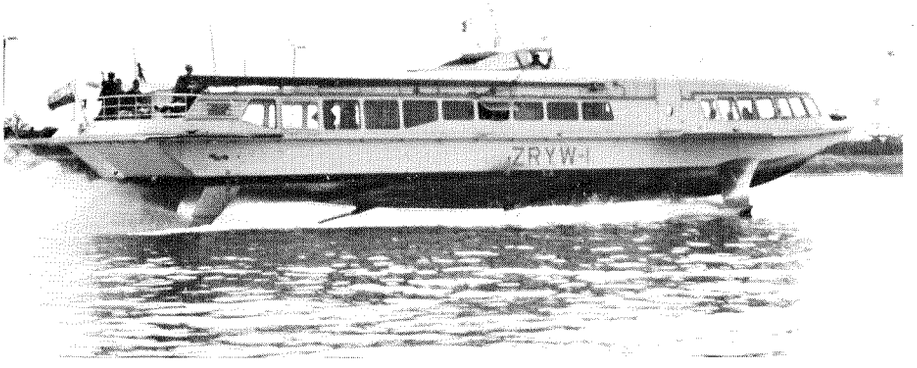
The wheelhouse, crew cabin and toilet are situated forward. Passenger entrance doors are provided on both sides of the craft and lead to a small vestibule forward of the crew's cabin. The two passenger compartments are provided with heat and accoustic insulation, and are electrically heated when stationary (shore supplied) and when in motion.

DIMENSIONS:

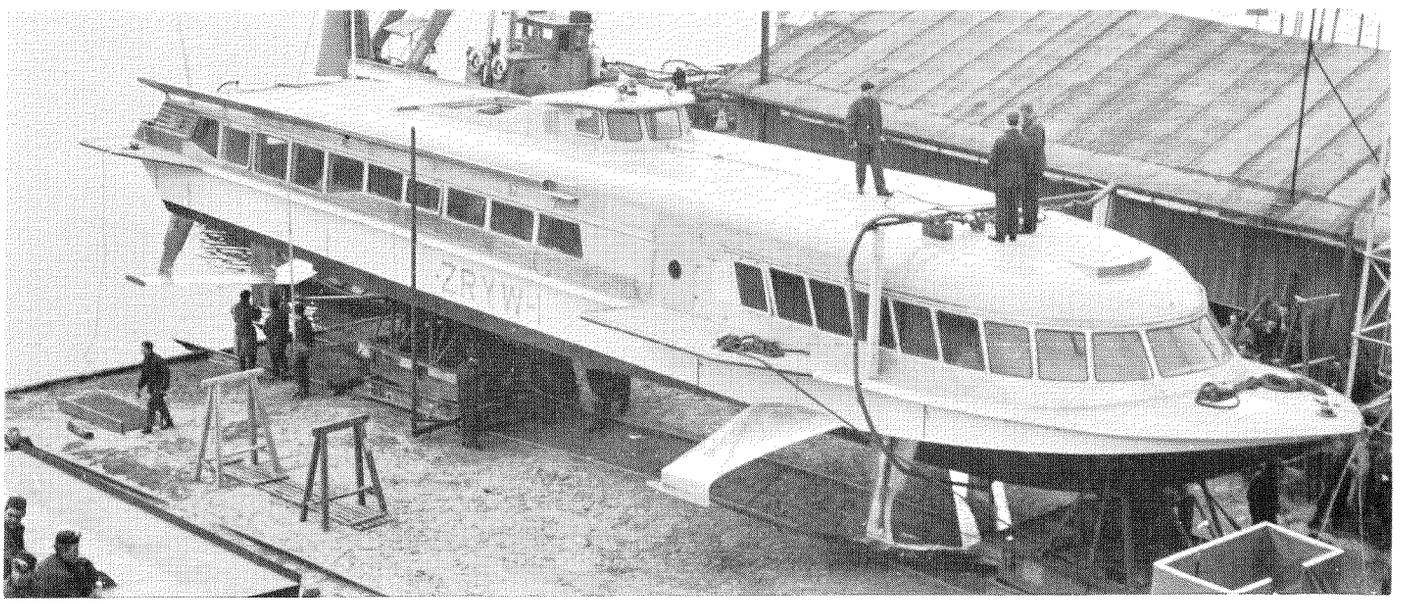
Length overall, hull	90 ft 7 in (27·60 m)
Length waterline, hull	75 ft 6 in (23·00 m)
Hull beam	14 ft 6 in (4·40 m)
Width across foils	24 ft 10 in (7·56 m)
Draft afloat	8 ft 1 in (2·45 m)
Freeboard	4 ft 3 in (1·30 m)

WEIGHTS:

Light displacement	22·7 tons
Max take-off displacement	30·7 tons
Useful load (fuel, water, passengers, baggage and crew)	8·0 tons



The ZRYW-1 (one Soviet-built M-50F 4 diesel) averages more than 39 knots on scheduled services between Szczecin and Swinoujscie, a distance of 36 nautical miles (67 km)



The 76-seat ZRYW-1, first Polish designed passenger hydrofoil to go into service

HYDROFOILS

Poland: GDANSK

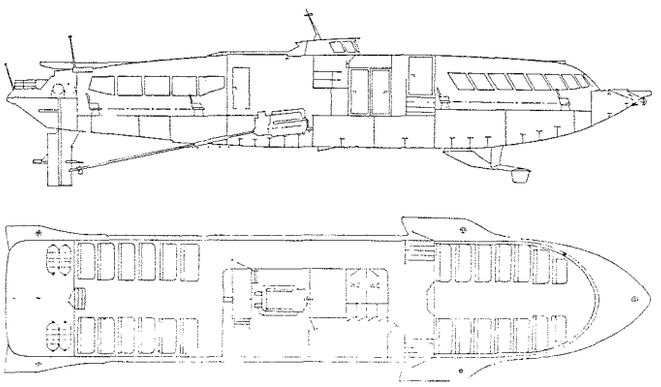
PERFORMANCE

Cruising speed:	
foilborne	35 knots (65 km/h)
hullborne	16 knots (30 km/h)
Sea State max capability	State 3
Design foilborne range	250 miles (460 km)
Fuel consumption at cruising speed	176 lb/hr (80 kg/h)
Fuel consumption hullborne	330 lb/hr (150 kg/h)

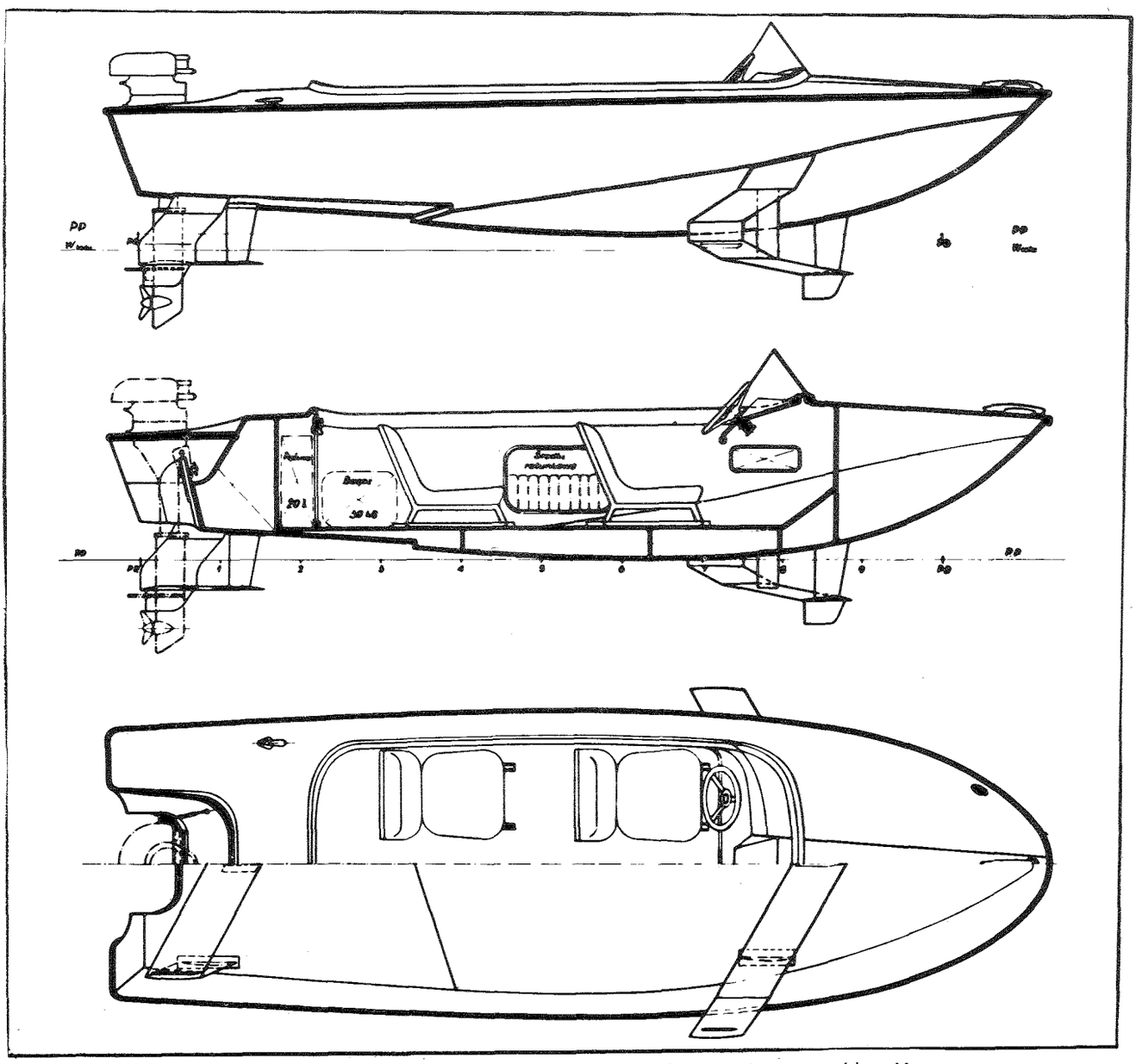
WS-4 AMOR

A four-seat sports hydrofoil designed by E. Brzoska, the WS-4, is of moulded fibreglass construction and powered by an outboard engine. It will be put into series production in 1969.

FOILS: The foil system is of combined surface piercing and submerging type and non-retractable. It comprises a shallow draft surface-piercing bow foil and a fully submerged rear foil. Both are made of solid aluminium alloy. The foil arrangement is tandem in the sense that when foilborne the load is balanced between bow and rear foils.



The ZRYW-1 76-seat passenger hydrofoil designed by Gdansk Technical University, Ship Research Institute, High Speed Division



The Gdansk Ship Research Institute WS-4 Amor. The standard model is powered by a Mercury 350 outboard with single lever throttle and gearshift control

ACCOMMODATION: Comfortable upholstered seats are provided for a helmsman and three passengers. The hull is of moulded fibreglass construction and incorporates a step to facilitate take-off.

POWER PLANT: The standard model is equipped with a Mercury 350 outboard, with single lever throttle and gearshift control. The engine propeller unit turns for steering. Fuel is contained in a 6 gallon tank.

DIMENSIONS, EXTERNAL:

Length overall, hull	15 ft 4 in (4·67 m)
Length waterline, hull	13 ft 2 in (4·0 m)
Hull beam	5 ft 0 in (1·5 m)
Width across foils	5 ft 11 in (1·8 m)
Draft afloat	1 ft 8 in (·05 m)
Draft foilborne	9 in (0·23 m)
Height overall	3 ft 4 in (1·0 m)

DIMENSIONS, INTERNAL:

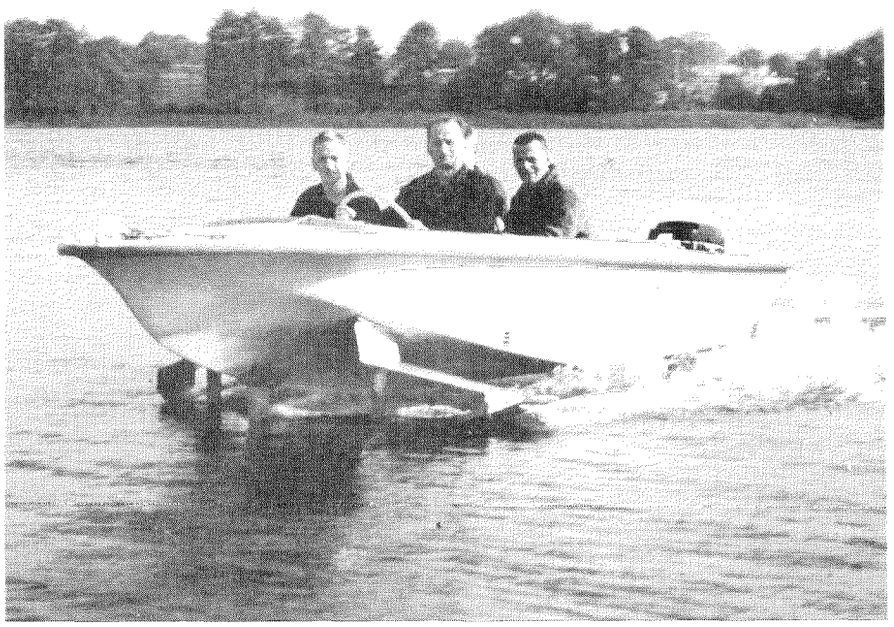
Length	7 ft 3 in (2·2 m)
Max width	4 ft 0 in (1·2 m)
Floor area	27 sq ft (2·5 m²)

WEIGHTS:

Light displacement	1,521 lb (686 kg)
Max payload	881 lb (400 kg)

PERFORMANCE (with normal payload):

Max speed foilborne	34 mph (55 km/h)
Max speed hullborne	19 mph (30 km/h)
Cruising speed foilborne	30 mph (50 km/h)
Max permissible wave height in foilborne mode	6 in (0·15 m)
Designed range at cruising speed	31 miles (50 km)
Number of seconds to take-off (theoretical, approx)	15 sec
Number of seconds to stop craft (theoretical, approx)	10 sec



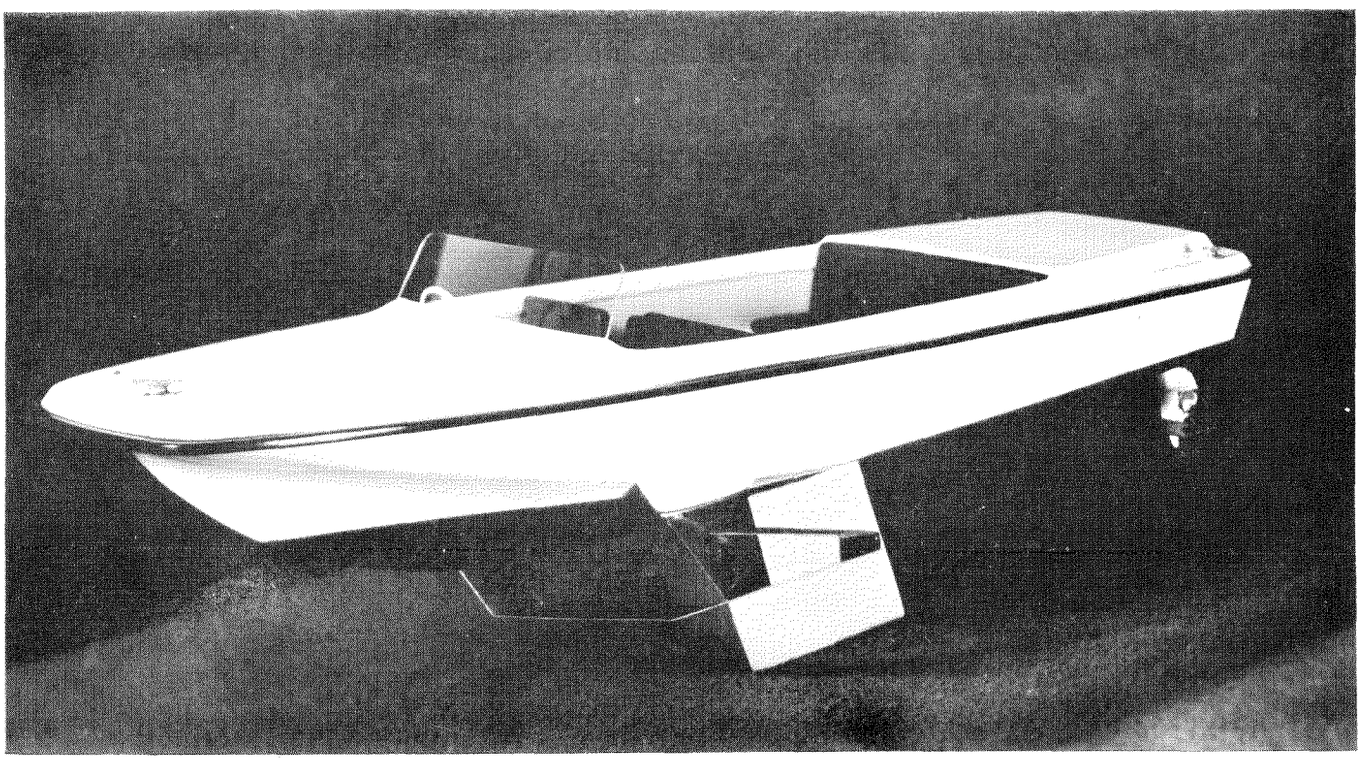
The WS-4 Amor, a four-seat runabout designed by Gdansk Ship Research Institute and powered by a Mercury 350 outboard motor

WS-6 EROS

A six seater hydrofoil runabout, the WS-6 Eros, like the smaller WS-4, was put into series production in 1969.

HULL: The prototype is built of marine plywood, but the hull of the production models will be in moulded fibreglass.

FOILS: The foil system is similar to that of the WS-4. It is a combined surface piercing and submerged configuration with a shallow draft surface piercing bow foil central "keel" and a fully submerged rear foil. Foils are of solid aluminium alloy. About 52% of the load is carried by the bow foil and 48% by the rear foil. Total foil area is 11·5 sq ft (1·07 m²).



WS-6 Eros, six-seat sports hydrofoil

HYDROFOILS

Poland: GDANSK

ACCOMMODATION: Upholstered seats are provided for a helmsman and five passengers.

POWER PLANT: The production model will have a Volvo Penta Aquamatic 110/200. Power is transmitted through a right-angle drive transmission to a 3-blade propeller at the base of a strut-and-pod assembly which rotates for steering. Total fuel capacity is 100 litres.

DIMENSIONS, EXTERNAL:

Length overall, hull	23 ft 9 in (7·25 m)
Length waterline, hull	20 ft 2 in (6·15 m)
Hull beam	7 ft 4 in (2·24 m)
Beam overall, foils extended	8 ft 6 in (2·6 m)
Draft afloat	3 ft (0·9 m)
Draft foilborne	1 ft 2 in (0·36 m)
Freeboard	2 ft 2 in (0·65 m)
Height overall	5 ft 1 in (1·55 m)

DIMENSIONS, INTERNAL:

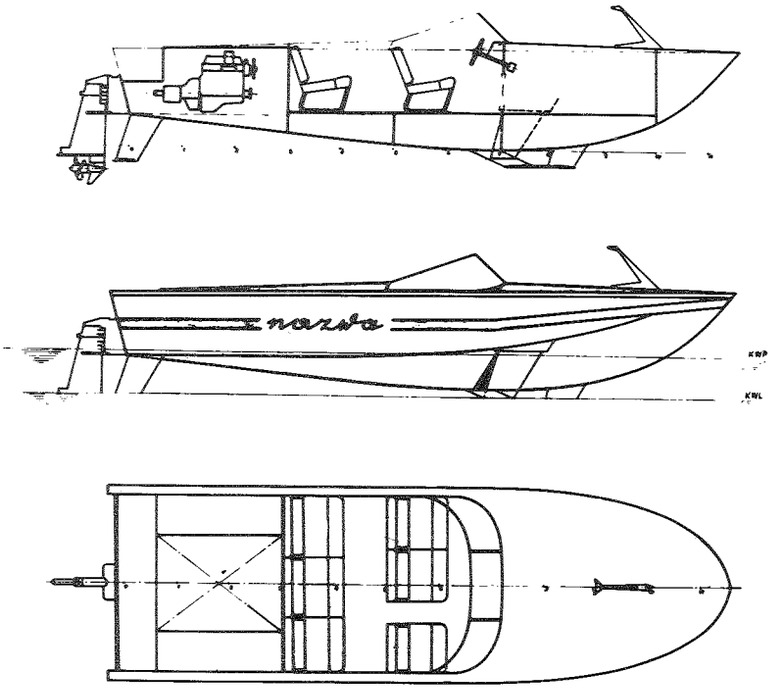
Cockpit length	10 ft 2 in (3·1 m)
Max width	6 ft 7 in (2 m)
Floor area	67·2 sq ft (6·2 m²)

WEIGHTS:

Light displacement	1·05 tons
Normal take-off displacement	1·6 tons
Max take-off displacement	1·75 tons
Normal payload	0·55 tons
Max payload	0·7 tons

PERFORMANCE:

Max speed foilborne	35 mph (56 km/h)
Cruising speed foilborne	31 mph (50 km/h)
Max permissible wave height in foilborne mode	10 in (250 mm)
Number of seconds and distance to take-off	10 sec, 394 ft (120 m)
Number of seconds and distance to stop craft	8 sec 329 ft (100 m)
Turning radius at cruising speed	820 ft (250 m)



WS-6 Eros, a six-seat fibreglass-hulled sports hydrofoil

W-2 REKIN

The W-2 is a projected hydrofoil ferry designed primarily for operation in the Baltic. Similar to the ZRYW-1, which was designed specifically for the relatively sheltered waters of the Szczecin Bay, the W-2 is slightly larger and more sturdily built. It will have a completely redesigned bow, V-foils of revised and deeper configuration and the more powerful Paxman Ventura 12YJXM marine-diesel, rated at 1,020 hp at 1,350 rpm.

Design of the W-2 and tests of the $\frac{1}{3}$ scale dynamic model illustrated in Jane's Surface Skimmer Systems 1967-8 edition are now complete.

DIMENSIONS:

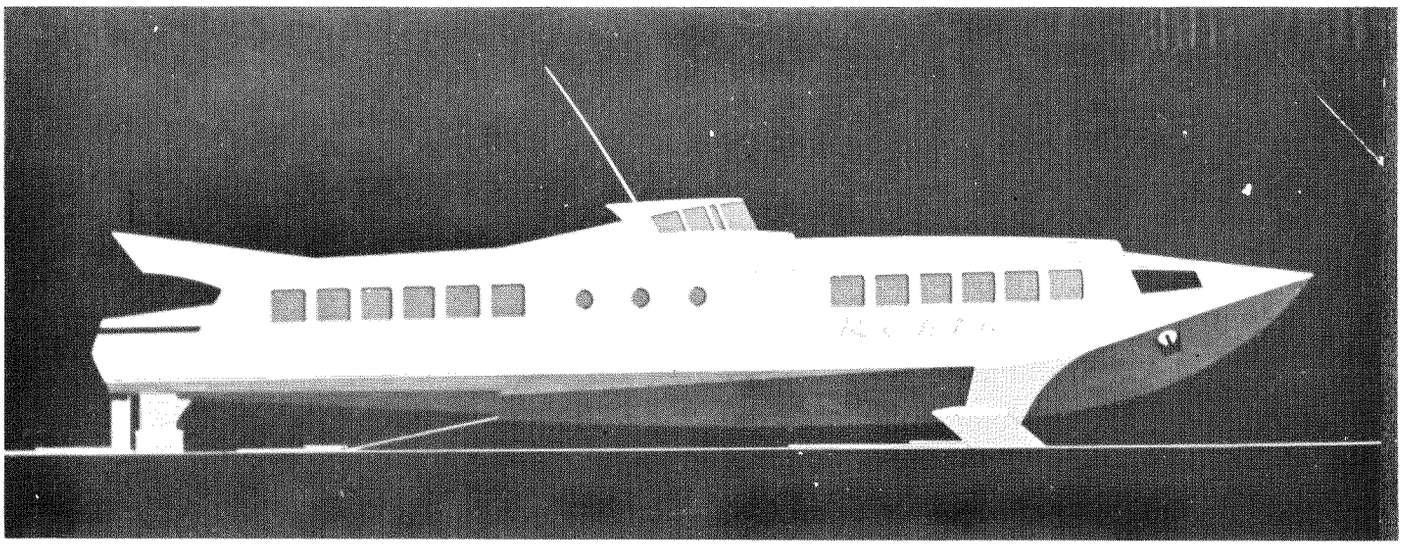
Length overall	93 ft 6 in (28·50 m)
Beam	15 ft 5 in (4·70 m)
Width across foils	24 ft 7 in (7·50 m)
Draught afloat	9 ft 1 in (2·75 m)
Draught foilborne	5 ft 5 in (1·65 m)

WEIGHTS:

Displacement, loaded	35 tons

PERFORMANCE:

Maximum speed	47 mph (75 km/h)
Cruising speed	40 mph (65 km/h)



Impression of the W-2 Rekin, a passenger hydrofoil designed at Gdansk University for services between ports on the Baltic

SWITZERLAND

Supramar

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Supramar was founded in Switzerland in 1952 to develop on a commercial basis the hydrofoil system introduced by the Schertel-Sachsenberg Hydrofoil Syndicate and its licencee, the Gebruder Sachsenberg Shipyard.

The co-operation between the companies started in 1937 and led to the development of the VS6, a 17 ton hydrofoil, which in 1941 attained 47·5 knots, and the VS8 an 80-ton supply hydrofoil completed in 1943 which attained 41 knots. The inherently stable, rigid V-foil system used on these and subsequent Supramar vessels, stems from experimental work undertaken by Baron Hanns von Schertel between 1927-1937.

In May 1953, a Supramar PT 10, 32-passenger hydrofoil began the world's first regular passenger hydrofoil service on Lake Maggiore, between Switzerland and Italy. In August 1956, the first Rodriquez-built Supramar PT 20 opened a service across the Straits of Messina and became the first hydrofoil to be licenced by a marine classification authority for carrying passengers at sea.

Basically a research and design company, Supramar employs a staff of 40, mainly highly qualified scientists and engineers specialising in hydrodynamics, marine engineering, foil design and propulsion. The company does not build hydrofoils but licences shipyards to produce its hydrofoil designs. Current licensees are Cantiere Navale Leopoldo Rodriquez, Messina, Italy; Hitachi Shipbuilding & Engineering Co Ltd, Osaka; Westermoen Hydrofoil A/S, Mandal, Norway; and the General Dynamics Corp, Quincy Division, Quincy, Mass, USA. Hydrofoils being built by these companies are referred to elsewhere in this section under the respective company headings.

The latest Supramar design to be completed is the PT 150 DC, a 165 ton passenger/car ferry, the first of which was built by Westermoen Hydrofoil A/S and put into service on June 28, 1968 between the cities of Gothenburg and Aalborg. The craft cruises at 35 knots in waves up to 8 ft (2·5 m) in height and will carry 150 passengers and eight cars, or 250 passengers. In February 1969 Westermoen Hydrofoil a/s received an order for two PT 150Ds (passenger version) from Joh. Presthus Rederi of Bergen. Construction of these craft is now under way.

The PT 150 has a partly air stabilised foil system, stability being maintained jointly by the inherent stability of the vee-shaped surface-piercing bow foil and the air-fed, fully-submerged rear foil.

The company is now developing a fully submerged foil system with air stabilisation. First craft to use this system is the Supramar ST 3A, a 4·9 ton experimental boat built under a US Navy contract. During tests in the Mediterranean it has demonstrated promising stability and seakeeping qualities and has reached a speed of 54·5 knots.

PT 4

A 4·4 ton hydrofoil with applications ranging from sightseeing and sport-fishing to fast passenger ferry, the PT 4 is designed for use on comparatively sheltered waters—lakes, rivers and bays. Powered by a 300 hp Chrysler M413D, it has a payload of 1·3 tons and cruises at 32 knots.

The PT 4 was given Board of Trade approval on completion of sea tests off the Cornish coast in March 1966. Since the craft is powered by a gasoline engine, passenger capacity is restricted to 12 persons in accordance with international safety regulations.

FOILS: The foil configuration is a combined surface-piercing and submerged system. The surface piercing bow foil supports 68% of the load and the fully submerged rear foil supports the remaining 32%. Total foil area is 1·16 m².

The bow foil is made in solid, machined FB 70 steel, and the rear foil which is of partly hollow construction, is in FB 70 and MSt 52·3 steel.

Bow and rear foils, together with their supporting struts and a horizontal guide form a uniform framework which facilitates the exchange of the foil structure.

The rudder, of combined hollow and solid steel construction, forms part of the aft foil frame.

Angle of incidence of the bow foil can be adjusted in flight by a hydraulic actuator to counteract the effect of large variations in passenger loads.

HULL: Constructed in seawater-resistant light metal alloy, the V-bottom hull is longitudinally framed, with web frames spaced 2·95 ft (900 mm) apart. Joints are partly welded, partly riveted. Steel is used for higher-stressed parts such as foil hull connections and the shaft bracket.

POWER PLANT: Power is supplied by 300 hp Chrysler M413D gasoline engine coupled to a reverse and reduction gear with a 2 : 1 reduction ratio.

Engine output is transmitted through an inclined shaft to a three-bladed bronze propeller located ahead of the rear foil.

SYSTEMS:

ELECTRICAL: 12V, 135 Ah batteries for electrical services.

HYDRAULICS: 120 kp/cm² pressure hydraulic system for operating rudder and bow foil angle of incidence.

COMMUNICATIONS:

RADIO: Small ship-shore radio-telephone.

DIMENSIONS, EXTERNAL:

Length overall, hull	37 ft 6 in (11·45 m)
Length over deck	36 ft 3 in (11·05 m)
Beam max	10 ft 6 in (3·20 m)
Width over foils	14 ft 2 in (4·32 m)
Draft afloat	4 ft 8 in (1·45 m)
Draft foilborne	1 ft 8 in (0·57 m)

DIMENSIONS, INTERNAL:

Cabin (Pilot stand incl):	
Length	15 ft 6 in (4·8 m)
Max. width	8 ft (2·4 m)
Max. height	6 ft 6 in (2·0 m)
Floor area	87 sq ft (8·0 m²)
Volume	813 cu ft (23·0 m³)

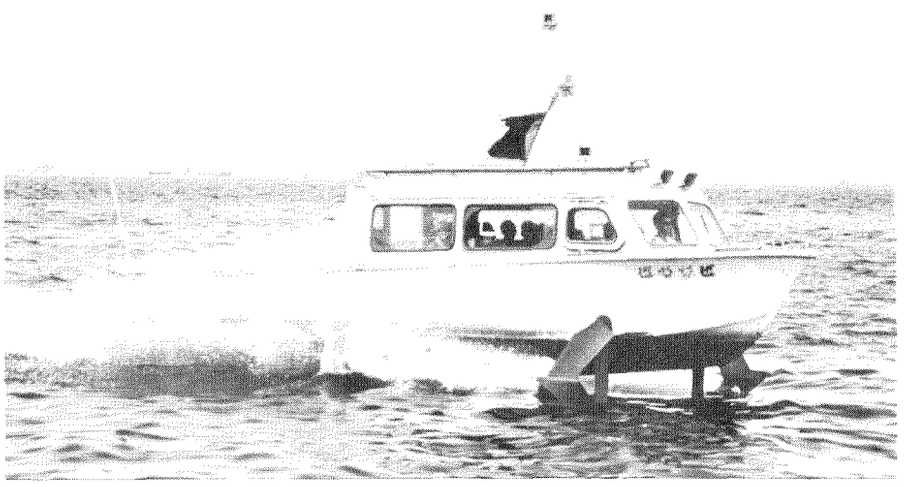
WEIGHTS:

Max take-off displacement	4·4 tons
Payload	1·275 tons
Light displacement	3·125 tons

PERFORMANCE:

Max speed foilborne	39 knots
Cruising speed foilborne	32 knots (60 km/h)
Range	155 nautical miles (290 km)

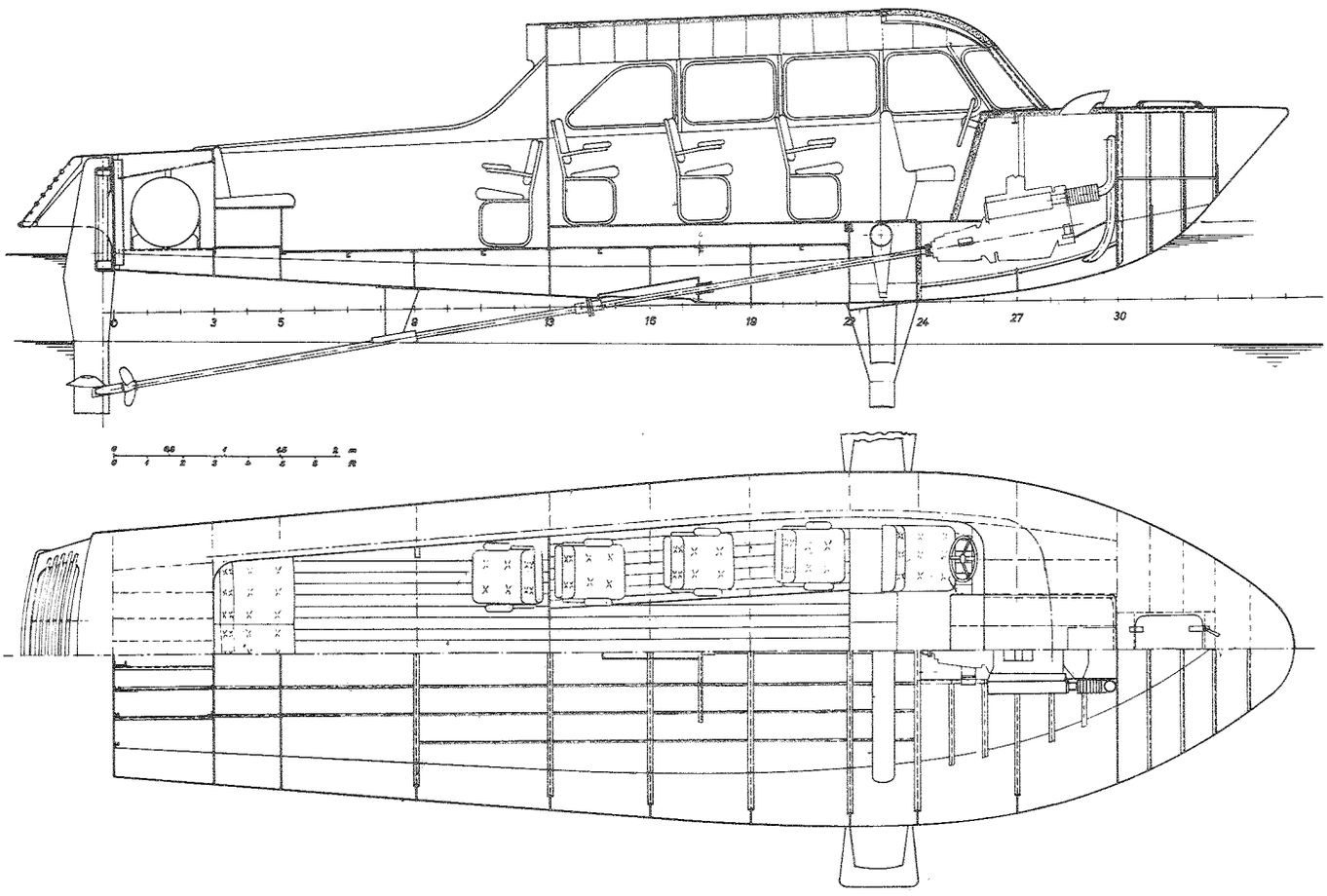
Cost of standard craft: approx $US 40,000



The Supramar PT 4 (one 300 hp Chrysler M413D) seats up to 12 passengers and is designed for services on lakes and rivers

HYDROFOILS

Switzerland: SUPRAMAR



Inboard profile and deck view of the Supramar PT 4

PT 10

A 13-ton boat for 32-36 passengers, the PT 10 has been designed for commuter and sightseeing services on inland waters and protected bays.

Powered by a single 540 hp Daimler-Benz MB 837 diesel engine, it is of riveted light metal alloy construction and has a cruising speed of 35 knots.

FOILS: Bow foil and rear foil are of standard Schertel-Sachsenberg surface piercing type, with the bow foil supporting 52% of the load and the rear foil supporting the remaining 48%. Both are made from solid high tensile steel, and their struts and fins are of hollow steel design. The two foils together with their supporting elements form rigid frame units which are easily attached or detached as necessary.

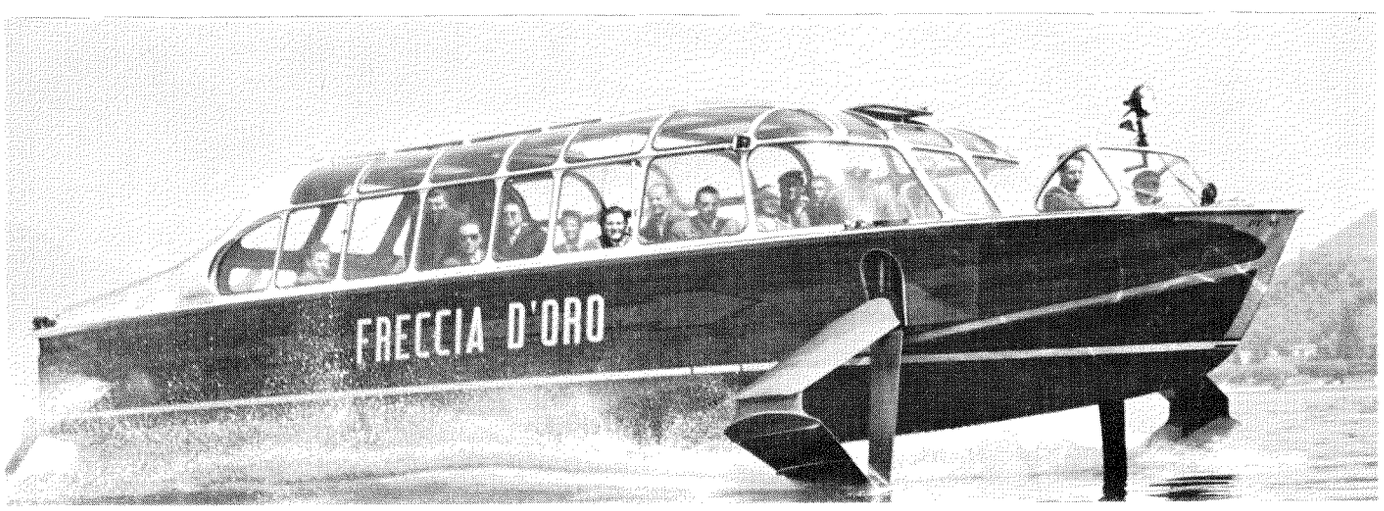
The angle of incidence of the bow foil may be adjusted during flight by means of a hydraulic actuator acting on the foil strut supporting tube.

RUDDER: Hydraulically operated, the rudder is of hollow, welded steel design, and forms part of the aft foil frame.

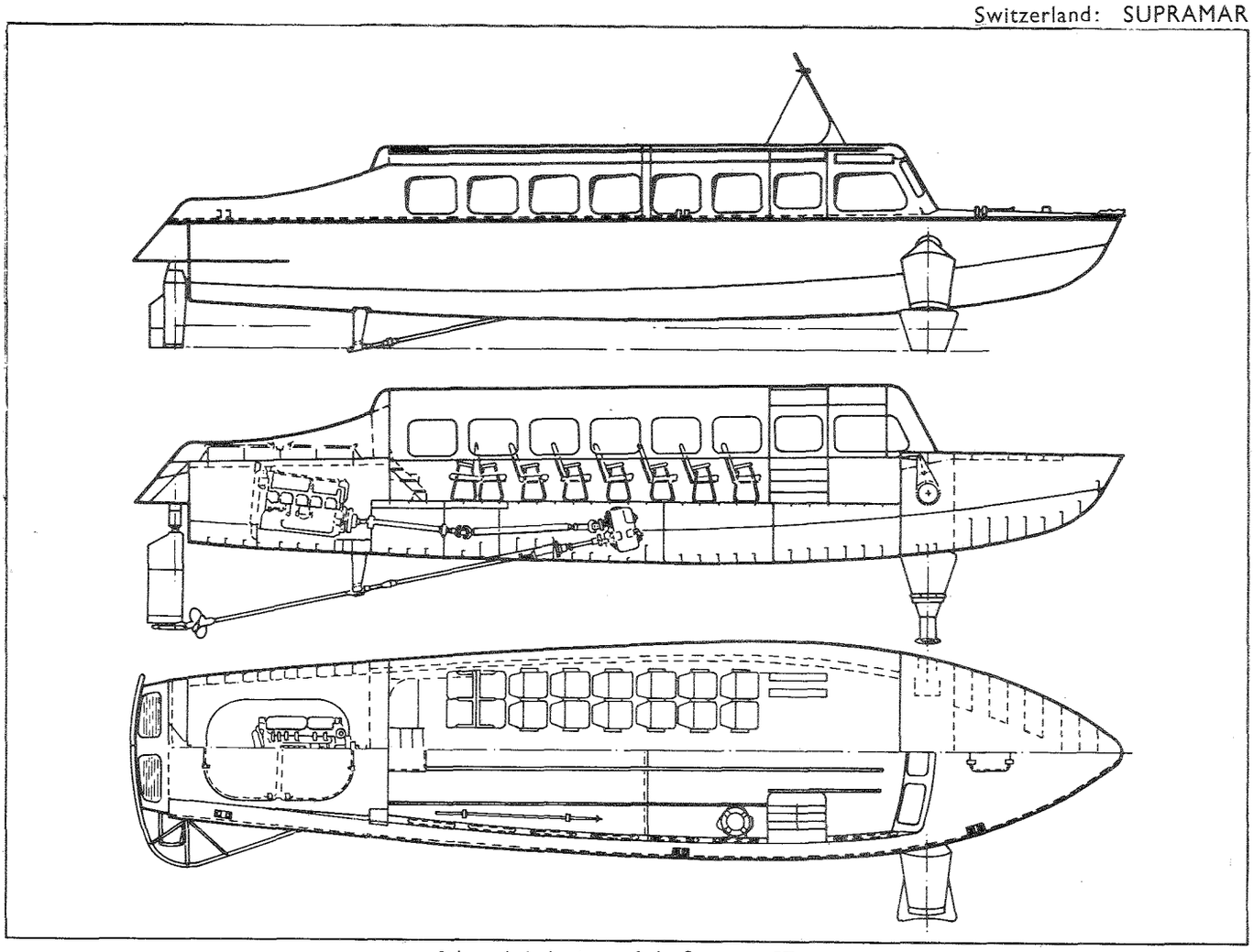
HULL: The V-bottom hull is of riveted light alloy construction. Transverse framing is employed with 1 ft (300 mm) frame spacing. Foil fittings, shaft brackets and the shaft exit are in high tensile steel.

ACCOMMODATION: A single cabin seats 32 passengers and a crew of 2. Access is through either of two sliding hatches, located forward, port and starboard aft of the steering-stand. An emergency window exit is provided at the aft end of the compartment. Lifebelts are provided for each passenger and the two crew members.

POWER PLANT: Power is supplied by a single Daimler-Benz MB 837 Ea 8-cylinder supercharged diesel, rated at 540 hp at 1,800 rpm. Engine output is transferred to the propeller through a V-drive and a stainless steel propeller shaft. A special reverse and reduction gear, type BW 200 ES 28, made by Zahnradfabrik Friedrichshafen, is placed between the engine and the drive shaft.



The Supramar PT10 (one 1,100 hp MB 820 Db diesel), a 32 passenger hydrofoil for sightseeing or commuter services on inland waters and protected bays



Side and deck views of the Supramar PT 10

SYSTEMS:

ELECTRICAL: 24 volt generator driven by the main engine; batteries with capacity of 500 Ah.

HYDRAULICS: 120 kp/cm² pressure hydraulic system for steering and bow foil incidence control.

COMMUNICATIONS AND NAVIGATION: Ship-shore radio telephone is fitted; radar is optional.

DIMENSIONS, EXTERNAL:

Length overall, hull	53·60 ft (16·34 m)
Length over deck	51·50 ft (15·70 m)
Max beam	11·81 ft (3·60 m)
Width over foils	18·50 ft (5·64 m)
Draft afloat	6·73 ft (2·05 m)
Draft foilborne	2·79 ft (0·85 m)

DIMENSIONS, INTERNAL:

Cabin (inc pilot stand):

Length	27 ft 7 in (8·4 m)
Width	8 ft 7 in (2·6 m)
Height	6 ft 3 in (1·9 m)
Floor area	234 sq ft (21·8 m²)
Volume	1,449 cu ft (41·0 m³)

WEIGHTS:

Light displacement	9·5 tons
Normal take-off displacement	13·3 tons
Normal payload	3·8 tons

PERFORMANCE:

Max speed foilborne	36 knots
Cruising speed foilborne	35 knots
Range at cruising speed	145 nautical miles
Turning radius app.	400 m
Take-off time	30 sec
Fuel consumption at cruising speed	90 kp/h
Cost of standard craft: app $US	160,000.

PT 20

The PT 20, a 27-ton boat for 72 passengers, is considered by Supramar to be the smallest size hydrofoil suitable for passenger-carrying coastal services. The first of this very successful series was built by the Rodriquez shipyard at Messina in 1955 and since then nearly 70 PT 20s of various types have been built in Sicily, Japan, Holland and Norway. The design has been approved by almost every classification society. Fast patrol boat variants, the PT 32 and the PAT 20, are described under the entries for Hitachi (Japan) and Leopoldo Rodriquez (Italy) respectively.

FOILS: Foils are of standard Schertel-Sachsenberg, surface-piercing type, with 58% of the load supported by the bow foil and the remaining 42% by the rear foil. Submerged foil area in foilborne condition is 5·50 m². Together with the struts and a horizontal guide, each foil forms a uniform framework which facilitates the exchange of the foil elements. The medium steel foils are of partly hollow, welded construction. The angle of incidence of the bow foil can be adjusted within narrow limits from the steering stand by means of a hydraulic ram operating on a foil support across the hull. To counteract the effects of large variations in passenger load and to ensure optimum behaviour in sea waves the angle of attack can be adjusted during operation. If required, the rear foil can be stabilized by the Schertel-Supramar air feed system. A fully submerged foil then replaces the standard surface piercing type.

HULL: The hull has a V-bottom with an externally added step riveted into place. Frames, bulkheads, foundations, superstructure and all internal construction is in corrosion-proof light alloy. Platings are of A1Mg 5 and the frames, bars and other members are made in A1MgSi. Watertight compartments are provided below the passenger decks and in other parts of the hull. Several of these are filled with foam-type plastic which makes these boats practically unsinkable.

POWER PLANT: Power is supplied by a supercharged, 12-cylinder Daimler-Benz MB 820Db with an exhaust turbo-compressor. Maximum continuous output is 1,100 hp at 1,400 rpm. A BW 800/HS 20 reversible gear, developed by Zahnradfabrik Friedrichshafen AG, is placed between the engine and the drive shaft.

ACCOMMODATION: The boat is controlled entirely from the bridge which is located above the engine room. Forty-six passengers are accommodated in the forward cabin, twenty in the rear compartment and six aft of the pilot's stand in the elevated wheelhouse. There is an emergency exit in each passenger compartment, and the craft is

HYDROFOILS

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equipped with an inflatable life raft and life belts for each person. A crew of four is carried.

SYSTEMS:

ELECTRICAL: 24 volt generator driven by the main engine; batteries with a capacity of approx 250 Ah.

HYDRAULICS: 120 kg/cm² pressure hydraulic system for rudder and bow foil incidence control.

COMMUNICATIONS AND NAVIGATION: VHF ship-shore radio is supplied as standard equipment. Radar is optional.

DIMENSIONS, EXTERNAL:

Length overall, hull	68·07 ft (20·75 m)
Length over deck	67·50 ft (19·95 m)
Hull beam, max	16·37 ft (4·99 m)
Width across foils	26·39 ft (8·07 m)
Draft hullborne	10·10 ft (3·08 m)
Draft foilborne	4·59 ft (1·40 m)

DIMENSIONS, INTERNAL:

Aft cabin (inc toilet)	145 sq ft (13·5 m²)
Volume	954 cu ft (27·0 m³)
Forward cabin	280 sq ft (26·0 m²)
Volume	1,766 cu ft (50·0 m³)
Main deck level (inc wheelhouse)	129 sq ft (12·0 m²)
Volume	847 cu ft (24·0 m³)

WEIGHTS:

Gross tonnage	approx 56 tons
Max take-off displacement	32 tons
Light displacement	25 tons
Deadweight (incl. fuel, oil, water, passengers, baggage and crew)	7 tons
Payload	5·4 tons

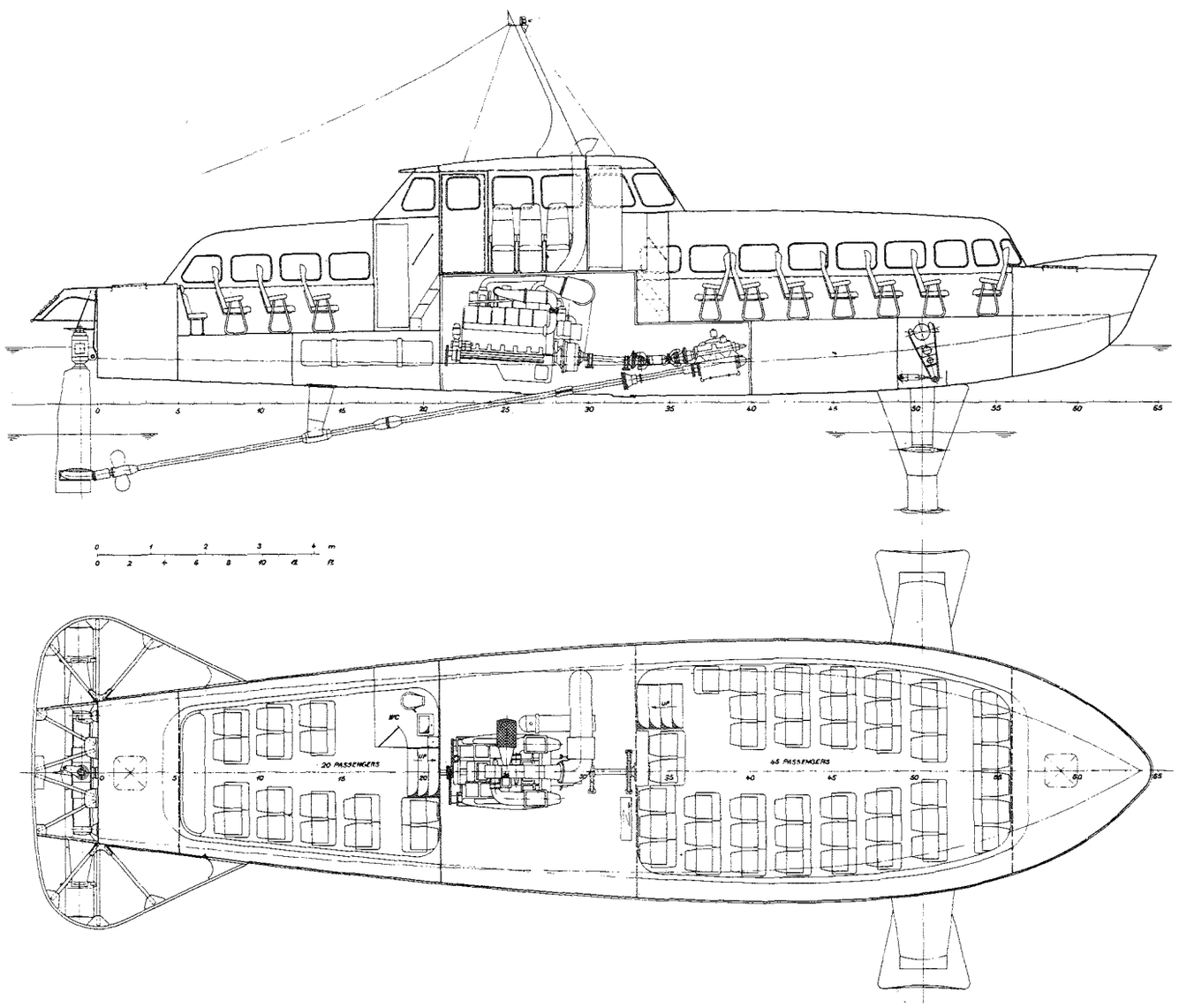
PERFORMANCE (with normal payload):

Cruising speed, foilborne	34 knots (63 km/h)
Max permissible wave height in foilborne mode	4·25 ft (1·29 m)
Designed range at cruising speed	216 nautical miles (400 km)
Turning radius	427 ft approx (130 m)
Take off distance	493 ft approx (150 m)
Take-off time	25 sec
Stopping distance	230 ft (70 m)

Fuel consumption at cruising speed 150 kp/h

SEA TEST: Prototype tests were undertaken in the Mediterranean in every kind of sea condition, and further tests have taken place off Japan. Acceleration measurements have shown maximum values below 0·5g when accelerometer had been fitted above the bow foil. Maximum lateral acceleration was 0·32g. Measurements were made in wave heights of approx 1·2 to 1·5 m. These are the maximum measurements obtained and subsequent tests have seldom equalled these figures.

Cost of standard craft: $US 330,000.



Inboard profile and main deck views of the PT 20

PT 20B

In this model of the PT 20, the engine room and bridge are arranged in the foreship. This improves the pilot's vision in waters likely to have an influx of driftwood and provides a large main passenger cabin with seats for 65 for commuter services.

The first four craft in this series, built for the servicing of offshore drilling platforms on Lake Maracaibo, Venezuela, were designated PT 27.

FOILS: The foil design is similar to that of the PT 20. About 66% of the total weight is borne by the bow foil and 34% by the rear foil. Submerged foil area in foilborne condition is 6·2 m². The forward foil can be tilted within narrow limits by means of a hydraulic ram acting on the foil strut supporting tube. The angle of attack can therefore be adjusted during operation to assist take-off and to counteract the effect of large variations in passenger loads.

The rear foil can be stabilized by the Schertel-Supramar air feed system with a fully-submerged foil replacing standard surface piercing type.

HULL. This is of riveted light metal alloy design and framed on a combination of longitudinal and transverse formers. Watertight compartments are provided below the passenger decks and in other parts of the hull, and some are filled with foam-type plastic.

POWER PLANT: Power is supplied by a 12 cyl Mercedes-Benz Mb 820 Db with a max continuous output of 1,100 hp at 1,400 rpm. Average service time between major overhauls is approx 10,000 hours. Engine output is transferred to a 3-bladed 700 mm diameter bronze subcavitating propeller through a BW 800/H 20 reversible gear made by Zahnradfabrik. The propeller shaft is of 3·5 in (90 mm) diameter stainless steel and supported at three points by seawater lubricated rubber bearings.

SYSTEMS:

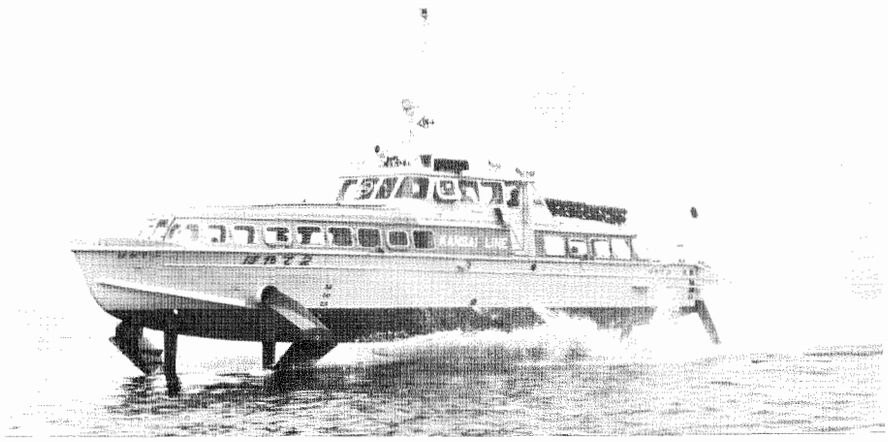
ELECTRICAL: MWM AKD412E single-phase, 220 volt, 7·1 kVa, 50 c/s generator.

HYDRAULICS: 120 kp/cm² pressure hydraulic system for operating rudder and bow foil angle of incidence control.

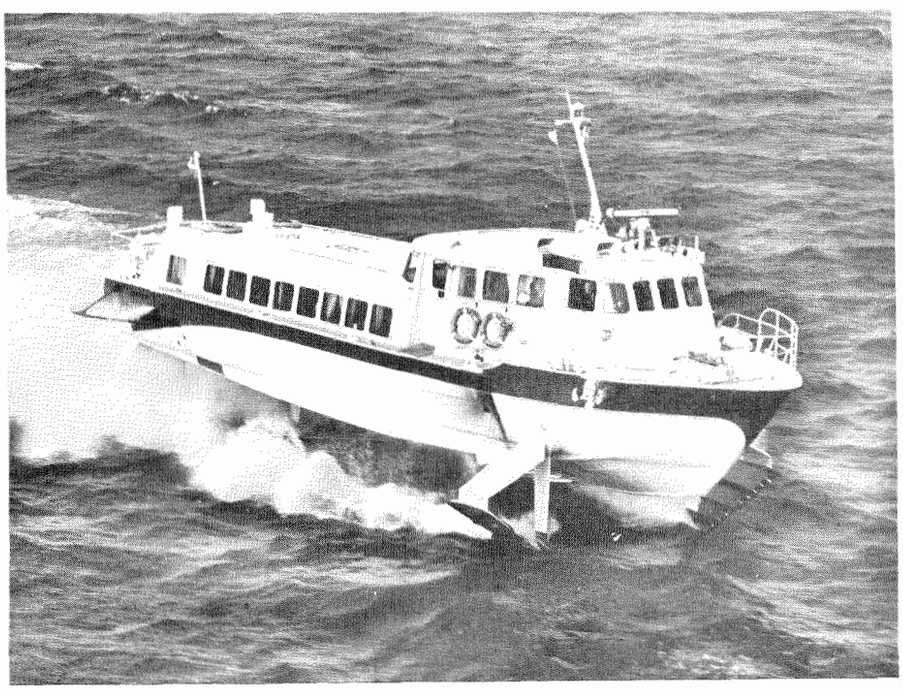
ACCOMMODATION: The PT 20B has a crew of 4 and seats 71 passengers. The main passenger compartment seats 65, and the small cabin behind the pilot's stand seats a further 16. Access to the main compartment is through either of two doors, located port and starboard, to the rear of the wheelhouse. An emergency exit is provided at the rear of the main passenger compartment.

A full range of safety equipment is carried, including inflatable rafts and lifebelts for each passenger and crew member.

COMMUNICATIONS AND NAVIGATION: A vhf ship-shore radio is supplied as standard equipment. Radar is an optional extra.



The PT 20, first passenger carrying hydrofoil to be approved by classification societies for coastal services



A feature of the PT 20B is the location of the bridge in the foreship to provide improved vision. The standard version seats sixteen passengers in the forward cabin above the engine room and fifty-four in the main compartment. Powered by an MB 820 Db diesel rated at 1,100 hp continuous, the craft cruises at 34 knots (63 km/h)

DIMENSIONS, EXTERNAL:

Length overall, hull	67·50 ft (20·58 m)
Length waterline, hull	67·10 ft (20·45 m)
Hull beam, max	17·05 ft (5·20 m)
Width over foils	26·40 ft (8·05 m)
Draft hullborne	10·04 ft (3·06 m)
Draft foilborne	4·56 ft (1·39 m)

DIMENSIONS, INTERNAL:

Main passenger compartment (inc toilet):	
Length	30 ft 7 in (9·3 m)
Width	12 ft 6 in (3·8 m)
Height	6 ft 7 in (2·0 m)
Floor area	379 sq ft (35·3 m²)
Volume	2,489·5 cu ft (70·6 m³)
Main deck compartment (inc wheelhouse)	
Length	17 ft 9 in (5·4 m)
Width	13 ft 6 in (4·1 m)
Height	6 ft 7 in (2·0 m)
Floor area	237 sq ft (22·1 m²)
Volume	1,553 cu ft (44·0 m³)

WEIGHT:

Max take-off displacement	32·5 tons
Light displacement	25·4 tons
Deadweight (inc fuel, oil, water, passengers, luggage, crew)	7·1 tons
Payload	5·44 tons

PERFORMANCE (with normal payload):

Cruising speed	34 knots (63 km/h)
Max permissible wave height in foilborne mode	4·25 ft (1·29 m)
Turning radius	426 ft (app 130 m)
Take-off distance	492 ft (app 150 m)
Take-off time	app 30 sec
Stopping distance	231 ft (app 70 m)
Stopping time	app 10 sec

Fuel consumption at cruising speed 150 kp/h

Cost of standard craft, app: $US 330,000

HYDROFOILS

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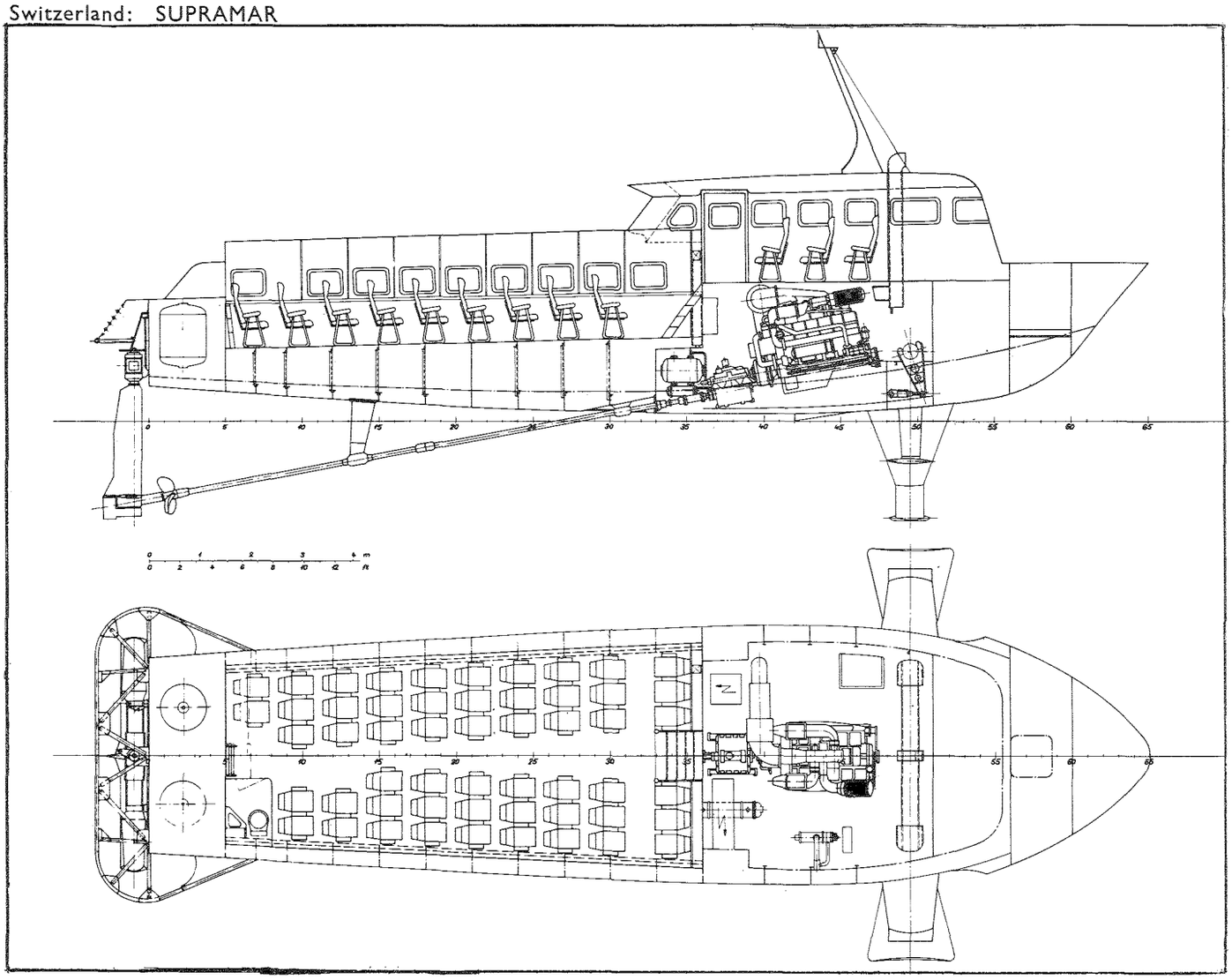


Inboard profile and main deck view of the PT 20B

PT 50

The successful and profitable operation of the PT 20 led to the development of the PT 50, a 63-ton hydrofoil passenger ferry designed for offshore and inter-island services. The prototype was completed by Rodriquez early in 1958, and more than thirty are now operating regular passenger services in areas ranging from the Baltic and Mediterranean to the Japanese Inland Sea.

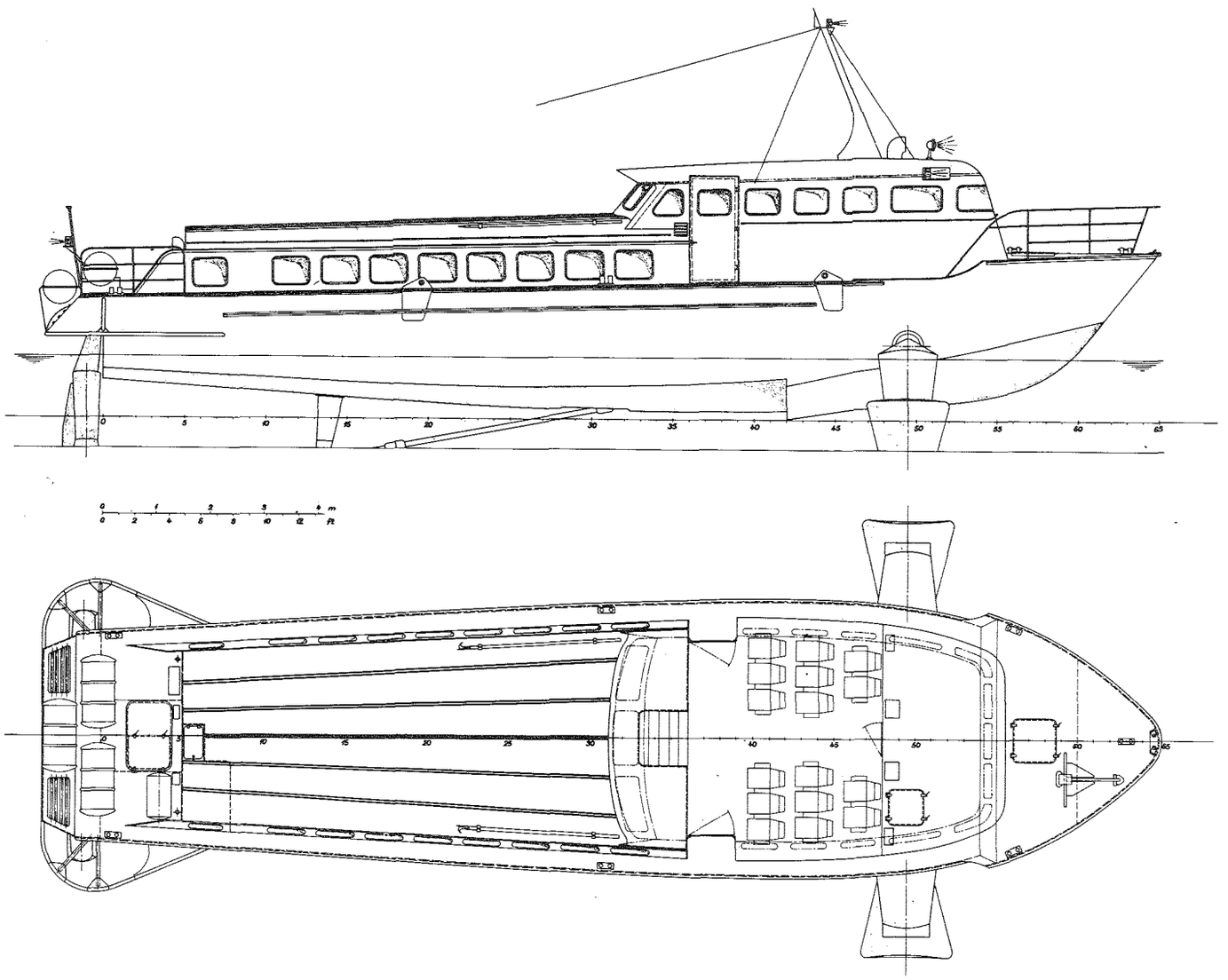
The craft has been approved by almost every Classification Society including Registro Italiano Navale, Germanischer Lloyd, Det Norske Veritas, American Bureau of Shipping and the Japanese Ministry of Transport. The requirements of the SOLAS 1960 convention for international traffic can be met by the type if required.

FOILS: Both rear and forward foils are rigidly attached to the hull but the lift of the forward foil can be modified by hydraulically-operated flaps, which are fitted to assist take-off and turning, and for making slight course corrections and adjustments of the flying height. The foils are of hollow construction using MSt 52-3 steel and GS 22 Cr Mo 4 castings.

The bow foil comprises the following elements:

Two fins, forming connecting links between the foil and the supporting structure which is riveted to the hull.

The hydrofoil which (according to its foil



PT 20B outboard profile and bridge deck plan

section characteristics) generates the lift and, with the stern foil, provides transverse stability in foilborne conditions.

Two struts, which transmit the main lift loads to the supporting structure.

The stern foil, also a rigid frame structure, is formed by the following:

A supporting structure (stern box) connecting the two sides of the frame at the transom.

Two struts, forming the connection between the foil and the supporting structure.

The surface-piercing V-foil.

The rudders, which also transmit the main part of the lift into the supporting structure.

The rear foil can be stabilised by the Schertel-Supramar air feed system, with a fully-submerged foil replacing the standard surface piercing type.

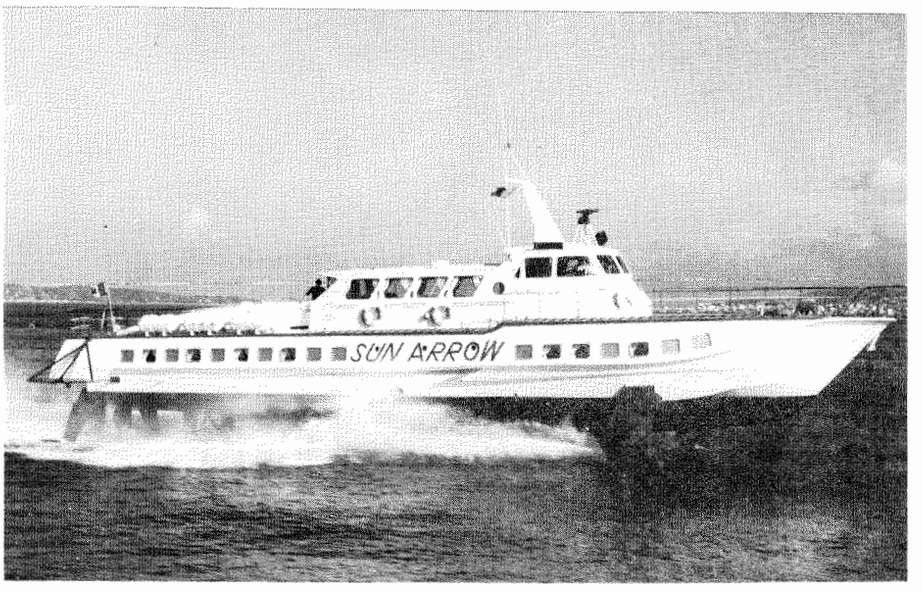
HULL: Of hard chine construction, the hull is of riveted light metal alloy design and framed on longitudinal and transverse formers. Steel is used only for highly stressed parts such as the foil fittings, and the shaft brackets and exits.

ACCOMMODATION: On long distance operations 105 passengers are carried in three saloons, two of which have bars. On shorter operations and ferry services the bars are omitted and seating can be provided for up to 140 passengers. The crew varies from 6-8 members, depending mainly on local regulations.

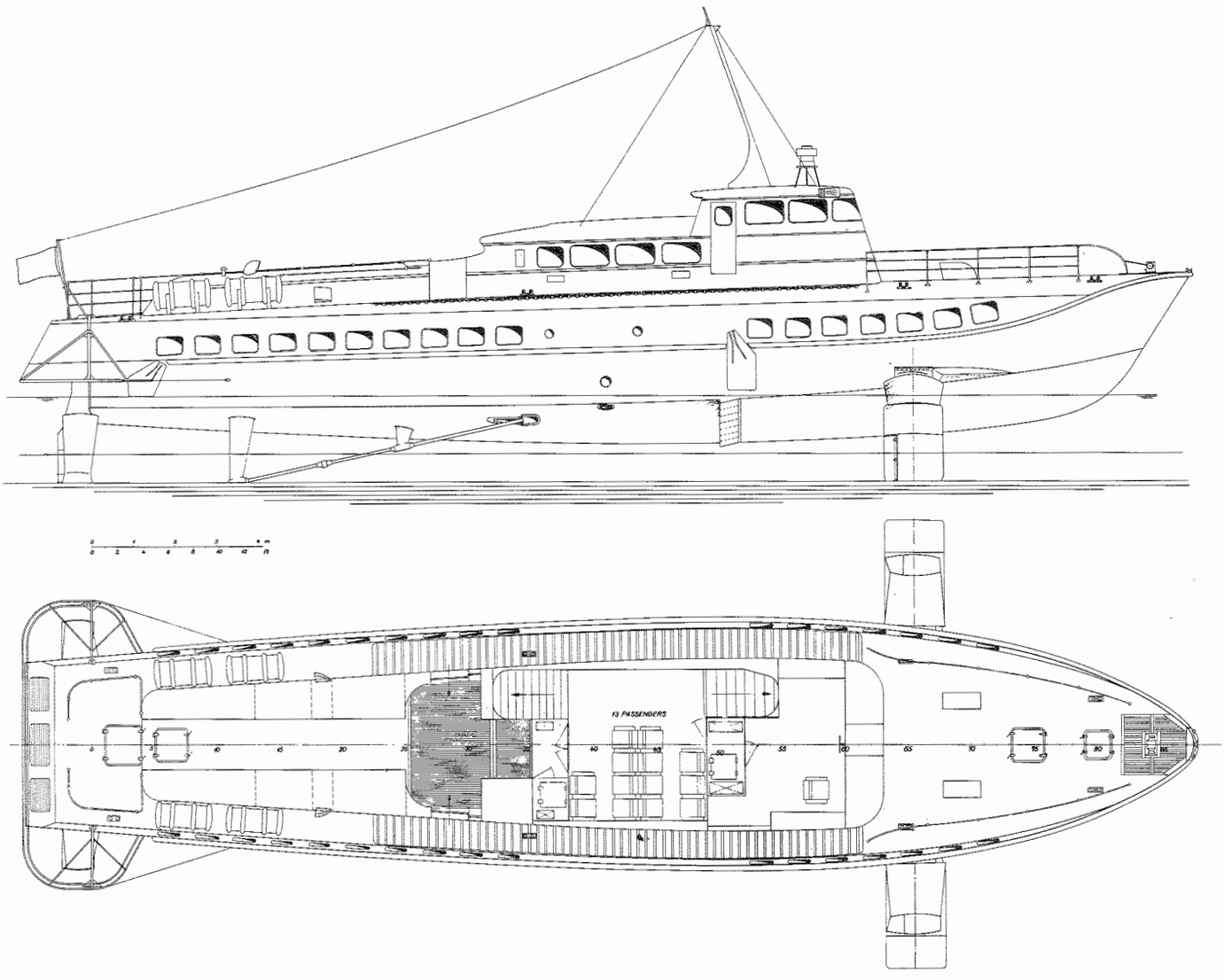
HYDROFOILS

Switzerland: SUPRAMAR

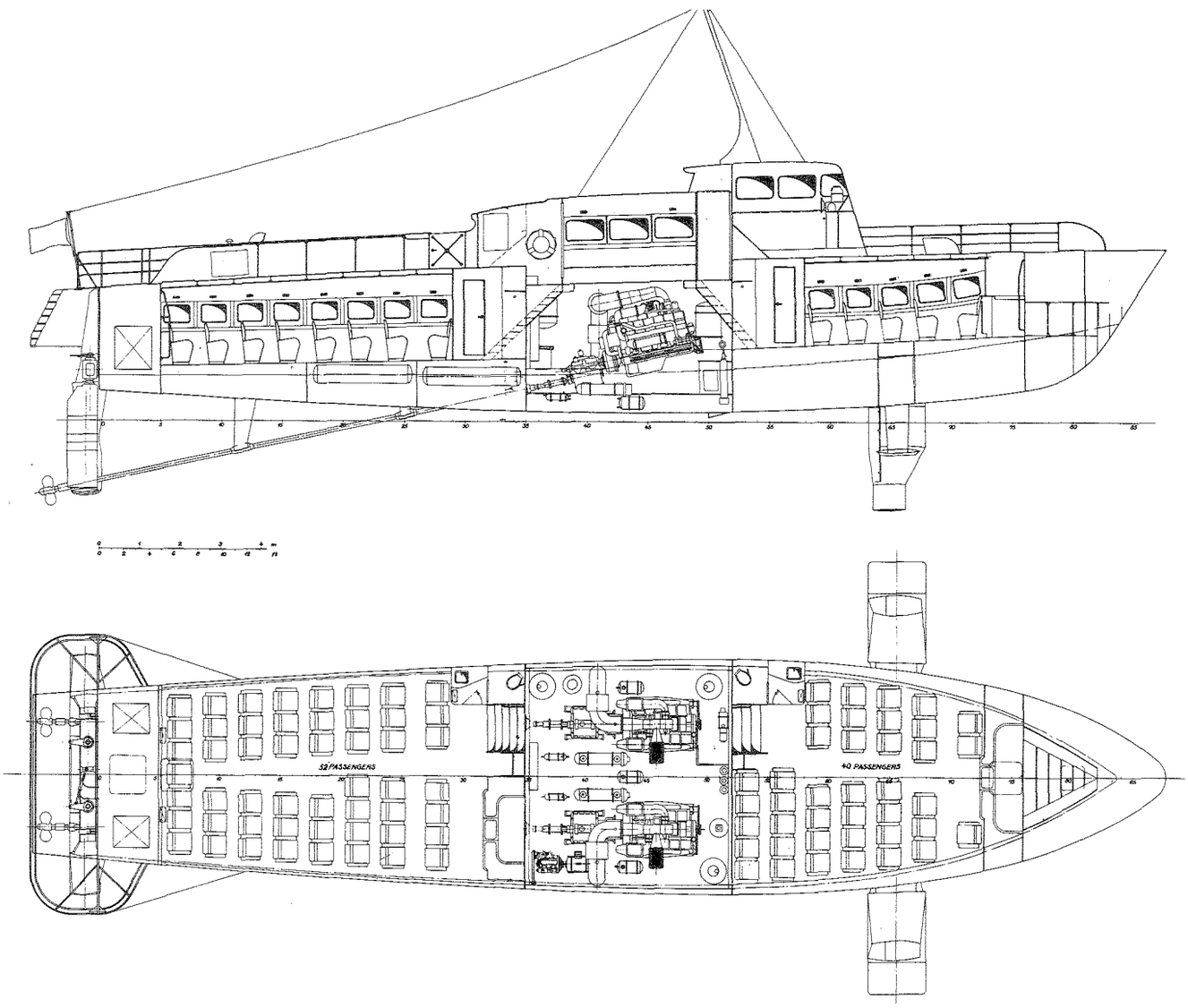
Passenger seats are of lightweight aircraft type and the centre aisle between the seat rows has a clear width of 30 in (0·76 m). Floors and ceilings are covered with lightweight plastic material and the walls, including web frames, are clad in luxury plywood. Toilets are provided in the rear and forward passenger spaces. Each passenger compartment has an emergency exit. Inflatable life rafts and lifebelts are provided for 110% of the passenger and crew capacity. POWER PLANT: The craft is powered by two Maybach-Mercedes-Banz MB 820 Db diesels each with a continuous output of 1,100 hp at 1,400 rpm. Engine output is transmitted to two 3-bladed 700 mm diameter bronze propellers through two inclined stainless steel propeller shafts, each supported at four points by seawater lubricated rubber bearings. Average operation period between overhauls is 10,000 hours. Electric or pneumatic starting can be provided. Reverse and reduction gear with built-in thrust is manufactured by Zahnradfabrik Friedrichshafen, Germany. The reverse clutches are solenoid-operated from the bridge.



A Rodriquez-built PT 50, a 63-ton hydrofoil with a cruising speed of 34 knots and seating up to 140 passengers



Outboard profile and bridge deck plan of the PT 50



Inboard profile and main deck view of the Supramar PT 50

Eight cylindrical fuel tanks with a total capacity of 3,650 litres are located in the aft peak and below the tank deck. Oil capacity is 320 litres.

SYSTEMS

ELECTRICAL: One diesel generator set, Daimler-Benz-Still, type DM 636-DAK 166-2, capacity 24 KVA, 50 cps, 3-phase. Engine-driven 24 V dc generator with 210 AH batteries for emergency lighting and navigation equipment.

HYDRAULICS: 120 kp/cm² pressure hydraulic system for operating twin rudders and front foil flaps.

COMMUNICATIONS AND NAVIGATION: Standard equipment includes UHF and VHF radio telephone. Radar and Decca Navigator is optional.

DIMENSIONS, EXTERNAL:

Length overall, hull	91·55 ft (27·90 m)
Length overall, deck	89·50 ft (27·23 m)
Hull beam, max	20·01 ft (6·11 m)
Width across foils	34·93 ft (10·68 m)
Draft afloat	11·48 ft (3·50 m)
Draft foilborne	4·66 ft (1·42 m)

DIMENSIONS, INTERNAL:

Aft passenger Compartment (incl. bar and toilet):	
Length	9·0 m
Width	4·9 m
Height	2·0 m
Floor area	44·1 m²
Volume	88·0 m³
Forward passenger compartment (incl bar and toilet):	
Length	7·1 m
Width	5·4 m
Height	2·0 m
Floor area	38·3 m²
Volume	76·6 m³
Main deck passenger compartment (incl wheelhouse):	
Length	8·0 m
Width	3·6 m
Height	2·0 m
Floor area	28·8 m²
Volume	57·6 m³

WEIGHTS:

Max take-off displacement	63·3 tons
Light displacement	49·3 tons
Deadweight (incl fuel, oil, water, passengers, baggage and crew)	14·0 tons
Payload	9·5 tons

PERFORMANCE (with normal payload):

Cruising speed	34 knots (63 km/h)
Range	300 nm (555 km)
Turning radius	1,542 ft (470 m)
Take-off distance	819 ft (250 m)
Take-off time	35 sec
Stopping distance	264 ft (80 m)
Time to stop craft	10 sec

Fuel consumption at cruising speed 300 kp/h

SEA TESTS: Location of the most recent test was off the south coast of Norway.

CONDITIONS:

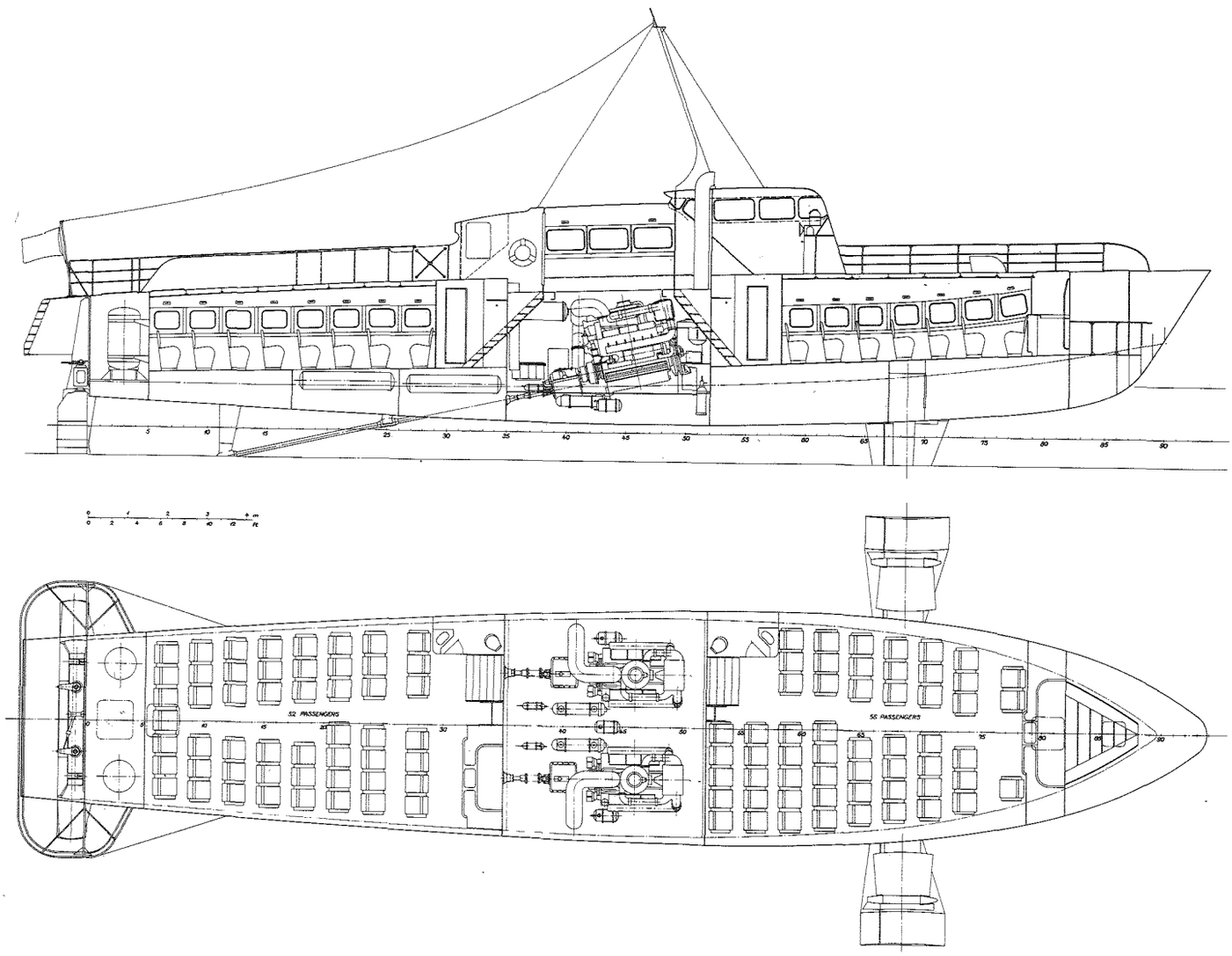
Beaufort	6-7
Speed of Boat	30 knots
Wave height	3 ft 4 in-5 ft (1·1·5 m)
Wave-length	65 ft 8 in-166 ft (20-50 m)

ACCELERATIONS:

Max vertical 0·5g bow foil; 0·37g stern foil

Max transverse

0·23g rear section; 0·32g forward section



Inboard profile and main deck of the PT 70, a hydrofoil passenger ferry designed to seat up to 155 passengers

The test, of 40 minutes duration, was undertaken in all wave directions and the above values were the absolute maximum obtained.

Cost of craft (standard): approx $US 650,000

PT 70

This recent addition to the Supramar design range is basically an enlarged and more powerful PT 50, seating up to 155 passengers. It is almost identical to the PT 50 in most respects but the hull length is increased by 6 ft (1·8 m) and there is a choice of three different twin-diesel power plants. The type has not been constructed so far.

FOILS: As for PT 50.

HULL: A combination of transverse and longitudinal framing has been adopted for the V-shaped hull. The bottom of the craft has transverse frames while the decks and sides are framed longitudinally. Thickness of the corrosion proof light metal alloy sheets is between ·08 in (2 mm) and ·20 in (5 mm). For several of the constructional members high tensile steel is used.

ACCOMMODATION: Normally seating is provided for 120 passengers. If the bars are omitted a further 35 seats can be installed.

POWER PLANT: Three different twin-engine arrangements are available:

Bridge of the PT 150

Two 1,450 hp Maybach-Mercedes Benz MB 835s; two 1,450 hp MB 655/18s, or two 1,500 hp Paxman Ventura 12YJCM. Fuel consumption of each of these engines is approx 170 gHPh or 0·38 lbHPh. Engine output is transferred to two 3-bladed bronze propellers through two inclined stainless steel shafts. Reduction and reverse gears are Zahnradfabrik Type BW 800/H20s with built-in thrust bearings.

SYSTEMS: As for PT 50.

DIMENSIONS, EXTERNAL:

Length overall, hull	96·75 ft (29·50 m)
Length overall, deck	95·00 ft (28·93 m)
Hull beam, max	19·80 ft (6·03 m)
Width over foils	34·95 ft (10·66 m)
Draft afloat	12·36 ft (3·77 m)
Draft foilborne	5·28 ft (1·66 m)

Main passenger compartment of the standard PT 150 seats 100 passengers

WEIGHT:

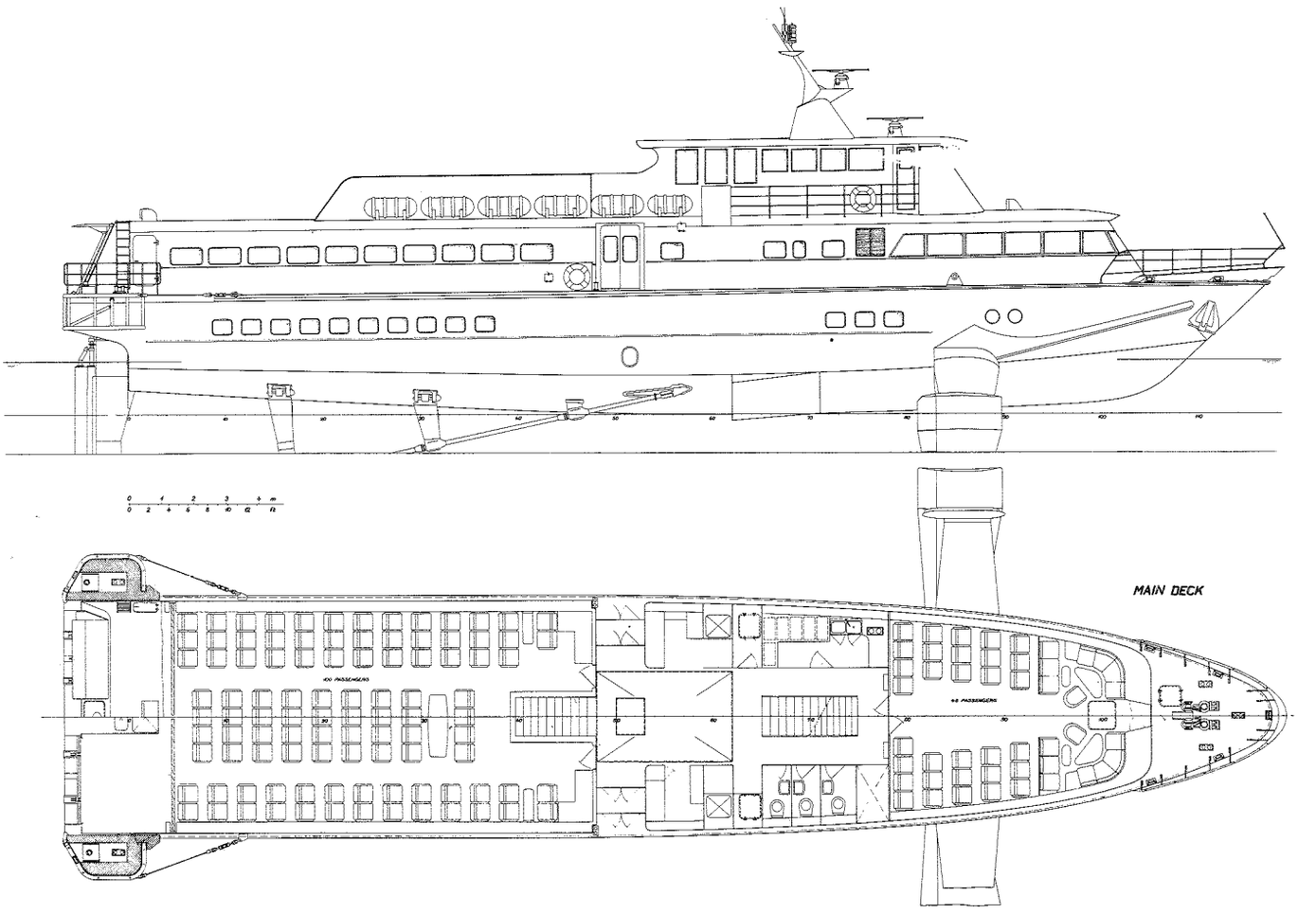
Displacement, fully loaded	70 tons

PERFORMANCE:

Cruising speed	35 knots (67 km/h)
Range	260 nm (480 km)

PT 150

In August 1966, Gothenburg-Fredrikshaven-Line placed an order with Westermoen Hydrofoil A/S, Mandel, Norway, for a 150 ton



Profile and main deck view of the Supramar PT 150

Supramar PT 150 to operate a fast passenger/car ferry service between Sweden and Denmark, calling at Gothenburg, Aalborg and Fredrikshavn. Originally the PT 150 was intended purely as a 250 seat passenger ferry, but at the request of the operating company, the basic design was modified to allow an alternative payload of 150 passengers and 8 cars to be carried

Close co-operation between the customer, Westermoen and Supramar led to the completion of the first craft within twenty-two months of the order being placed. The prototype PT 150, the world's largest seagoing commercial hydrofoil to date, was delivered at the end of June 1968.

Building was superintended by Norske Veritas, and the craft was granted the class designation 1A2-Hydrofoil-K.

FOILS: The foil configuration is a combined surface piercing and submerged system. The bow foil, which provides the necessary static lateral stability, is of the Schertel-Sachsenburg surface-piercing V design and carries 60% of the load. The rear foil, which bears about 40% is of the submerged, Schertel-Supramar air-stabilized type. In foilborne condition the boat is inherently stable.

Hydraulically-actuated flaps are fitted at the trailing edges of the bow foil to balance out larger longitudinal load shiftings, assist take off and adjust the flying height.

The rear foil is fully submerged and makes only a small contribution to lateral stability. It includes the lift-generating sections, rudders and the rear suspension structure which serves as a connecting element with the hull. Struts for the aftermost propeller bearings are also attached to the rear foil, the propellers being sited beneath the foil. The complete assembly is a framed structure which can easily be detached from the transom. The angle of attack of the rear foil can be controlled hydraulically both during take-off and when foilborne.

Air stabilisation is fitted to the rear foil for improved passenger comfort under heavy sea conditions. Separate port and starboard systems are installed to stabilise rolling and pitching.

The system feeds air from the free atmosphere through air exits to the foil upper surface (the low pressure region) decreasing the lift. The amount of lift is varied by the quantity of air admitted, this being controlled by a valve actuated by signals from a damped pendulum and a rate gyro. The stabilising moment is produced by decreasing the available air volume for the more submerged side and increasing that of the less submerged one.

The bowfoil centre section is also provided with submergence depth stablization, the quantity of air admitted being varied with the degree of submergence. The submergence depth control is only used in a following sea.

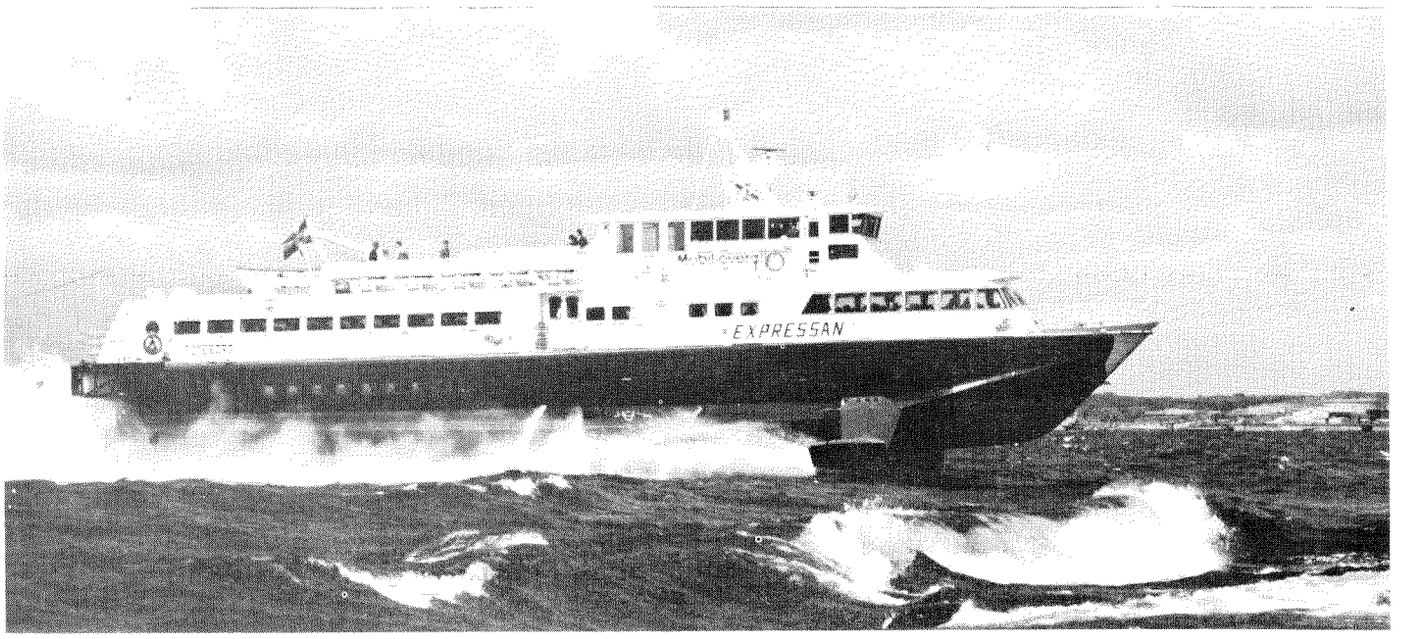
Front and rear foil are of hollow construction and by the extensive use of welding, the number of connecting parts requiring screws, bolts or similar means of attachment is reduced to a minimum.

HULL: This is of riveted light alloy construction and framed on longitudinal and transverse formers. It has fairly high dead-rise and hard chine sections for performance as a planing hull and for structural impacts in a seaway while foilborne. A step is provided to facilitate take-off. While the main or structure deck is continuous from bow to stern, the lower deck is interrupted by the engine room, sited amidships. The superstructure, which is also framed on longitudinal and transverse formers, is not included in the load bearing structure.

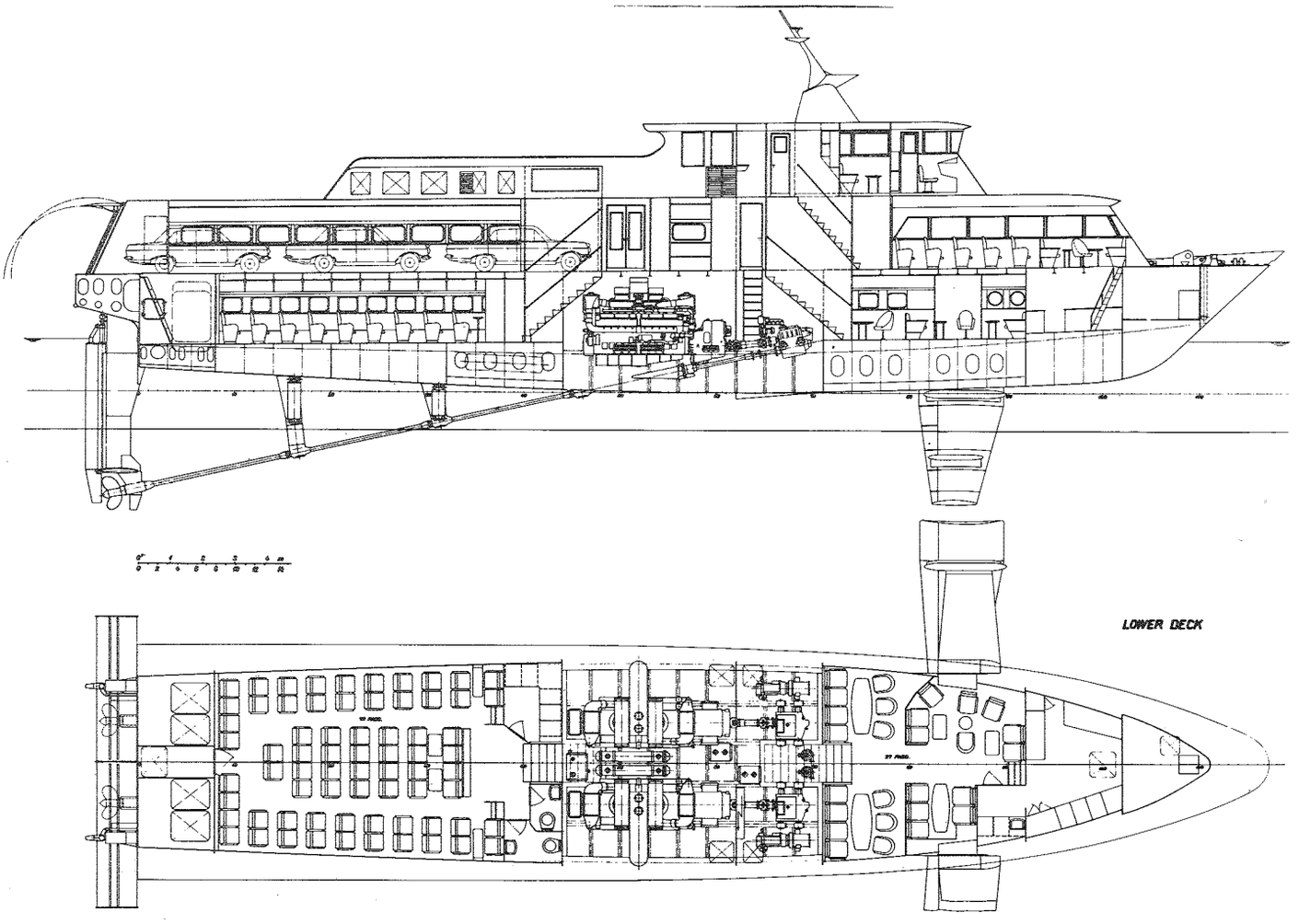
ACCOMMODATION: The forward part of the upper deck forms the forward upper passenger saloon, and seats 48. The aft saloon, which seats 100, is designed for rapid conversion to carry eight cars or the corresponding amount of palletised freight. Hydraulically-operated loading ramps at the rear of the superstructure are lowered for cars to roll on or off over the stern.

Passengers board the craft through double doors to the single centralized foyer, from which doors and companion ladders lead to the respective passenger saloons on the upper and lower decks.

HYDROFOILS
Switzerland: SUPRAMAR



The first PT 150, a 165 ton, 36 knot passenger/car ferry built by Westermoen Hydrofoil A/S, Mandal, Norway. The standard version seats 250



Supramar PT 150 prototype—Inboard profile and lower deck view.

The lower aft passenger saloon seats 70. A companion ladder at the centreline leads to the main deck foyer. The lower forward saloon has a bar and seats 27.

Provision is made for all passengers to be served in their seats with cold meals and drinks as in an airliner.

Passenger seats are of lightweight aircraft type. Floors and ceilings are covered with lightweight plastic material and the walls are clad in luxury plywood. Each passenger saloon has fitted carpets. Each room has an independent ventilation unit. Six toilets are provided.

The bridge, which is on a separate level above the main deck, slightly forward of midships, is reached by a companion ladder at the aft of the forward passenger compartment. The bridge itself has seating for another 5 passengers, but these are reserved for VIP guests of the shipping company. All passenger saloons have emergency exits.

The craft carries 12 inflatable RFD liferafts (for 110% of the classified number of passengers and crew) which are stowed along both sides of the superstructure deck, aft of the wheelhouse extension. Lifebelts are arranged beneath the seats.

POWER PLANT: Power is supplied by two 20-cylinder Maybach MD 20V 538 TB8 supercharged and intercooled diesels each rated at 3,400 hp continuous. To improve torque characteristics during take-off two engine mounted Maybach torque converters are provided.

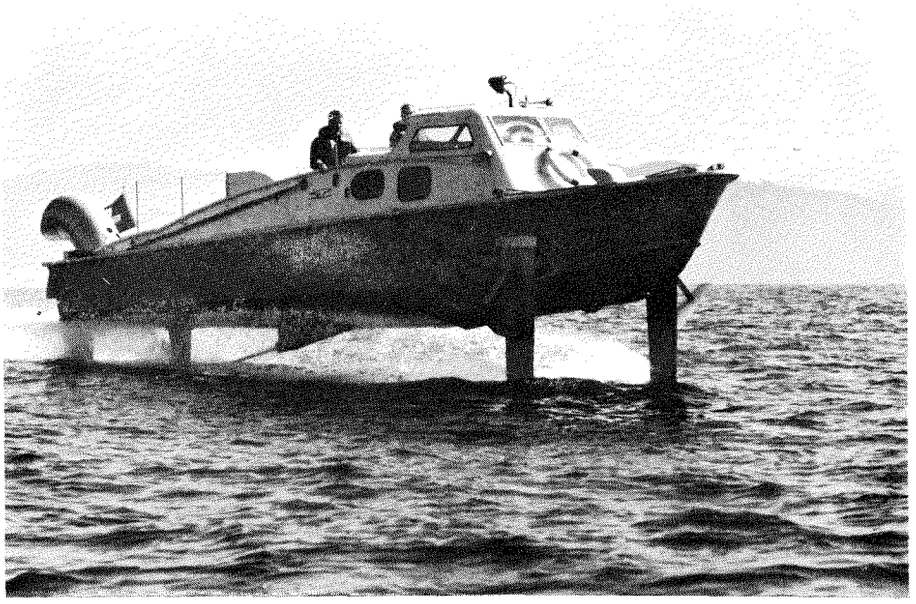
Reverse and reduction gears are of the lightweight Zahnradfabrik BW 1500HS18 hydraulically-operated type, and incorporate the propeller thrust bearings. They have three shafts and two gear trains, one of which has an idler. The output shafts rotate either in the same direction as the input shaft or the opposite direction, depending upon the gear through which power is directed. Selection is by pneumo-hydraulic double-plate clutches on the input shafts. A mechanical lock-up is provided so that the gear can transmit full torque in the event of clutch slip while in service. This takes the form of a dog clutch which is effective in one direction, and can only be engaged in the "stop" condition. The gearboxes each have integral oil pumps for lubrication and clutch operation.

The inclined propeller shafts are made of high tensile stainless steel. The propellers are 3-bladed and of approx. 41 inch diameter.

SYSTEMS:

ELECTRICAL: The total electrical system is supplied by two diesel generators with an output of 44 KVA each. An emergency diesel generator of 32 KVA output is installed on the upper deck.

In the event of an electrical failure the emergency generator is switched on automatically by a STILL starter to operate the emergency lighting system as well as the services and communications system.



The modified ST 3 being employed by Supramar as a research craft for the Schertel-Supramar fully-submerged air stabilized foil system. Powered by a single 1,000 hp GE 7LM100 PG102 gas turbine, the craft has attained 54.5 knots during tests in the Mediterranean

HYDRAULICS: Steering, variation of the front foil flap angle and the angle of attack of the rear foil are all operated hydraulically. Each system has its own circuit which is monitored by a pressure controlled pilot lamp.

CONTROL: Starting, manoeuvring and operation of the craft is controlled from the bridge, but in cases of emergency the main engines may be controlled from the engine room.

The two main engines are each controlled by an operating lever designed for single-handed control. Propeller reversal is also by means of these levers, the reverse gear being actuated by pneumatic remote control between bridge and main engines.

To start the boat both operating levers must be put in the "full ahead" position simultaneously. The engine mounted torque converter gear is actuated automatically. Foilborne speed can be regulated by five adjusting of the operating levers. No other control devices are necessary for the main engines.

Levers for variation of the front foil flap angle and the angle of attack of the rear foil are actuated only before and after starting. During foilborne operation these can be used for trim compensation. All instrumentation and monitoring equipment is installed on the bridge.

COMMUNICATION AND NAVIGATION: Standard navigation equipment of the PT 150 DC includes two Raytheon 2502-3 cm radar units with IP-33 display panels, one of which is north-stabilized; an Arma Brown gyro compass type Mk 1 Mod 5; a Plath T 12 magnetic compass and a Decca Navigator Mk. 12 with track plotter.

Communications equipment includes a Fisher F811 coast telephony station, a VHF telephony transceiver type ME-23C, produced by SRA Stockholm, and an intercom system to the engine room and office.

DIMENSIONS, EXTERNAL:

Length overall, hull	123·2 ft (37·55 m)
Length overall, deck	121·8 ft (37·10 m)
Hull beam, max	24·6 ft (7·50 m)
Deck beam, max	24·3 ft (7·40 m)
Width across foils	52·45 ft (16·0 m)
Draft afloat	17·7 ft (5·38 m)
Draft foilborne	8·3 ft (2·53 m)

WEIGHTS:

Displacement, fully loaded	165 tons
Payload	23 tons
As passenger ferry	250 passengers
As passenger/car ferry	150 passengers + 8 medium size cars

PERFORMANCE:

Cruising speed at 6,880 hp	36 kt (66·5 km/h)
Cruising range	300 nautical miles (555 km)
Max permissible wave height in foilborne mode at full power	7 ft 6 in (2·28 m)
Approximate cost	$US 1,500,000

HYDROFOILS

SUPRAMAR: Switzerland

ST 3A FULLY SUBMERGED FOIL RESEARCH CRAFT

In 1965 the US Navy awarded Supramar a contract for the construction and testing of a 5-ton research craft with fully submerged air stabilized foils. The object of the tests was the investigation of the effectiveness and reliability of the Schertel-Supramar air stabilization system under a variety of wave conditions.

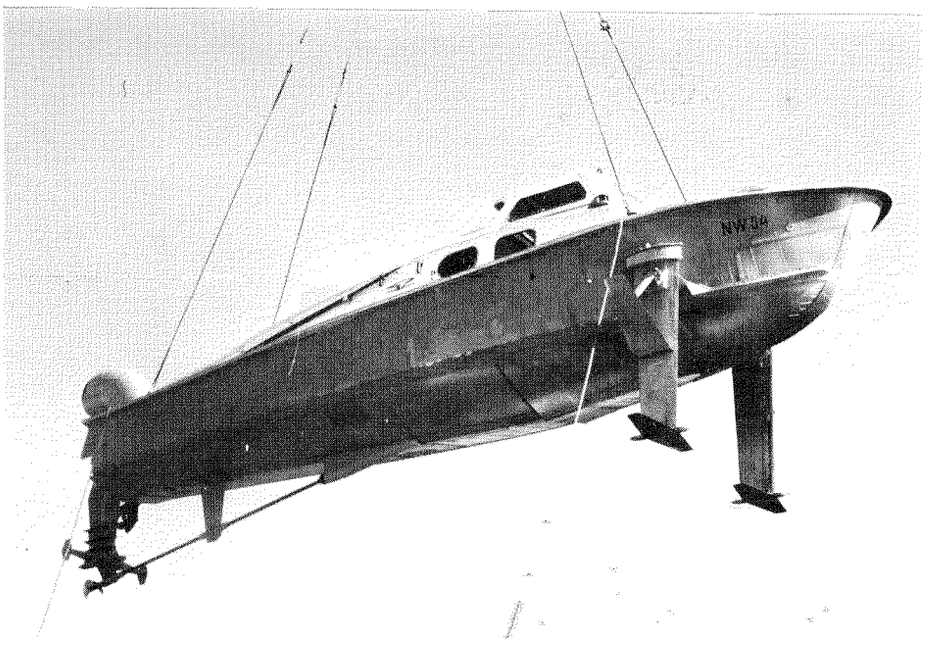
FOIL SYSTEM: The craft is fitted with two fully submerged bow foils and one fully submerged rear foil. The load distribution is 62% on the bow foils and 38% on rear foil. The centre of the front foils is 3 ft 11 in (1·20 m) from the craft centre line. Normal submergence depth for the bow foils is 1 ft 8 in (0·50 m) and for the rear foil 1 ft 2 in (0·35 m). Foil outlines are tapered. The foils are in solid stainless steel "Remanit" 2604 Mo S (standard German designation: X4 Cv Ni Mo Nb 25 7).

The front foils are connected by 5 ft 3 in (1·6 m) long struts to a supporting tube to which they are flanged. The tube pivots to enable the angle of attack to be adjusted.

The struts are of welded stainless steel plate and have solid leading edges. At their top is a casing which accommodates the devices for transmitting signals from the sensors to the air valves which are located in the foil centres. On the outer faces of the front foil struts are small auxiliary fins which give added stability during the transition from displacement condition to the onset of air stabilization. The rudder flap is attached to the end of the rear foil strut.

AIR FEED SYSTEM: Lift variation is achieved without movable foil parts. Each foil has two air ducts with outlets on the suction side. Air is drawn through these apertures from the free atmosphere via the foil suspension tube and the hollow struts. Air valves, controlled by sensors, govern the quantity of air admitted to the respective ducts. Lift is normally only influenced by the air emitting from the rearward row of outlets. No power is required for a change in lift. The forward row, which is fed by overpressure, is automatically engaged for attaining very low or negative lift. For this purpose, a comparatively small quantity of air is drained off from the last stage of the turbine compressor, reduced by a valve to about 1 atm, and then accumulated in a reservoir before it is led to the control valve. The slight power loss in the turbine is compensated by a drag reduction of the foil which takes place in the pressure fed condition.

CONTROLS: The signals of a depth sensor, a rate gyro and damped pendulum are added and amplified. The pneumatic follow-up amplifier draws its propulsion power from the subpressure which is produced at a suction opening at the strut near the foil. The amplifier output is connected with the air valve. The depth sensor probes the submergence depth digitally by means of suction orifices at the front struts. No motor-driven power source is required for the control system which, as well as the air feed system for lift variation of the foils, is designed for simplicity and reliability.



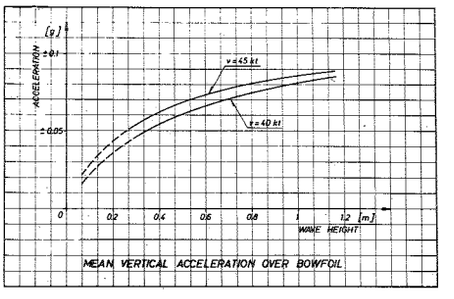
The ST 3A showing the fully-submerged air-stabilized foils. Two small dihedral fins are attached to the outer sides of the struts of the two bow foils to provide additional stability during the transition from hullborne to foilborne mode

HULL: The hull, which is of hard chine construction, is bascially that of a standard Supramar ST 3, modified to accommodate a new foil system, gas turbine and test equipment. To facilitate take-off, a step is provided at frame 24 (see inboard profile) and a ram wedge is fastened to the stern bottom.

The hull clearance (tip of step to water surface) of only 1 ft 2½ in (0·36 m) was due to the requirement that an existing ST 3 hull, with an inclined propeller shaft, should be used for the tests.

Hull, transverse framing and superstructure are of riveted light metal alloy. The main engine, ducting for fresh air, exhaust pipe and most of the auxiliary units are positioned between frames 0-16½.

Above the Vee-drive, between frames 16½ and 20, there is an observation platform which lies 8 in (200 mm) lower than the turbine casing. From this platform the outer section of the front foils can be observed. A short staircase at frame 20 leads to the wheelhouse which extends forward to bulkhead 31. At the front of the wheelhouse are two seats for pilot and observer, controls and the steering wheel which is hydraulically connected with the rudder flap. In the rear section two benches are arranged in longitudinal direction. The stabilization control device is located direct behind bulkhead 31 so that it can be easily watched by the observer. The sequence and control system for the gas turbine is arranged on the port side, between frames 20 and 23.



Graph showing mean vertical accelerations over the ST 3A's bow foil in a seaway

POWER PLANT: The craft is powered by a 1,000 hp GE 7LM100 PG 102 gas turbine. Engine output is transferred to a 1 ft 3 in (0·38 m) diameter S-C bronze propeller through a reduction gear, a Vee-drive and an inclined stainless steel shaft. A 35 hp Mercury outboard is installed on the port side of the transom to provide auxiliary propulsion. To feed the stabilization gyros a 6 hp gasoline engine is installed in the forepeak and coupled to a 3-phase ac generator.

DIMENSIONS:

Length overall (hull)	33 ft 10 in (10·32 m)
Breadth over foils	11 ft 10 in (3·6 m)
Breadth over hull	8 ft 10 in (2·7 m)
Draft hullborne	5 ft 1 in (1·55 m)
Draft foilborne (front foil)	1 ft 7½ in (0·5 m)
Hull clearance	1 ft 2½ in (0·36 m)

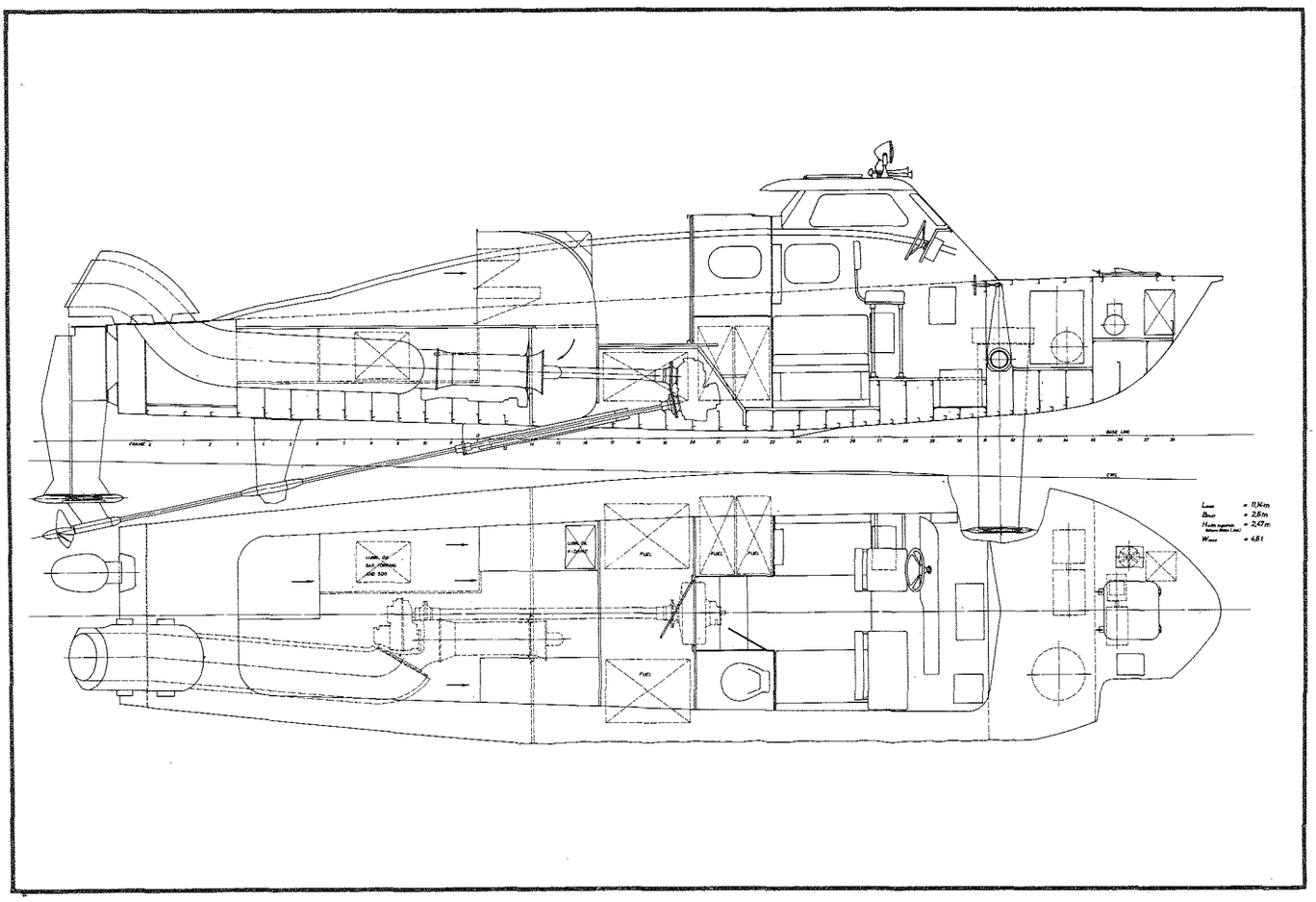
WEIGHTS:

Displacement	4·9 tons

PERFORMANCE:

Max measured test speed	54·5 knots (101 km/h)
Max. speed (design)	56 knots (104 km/h)
Take-off time	14·5 sec
Stopping distance (50 kt to 5 kt)	390 ft (120 m)
Turning radius at 40 kt	750 ft (230 m)

SEA TEST: Sea trials along the Mediterranean coast revealed that the craft, despite a small hull clearance, is capable of taking waves 3·4 ft (0·9-1·2 m) high, and with a minimum length of about 100-120 ft (30·4-36·4 m), at 45 kt in all courses from head to beam seas, partially contouring. In waves over 4 ft (1·2 m) the hull periodically touches wave crests, which is accompanied by a marked speed reduction (very high froude number) during water contacting. In a following sea, and in all courses up to about 60° to a following sea, foilborne operation was limited to 2½ ft (0·76 m) waves due to the control system, which at that time had no heave sensor. A further improvement will be achieved when the lower foil side feeding, which is still under development, materialises. The smooth run in waves can be seen in the accompanying table of mean vertical acceleration over the bow foil. At a wave height of 3 ft (0·91 m) (1/10 of boat length), vertical accelerations of only 0·08 g have been measured, which compares very favourably with the sea test results of other craft with fully submerged foils.



Inboard profile and deck plan of the ST 3A foil research craft

UNITED KINGDOM

Airavia

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Formed in January 1968, Airavia is the sales representative for Sudoimport hydrofoils and air cushion vehicles in the United Kingdom, British Commonwealth countries, Scandinavia and Western Europe. The company will also lease Kometa passenger hydrofoils on wet or dry charters in these areas. Airavia has imported eleven Volga sports craft and has ordered a Kometa for service on a route in the United Kingdom, subject to a passenger licence being granted by the Board of Trade.

Anglian

ANGLIAN DEVELOPMENT

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C. I. Browne
SENIOR EXECUTIVE:
P. A. Nott MA (Cantab)

Development of the Hi-foil started in 1964 and the craft is the company's only product to date. It is the first sports hydrofoil designed in the UK to go into production, and has been sold to private owners in many parts of the world.

Hi-foil 2

FOILS: The foil system is of canard configuration with a fully submerged main foil located at the stern, and bearing 67% of the weight, and a small inverted 'V' emerging foil located at the bow.

The bow foil is mounted at the base of a handle-bar equipped steering head, an arrangement similar to that of a motor cycle. The operator turns the handlebars and leans inwards to match the radius of turn required. The foil system is designed to maintain stability in a turn and prevent 'digging-in' or 'skidding'. If the craft meets a large wave, the increased drag pivots the front foil against a spring and shock absorber to a lower angle of incidence, thus producing less lift and helping to dampen both porpoising and shocks.

HULL: A flat-bottomed planing design, the hull comprises two fibreglass mouldings bonded together to form a single large buoyancy chamber.

The cockpit well is located amidships and fitted with a motor cycle pillion style seat for two. The seat is fitted with a safety ignition cut-out switch and unless the operator is sitting on the seat the motor will not operate.

Hi-Foil 2, a two-seat, fibreglass-hulled sports hydrofoil. The bow foil is mounted at the base of a handle-bar equipped steering head. Top speed is 25-35 mph according to the outboard motor installed

Beneath the seat is a portable 5 gallon fuel tank. A 3-position gear lever—forward, neutral, reverse—is mounted at the side of the cockpit, and a twist-grip controls engine output. The central boss in the steering head will house a speedometer or compass if required.

The forward deck section, with the steering head and front foil, hinge upwards for transport and easy launching, as do the motor and rear foil, which are mounted on a pivoted steel frame.

POWER PLANT: The craft can be fitted with any standard long-shaft outboard from 15-25 hp. A subcavitating propeller of about 9 in (229 mm) diameter is normally used.

DIMENSIONS:

Length overall, hull	8 ft 10 in (2·69 m)
Length waterline, hull	7 ft 10 in (2·38 m)
Length overall, foils retracted	9 ft 10 in (2·99 m)
Length overall, foils extended	8 ft 10 in (2·69 m)
Hull beam	3 ft 5 in (1·04 m)
Beam across foils	3 ft 5 in (1·04 m)
Draft afloat, foils extended	2 ft 9 in (0·8 m)
Draft afloat, foils retracted	9 in (230 mm)
Draft foilborne	1 ft 4 in (0·4 m)
Freeboard	6 in (153 mm)
Height overall, foils extended	4 ft 2 in (1·27 m)

WEIGHTS:

Craft and motor without fuel	300 lb (136 kg)
Max take-off weight with fuel driver and passenger	650 lb (294 kg) app

POWER PLANT: The craft can be fitted with any standard long-shaft outboard from 15-25 hp. A subcavitating propeller of about 9 in (229 mm) diameter is normally used.

DIMENSIONS:

Length overall, hull 8 ft 10 in (2·69 m)

PERFORMANCE:

Max speed foilborne 30 mph (48·2 km/h)

Cruising speed foilborne 20 mph (32·2 km/h)

Max permissible wave height in foilborne mode 12 in (306 mm)

Turning radius at cruising speed:

Number of seconds and distance to take-off 5 secs, 60 ft (18·28 m)

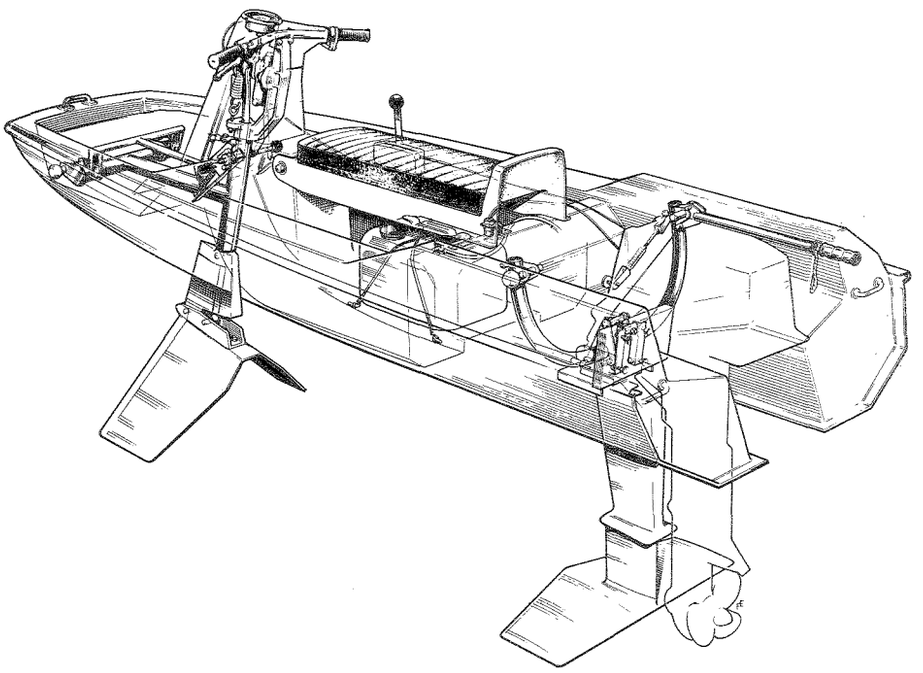
Number of seconds and distance to stop craft 3 secs, 60 ft (18·28 m)

Fuel consumption at max speed $2\frac{1}{2}$ gal. p/h (9·2 lit p/h)

Fuel consumption at cruising speed $1\frac{1}{2}$ gal/ p/h (6·7 lit. p/h)

COST:

Standard craft, f.o.b., less engine, £150



Hi-Foil 2 sports hydrofoil

Hydrofin

NEW HYDROFIN LTD

HEAD OFFICE:

Burfield Flat, Bosham Lane, Bosham, Sussex

MANAGING DIRECTOR:

Christopher Hook

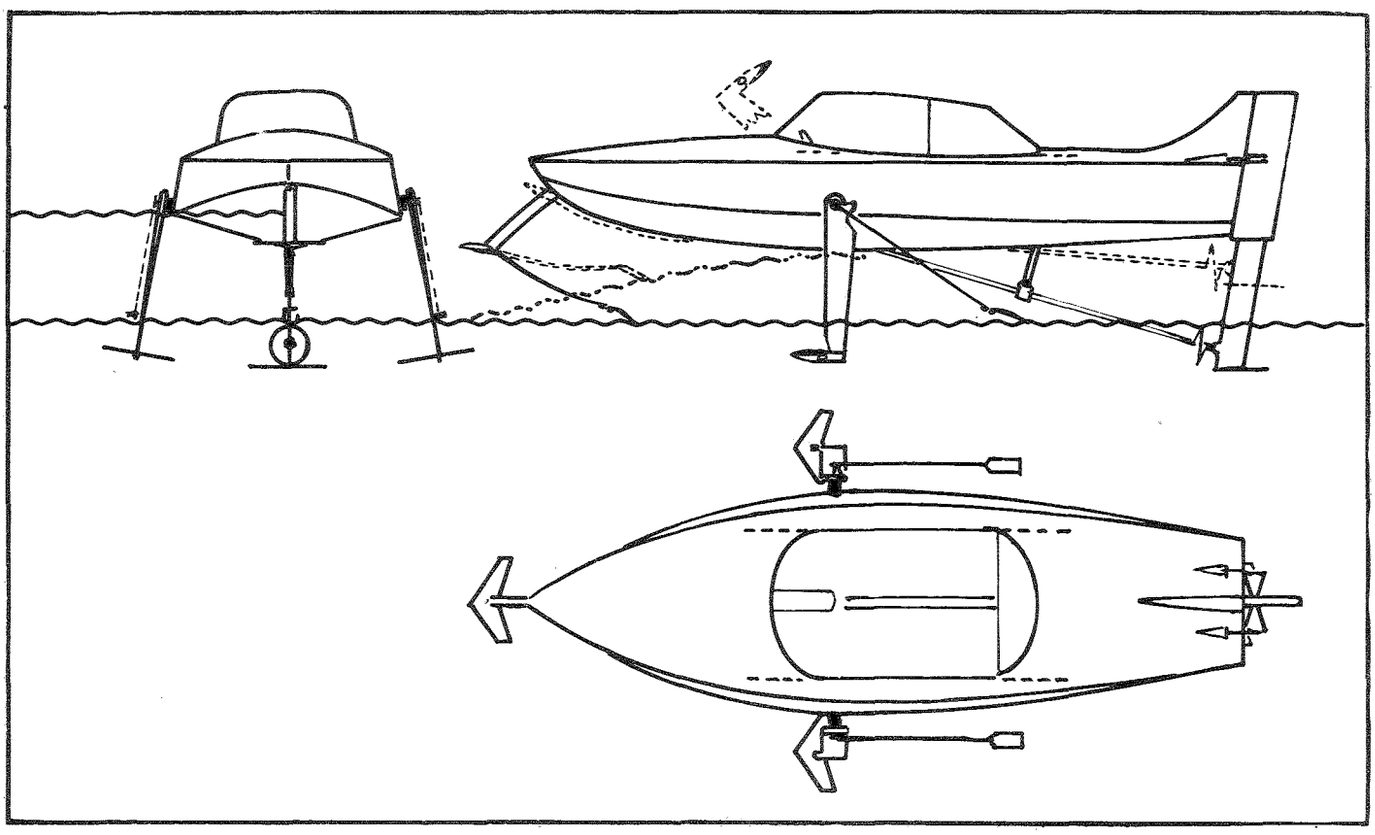
Christopher Hook's early Hydrofins demonstrated for the first time the stability and excellent seakeeping qualities of incidence-controlled, submerged foil craft, and marked a turning point in hydrofoil design.

Nearly seventy Hydrofins of various types have been built since 1949 in Norway, the USA, Poland and Israel. The company's latest design is the 22 ft Channel Skipper, a four-seat fibreglass-hulled runabout.

CHANNEL SKIPPER

Developed from the earlier K2 Hydrofin, the K2D Channel Skipper is a four-seat sports hydrofoil fitted with mechanical wave sensors to control the incidence angle of the fully submerged main foils. Torsionetic universal joints are fitted to the propeller drive shaft to permit retraction.

FOILS: The fully submerged foil system is of "aeroplane" configuration with 65% of the weight carried on the two main foils and the remainder on the aft foil. All three foils have swept back leading and trailing edges. A high-riding crash preventer plane is mounted ahead of and beneath the bow. The plane is also used as a platform for mounting a lightweight pitch sensor which is hinged to



New Hydrofin K2D Channel Skipper

HYDROFOILS

United Kingdom: NEW HYDROFIN

the rear. The sensor rides on the waves and continuously transmits their shape through a connecting linkage to vary the incidence angle of the main foils as necessary to maintain them at the required depth. A filter system ensures that the craft ignores small waves and that the hull is flown over the crests of waves exceeding the height of the keel over the water.

Two additional sensors, trailing from port and starboard beams immediately aft of the main struts, provide roll control. The pilot has overriding control through a control column, operated in the same manner as that of an aircraft

All three foils and the crash plane arm are retractable. The crash plane arm retracts into a hull slot: the two main foils swing forward above the displacement waterline and the rear foil strut assembly retracts upwards into the hull at the same time raising the propeller and drive shaft.

POWER PLANT: Motive power is provided by a single 80 hp Ford diesel engine, driving a 3-bladed propeller through a Vee-drive and a system of Torsionetic joints produced by the Eaton Spring Division of Eton, Yale and Towne Inc. The joints are fitted between the engine and the gearbox, and the gearbox and the drive shaft to permit retraction.

DIMENSIONS:

Length overall	22 ft 0 in (6·71 m)
Length waterline, hull	18 ft 0 in (5·48 m)
Hull beam	6 ft 7 in (2·00 m)
Length overall, foils extended	19 ft 7 in (5·96 m)
Max beam, foils retracted	10 ft 9 in (3·27 m)
Max beam, foils extended	13 ft 5 in (4·09 m)
Draft afloat, foils retracted	1 ft 7 in (0·48 m)
Draft afloat, foils extended	5 ft 3 in (1·60 m)
Freeboard	2 ft 6 in (0·76 m)

WEIGHTS:

Gross tonnage	1·8 tons
Net tonnage	1·2 tons
Light displacement	1·2 tons
Useful load (fuel, water, passengers, baggage and crew)	1,300 lb (598 kg)

PERFORMANCE:

Cruising speed, foilborne	32 knots (51 km/h)
Cruising speed, hullborne	8-12 knots (14-21 km/h)
Sea state capability	Unlimited in seas corresponding to Barnaby's "average rough sea" providing they conform as regards proportions
Turning radius at cruising speed	150 ft (45·7 m) fully banked on turns.

SAILING HYDROFIN

The Sailing Hydrofin adopts the Hook system to the requirements of sail. A 7 ft long prototype model of the craft is now under construction.

The foils are of the fully submerged incidence-controlled type, with full retraction. The foil system is of 'aeroplane' configuration, with the main foils carried on outrigged sponsons. The foil struts are inclined outwards so that the lift on the foils can offset the sail thrust.

Stability is maintained by sensors adjusting the angles of the foils as necessary.

A control column is used to give more angle to the lee foil and less to the windward to maintain the craft in the upright sailing position.

The first production craft will be a two-seat model for sailing enthusiasts, but a much larger craft is envisaged which would be employed in the South Seas, where commercial operation of the craft would be practical because of the strong, regular trade winds.

Southern

SOUTHERN HYDROFOILS LIMITED

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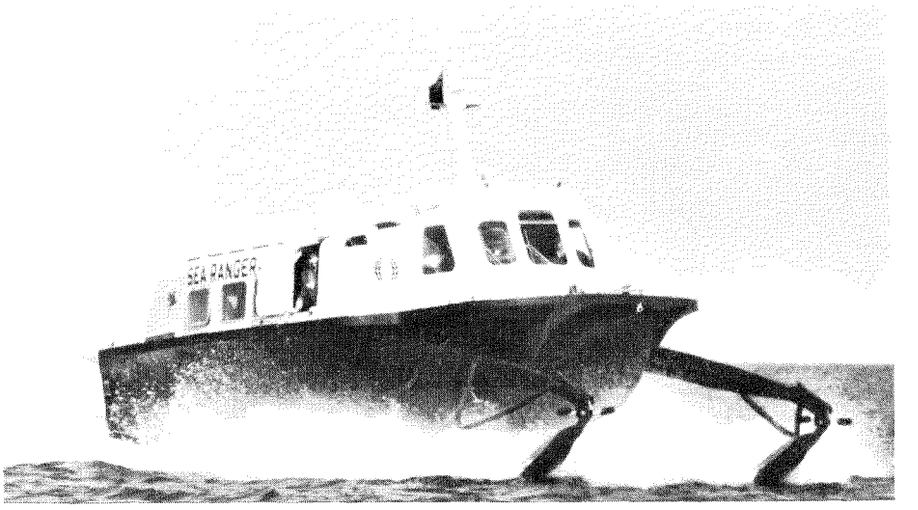
C. M. Stacey CEng, AMRINA, Technical Director

Southern Hydrofoils was founded in April 1963 to design, manufacture and market hydrofoils with fully-submerged systems.

A small test craft was used during 1964-5 to develop a mechanical feeler arm system, which was later improved by the addition of an electro-hydraulic response modification unit. The system is being employed in the prototype Sea Ranger 1, constructed by Philips & Son Ltd, Dartmouth, and now undergoing trials at Dartmouth, Devon.

The company is planning a larger, 35 seat version of the Sea Ranger 1, to be powered by a gas-turbine and is conducting experiments with a new wave sensor system designed for larger craft.

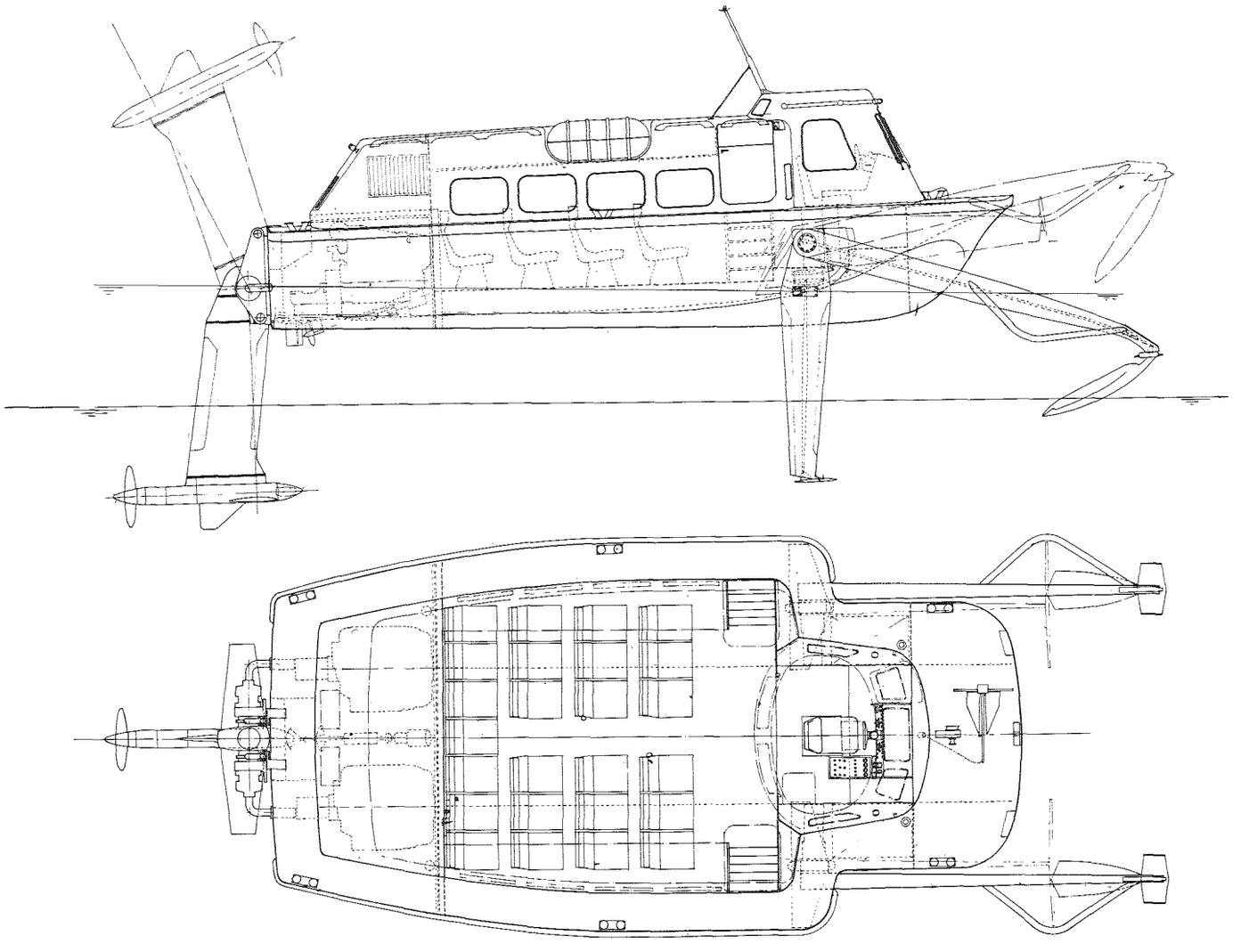


The Sea Ranger, a 25 seat passenger ferry, has a mechanically-operated submerged foil system. The angle of incidence of the two bow foils is varied by two wave sensing arms extending well ahead of the main foil struts and pivotting on the strut axes. Powered by two 283 hp General Motors Detroit 8V53 diesels, the craft cruises at 35-40 knots

SEA RANGER 1

Sea Ranger is an 8½ ton passenger hydrofoil powered by two 283 hp General Motors Detroit 8V53 diesels. Wave sensing arms control the incidence angle of the submerged bow foils to maintain them at the required depth and provide the necessary hydrodynamic forces for stability. The foil arrangement, two forward and one aft, is tandem in the sense that the total forward foil area is equal to the aft foil area.

The standard craft will seat up to 25 passengers, but alternative versions, with modified superstructure and internal arrangements will be offered for a variety of applications ranging from fast naval, police and customs patrol to ambulance duties.



Sea Ranger 1 inboard profile and deck plan

United Kingdom: SOUTHERN

FOILS: The two bow foils are located slightly forward of amidships and the single rear foil is attached to the propeller pod.

The angle of incidence of the two bow foils is varied by two wave-sensing arms extending well ahead of the main foil struts and pivotting on the strut axes. The sensing arms are supported on the surface by sprung trailing planing surfaces. Rotation of the arms is heavily damped and the characteristics may be adjusted to give the best response for any sea condition. The pilot adjusts the flying height and banks the craft as required through an overriding electro-hydraulic control system. A secondary function of the wave sensors is the provision of temporary support for the bow should there be a loss of lift on either or both of the bow foils. Angle of attack of the rear foil can be adjusted to balance out longitudinal load shifting. The stern strut rotates for steering and bow and rear foils and the two sensor arms are raised hydraulically above the waterline to permit manoeuvring in shallow water.

HULL: Designed for production in glass-reinforced plastic, the wide "W" section, twin-keel hull has high deadrise bows flattening to a planing surface aft. The main foils are sited within the hull beam to simplify berthing.

POWER PLANT: Propulsion is supplied by two 283 bhp General Motors Detroit Type 8V53 marine diesels. Power is transferred through a hydrostatic transmission system to a 2 ft 6 in (0·76 m) diameter fixed pitch propeller. Hullborne propulsion, forward and astern, is provided by a propeller on an angled shaft, driven hydrostatically from either engine.

Total fuel (diesel) capacity is 140 gallons (568 litres).

DIMENSIONS:

Length overall, hull	30 ft 0 in (9·140 m)
Beam overall, hull	15 ft 6 in (4·720 m)
Draft foils, extended	9 ft 9 in (2·97 m)
Draft, hullborne	2 ft 4 in (0·71 m)

WEIGHTS:

Disposable load	5,560 lb (2,520 kg)
Displacement	8½ tons

PERFORMANCE (designed):

Speed, hullborne	7½ knots
Cruising speed	35/40 knots
Fuel consumption at continuous rated speed	20 Imp galls per hour (22·7 litres per hour)
Fuel consumption at displacement cruise speed	5 Imp galls per hour (22·7 litres per hour)
Designed endurance and range at cruising speed	7 hours/240 n. miles at 35 knots (64 km)

SEA RANGER 11

This is a design for a gas-turbine powered development of Sea Ranger 1, with seats for 35 passengers.

SEA RANGER 111

The company is developing a revised form of mechanical wave sensor for large craft with submerged foils. Sea Ranger 111, with seats for 56 passengers, will have two bow-mounted reference foils instead of the feeler arms of its predecessor. Power will be provided by four 283 hp GH Detroit 8V53 marine diesels, driving two propellers at the base of the stern foil struts through hydrostatic transmission units.

DIMENSIONS, External:

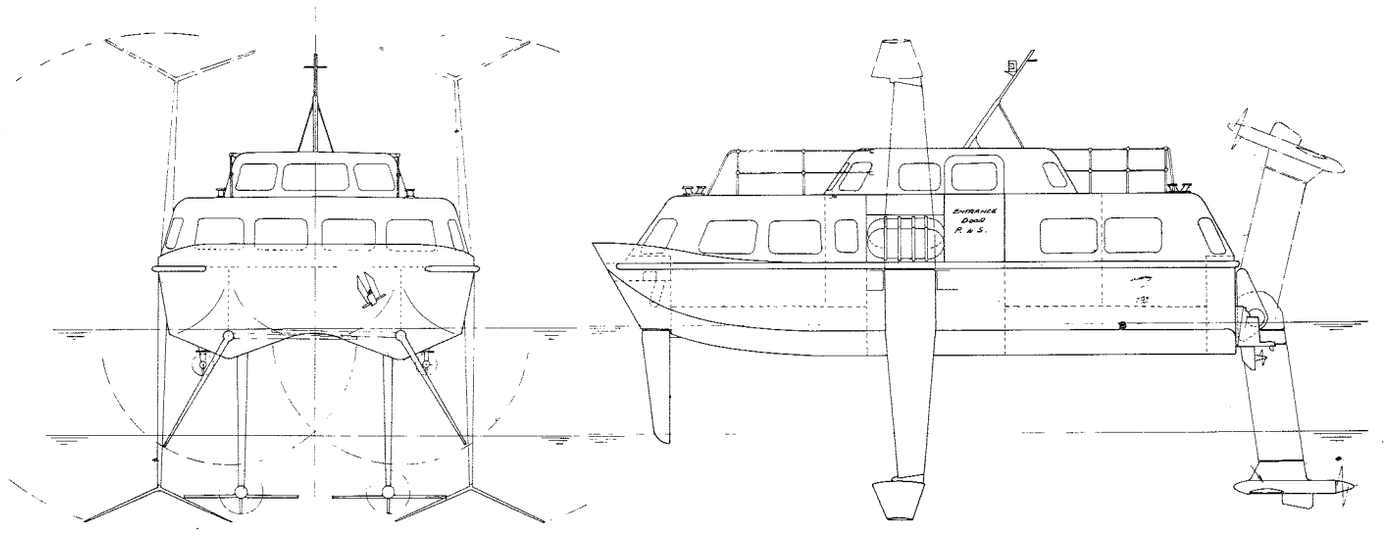
Length overall	37 ft 6 in (11·43 m)
Length waterline, hull	34 ft 9 in (10·62 m)
Hull beam	18 ft 3 in (5·57 m)
Draft afloat, foils extended	11 ft 6 in (3·50 m)
Draft afloat, foils retracted	2 ft 10 in (0·88 m)

WEIGHTS:

Max take-off displacement	17 tons
Deadweight	5-8 tons

PERFORMANCE (estimated)

Cruising speed foilborne	35-40 knots
Hullborne speed	9 knots



Sea Ranger 111

THE UNITED STATES OF AMERICA

Atlantic

ATLANTIC HYDROFOILS INC

HEAD OFFICE:

Box 1174, Stony Brook, New York 11790

TELEPHONE:

516 (Area Code) 751-0711

DIRECTORS:

John K. Roper, President

Atlantic Hydrofoils' mechanically-controlled submerged foil system was the first to be approved for use on hydrofoil passenger ferries. The first order for craft employing this system, was placed by Sea World, Inc of San Diego. The success of the first 28-passenger, 30-knot craft ordered by the company resulted in orders for an additional three.

The Flying Cloud, described below, is a development of the Sea World craft and utilises a similar foil system. Two versions of the Flying Cloud were built, the first with two 600 hp Cummins Vimmer T diesels, production of which was abandoned, and the second with a Solar Saturn gas turbine.

The company's efforts are now being directed towards the development of a hydrofoil-equipped catamaran. The flat inboard sides of the catamaran hulls are joined at the bottom by submerged hydrofoils which carry about 85% of the weight. The hulls will carry the remaining 15% and provide the required stability. This approach is expected to result in a simple, easily handled craft with generous payload capacity and a price which will be slightly less than that of a conventional planing craft of comparable size and speed.

FLYING CLOUD 2

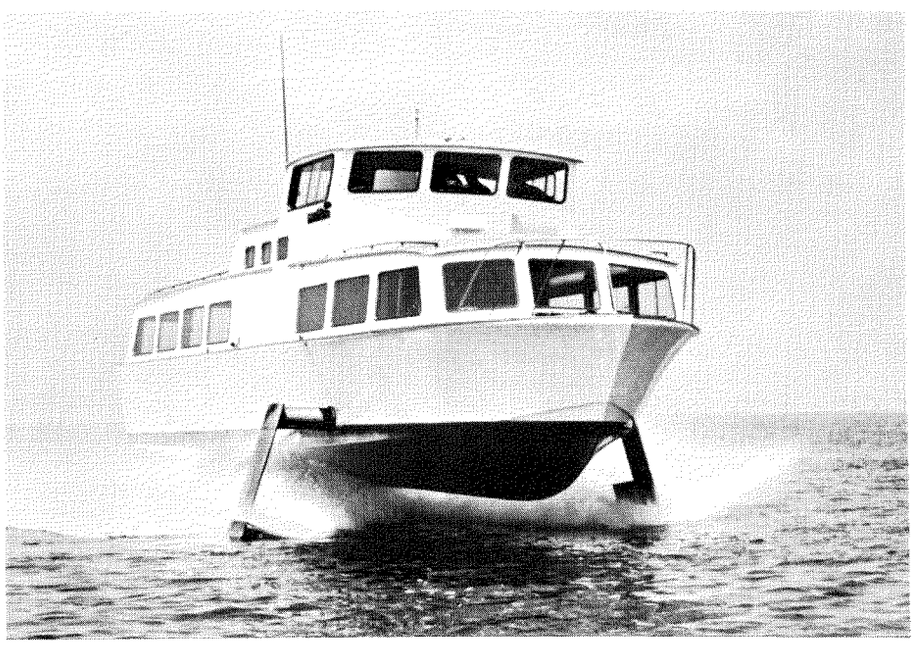
The Flying Cloud 2 was the first gas-turbine powered hydrofoil built for commercial passenger services in the United States. Powered by a 1,100 hp Solar Saturn gas-turbine, it accommodates 70 passengers and a crew of 3.

FOILS: The foil system is of fully submerged aeroplane configuration with two split foils forward and an identical single foil aft. All three foils have trailing edge flaps, those of the forward foils being controlled by an automatic mechanical control device. Hinged vertical control flaps on the trailing edges of the forward struts automatically deflect the foil flaps to maintain the craft at a stable inflight attitude in all sea states. The aft foil can be adjusted in flight to compensate for changes in the longitudinal position of the centre of gravity. The aft foil-strut unit is steerable and acts as a rudder. All three foils retract clear of the water when not in use.

HULL: Laminated wood framing with plywood-fibreglass plating. Deck and superstructure are of plywood and fibreglass construction.

POWER PLANT: Power is provided by a Solar Saturn gas turbine with a normal service output of 1,100 hp, driving a 30 in (762 mm) diameter, 26 in (661 mm) pitch Columbian Style B propeller through a V drive. The turbine is mounted below deck amidships, with air intake apertures on the port side of the cabin superstructure. The exhaust stack discharges directly aft of the pilothouse.

Flying Cloud, showing the mechanically-operated foil system. Hinged vertical control flaps on the trailing edges of the forward struts automatically deflect the foil flaps to maintain the craft at a stable inflight attitude in all sea states



Flying Cloud, designed by Atlantic Hydrofoils Inc, and built by Teledyne Inc of Gardena, California, is powered by a 1,100 hp Solar Saturn gas turbine and has a service speed of 32 knots

ACCOMMODATION: Seats are provided in a comfortably appointed cabin for 70 passengers and a crew of three. Access to the cabin is through either of two doors located amidship, port and starboard. An emergency window exit is provided in the aft passenger compartment. A full range safety equipment is carried in accordance with US Coast Guard requirements.

DIMENSIONS:

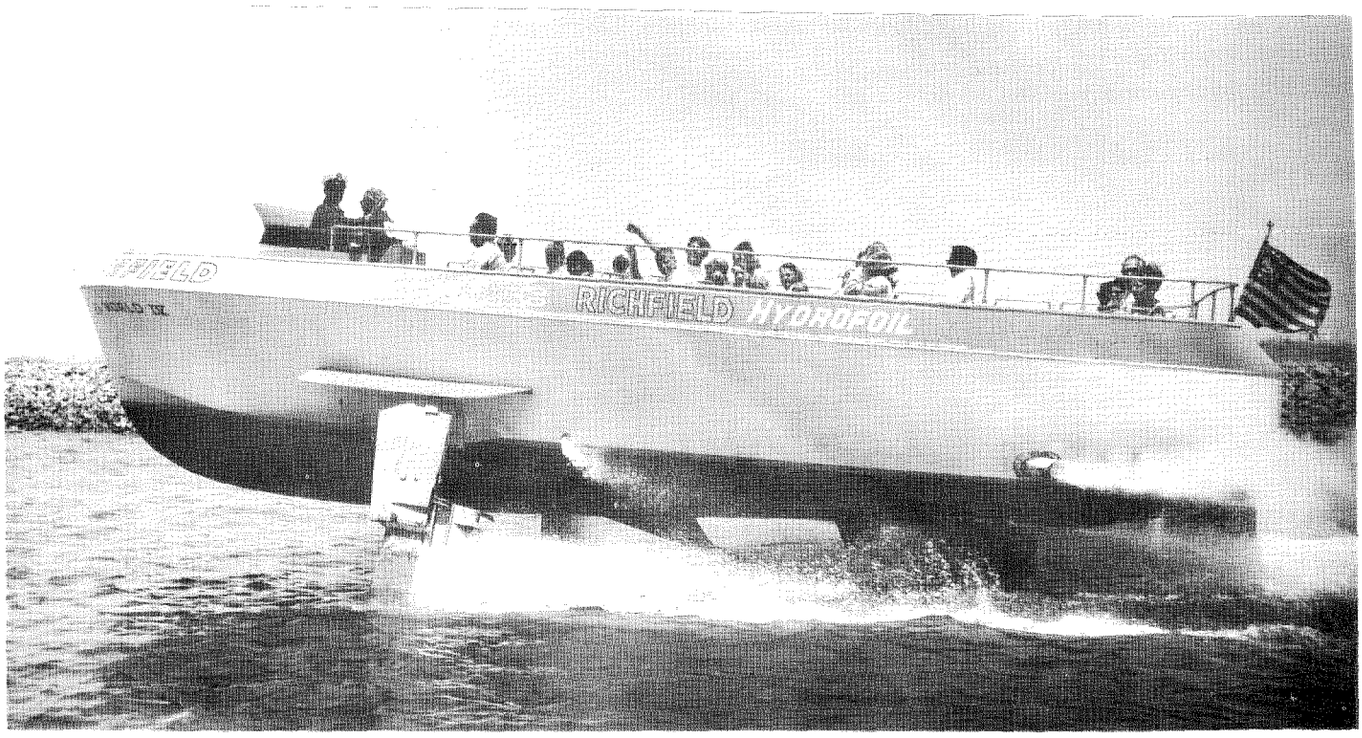
Length overall, hull	61 ft 6 in (18·7 m)
Hull beam	12 ft 0 in (3·6 m)
Width across foils	28 ft 0 in (8·5 m)
Draft afloat	7 ft 9 in (2·3 m)
Forward foil area	30·6 sq ft (2·82 m²)
Aft foil area	15·3 sq ft (1·43 m²)

WEIGHTS:

Gross weight	46,000 lb (20,861 kg)
Max payload	11,500 lb (5,221 kg)
Fuel capacity	500 gallons (2,272 litres)

PERFORMANCE:

Max speed	35 knots (64 km/h)
Cruising speed	32 knots (57 km/h)
Cruising speed hullborne	10 knots (14 km/h)
Take-off speed	18 knots (32 km/h)
Designed range at cruising speed	200 nautical miles (322 km)



Sea World IV, one of four 28-seat hydrofoils built by Atlantic Hydrofoils for Sea World Inc, of Mission Bay, San Diego, proprietors of the world's biggest oceanarium. The craft are sponsored by Atlantic Richfield Oil Company and carry sightseers over a route of about six miles. Sea World IV is powered by a 520 hp diesel and has a maximum speed of 44 knots

Boeing

THE BOEING COMPANY

Marine Branch

HEAD OFFICE:

PO Box, 3707 Seattle, Washington 98124

TELEPHONE:

Area 206, 656-2121

EXECUTIVE:

Airo M. Gonnella, Manager, Marine Branch

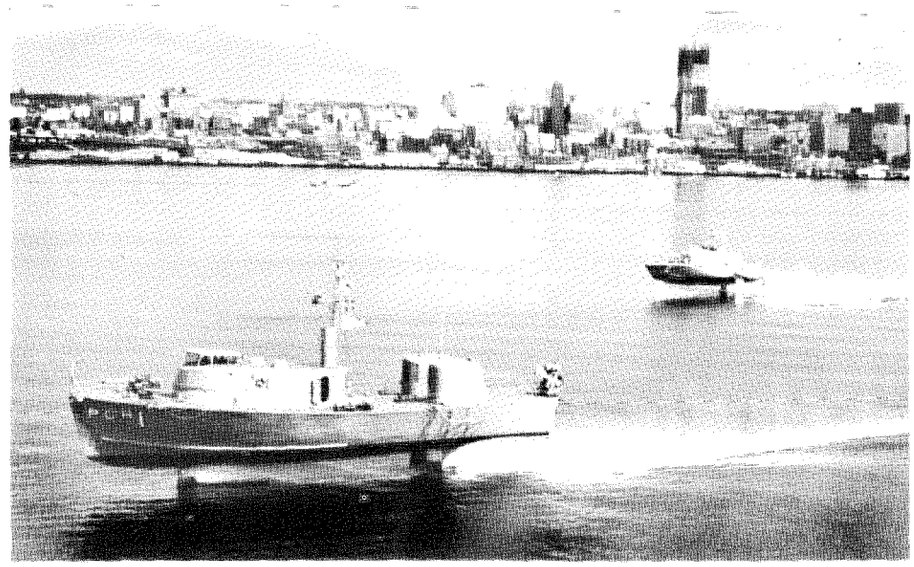
The Boeing Advanced Marine Systems Organisation, recently reorganised as the company's Marine Branch, was formed in 1959 to conduct research, development, design, manufacture and the testing of high performance marine vehicle systems. Boeing also has a 60 per cent interest in Alinavi SpA, the Italian hydrofoil company, with headquarters in Rome. Boeing's entry into the hydrofoil field was announced in June 1960, when the company was awarded a $2 million contract for the construction of the US Navy's 120 ton PCH-1 High Point, a canard design which was the outgrowth of experiments on a similar arrangement in the test craft Sea Legs.

Boeing has also built a jet-driven hydroplane, the HTS, for testing foil models at full-scale velocity; the Fresh-1, a manned craft for testing superventilating or supercavitating foils at speeds between 60-100 knots and a water-jet test vehicle, Little Squirt. The company has also completed a water-jet propelled gunboat, the PGH-2 Tucumcari, for the US Navy's Ship Systems Command.

The Tucumcari is now based at San Diego and is serving with the US Navy Pacific Fleet Amphibious Command.

PCH-1 HIGH POINT

General design of the PCH-1 High Point was specified by the US Navy's Bureau of Ships, with responsibility for detail design and construction assigned to Boeing. The ship was accepted by the US Navy in August 1963 and based at the Puget Sound Naval Shipyard at Bremerton, Washington. Since then it has been undergoing a wide range of tests to evaluate the performance of an inshore hydrofoil ASW system.



PCH-1 High Point (foreground) accompanied by the Tucumcari. The craft are seen cruising out of Seattle harbour. The 110-ton High Point became operational in 1963 and the 57-ton Tucumcari has been operating with the US Navy's Pacific Fleet Amphibious Command since 1968

FOILS: The submerged canard foil system, with 70 per cent of the foil area located aft, and trailing-edge flaps on all foils for lift control, is a scaled-up version of that employed on Sea Legs. The foil struts retract vertically into the hull. Foils and struts are of built-up construction in HY-80 weldable steel.

HULL: The hull is of all-welded, corrosion resistant 5456 aluminium. Integral plate stiffener extrusions are extensively used for decks and portions of the sides not having excessive curvature.

POWER PLANT: Foilborne propulsion is provided by two Proteus Model 1273 gas turbines, each rated at 3,900 shp. The turbines are located aft and take air through the two towers housing the retracted foil struts. The exhaust is discharged directly aft through the transom. Each gas-turbine is coupled to a pair of contra-rotating, subcavitating propellers, 29 in (737 mm) in diameter, through two right-angle gearboxes; one at the top of each aft strut and the others in each of the underwater nacelles.

Hullborne propulsion is supplied by a single Curtiss-Wright Model 1D-700 rated at 600 hp for continuous operation. The engine is

coupled to a 43 in (1,092 mm) diameter propeller through a retractable outdrive unit, which is steerable through 360 degrees and rotates about the axis of the horizontal shaft for retraction.

CONTROLS: Foil lift is controlled through trailing edge flaps. The flying height is controlled by the flaps on the forward foil by comparison between the signal from two bow-mounted ultra-sonic height sensors and a manually positioned altitude-set device. Pitch is controlled by the two flaps on the aft center foil span and roll is controlled by differential operation of the flaps on the aft outboard foil sections. Foilborne steering is accomplished by means of a small strut-flap above the forward foil and a spade rudder, on the same shaft, positioned below the forward foil. Hullborne steering is accomplished by rotation of the hullborne propulsion unit about a vertical axis. This unit can also be rotated upward 87° about a longitudinal axis to eliminate its drag during foilborne operation.

The attitude control is entirely automatic except for steering. The take-off procedure on the PCH-1 is simply to set the desired flying height, then advance the throttles. At a gross weight of 117 tons take-off occurs at 27 knots with 3,880 total horsepower delivered to the transmission system, the speed stabilizing at 36·6 knots at that power setting. Minimum foilborne speed is 24 knots. At a cruising speed of 40 knots 4,400 hp is required, with propellers turning at 1,270 rpm.

DIMENSIONS, EXTERNAL:

Length overall, hull	115·7 ft (35·3 m)
Length, waterline, hull	110·0 ft (33·5 m)
Length overall:	
foils retracted	117·0 ft (35·7 m)
foils extended	117·0 ft
Max beam:	
foils retracted	31·5 ft (9·6 m)
foils extended	31·5 ft
Hull beam	32·0 ft (9·75 m)
Draught afloat, foils retracted	6·5 ft (2·0 m)
Freeboard	12·0 ft (3·7 m)

WEIGHTS:

Light displacement	93·0 tons
Max take-off displacement	120·0 tons
Useful load (fuel, water, equipment, armament, crew)	27·0 tons

PERFORMANCE:

Cruising speed:	
foilborne	in excess of 40 knots
hullborne	12 knots

ACCOMMODATION:

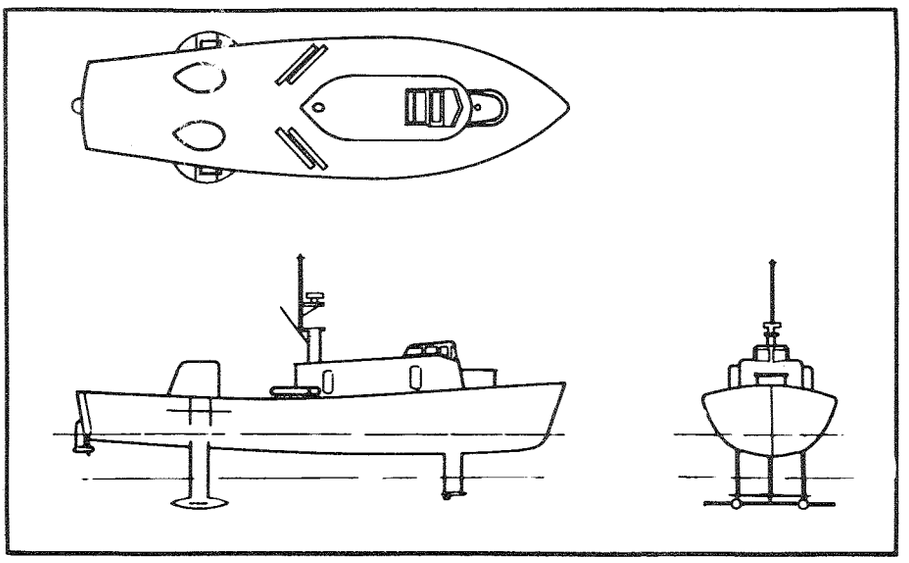
Crew	13

LITTLE SQUIRT

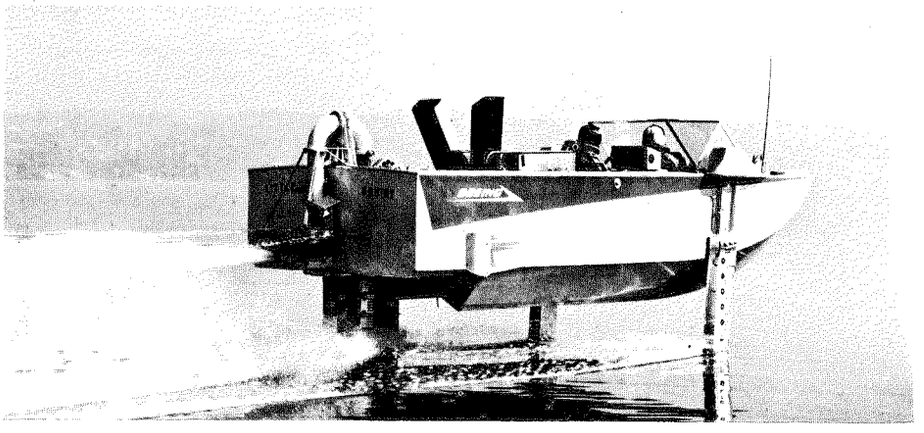
Little Squirt was designed and built by Boeing in 1962 as a company sponsored water-jet research vehicle.

FOILS: The three fully submerged, fixed foils have subcavitating sections with trailing edge flaps. Control of lift is obtained through variable incidence by rotating each foil. The flaps are for lift augmentation during take-off and are retracted for cruising. The foil arrangement, two forward and one aft, is tandem in the sense that the total forward foil area is equal to the aft foil area.

The foil incidence can be adjusted during operation, compounding the action of the moveable control surfaces. A Boeing automatic control system is installed that utilises craft motion and height inputs to maintain foilborne flight.



The Boeing PCH-1 High Point. Foilborne propulsion is provided by two Proteus 1273 marine gas turbines, each rated at 3,900 shp. Cruising speed is in excess of 40 knots



Little Squirt, Boeing's waterjet research craft. Propulsion water enters a ram scoop at the base of the aft strut and is ducted upwards to a double-suction centrifugal pump powered by a Boeing 502 gas turbine

HULL: Built in plywood, the hull is of stepped "W" form. This configuration was chosen as it would provide greater roll safety for the craft.

POWERPLANT: The waterjet is provided by a double-suction centrifugal pump powered through a reduction gearbox by a Boeing 502 gas-turbine rated at 450 hp. The propulsion water enters a ram scoop at the base of the aft strut and is ducted upward through the strut to the pump. At 2,360 rpm the pump absorbs 425 hp and produces a flow of 3,600 US gallons (13·63 m^3) per minute at a pressure head of 400 ft (121·9 m).

DIMENSIONS, EXTERNAL:

Length overall, hull	22 ft (6·71 m)
Length waterline, hull	17·1 ft (5·20 m)
Length over foils	22 ft (6·71 m)
Hull beam	8 ft (2·49 m)
Width across foils	11·25 ft (3·43 m)
Draft afloat	5·5 ft (1·68 m)
Draft foilborne	8 in to 2·5 ft (0·2 m to 0·7 m)
Freeboard	3·0 ft (0·91 m)

WEIGHTS:

Light displacement	2·28 tons
Max. take-off displacement	2·65 tons
Useful load	0·37 tons

PERFORMANCE:

Cruising speed, foilborne	48 knots
Max permissible wave height in foilborne mode	2·5 ft (0·762 m) waves

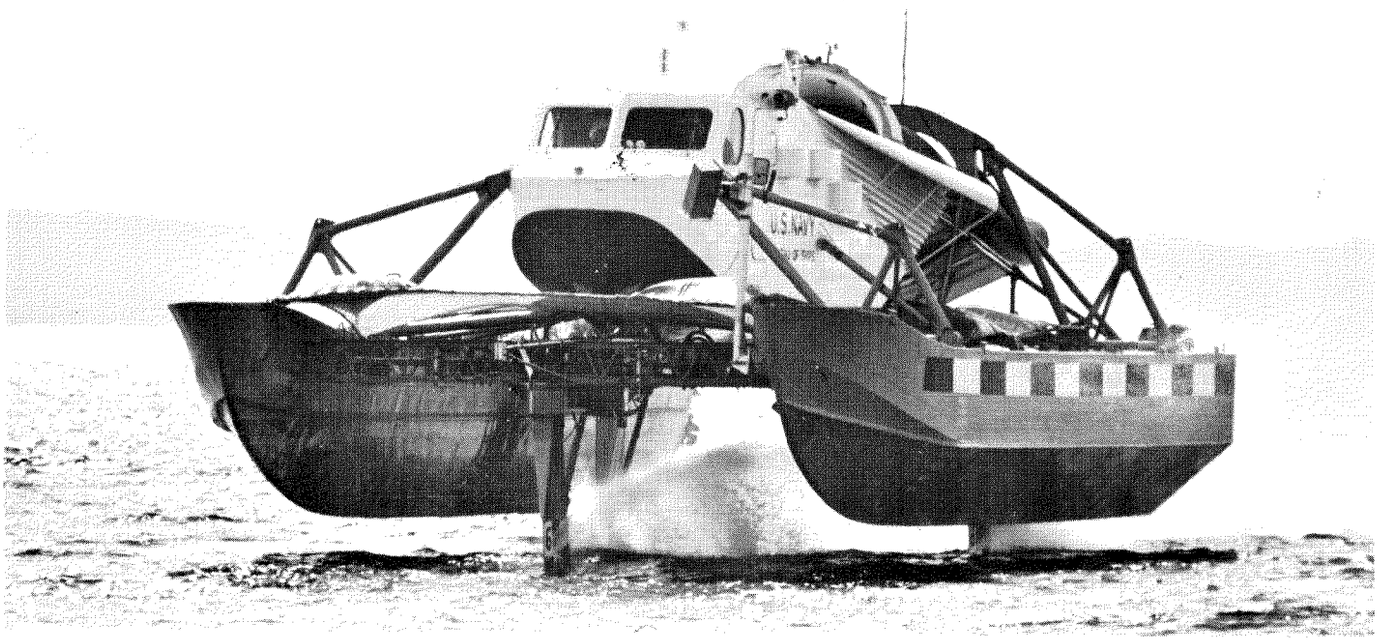
ACCOMMODATION:

Crew	1
Passengers	2

FRESH-1

The FRESH-1 (Foil Research Supercavitating Hydrofoil) was built as part of the US Navy's accelerated research and development programme aimed at gathering data for the design of large, high-speed, ocean-going hydrofoils.

FOILS: The twin-hull catamaran arrangement provides a large, clear space between the hulls, within which different foil systems can be mounted. The foils and struts are attached to lateral beams between the hulls and may be positioned at several different longitudinal attachments point, providing a great deal of freedom in the choice of the foil locations. The foils have been arranged in a conventional configuration, with two foils forward and one aft, and also in a canard



The Boeing FRESH-1 (Foil Research Supercavitating Hydrofoil) twin hulled test craft is capable of speeds of 80-100 knots. Foils under test are attached to lateral beams between the hulls. Foilborne propulsion is supplied by a JT3D-3 fan-jet developing 18,000 lb (8,200 kg) thrust

configuration, with one foil forward and two foils aft.

The first system tested comprised three fully submerged and fully flapped foils of cambered-parabolic blunt base section. The foils, of machined 17-4 PH steel forgings, each had an area of 7·46 sq ft. The foil loading was 1,600 lb sq ft.

POWER PLANT: The choice of powerplant a JT3D-3 fan-jet developing 18,000 lb (8,200 kg) st—means the propulsion system does not disturb the water flow around the test-foils.

Hullborne propulsion is supplied by two 75 hp outboard engines.

AUXILIARY POWER: Electrical and hydraulic power are furnished by a turbine-driven auxiliary power unit and by the main engine respectively. Auxiliary power systems have been designed to accommodate a wide range of future hydrofoil systems.

HULL: The catamaran hulls are in aluminium with steel truss members. The hull and cabin have been constructed to withstand a variety of loadings due to different attitudes of crash as a result of system failures during tests.

TEST EQUIPMENT: A most important tool in the test programmes is the analogue computer. An analogue simulation of the characteristics of each foil configuration is developed and maintained.

As the test data becomes available, the simulation is modified to ensure that it will duplicate the characteristics of the boat as accurately as possible. Before each test is run, it is simulated. It is possible in this way to analyse the system behaviour and thus determine the safety of the test. The accuracy of the simulation is most important if accidents or errors are to be avoided, particularly when a test is conducted near the limits of the boat's capability.

In the design of FRESH-1, the problem of data acquisition was given as much attention as the design of the craft itself. Because the purpose of the craft is testing untried foil systems, it was necessary to provide a data system capable of recording instantaneous and continuous dynamic data.

The data system utilizes a magnetic-tape recording system with instrumentation capable of providing 84 continuous channels, 82 commuted channels sampled 20 times per second, and 176 pressure channels sampled once per second.

SYSTEMS:

ELECTRICAL: Turbine-driven 120/208 volt, 3-phase 400 cycle generator with 30 KVA continuous rating.

HYDRAULICS: Dual system for foil flaps; pressure, 3,000 psi.

DIMENSIONS, EXTERNAL:

Length overall, hull	47·0 ft (14·33 m)
Length waterline, hull	45·0 ft (13·72 m)
Length over foils	57·3 ft (17·44 m)
Hull beam	22·5 ft (6·86 m)
Draft afloat	10·5 ft (3·20 m)
Freeboard	2·5 ft (0·76 m)

WEIGHTS:

Light displacement	12·4 tons
Max. take-off displacement	16·5 tons
Useful load	4·1 tons

PERFORMANCE:

Cruising speed, foilborne
80-100 knots (148-180 km/h)

Cruising speed, hullborne
4·5 knots (8·4 km/h)

ACCOMMODATION:

Crew	3

PGH-2 TUCUMCARI

A 58-ton waterjet-propelled hydrofoil gunboat, the PGH-2 was ordered from Boeing by the US Navy's Ship Systems Command in 1966, under a $4 million, fixed price PGH (Patrol Gunboat Hydrofoil) programme.

The craft was designed, constructed and tested in 23 months and delivered on schedule to the US Navy on March 7, 1968.

The craft is now with the US Navy Pacific Fleet Amphibious Command, San Diego, where it has been participating in fleet exercises and undergoing operational evaluation trials.

FOILS: Like High Point, Tucumcari has a fully submerged canard arrangement with retractable foils. Unlike High Point however, the aft foils are divided for sideways retraction, instead of retracting vertically, and the single forward strut retracts forward into a slot in the bow. Doors preserve the hull lines when the strut is either fully extended or retracted.

Foils and their struts are fabricated in 17-4PH steel and have thin sections to avoid cavitation within the speed design range. Control flaps on the three foils are of marine aluminium alloy.

Both aft foils have anhedral to reduce their tendency to ventilate in bauked turns.

CONTROLS: A Boeing automatic control system stabilizes the craft in foilborne operation. This system consists of dual sonic height sensors; an inertial sensor package with vertical gyro, yaw rate gyro and vertical accelerometer; command signal equipment, control system computer and the hydraulically actuated control surfaces. The helmsman is responsible for controlling craft heading from the bridge through a wheel which controls the steerable bow foil. Height command is the only other manual input and this control is used primarily during take-off and landing.

HULL: The hull shape is designed to minimize the structural loadings due to wave impact. It has a 25 degree deadrise, rounded chines, a flaring bow and straight runs aft. Construction is entirely of welded aluminium and careful design has resulted in a relatively low hull weight of 10 tons. The deckhouse includes both welded and mechanically fastened aluminium structures. Four watertight bulkheads are incorporated.

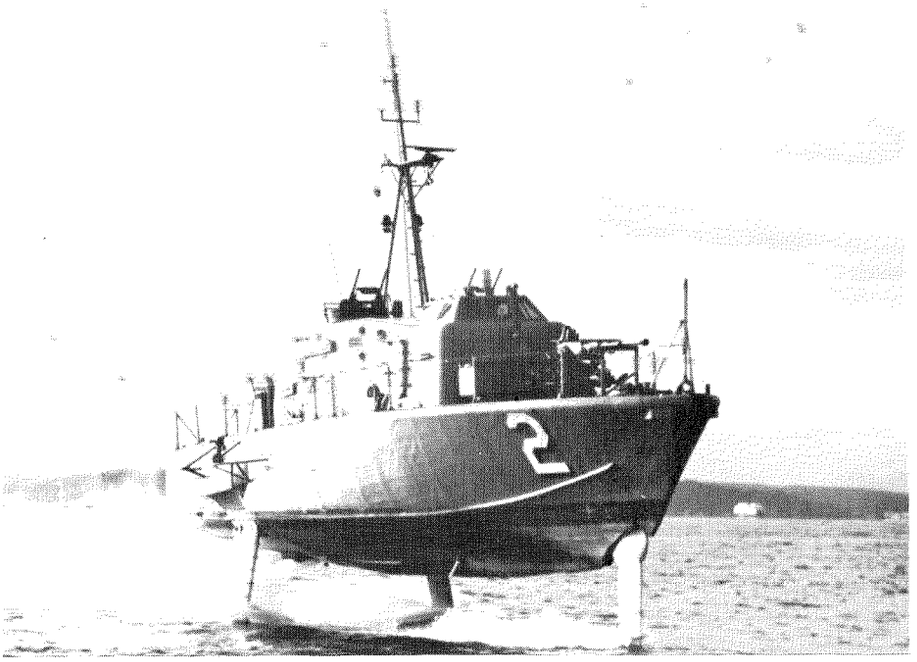
POWER PLANT (foilborne): The waterjet propulsion system consists of a 3,200 hp Rolls Royce Proteus gas turbine driving a lightweight Byron Jackson two-element double suction centrifugal pump through a direct coupling.

Water is drawn into the system through two ports in the two aft foil/strut intersection pods then ducted up through the hollow struts to the pump's intakes, each strut supplying one pump element. From the pump it is discharged through two nozzles beneath the transom. The system ejects about 27,000 US gallons (102 m^3) of water a minute, providing 24,000 lb (10,000 kg) thrust.

POWER PLANT (hullborne): A Buehler centrifugal pump, powered by a General Motors 6V-53 160 hp diesel propels the vessel when hullborne. Steering and reversing are accomplished by vectoring the water jet exit flow, eliminating the need for reverse gearing.

The propulsion machinery space is divided into two watertight compartments. The hullborne diesel is located in one compartment and the Proteus in the other, permitting the craft to operate with either engine compartment flooded. Both foilborne and hullborne waterjet pumps are designed to operate under water in an emergency.

ARMAMENT: Main armament comprises a 40 mm gun forward of the bridge and an 81 mm mortar aft. Hand operated twin ·50 machine guns are sited each side of the bridge.



Boeing PGH-2 Tucumcari waterjet-propelled hydrofoil gunboat, designed for high-speed, heavy weather, offensive and defensive operations. Main armament comprises a 40 mm rapid-fire cannon forward of the bridge and an 81 mm mortar aft. Manually-operated twin .50 machine guns on ring mountings are sited aft of the pilothouse on each side of the bridge superstructure. Foilborne cruising speed is in excess of 40 knots

The Tucumcari has now been in service with the US Navy for well over a year, during which time it has been operated and maintained solely by its crew. It has operated a total of more than 300 foilborne hours without a single control failure, either electronic or hydraulic. The gunboat is operated by a 12 man crew, plus one officer on a three duty section basis. At no time in the operational history of the craft has foilborne operation been terminated or cancelled because of weather conditions

DIMENSIONS, EXTERNAL:

Length overall, hull	70 ft 1 in (21·64 m)
Length waterline, hull	66 ft 0 in (20·12 m)
Length overall:	
foils retractad	80 ft 0 in (24·38 m)
foils extended	74 ft 6 in (22·71 m)
Hull beam	19 ft 6 in (5·94 m)
Max. beam:	
foils retracted	25 ft 0 in (7·62 m)
foils extended	35 ft 4 in (10·77 m)
Draft afloat (foils retracted)	4 ft 6 in (1·37 m)
Freeboard	7 ft 0 in (2·13 m)

WEIGHTS:

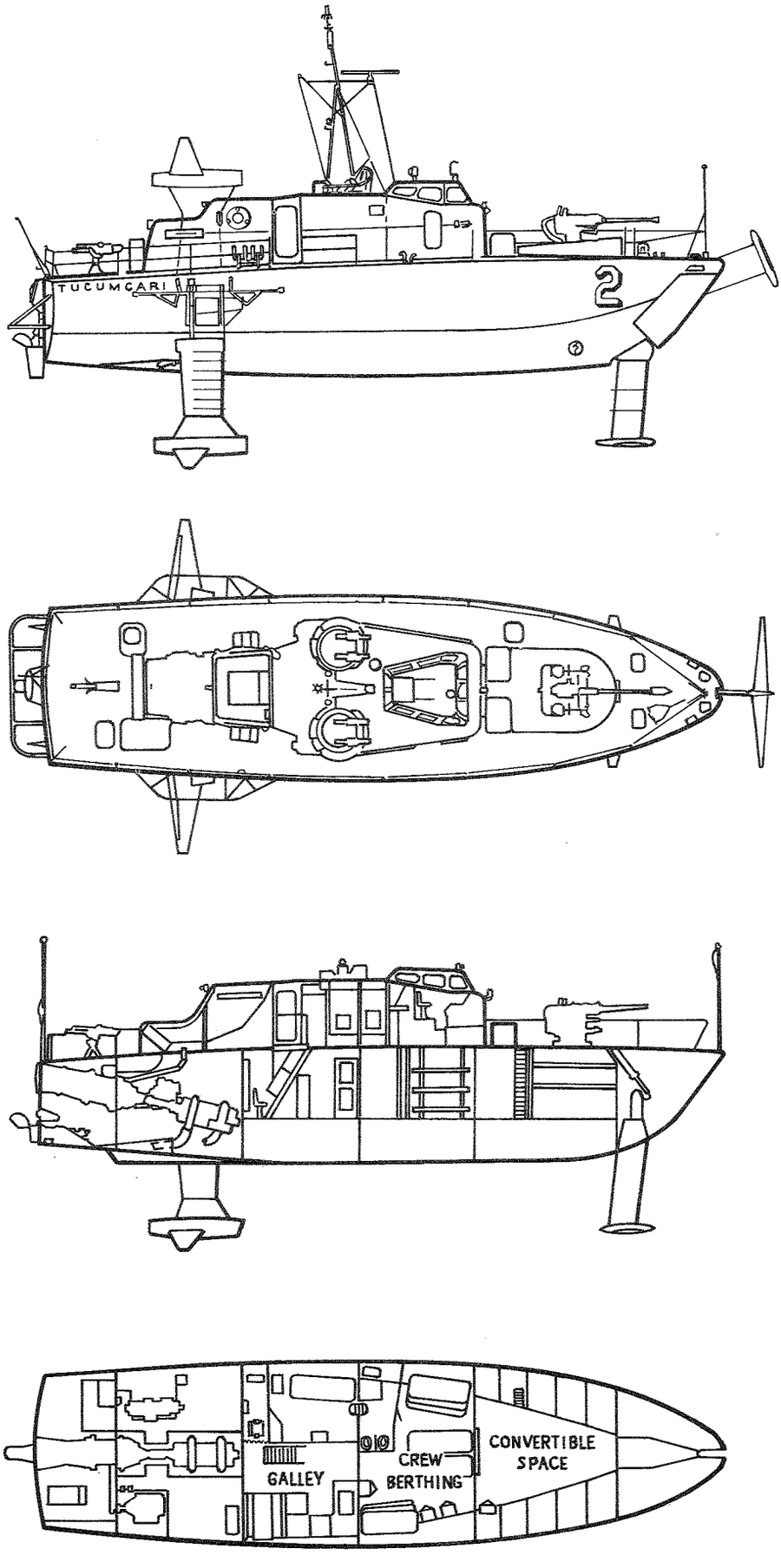
Light displacement	40·8 tons
Max take-off displacement	57·5 tons
Useful load (fuel, water, equipment, armament and crew)	18·7 tons

PERFORMANCE:

Cruising speed, foilborne in excess of 40 knots

ACCOMMODATION:

Crew	13



Outboard and inboard profiles and deck views of the 60.1 ton Boeing PGH-2 Tucumcari, waterjet propelled patrol gunboat hydrofoil. During extensive rough water testing it was found that high speed foilborne operation could be maintained indefinitely in all seas encountered and at all headings without interfering with normal crew duties or causing discomfort

FMC

FMC CORPORATION

Ordnance Engineering Division

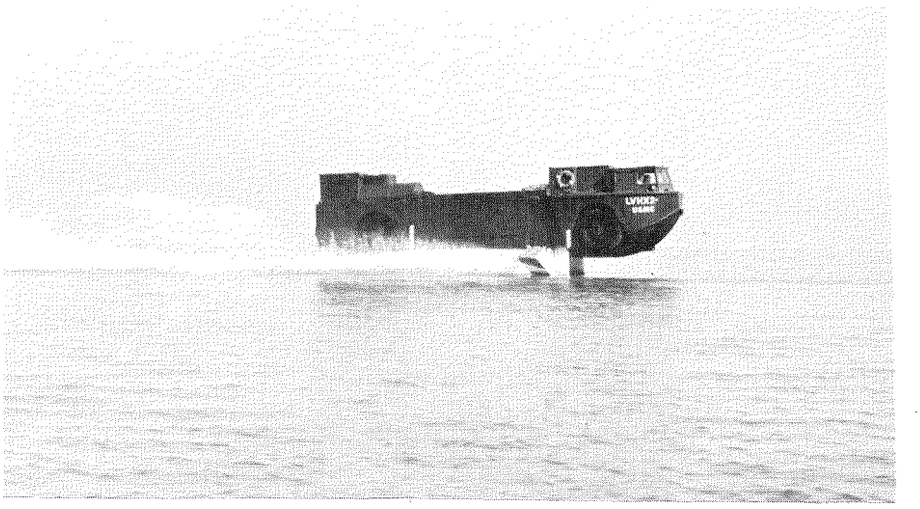
HEAD OFFICE:

1105 Coleman Avenue, Box 367, San Jose, California

The Ordnance Engineering Division of FMC Corporation has engaged in concept, research, design, development and production of defence material for over 25 years, starting early in World War II with the design and production of over 11,000 amphibious assault vehicles. Current activities include the development of amphibious vehicles, landing craft, airborne multipurpose vehicles, and the Mark I Deep Dive System.

During World War II, FMC designed, developed and produced seven versions of LTVs, under contract to the Bureau of Ships.

Current amphibious vehicle programmes being conducted for the Bureau of Ships (Now Naval Ship Systems Command) are: Landing Craft Assault (LCA), Assault Amphibian Personnel Carrier (LVTPX12 and family of Vehicles), and Landing Vehicle Tracked Family of Vehicles (LVTP5A1).



The LVHX2, an amphibious hydrofoil landing craft built by FMC for the US Marines. The craft operates at 35 knots to the surf zone, negotiates shallow areas as a displacement craft, then moves quickly inland on four sand-type tyres

The LVHX2 is the final product of a programme which began in 1961 and included design, development, scale-model hull and foil testing, and fabrication of two full-scale vehicles. This vehicle is 38 ft long, capable of 35 knot foilborne speed, and 40 mph land speed while transporting a 5-ton cargo. The division also designed and developed the L312G hydrofoil test craft for the purpose of optimising hydrofoil system configurations and craft control systems. This 30 ft craft carries 12 passengers at speeds up to 45 knots. The latest hydrofoil passenger craft built by the company is the 48 passenger L548D.

LVHX-2

Designed and built for the US Marine Corps under a Naval Ship System Command contract, the LVHX2 is an amphibious, aluminium-hull, 38 ft hydrofoil landing craft with a cargo capacity of 10,000 lb. Its mission is the high-speed transfer of cargo and equipment from ship to shore during amphibious assault operations. It operates foilborne to the surf zone, negotiates off-shore waters and the surf in the displacement mode, then quickly moves inland on four large, sand-type tyres.

The maximum foilborne water speed is 35 knots. Maximum displacement speed is 12 knots, and maximum land speed on hard surfaces is 40 mph.

FOILS: The foil system consists of split forward surface-piercing foils and a rear foil which remains fully submerged. The foil struts retract vertically into the hull and the hinged sections of the forward foil fold upward into recesses in the hull sides.

The foils may be retracted or extended while in motion. A simple autopilot system is used to provide a smoother ride in State 3 seas and to counteract adverse effects of a following sea. The LVHX2 can be operated, however, in the foilborne mode without the autopilot.

Land power for the LVHX2 is transmitted from the Solar T 1,000-S27 gas turbine to the wheels through an Allison TX 365-2 six speed transmission. The craft is able to negotiate 60% slopes in forward or reverse and can operate on 30% side slopes

POWER PLANT: The LVHX2 is powered by an 1,100 hp Solar T1000-S27 two-shaft gas turbine engine. The integrated drive system permits use of marine and land power simultaneously when needed. This system also increases vehicle reliability and decreases weight. Power for marine operation is transferred through a marine reverse gear to the vertically-retracting rear strut assembly of the aft foil. This arrangement provides full power transmission to the propeller when the strut is being extended or retracted. For land operation, the gas turbine engine is de-rated to the necessary power level. Land power is transmitted to the wheels through an Allison TX365-2 six-speed transmission and non-slip differentials. The craft is capable of negotiating 60% slopes in forward or reverse and can operate on 30% side slopes.

CONTROLS: Two power-assisted steering modes are provided; conventional two-wheel steering and conventional four-wheel steering. The four wheels are individually suspended by a simple air-spring and hydraulic shock absorber system which provides a smooth ride over rough terrain. The wheels are retractable for water operation to facilitate loading and unloading in the land mode. Individual wheel retraction capability permits the vehicle to "kneel", "squat", or tilt, simplifying cargo loading and unloading on irregular terrain.

Air pressure in the 8·00 × 25 sand-type tyres can be varied by a central inflation system controlled by the driver.

Two LVHX2 prototypes have successfully completed Navy acceptance trials and test by the US Marine Corps.

FMC Corporation's L548D 48-seat hydrofoil ferry. Twin Cummins VT8-390M diesels, each rated at 390 hp at 3,000 rpm and driving counter-rotating propellers give the craft a cruising speed of 41 mph (66 km/h)

DIMENSIONS:

Length overall	37 ft 0 in (11·28 m)
Vehicle width	10 ft 6 in (3·20 m)
Width over main foil	21 ft 6 in (6·55 m)
Freeboard, combat weight	3 ft 9 in (1·14 m)

WEIGHTS*:

Combat	17·4 tons
Net	12·9 tons
Payload	4·5 tons

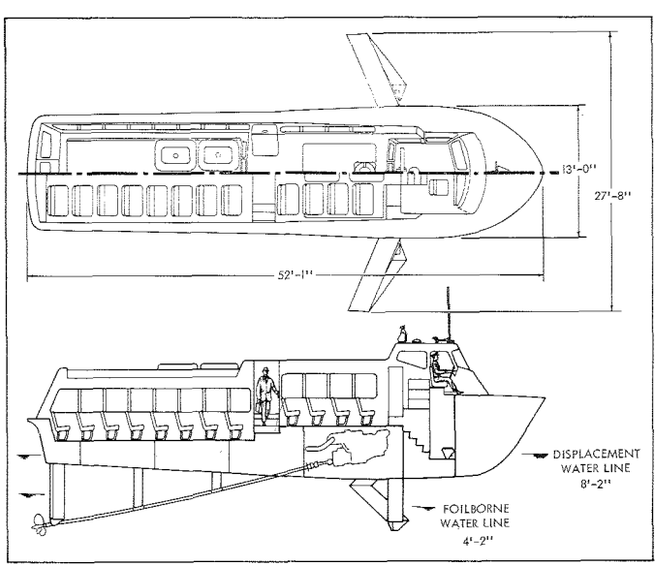
PERFORMANCE:

Fuel capacity	430 US gal (1,625 litres)
Speed foilborne	35 knots (65 km/h)
Speed, afloat	12 knots (22 km/h)
Speed, beaching	8 knots (15 km/h)
Speed, land	40 mph (64 km/h)
Gradeability, forward slope	60%
Gradeability, side slope	30%
Turning radius, foilborne	300 ft (91·4 m)
Turning radius, afloat	75 ft (22·9 m)
Turning radius, land	35 ft (10·7 m)
Endurance on water at 35 knots	5 hrs
Endurance on land at 25 mph	10 hrs

*Weight

Combat: Weight of vehicle fully equipped and serviced for combat, including crew and payload for 10,000 lb.

Net: Weight of vehicle fully equipped and serviced for combat, including crew, but without payload.



The FMC L548D, designed for fast ferry services across bays, lakes and sounds. The prototype has logged over 6,000 miles during engineering tests and operations in San Francisco bay

L548D

Designed for fast, comfortable services across bays, lakes and sounds, the L548D hydrofoil passenger ferry has an operating cost of about 3½ cents per seat mile at 100% load factor. The prototype has logged over 6,000 miles during engineering test and operations in San Francisco Bay.

The maximum operating displacement is 14·29 long tons which includes 4.33 long tons of useful load. Design speeds are 45 mph maximum, 41 mph cruising and 10-11 mph during hullborne operation.

FOILS: A surface piercing foil configuration is employed, with two forward surface piercing foils supporting 70% of the load and two aft foils supporting the remainder. The foils, which are fixed, are built in aluminium. The foil configuration is designed to be inherently stable in any expected combination of heave, pitch, roll and yaw.

To prevent settling in a following sea and also to smooth out the ride generally, a Hamilton Standard stability augmentation system automatically controls trailing edge flaps on the forward foils to provide additional stability in heave and roll. Rudder flaps are fitted to the trailing edges of the aft foil struts for steering control.

HULL: The craft is of welded aluminium construction and carries 48 passengers in an attractive, soundproofed cabin with a temperature controlled ventilation system.

POWER PLANT: Power is provided by twin Cummins VT8-390M watercooled diesels, each with a normal service output of 390 hp at 3,000 rpm. Each engine drives its own propeller shaft and the twin screws are contra-rotating. Controls are all sited in an elevated wheelhouse with a 360°-view at the fore end of the passenger compartment.

The engine transmission units are mounted in a compartment below the forward passenger deck. Removable seat deck sections and a removable roof hatch facilitate speedy replacement of either unit.

ACCOMMODATION: Passengers are accommodated in a split-level cabin with 32 in the main, aft compartment, and 16 in the forward

compartment. Access to both is through either of two gull-wing doors located amidships, port and starboard. Separate doors, port and starboard, are provided for the pilot and crew. An emergency window exit is provided in the aft passenger compartment.

A full range of safety equipment is carried, including four portable fire extinguishers, life jackets for each passenger and crew member, plus five additional children's life jackets. Buoyant apparatus, catering for 50% of the passenger and crew capacity (minimum) is also carried.

SYSTEMS AND CONTROLS: Standard electrical equipment of the L548D includes a Raytheon Model DE-718A depth sounder, a Raytheon Model 1065C radio-telephone and Decca 202 radar.

DIMENSIONS:

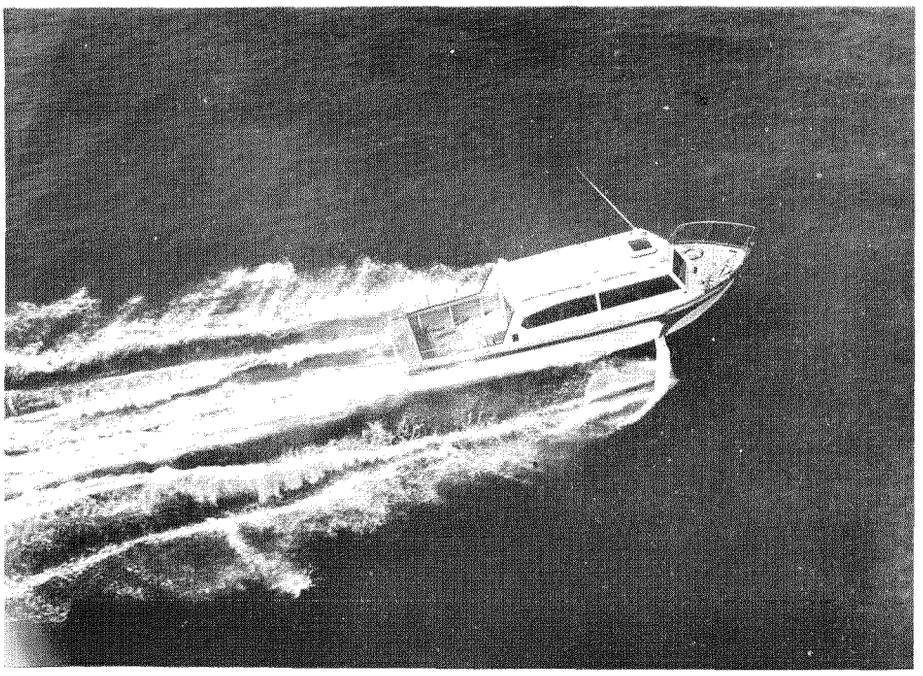
Length overall, hull	52 ft 1 in (15·88 m)
Length waterline, hull	47 ft (14·32 m)
Hull beam	13 ft (3·96 m)
Width across foils	27 ft 8 in (8·43 m)
Draught afloat	8 ft 2 in (2·49 m)
Draught foilborne	4 ft 2 in (1·27 m)
Freeboard	5 ft 8 in forward (1·73 m)
	3 ft 6 in aft (1·07 m)

WEIGHTS:

Gross tonnage	36
Net tonnage	24
Light displacement	9·96 long tons
Max take-off displacement	14·29 long tons
Useful load	4·33 long tons

PERFORMANCE:

Cruising speed, foilborne	41 mph (66 km/hr)
	45 mph max (72 km/hr)
Cruising speed, hullborne	10-12 mph
Design foilborne range	270 statute miles (334 km)
Turning radius at cruising speed	550 ft (167·6 m)
Fuel consumption at cruising speed	32 gal/hr (22·7 litres/hr)
Fuel consumption, hullborne	5 gal/hr (13·6 litres/hr)



Seating 12 passengers and capable of speeds in excess of 45 mph (72 km/h), the FMC L312G is a 30 ft (9·14 m) test and demonstration craft. It was used to obtain data for the design of the 48-passenger L548D

L312G

After completing the basic design of the LVHX2, the FMC Ordnance Division conducted a company-sponsored research programme into hydrofoil systems. Following this investigation, it was decided to build a 30 ft test and demonstration hydrofoil to verify the results of the study and to provide a test vehicle for further research.

The L312G, an all-aluminium craft with surface-piercing foils, was launched in September 1964.

Powered by a Daytona Marine rated at 380 hp at 3,800 rpm, it has a maximum speed of 50 mph. Seats for 12 passengers are provided in the enclosed cabin, or alternatively, 2,880 lb of equipment or cargo can be carried.

DIMENSIONS:

Length overall	30 ft (9·14 m)
Hull beam	9 ft (2·74 m)
Width across foils	17 ft 6 in (5·33 m)
Draught afloat	5 ft 3 in (1·6 m)
Draught foilborne	2 ft (0·6 m)
Displacement:	
Nett	5,900 lb (2,676 kg)
Gross	9,500 lb (4,309 kg)
Range at gross weight	120 mile (193 km)

General Dynamics
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General Dynamics has entered into a licence agreement with Supramar Ltd of Lucerne, Switzerland, under which General Dynamics will manufacture and sell hydrofoil boats in the United States and other Western Hemisphere nations based on Supramar's patents and engineering drawings.

The company is exploring adaption of Supramar hydrofoil concepts for a number of military missions, including fast patrol boats, antisubmarine warfare and air-sea rescue missions.

General Dynamics also will direct its efforts to expand the use of hydrofoils as fast, stable passenger ferries on lakes, rivers and coastal waters, for Coast Guard and customs work, and for use in connection with off-shore drilling operations.