... TANCE PROGRAM

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Second Report to the Government of

INDIA

FISHING BOATS

... OF THE UNITED NATIONS

Report No. 1096

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2nd REPORT

to the

GOVERNMENT OF INDIA

on

FISHING BOATS

Based on the Work

of

Peter Gurtner
FAO/TA Naval Architect

Rome, 1959

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1. INTRODUCTION

FAO appointed Mr. Peter Gurtner in January 1958 to continue Mr. K. K. Rasmussen's assignment in India as FAO/TA Naval Architect. His terms of reference were:-

1. To advise and assist in the development of designs of new, improved types of fishing boats, fish carriers and fishing research vessels.

2. To advise on the improvement of available boat types with regard to the design, construction, safety and engineering.

3. To advise on the mechanization of the available boats.

It was emphasized that his activities should be concentrated on the following:-

(a) To design a number of new, improved fishing boats.

(b) To give ad hoc advice as to the improvement of fishing boats and engine installations, the selection of optimum propellers, etc., and the equipment of the boats with winches for easier handling of the fishing gear.

(c) To assist in the mechanisation of available boats.

(d) To make proposals with regard to improvements for boatbuilding yards.

Mr. Gurtner arrived in New Delhi on 18 February 1958 and, after a few days briefing in New Delhi, started his work in Madras. He left India on 24 March 1959 to attend the Second FAO World Fishing Boat Congress in Rome and for home leave.

During his stay in India he served the States of Madras, Kerala, Mysore and Bombay as follows :-

State			Number of months
Madras	...	...	$4\frac{1}{2}$
Kerala	...	...	$2\frac{1}{2}$
Mysore	...	...	1
Bombay	...	...	$\frac{1}{2}$
			$8\frac{1}{2}$

One month was spent as lecturer at the second Boat Design Training Centre in Cochin. The remaining $4\frac{1}{2}$ months of the total period were spent in extensive travel, development work on a beach landing boat, attending various symposiums and conferences, model testing programs at the Poona Tank and design projects of All India importance.

The following meetings were attended by the expert:

1. Symposium at Quilon The boat and the beach. Organised by the Indo-Norwegian Project in March 1958.

2. Symposium at Cochin: Improved methods of fishing from small mechanised boats. Organised by the Central Fisheries Technological Research Station, Cochin.

3. Meeting of the ad hoc Committee on Fisheries Investigation in Madras in November 1958.

4. First Indian Shipbuilding and Shipping Conference, organised by the Society of Naval Architecture and Marine Engineering, Indian Institute of Technology, Kharagpur, in November 1958. During this meeting, valuable contacts were established with the only faculty of Naval Architecture at an Indian University, and the expert had the opportunity to address the students of the faculty on general problems of fishing boat design, with special emphasis on the Indian scene. The meeting also resulted i close contacts being established between the expert and representatives of the Indian shipbuilding firms in Calcutta and Vizagapattinam.

5. In December 1958, the expert interrupted his assignment to India for ten days at the request of FAO, and with the consent of the Government of India, to attend the annual meeting of the Indo - Pacific Fisheries Council in Colombo.

Extensive travel brought the expert in close contact with fisheries workers in Madras, Tuticorin, Trivandrum, Vizhingam, Mangalore, Cochin - Ernakulam, Bombay, Calcutta and New Delhi. Contacts were also established with the Central Water and Power Research Station, Poona, which collaborated very closely with the expert on studies in their ship testing laboratory of various small fishing boat designs, as well as with manufacturers of diesel engines in India.

In May 1958 it was decided that the expert should have his permanent duty station at Cochin and work from there for the various States that had requested his services, as well as for the Central Government. This arrangement proved to be a very workable proposition, and, apart from some administrative difficulties, which no doubt will be solved in the future, has resulted in much more flexible programming and more efficient use of time.

II. SUMMARY

The following report, rather than giving a multitude of technical detail recommendations, attempts to give a short account of the expert's work during the period February 1958 to March 1959.

It contains the gist of experience gathered and proposals made to improve the efficiency of the small boat fleets.

The first part of the report deals with various finalised projects of fishing boats of between 25 to 30 ft. in length, designed for commercial fishing i.e. gillnetting, longlining, trawling, purse seining and pole and line fishing, together with a vessel for training purposes. Consultations and suggested improvements have effected a change in the layout of previously designed boats. Some earlier FAO work on the mechanisation of Tuticorin vallams has been completed.

New fishing boat designs have been introduced of from 24 to 63 ft. in length. As the importance of model testing of smaller vessels is agreed upon, a comprehensive programme has been ordered at Poona. The expert has discussed the boatbuilding programme with various Government officials, in order to increase the efficiency of the boatbuilding yards. Due to import restrictions on smaller marine engines, the expert has tried to induce Indian engine menufacturers to make their own engines.

The importance of training is stressed through the expert's experience in counterpart training, formal training centres and in giving ad hoc advice. The work of the training courses held is also reported.

Conclusions and experience gained through the expert's activities lead to a number of recommendations. In this context, great importance is attached to chapter VII of this report - Recommended Program for Future Work.

The standard reference work for any background information and technical details regarding small boat construction remains Report No. 1 to the Government of India on Fishing Boats, based on the work of Paul B. Ziener and Kjeld K. Rasmussen.

III. FINALISED PROJECTS

25 ft. Open Fishing Boat

During the initial stages of his assignment, the expert was frequently questioned as to the possibility of providing a design for a small, open fishing boat, essentially of similar dimensions as the well-known "Pablo" type boat, but with somewhat bigger capacity. These requests came mainly from Mysore State and Kerala, where it was felt that the "Pablo" did not allow sufficient fishing activities for its size.

A design was prepared in Madras, and finalised later in Ernakulam, of a 25 ft. open boat, suitable for line and gillnet fishing. The lines, Fig. 1, were originally prepared by Mr. D.A.S. Gnanadoss, Assistant Director of Fisheries (Craft and Tackle), Madras, and after approval by the expert were finalised in Ernakulam. (Drawings No. 1 to 5).

The main dimensions of the boat are:-

LOA	...	25 ft.
B, max.	...	7 ft. 1 in.
T, max.	...	2 ft. $7\frac{1}{2}$ in. (in light condition)
Δ, light	...	2.8 tons

The lines are of a transom stern boat, with a sharp forebody and a generous flare in the topsides forward, resulting in a dry hull, even in very bad weather conditions. The aft body is likewise fairly sharp, resulting in good behaviour in following seas. This design feature could be adopted as there is no likelihood of the boat having to carry heavy weights far aft. Engine, gear and catch are concentrated in the middle of the boat, where maximum buoyancy is available. Thus the boat should run with easy trim under various loading conditions.

Scantlings are on the heavy side, giving a very sturdy boat that should serve for a maximum time. Stern deadwood construction is of a different type than specified up to now, with a vertical propeller post, separate stern post and deadwood, and solid shaft log. This arrangement permits much better sharpening of the deadwood outside the rabbet than in previous arrangements. Sharpening of deadwoods is of utmost importance as many model tests have shown (see specially FAO Report No.403 to the Government of Pakistan).

Marine diesels of 10 h.p. are specified , preferably with 3:1 reduction gear and the biggest possible propeller diameter. Engines should have provision for power take off at the front end to drive a mechanical gurdy cum line hauler, placed on a thwart in the forward part of the main cockpit

Steering is by tiller, much preferable to wheel steering in small boats of this type, and much cheaper. Wheel steering may be installed as an option, should the boat be used for trawling small nets over the stern. (The expert holds the view that this should not be adopted, as the boat is basically too small for effective trawling operations). At the time of writing (March 1959) some eight boats of this type were being built, and it is planned that this design will replace completely the small 24 ft. 7 in. "Pablo" boats in future building programs.

These boats should be able to work out of all harbours, inlets and sheltered places where formerly "Pablo" boats were used, but they will be of main importance in areas where gillnet fishing and longlining are the main fishing methods, i.e. south-east coast, south of Cochin, Laccadive islands.

32 ft. Multi-Purpose Fishing Boat

As outlined in Report No.1 to the Government of India on Fishing Boats (FAO Report No.945), the 32 ft. shrimp trawler design, by Mr. K. K. Rasmussen, was used as a base to evolve a suitable 32 ft. Multi-Purpose Vessel. The demands for the versatility of such a boat proved very difficult to accommodate in one design, and it was decided to use the lines as a base for various sets of arrangements, depending on the principal fishing methods to be adopted. This design was finalised in July/August 1958. As there was no possibility of having any such boat built immediately in any of the maritime states, only the design of the arrangement for trawling over the stern was made at the time. The lines were sent to Poona to be model tested, together with the lines of Rasmussen's design.

The Central Fisheries Technological Research Station at Cochin built one such vessel during the period of the second Training Centre for Fishing Boat Design. In the course of building, certain improvements and changes in the layout of the boat were made, and the boat will eventually, when completed, serve the station as a true multi-purpose boat for trawling, purse seining, gillnetting and longline fishing. When the results of the model tests became available in early February 1959, a completely new design was prepared, with emphasis on use as a trawler and purse seiner but with possibilities for use as a gillnetter and longliner also. This latest design was distributed in March 1959, and it is expected that some six to eight boats will be built during 1959. Definite interest for this type was registered in Madras, Kerala, Mysore and Andhra, and there are also possibilities that it will be built in Orissa.

This boat represents the first type of integrated fishing boat design made in India so far. Fully decked, with a small wheelhouse, generous hold space for its size, and with engine power up to 40 h.p., this vessel will be very suitable for a multitude of uses in almost any place where more than 4 ft. of water is available. At the same time it must be pointed out that the size and layout of the boat puts it into a hitherto forbidden price class: the hull alone costs approximately Rs. 30,000 and if fully equipped, Rs. 50,000, making ownership possible only for fishing corporations, fishermen's cooperatives and the like, but very unlikely for individual fishermen.

The salient features of this design are seen in the drawings No. 6 to 11. The main dimensions are:-

LOA	...	...	32 ft.
B, max.	...	...	$9\frac{1}{2}$ ft.
T, WL	...	...	$3\frac{1}{2}$ ft.

The latest design of February 1959 calls for a boat with very wide transom stern, fully decked, with sharp forebody and ample flare to the topsides forward. The engine is installed aft, with a generous fish hold amidships and forward, and a small storage flat in the bow. The wheelhouse may be arranged either forward or aft, depending on the preferred fishing methods. No insulation of the hold is foreseen; however, should the boat be required for trips of longer duration than 24 hr., insulation must be provided. The easiest way of doing this, would be to arrange a thin ceiling ($\frac{1}{2}$ in.) over the frames, coated on the inside with bituminous paint. Cork slabs would be laid on this ceiling, and covered by another ceiling of about 3/4 in. thickness. Cork is readily available on the market in slabs of 3 sq. ft. and 2 in. thick Great care must be taken to ensure that there is adequate air circulation between the planking and the cork insulation. Double cork slabs can be laid under the deck, against the deck planking, and covered with 3/4 in. thick ceiling. The bottom of the hold should then be cemented, arranging a deep duct in the centre, to take melting ice water and drip water from the fish. This duct must be continuously cleared by a bilge pump.

The engine should be provided with the following accessories: Electrical starting, bilge pump, fuel lift pump, power take off for winches, dynamo and remote control gear (mechanical) for throttle and reverse gear. All engine controls are placed in the wheelhouse.

38 ft. Training Vessel for Madras Polytechnic

At the request of the Government of Madras, the expert prepared an outline design for a training vessel for the fisheries section of the Madras Central Polytechnic. Rs. 75,000 being available for this project, it was necessary to dampen the enthusiasm of the Polytechnic officers, who wanted a fairly big ship, equipped with all conceivable gadgets, able to demonstrate all fishing methods, and with living accommodation on board for about six men. After several discussions, it was agreed to limit the size of the boat to 38 ft., lay her out as a multi-purpose fishing vessel, without any view to commercial operations, and discard the provision of elaborate accommodation. Instead, the engine room was to be oversize, so that engineering students could gather there for practical training. Hold space was of secondary importance. The resulting design study is shown in Fig. 12 to 15 (Appendix 1). The boat's main dimensions are as follows:-

LOA	...	...	38 ft.
B, max.	...	...	11 ft. 6 in.
T, max.	...	...	4 ft. 9 in.
Δ	...	...	17 tons .(approximately)

The boat is a flush deck, transom stern vessel, with moderately sharp forebody, but flaring topsides. The engine is installed almost amidships under a raised trunk which carries the wheelhouse. This arrangement provides full standing headroom beside the engine, and allows some six to eight people to stay in the engine room for instruction. The space forward of the engine room may be used as accommodation for four men, or, better, for gear storage. A small hold is provided aft of the engine room. Deck equipment includes a small trawl winch, gurdy forward, removable, purse davit and deck sheaves, removable trawl gallows and a simple mast and boom stopped on deck just aft of the trawl winch. Access to the engine room is through a hatch behind the wheelhouse, while a big hinged hatch forward leads to the store. The wheelhouse is generously proportioned, again to facilitate instruction to be given on the spot in navigation and boat handling. It will contain all the engine controls, electrical switchboard, compass, chart table and signal flag racks. If possible, a small echo-sounder should be installed, preferably to the left of the steering wheel in clear view of the helmsman. On the port side, a closet may be built in containing a cooker and the necessary cooking utensils. Awning posts should be provided to hang a large awning between the wheelhouse and the trawl gallows.

A marine diesel of about 50 h.p. is to be installed. The Mercedes-Benz type M.202.B was recommended as very suitable because it requires little space and is readily available in India without foreign exchange difficulties at present.

The boat had not been built at the time of writing.

40 ft. Trawler - Purse Seiner

The need has been recognised for a medium sized boat of substantial catching capacity, able to make trips of three to four days at a time. This is especially desirable on the West coast, with its prolific prawn fishery. Such a vessel should be equipped essentially for shrimp trawling and purse seining for mackerel and sardine, and, perhaps, pole and line fishing for tuna should be tried with it in the Laccadive Island area. Experience with the vessels of the Government of India Deep Sea Fishing Station at Cochin and Bombay has indicated that at least 60 h.p. should be available in such a boat. It became evident on investigation that careful design could produce a boat of much greater efficiency than the vessels at present in use by the station.

The 40 ft. trawler - purse seiner, as shown in Fig. 16 to 23 should prove to be an excellent boat, especially for the West coast prawn fishery, although it will most likely also be useful in fishing from the deep water ports on the East coast.

The main dimensions are as follows:-

LOA	...	40 ft.	
B, max.	...	12 ft.	
T, max.	...	4 ft. 10 in.	(light condition)
T	,,	6 ft. 6 in.	(loaded condition, approximately)

The lines provide for a vessel with moderately sharp entrance (due to the front engine installation), flaring top sides and very flat, wide aft body to give her sufficient buoyancy when carrying a heavy purse seine and full load in the hold. Underwater, the aft body sections are made very fine, to ensure good waterflow to the propeller under all conditions. The flat buttocks indicate a boat that should not squat excessively under high speed, while the midsection should dampen rolling motions in a seaway. Generous beam allows the draught to be kept at a minimum. Careful stability calculations were made for various loading conditions of the vessel, and they indicate that she should have sufficient stability even under most undesirable conditions, such as when carrying a wet purse seine net on the aft deck.

The scantlings provide for a very sturdy vessel to be built on sawn frames with bent frames between. This method is adopted as it is felt that very few boatbuilders in India would at present be able to construct a hull of this size on bent frames only.

The internal arrangement shows a vessel of ample capacity in a hold reaching from just forward of midships to well aft of the deadwood. The engine room follows forward of the hold, with a 60 h.p. Ailsa Craig diesel driving a 40 in. propeller (maximum possible size) through a 2 3/4 in. reduction gear. Accommodation space for four men is provided forward under the raised deck. The wheelhouse is arranged over the engine room, with a small galley separated in its aft port corner. Access to the accommodation is from the wheelhouse. Portable deck panels are provided in the wheelhouse to facilitate removal of bulky engine parts, while access to the engine room is through a trunking behind the wheelhouse, which also houses the winch drive. A skylight is provided over the forward accommodation space to allow for effective ventilation.

The fish room hatch is built up on high coamings for safety reasons and the hatch cover is insulated inside.

The hold must be insulated fully if best possible results are to be achieved. It is necessary for such a vessel to carry ample ice to maintain good quality of the catch even after a few days out. Insulation may be laid over a thin ceiling between sawn frames, and covered by a 3/4 in. ceiling inside throughout. For further details see the description for the 32 ft. multi-purpose fishing boat.

Fig. 21 to 23 of the series give an impression of three rigs that could be used for this boat. Fig. 22 shows the rig that should prove most versatile; it provides for trawling by the Gulf of Mexico outrigger method, with either one or two trawl nets, and is basically the same rig that would be adopted for a purse seiner. Fig. 23 shows the boat rigged for purse seining only. It will be seen that a flying bridge could be arranged on top of the wheelhouse, an arrangement that has its advantage when purse seining for mackerel and sardine, as it gives a high point of observation to watch for shoals.

Fishing equipment would consist of a trawl winch between wheelhouse and hatch, removable pursing davit and deck sheaves, and, possibly, removable trawl gallows aft (Fig. 21). In addition, a small hand-operated windlass is foreseen on the foredeck to handle anchors. Chains are fed from the windlass through a centre chain pipe into a chain locker below.

The wheelhouse should hold all the engine controls, as well as adequate navigational equipment, such as compass, charts, radio-telephone and an echo sounder. As indicated above, the galley is arranged in the aft port corner of the wheelhouse with a separate entrance from outside.

Wide interest has already been shown in this design. It is quite possible that some of the larger, private, fish processing firms in the Malabar area will build such boats in the near future to ensure adequate supplies of raw material to their factories. There are at present very few boatyards in which a boat of this size, with its fairly complex equipment, could be successfully built. It will have to be studied whether it might be useful to re-design this boat for eventual building in steel, which could also be done by a few firms in India. The cost of this vessel, conservatively estimated, will be in the neighbourhood of Rs. 150,000, fully equipped.

24 ft. 7 in. Boat - Change in Arrangement

Several of these well-established cruiser stern boats had been used in Mysore State for trawling for shrimps. The Government boatyard at Mangalore was building three such boats during early 1958. When the expert visited Mangalore, at the request of the Director of Fisheries, Mysore, two boats were already completed, while one had only just been started. After consultations with G. Illugason, FAO Master Fisherman and R. Ruppin, FAO Training Specialist, who confirmed the very good results obtained with small trawl nets, the expert advised certain changes in the last boat. The building went on accordingly.

The stern of the boat was altered and a transom stern introduced instead of the cruiser. A low deck-cum-flooring was laid aft, to provide working space for trawl net operations. The engine was installed further forward and only a low hatch provided over it for access. The gurdy was installed as previously in the fore part of the boat, while the helmsman sits on the port side, forward of the engine, in easy reach of all controls.

The boat has since been finished, and good operational results are reported. Fig. 24 contains the drawing showing the constructional changes introduced.

30 ft. Open Fishing Boat - Changes in Layout

Similar changes were introduced for the established 30 ft. type to make the boat suitable for trawling with small nets. This project also originated in Mysore but the changed layout has since been incorporated in boats being built for Kerala and Madras, as well as the Laccadive Islands. Apart from simple layout changes, the lines of the boat were redrawn with 6 in. more draught at the propeller and 6 in. more freeboard forward. This change will enable the boat to use a big propeller with better results and will make her appreciably dryer in a seaway. The layout appears in Fi. 25. Three such boats have been or are building in Mysore, while Kerala is now receiving two boats to these specifications, and Madras has completed one and is building two more. Most of these boats will be used at the established Fishermen's Training Centres, as they can conveniently be converted for a multitude of fishing methods. The cost of the changed type is not appreciably higher than the original open boats, and approximates Rs. 14,000 without engine and fishing gear.

31 ft. 9 in. Training Centre Boat - Changes in Layout

The Fishermen's Training Centre at Mangalore, having one such boat in use, desired a second boat of similar type, but mainly for trawling operations. When the expert visited Mangalore, he was asked to make on-the-spot recommendations for a revised layout of the boat, which was already far advanced in construction. The result of these recommendations is shown in Fig. 26. The main advantages over the old arrangement are readily seen, i.e. a lower deck aft, with greatly increased working space (no cockpit), a small fish hold forward, and a tiny wheelhouse keeping all engine controls and the helmsman out of the way of the fishing operations. Trawl rigging, as currently used in the Mediterranean Sea, was foreseen, but other types of rig could easily be tried out with this boat. If warranted, purse seining can be tried by adding a removable pursing davit on one side, and providing sheaves on deck to take the purse lines on the warping heads of the trawl winch. This boat has just been commissioned in Mangalore and no reports as to her behaviour have so far been received.

One such boat is currently building at Cochin for the use of the Laccadive Fisheries Administration. However, this boat is of similar layout to the above-mentioned 30 ft. boats, the intention being to use the boat for testing many different fishing methods.

It is normally not a good practice to change existing designs, and this should only be done if circumstances prevent the adoption of a new design (as was the case with the 24 ft. 7 in. boat in Mangalore), or if substantial increases in the boat's working efficiency can be expected. Even then, changes should not be accepted as a "new design", but should be treated as transitionary. Any other boats needed for work different from that intended for the old, established types, should be built to new special designs.

Mechanisation of Tuticorin Vallams

Two Tuticorin Vallams were mechanised under the supervision of the expert in April 1958 in continuation of earlier work by P. B. Ziener (see Report No. 1).

The engines used were:-

(a) 3½ h.p. air-cooled Lister Marine Diesel
(b) 8 h.p. Solo Marine Petrol/Kerosene Engine

It was difficult to find a suitable boat for the experiment. At last it was decided to instal the Solo in the Departmental craft, Marit, and the Lister in the privately owned boat, Sagayan Rani. The responsible persons representing the Tinnevelly District Fishermen's Federation, were most helpful in the selection of this latter boat.

The Marit, having had an engine installed before, presented little difficulty in installing the Solo unit. However, to prevent serious misalignment and structural damage to the boat due to the forces set up by the engine, great care was taken to increase the longitudinal strength by fitting two long, heavy engine stringers, through-bolted to alternate frames and drift bolted to the other frames. Actual engine beds were bolted to the inside of these stringers. The existing hole in the sternpost was plugged and a new hole bored to take a sterntube of less diameter than previously used. The engine installation was a very easy job on the heavy beds provided. An intermediate shaft bearing was fitted between the engine flange and the stern tube stuffing box. A new seacock had to be fitted very near the keel, and a flexible rubber hose (steel reinforced) was used for the wet exhaust line. The fuel tank was fitted on the port side of the engine, high enough for gravity feed. An engine casing was provided, open at the aft side for easy access.

As the Solo engine was much lighter than the previously used Petter unit, the boat showed a much better trim and the extra wash board fitted as a precaution earlier could be partly removed. It appeared that kerosene engines might be a bit troublesom, as they need careful operation, and the fishermen were not used to the special system of starting on petrol and operating on kerosene. Performance of the boat during short trials was satisfactory, although it was evident that 8 h.p. was perhaps too much for this type of vessel. An economic power would be about 7 h.p., provided by a diesel engine of simple, rugged construction.

The trials with the Marit indicated beyond doubt, however, that these Tuticorin boats could easily be mechanised, but it would be advisable that new boats built with a view to being mechanised should be designed on somewhat different lines. The beam should be increased and a transom stern added. Longitudinal strength should be built in by providing at least one set of bilge stringers fore and aft each side, as well as making the keel assembly heavier. To prevent a leakage developing after some time the frames should be spaced closer (or bent frames introduced between the grown timbers, at about 10 in. centre to centre).

Revised lines and a suggestion for the construction of such boats are being worked out in the office of the Assistant Director of Fisheries (Craft and Tackle), Madras, under the supervision of the expert.

A very different course of action was taken with the installation of the $3\frac{1}{2}$ h.p. Lister engine. This unit was used to see whether old suitable Vallams could be mechanised cheaply without substantial structural changes (such as altering the stern section to take a propeller in the centre line). It was decided to instal the engine at an angle and to pass the shaft through the hull on one side, thus having the propeller either to port or starboard depending on the sense of rotation of the engine. The combined effect of the propeller rotation and the angle between centre line of the boat and shaft line should keep the boat on a straight course without excessive rudder action.

Due to the peculiar position of the engine, transverse engine beds were fitted. A heavy floor was put into the aft part of the boat, taking the inside flange of the stern tube. Between this floor and the planking, a wooden block was fitted, carefully shaped to fit against the floor and the planking. A similar block was fitted outside, and both blocks through-bolted together to the floor timber. The blocks and the floor were bored and the stern tube fitted. The propeller end of the shaft was supported in a bearing, held in a bronze tube and fitted to the hull by two struts. This fitting proved to be the most difficult, as it had to be strong and yet of slender dimensions and very accurately fitted. No suitable bearing material being available locally, a white metal bearing was used encased in teak! It is readily admitted that this is not ideal, but on the other hand such a bearing can easily be made locally and a replacement will be easy to get when it wears out. As the engine is air-cooled, no water piping was required. Due to the flexible engine mountings, vibrations in the assembly are heavy, a fact that provided some difficulties with regard to the exhaust line. It is absolutely necessary to have some length of flexible exhaust pipe to absorb the vibrations. The wooden engine casing was provided with generous openings for air intake and outlet.

Fishermen on the spot were most critical about the eccentricity of the engine installation. They predicted the boat would go in circles! However, when the boat was first tried the fishermen were invited on board and could see for themselves that it held a very straight course without much rudder action. The simplicity of the whole installation then found their approval, and they were only too willing to bring their own boats for similar installations. Trials showed that $3\frac{1}{2}$ h.p. was on the low side even for this small boat: 5 to 7 h.p. would be the correct power to instal. The flexible engine mountings have since been changed to rigid ones, resulting in much less vibration.

The strut bearing proved to be too big and created severe air bubbling under way. This would indicate the need for a well-designed bearing and struts, and the necessity to use a propeller of bigger diameter and correspondingly less pitch. The speed recorded with this boat was between 4 and 5 knots at full power, with the engine overloaded.

Recent reports indicate that this installation (and the type of engine) is much preferred by the fishermen. The owner of the boat states that his earnings have increased by about 40 per cent since installing the engine.

Further installations of this type are highly recommended, but they must be executed by experienced craftsmen to ensure trouble-free working. The angle of the shaft line to the centre line of the boat must be properly investigated, but should be in the neighbourhood of 12°. Good quality, water lubricated, end bearings, such as Minitex or Dunlop Rubber, should be used. All boats with similar installations require additional stringers to be built in from the sternpost to at least midships.

Installation of 5 h.p. Kirloskar diesel engine in Tuticorin Vallam

Early in 1958, Messrs. Kirloskar Oil Engines, Poona, agreed to buy one Tuticorin boat, have it shipped to Cochin, and let the C.F.T.R.S. instal one of their 5 h.p. units at their cost. This was done in October 1958. The engine provided is a standard Kirloskar 5 h.p. unit for pump or generator driving, and not a marine diesel. It was fitted with a simple friction clutch at the drive end, and Messrs. Kirloskar provided a fixed pitch propeller and stern gear with the engine. The engine was installed in the same way as the above-mentioned Lister unit in Tuticorin, and a small centrifugal pump for the cooling water was fitted in the boat and driven off the flywheel end by a belt. The stern gear provided, together with the clutch, permits the boat to be driven ahead only! No provision is made for astern drive. This, in the view of the expert, is an unsatisfactory arrangement. To prove his point, a controllable pitch propeller to show the difference in manoeuvring ability was fitted by him. A representative of Messrs. Kirloskars witnessed the trials and was convinced that some means of going astern was highly desirable. The question of whether Messrs. Kirloskar can produce a small reverse gear unit for their engines or whether it is feasible to manufacture simple controllable pitch propeller units for these 5 h.p. engines is now being examined.

The engine gave very good results as far as speed of the boat is concerned but certain improvements are necessary to make it suitable for mass installation in Tuticorin boats. A marine type governor must be provided, allowing a low idling speed of the engine and sensitive speed control over a wide range. Similarly, it was felt that a cooling water pump should be an integrated part of the engine.

Such small, Indian-made engines will undoubtedly be a most economical means of mechanising several hundred Tuticorin Vallams, provided the above-mentioned changes are made and a suitable reversing mechanism is found and introduced.

Mechanisation of existing boats must be done with great care as each boat is different. There should be many more installations tried, and there should be constant improvement as experience is gained. Furthermore, mechanisation of existing boats should be treated as an intermediate measure only, a stage in the development of a fully mechanised fishing fleet. It should be used to improve the existing boats only, but boats newly built should be **designed** from the beginning to take an engine successfully. In the case of Tuticorin boats, for example, certain structural and design changes seem to be advisable, such as fitting a transom stern, providing more beam and a more marked turn of the bilges in the midship section, as well as generally fitting considerably more longitudinal strength. The end product will no longer look much like a Tuticorin Vallam, but it will be an efficient small fishing boat.

IV. INITIATED PROJECTS

24 ft. Beach Landing Boat

Considerable work was done in this development project. The reader is referred to Appendix I for information on its status.

28 ft. Fishing Boat for Mysore

The Department of Fisheries, Mysore, had accumulated a number of 20 h.p. marine diesels for which a suitable design was lacking. These engines are too powerful for the 25 ft. boat range but too weak for the 30 ft. vessel intended for trawling.

The Assistant Director of Fisheries (Engineer), Mangalore, was advised by the expert to develop a new type of boat, 28 ft. long, which essentially followed the lines of the 30 ft. boat. It was suggested that the forebody should be made somewhat sharper, with good flare to the topsides, and generous freeboard, while the transom should be wider and flatter in the underwater section, giving a very buoyant aft body, and providing plenty of deck space aft. This arrangement would be somewhat like that of the 30 ft. trawler.

The work on this project is still continuing, and no final drawings have been prepared so far.

37 ft. Training Centre Trawler for Andhra

The Kakinada Fishermen's Training Centre has been in need of a suitable vessel for training purposes since its beginning in early 1958. During Mr. Ruppin's stay at Kakinada, he and the Assistant Director (Craft and Tackle), evolved a general layout for a vessel to be used mainly for trawling. The Asst. Director then prepared a lines plan and a rough arrangement drawing which were sent to the expert for approval. Many modifications were thought desirable and the expert accordingly asked the Andhra Government to arrange for the Assistant Director to visit Cochin so that the design could be discussed in detail. He came in late October for one week and the preparation of the lines was discussed in detail, an engine was selected and the optimum propeller was calculated. Questions of fishing gear and rig were discussed and a rough outline for scantlings prepared. The Asst. Director then prepared the final drawings, which were sent to the expert for critical review. These drawings were almost perfect and required only a few small details to be changed, and, according to information available (March 1959) the boat should be commissioned within a month or two.

This project is an excellent ezample of the possible useful co-operation between the C.F.T.R.S. (and the FAO experts attached to it) and the Fisheries Departments of the Maritime States. It would often be of great advantage in dealing with a particular problem if the officer concerned could come to Cochin for a few days and discuss it in detail with the experts. This is a more effective arrangement than that of an expert travelling to the state concerned. Concentration on the difficulties presented by one specific problem can thus be achieved.. It also helps the experts concerned to plan their work more effectively and to make better use of their time.

63 ft. Pearl Fishery Vessel

At the instance of the Madras Government, the expert spent some time at Tuticorin to study the work planned for a new Pearl Fishery Vessel. He went on trips to the pearl banks to gain practical experience and to see how and when canoes are towed, the duties of the vessel during the diving operations, and the performance required of her.

As pearl diving is a seasonal activity, the expert pointed out to the Government officials that they should not build a 100% tug but a tug-cum-fishing boat or, preferably, a deep sea trawler.

The outline drawings for such a vessel were prepared. The proposed ship is 63 ft. overall, with a maximum beam of 18 ft. 6 in. and a draught aft of 6 ft. 6 in. This low draft figure had to be adopted because of the restricted water in Tuticorin harbour. Due to its various duties, the layout of the ship was planned on a rather lavish scale, with a large cabin below forward, a deckhouse cabin above, engine casing over the engine room and a big, roomy wheelhouse over. The aft fish hold is not very big but it was felt that this could be accepted as the vessel would not operate as a commercial fishing vessel. Emphasis was put on a large working deck aft, which is needed for sorting out the oysters and for possible exploratory fishing. The vessel will have a 210 h.p. Ruston - Paxman diesel, driving a S.P.M. controllable pitch propeller through a reduction gear. The engine and propeller are remote controlled from the wheelhouse.

The fishing gear consists of a trawl winch, mounted athwartships aft of the engine casing, removable trawl gallows aft and mast and boom with the usual fittings. It is also possible to rig the vessel for purse seining.

The ship should be equipped with radio-telephone (mainly for use during pearl fishing to relay information on the catch to the shore station) and an echo sounder. Aqua-lung equipment is to be carried on board for use by the trained Government divers; a small, 12 ft. dinghy with a glass bottom is to be carried aft while on pearl fishing duty.

The design has been model tested in Poona. The resistance tests indicate satisfactory resistance properties. It is planned to run self propulsion tests to gain information on wake and hull efficiency, as well as to test the model under actual towing conditions, with a string of canoes towed over the stern. These tests will all be finalised during the early part of 1959, and design work will be finalised during August/September.

A great deal of work remains to be done on this project, especially with regard to engine room layout and effective utilisation of cabin space.

A profile view of the vessel appears in Fig. 27.

Model Testing

A comprehensive program of model tests was ordered at Poona during 1958 to give comparative results of the performance of various small fishing boat designs. Due to the importance of having some of the results ready for use in further design work, certain priorities had to be agreed upon, and only a part of the total tests has been carried out so far. The detailed test results will be worked into a technical paper. The following Table gives an account of the tests ordered and those done so far (March 1959):

Type of Boat	Nature of Tests	Results
32 ft. shrimp trawler	Resistance tests, 2 displacements, 3 trims each	Available
32 ft. multi-purpose	Resistance tests, 2 displacements, 3 trims each	Available
25 ft.	Resistance tests, 2 displacements, 3 trims each	Available
24 ft. 7 in. with cruiser stern	Resistance tests, 2 displacements, 3 trims each	Not available
24 ft. 7 in. with transom stern	Resistance tests, 2 displacements, 3 trims each	Not available
30 ft. with transom stern	Resistance tests, 2 displacements, 3 trims each	Not available.
24 ft. beach	Self propulsion tests in surf	Not available
63 ft. P.F.V.	Resistance tests Self propulsion tests Towing tests	Available Not available Not available

It is gratifying to note that the importance of model testing, even of small boat designs, has generally been recognised, and it is very easy to get funds sanctioned for such tests. The evaluation of the results, and their presentation will, however, take considerable time and cannot be completed before the end of 1959.

Boat Building Programs of the States

Detailed discussions were held with responsible Government officers regarding their State's boatbuilding programs for 1959/1960, and considerable *ad hoc* advice is continuously given to the builders of the boats. In this way the expert has been dealing directly with builders constructing some 25 Pablo boats, 15 open 30 ft. boats, 5 revised 30 ft. boats, 2 revised 31 ft. 9 in. boats, 10 new 25 ft. boats, 1 32 ft. multi-purpose boat, and several boats of unspecified design.

The importance of determining as early as possible in each financial year what boats are to be constructed has continuously been stressed; this is important so as to be able to place building orders early enough to give sufficient time to the builders for careful construction work. Rush jobs at the end of the year should be avoided. Similarly, it was continuously recommended that engines and items of equipment should be ordered after knowing the exact requirements of boats and types. Only in this way can mistakes be avoided, such as the delivery of engines with the wrong shaft length, insufficient accessories, unsuitable propellers, etc. These mistakes cause unnecessary delay in building and add to the cost because new equipment must be ordered or made locally.

Significant progress was made during late 1958 and early 1959, when boats for Madras and Kerala State were ordered in a great many different boat yards, thus benefitting a number of small boatbuilding centres in many places along the coast, so that mechanised fishing can be developed on a national scale.

Indigenous Manufacture of Engines and Winches

The expansion of the mechanised fishing fleet is greatly hampered by the rigid import restrictions on marine diesel engines, accessories and spares, and fishing winches. The most widely needed engines are of the power ranges 5 to 30 h.p., with 40 h.p. becoming important within the foreseeable future.

There are several manufacturers of stationary diesel engines in India, but a survey of their plans revealed that only few of them are in any way interested in the marine field.

Of these, Messrs. Kirloskar Oil Engines, Poona, seem to be most keen to find ways and means of producing a marine version of their engines. The Kirloskar engines are a development of the standard Petter diesels, and as such are very well designed and built. In order to find out their usefulness for the fishing industry, Messrs. Kirloskars have agreed to build three fishing boats at their own cost, fit their engines to the expert's recommendations, and use the boats for fishing operations for some time to find out any weaknesses in the installations. They plan to build two

25 ft. boats equipped with 10 h.p. engines and one 12 ft. multi-purpose boat with a 40 h.p. engine. To make the best use of these engines, it is essential to fit them with reverse-reduction gears of a good make. As most Petter engines are fitted with Parsons' gears, it is suggested that this make of gears should be imported for the experiments. Ultimately the question will have to be carefully examined as to whether there is a possibility of producing such gearboxes in India.

It is the expert's considered opinion that the Kirloskar power units would be very useful for the types of boats now built in great numbers. The few changes required in the engines can be easily made by the manufacturers, apart from the gearboxes.

There are rumours that other makes of marine engines will soon be available on the inland markets. The makes mentioned are mainly Perkins and Ruston, with a possibility of Mercedes-Benz also coming in. But there is to date no concrete evidence available to the expert regarding the manufacture in India of these engines. To his knowledge, only Kirloskar are experimenting with their engines for marine use.

Winches will soon be in great demand. At present only two types of winches need to be made in great numbers: the well-known vertical gurdy type and the small, horizontal, two-drum trawl winch with warping heads, friction clutch and brakes.

Some gurdies have been made at Mangalore by a local engineering firm, and sold at very low prices (approx. Rs. 800). The same firm is at present building a horizontal trawl winch for the new training centre boat at Mangalore. This winch is similar to the small winches earlier supplied by FAO (Italian type), and is sufficient for all trawling done by boats up to 30 ft. length. Bigger boats will need a somewhat larger winch, which, however, could equally well be made by local firms. Small trawl winches have also been built by a firm at Cochin and one enterprise at Rajkot. However, there is no regular production as yet of these items. The C.F.T.R.S. is collecting information on the various firms interested in making such winches, and it is planned to supply the firms during 1959 with detail drawings of winches, gurdies, purse davits, hand winches for purse seining, and other deck gear for fishing vessels. It is most important that a number of engineering firms include these items on their list of products in order to ensure a reasonable chance of success in the efforts aimed at mechanising fishing operations.

Training

There are four main ways in which an expert can carry out effective training. The first - and probably the most effective - is Counterpart Training, i.e., the expert is followed throughout his stay or assignment by one or more appointed counterparts who have to work under his constant supervision.

The second, equally important, is the formal Training Course (State-wise, nation-wise, regional or international), with experts acting as technical instructors to appointed Government officers or interested parties from private enterprise.

The third way is through *ad hoc* advice, usually that of imparting instructions to craftsmen, such as carpenters and mechanics.

The fourth way might be termed *ad hoc* too. In this way, individual officers come to a central place to seek from the expert information and instruction regarding specific problems.

All four forms of training were imparted during 1958/1959 by the expert. Training courses will be treated in a separate chapter.

Counterpart training is only useful if the counterparts can be engaged in practical work. Thus it was found that not more than two counterparts can easily be employed usefully, as creating work for a larger number takes too much time, and often results in unproductive work being given to the counterpart, such as copying drawings or supervising work that has already been supervised. As the expert spent only short periods at specific places, he does not consider counterpart training in this instance to be very useful. A counterpart should be assigned to an expert for at least one year - preferably more - if he is to grasp technique and original thinking behind boat design and building. Provided he has a reasonable background of experience when he joins the expert, he should be able, after one year, to look after the old and new projects in his locality without having to ask for expert advice too often.

The expert had three men as assigned counterparts during his stay in Madras and one in Kerala State.

Ad hoc advice was given freely, mainly during extended travel periods all around India. Wherever possible, boat building places were visited and local methods scrutinised on the spot and suggestions for improvements given.

The Central Fisheries Technological Research Station at Cochin is an ideal centre to provide training as under method 4 above. It is well equipped to collect information on boatbuilding programs from all over India, and to give centralised information and advice to anybody who might seek it. Much time is saved if instructions are given in this way, perhaps followed later, when the work is in progress, by personal visits from the expert or the officer in charge of the particular department at the C.F.T.R.S. Very good results were obtained with this method, especially in Madras, Andhra, Mysore and Kerala State. The Fisheries Departments of these four States are in continuous touch with the C.F.T.R.S. and the expert, and advice can be given quickly on any problem arising locally. If there is need for personal intervention, an officer from the State Department can visit Cochin and discuss everything with the many experts and trained staff members available there.

It is advisable that the expert undertakes frequent inspection and information trips to the actual boatbuilding places and the offices of the State Departments so that he keeps in mind the particular problems pertaining to different localities. A close personal relation with the officers in charge of the fisheries development in all State Governments is most desirable.

The growing work load at the C.F.T.R.S. and the increasing demand for new designs of much larger vessels than previously catered for, makes it imperative for the expert to have the services of essential drawing office personnel. The minimum requirements are one draughtsman, one secretary and an assistant, who should preferably be a long-term counterpart with sufficient seniority in service to make it possible for him to assume a responsible position in the national fisheries organization.

It should be studied in this connection how the services of one or more graduate naval architects from the Indian Institute of Technology, Kharagpur, could be made available to the C.F.T.R.S. While the appointment of such a naval architect to the staff of the Ministry of Food and Agriculture in Delhi is a step in the right direction, it remains to be seen whether this technical officer could not be utilised to better advantage at the C.F.T.R.S. in Cochin or in the framework of some other organization more in touch with the boatbuilding industry serving fisheries.

During his short stay at Kharagpur in November 1958 the expert found the students of the Department of Naval Architecture at the I.I.T. greatly interested in fishing boat work. He feels that ways and means should be explored that would allow these students to spend at least part of their practical training in wooden boatbuilding yards or with the C.F.T.R.S. to familiarise themselves with the important differences between theoretical naval architecture, big ship construction and small boat development work. If at all possible, the interested students should be given the opportunity to attend relevant training courses held by the Government of India.

All aspects of training are of importance. It is not so much what the expert does that decides the success of his mission, but what the people to whom he gave training, and with whom he worked, are able to do after he leaves the country.

V. TRAINING COURSES IN BOAT DESIGN AND BUILDING AT C.F.T.R.S., COCHIN, 1957 AND 1958.

Training Courses in Boat Design and Building were organised by the Government of India at the C.F.T.R.S. in Cochin during 1957 and 1958. The courses were of six months' duration each and run from 1 July to 31 December respectively, following FAO's recommendation as given in Appendix 3 of the "Report No.1 to the Government of India on Fishing Boats" (FAO Report No.945).

FAO made available the services of Mr. P. B. Ziener, FAO Naval Architect as chief instructor for both courses. In addition, for the 1957 course Mr. E. Kvaran, working as FAO Marine Engineer in Ceylon, was seconded to give one month's lecturing in Marine Engineering according to the syllabus in Appendix II of this report. For the 1958 course, FAO instructed Mr. P. Gurtner, FAO Naval Architect, to devote as much of his time as possible to active teaching at the Centre. He spent accordingly about one month giving lectures.

Mr. G. K. Kuriyan, Assistant Director of Fisheries, was acting as Administrative head for both courses, apart from participating as a trainee in the first course.

A detailed report covering the 1957 training centre was submitted to the Central Government in February 1958 by Mr. Ziener, together with copies of the drawings made by the trainees during the course. As both courses were conducted on similar lines and with basically the same curriculum, only a summary report is given here for the second course.

The following eleven trainees attended the 1957 course:-

P. B. Sapre	Bombay	Asst. Mechanical Engineer, Veraval. Diploma in Engineering, A.M.I.E. (India), A,B Sec. In charge of FAO and TCM equipment and craft.
M. Jayaraj	Mysore	Asst. Director of Fisheries Engineer. Bachelor of Engineering (Electrical). In charge of Government Cold Storage and mechanised fishing craft.
N. M. Jade	Mysore	Asst. Superintendent Fisheries. Bachelor of Science. Bachelor of Education. Headmaster of Government Fisheries School, Karwar.
D. A. Gnanadoss	Madras	Asst. Director of Fisheries (Craft). Bachelor of Arts (Zoology). In charge of mechanisation of fishing craft and boatbuilding in Madras.
S. K. Arokiaswamy	Madras	Asst. Director of Fisheries, Madurai. Bachelor of Arts (Zoology).
Jayaram Jena	Orissa	Government Mechanic. Industrial Diploma. Mechanical overseer of mechanised fishing craft and tackle.
D. L. Guha	West Bengal	District Fishery Officer. Bachelor of Arts. Maintenance of Government fishing vessels and combustion engines.
V. G. Joseph	Kerala	Sub-Inspector of Fisheries, Fisheries Technology and Navigation at Madras Polytechnic.
T. J. Mathew	Kerala	Sub-Inspector of Fisheries. Fisheries Technology and Navigation at Madras Polytechnic. Apprentice Indo-Norwegian boatyard at Quilon.

1957 trainees (Continued):

E. W. Mukasa	East Africa	Instructor in boatbuilding at Kabalega Technical School, Masindi, Uganda.
G. K. Kuriyan	Govt. of India	Asst. Director of Fisheries (Techn.), Central Fisheries Technological Research Station Cochin. Administrative Head of Course.

The following twelve trainees attended in 1958:-

From State Governments -

K. A. Doraj Rajah	Madras	Asst. Director of Fisheries, Nellore. Bachelor of Science.
B. Krishnamurthy	Madras	Research Assistant, Fisheries Technological Station, Tuticorin. Bachelor of Science.
T. Selvaraj	Madras	Inspector of Fisheries, Madras. Bachelor of Science.
K. G. Dave	Bombay	Draughtsman, Department of Fisheries, Bombay.
B. R. Sastry	Andhra Pradesh	Inspector of Fisheries, Vizagapatinam. Bachelor of Arts.
M. Seetharam	Mysore	Sub-Inspector of Fisheries, Bachelor of Arts.
K. B. Menon	Kerala	General Foreman, INP Boatyard, Neendakara.

Non official participants -

Paulraj Fernando	Madras	Tirunevelli District Fishermen's Federation, Tuticorin.
V. Jyotischandra	Mysore	Draughtsman-Mechanic.
K. G. Dawson	Kerala	Brunton and Co., Boatbuilders, Cochin. Bachelor of Engineering.
A. Jackson	Kerala	Brunton and Co., Boatbuilders, Cochin.
S. Saleem	Govt. of India	Draughtsman at C.F.T.R.S., Cochin.

The following number of trainees from the different maritime States have so far been given formal training:-

Bombay	..	..	2
Mysore	..	..	4
Kerala	..	..	5
Madras	..	..	6
Andhra Pradesh	..	..	1
Orissa	..	..	1
West Bengal	..	..	1
Central Government	..	..	2

These figures show clearly that the bulk of formal training by TA naval architects has gone to nominees from Mysore, Kerala and Madras States, while Andhra Pradesh, Orissa and West Bengal have only one trained man each. It is somewhat disappointing to note that Mr. V. S. Devara, Asst. Director of Fisheries in charge of craft and tackle in Andhra Pradesh, who has been a most promising counterpart worker, has not so far been given the opportunity to partake in any formal training course.

Although the curriculum of the 1958 course followed closely that of 1957, it was not found possible to secure the help of a qualified marine engineer to impart basic training in engine maintenance and general marine engineering work. This part of the course had thus also to be taken care of by Mr. Ziener.

The trainees were fortunate to be able to follow full scale boat-building activities at Cochin, where several boats were at the time being built by Messrs. Brunton and Co., and one boat building at the C.F.T.R.S.

The general experience with these training courses is:-

(a) It is of utmost importance to clearly realise that the trainees, after such a six months training course are by no means naval architects or boat designers. They will have acquired a good amount of basic information and knowledge and should have received enough incentive to be able to channel their imagination properly. It is imperative that these men be given every possible opportunity to work in the specialised field of their training, in order to further their knowledge by continuous practical experience in day to day work. Only thus will they be of lasting benefit, and able to assume positions of responsibility, in the fisheries organization of their State. This point cannot be emphasised enough. Any impression that these men are fully trained and need no further training, if such becomes available, is mistaken and should not be allowed to restrict the volume of training available to one and the same officer.

(b) Trainees have not normally an even level of education. It thus becomes necessary to spend quite some time in levelling the background knowledge with respect to such important subjects as basic mathematics and physics. It seems important that definite standards of education be made a condition for participation at formal training courses.

(c) Apart from giving the trainees the necessary theoretical background (basic naval architecture), it is most important to teach them to use their own imagination rather than blindly copy their teachers. For this purpose it is exceedingly important that they see and feel for themselves what influence design has on the behaviour and performance of fishing vessels. To be able to apply this feel to their imagination, they will have to participate in fishing trips and undertake thorough performance trials with a variety of boats. They should also have a good idea of how to handle small boats under way, without going into intricate details like navigation. Understanding of the basic methods of fishing is a very important subject, which again is best taught by taking the trainees out during fishing trips and letting them explain the mechanics of the operation afterwards.

(d) Audio-visual means of teaching should be used as much as possible. Models, three-dimensional spaces made up of plywood or cardboard panels, large-scale blackboard drawings, films, stripped engines, winches and other full-scale equipment are excellent means of putting across practical considerations that would be difficult to explain otherwise.

(e) Drawing board work is also essential, inasmuch as the trainees should be able to clearly express their ideas by means of a technical drawing. First class finish of drawings (inking, lettering, etc.) is of secondary importance in such a short course; the trainees will be mainly concerned with supplying working drawings for particular jobs within their own fisheries department. Clarity and simplicity are the main requirements.

(f) Detail drawings should be studied carefully by the trainees to give them an idea of the many different ways in which a particular problem can be solved. After they acquire the necessary skill in clearly visualising the meaning of a drawing, they will be in a better position to suggest improvements and modifications, or to find new and simplified ways of doing the same thing.

VI. CONCLUSIONS AND RECOMMENDATIONS

In this chapter, conclusions are offered for a number of specific sectors of fishing boat development as a whole, based on the expert's experience from February 1958 to March 1959. These conclusions in each instance are followed by a set of recommendations meant to indicate suggested improvements and to show the main line of the expert's program of work for the future.

Boat Design:

Each maritime State has at present at least two or three officers in its fisheries department who have attended one or the other of the Training Courses in Fishing Boat Design at Cochin in 1957 and 1958. While this training could not be sufficiently comprehensive as to produce fully qualified boat designers, it has no doubt given the participants a basic knowledge of how to tackle the various problems which arise in designing and building small fishing boats. The training, together with the experience gained by the men in actual service in their States, qualifies them to deal with their State's small boat building programs without too much advice and help from experts. Should new designs for small boats be required in any State, these men should be able to attempt such work. Furthermore, they know that they can at all times ask the C.F.T.R.S. for help, and it is quite feasible that some existing design could be made available to them for their particular purpose.

These men, however, are not yet qualified to deal alone with detail designs for larger vessels. After some years of practical training and constant working in the sphere of boat design and building, they will acquire further knowledge and be able to decide design questions posed by bigger vessels.

At present, the following standard designs are available for building anywhere in India under the supervision of Craft and Gear officers of the Fisheries Departments:-

(1) 24 ft. 7 in. Pablo type open fishing boat, for gillnetting and line fishing.
(2) 25 ft. transom stern boat, for gillnetting, line fishing and trolling.
(3) 30 ft. open fishing boat, for gillnetting and line fishing.
(4) 30 ft. half-decked boat, for trawling, fillnetting and line fishing.
(5) 32 ft. multi-purpose boat, for trawling, purse seining, gillnetting, line fishing, trolling.

A number of arrangements are available for most of these boats, while some are even obtainable with lines specifically drawn for different depths of water. A number of special designs (see Report No. 1) are also available at the C.F.T.R.S. which can be released upon application.

The above-mentioned boats are sound, tried designs, and should be sufficient for the needs of expanding fishing communities for some years to come.

Recommendations: State Craft and Gear officers should be encouraged to tackle independently boat design and building problems in their regions. They should be relieved of much of their present administrative burdens to give them more time for study and to do actual design work. They should be encouraged to refer their special problems to the C.F.T.R.S., Cochin, where such problems will be treated by competent staff or referred to experts assigned to the Station. Full designs made by the officers in the State departments should always be sent to Cochin for review before any building is commenced. If possible, the officers should visit the Cochin station periodically to discuss difficulties and problems that might have accumulated in their departments with regard to boat design and building.

New designs should be asked for as sparingly as possible and constant effort should be made to perfect existing designs so that they become more suitable for any required fishing method. Thus, arrangement drawings should not always be followed meticulously but should be adapted to each specific purpose. Trying out of new types of fishing gear will almost always necessitate changed layouts. This should be decided upon at an early stage and not only when the boat is half finished. In these matters again, the advice of the C.F.T.R.S. is naturally available to all States.

Boatbuilding:

There are innumerable small boat builders all along the coast of India but only a few can build boats to drawings. This has resulted in contracts being given to a limited number of firms, thus creating a type of monopoly position. It is, however, gratifying to note that last year's boatbuilding contracts of Madras and Kerala State were split up and orders placed with a number of firms. While in certain cases this will bring initial difficultie in the way of explaining over and over again the features of the boats, it will in the long run be of great benefit to the industry. The more competen boatbuilders there are, the fiercer will be the price battle waged, and only efficient and good builders will eventually remain in business.

State-owned boatyards have not been able to take away much work from private enterprise as yet. Their output has so far been very limited because of insufficient building facilities.

Boatbuilding quality is generally good. Most builders now making mechanised boats have mastered the technique of steam bending (or oil bending) frames, building smooth hulls without excessive planing, and making complex stern and stem assemblies strong and exact. Joiner work is of good quality, too, although often a bit on the weak side. Hatch coamings, covers, linings, etc., tend to be too thin, resulting very soon in leaking joints, warping surfaces and cracks in planks. Decks generally are not very well made, the planks used being too broad, and no attempt is made to lay decks with long, continuous planks fore and aft.

Engine installations often are the weakest spot in new boats. Insufficient care is taken in the first instance to align the engine correctly, while, later, the fishermen rarely check the alignment periodically so that serious damage often occurs. The practice of throughbolting the engine to the planking is undesirable, and heavy hanger bolts would be preferable.

Great savings could be effected by using hot dipped galvanised iron bolts instead of copper rod, at least for inside boltings.

Boatbuilding timbers currently used in South India are several varieties of Aynee and Ven Teak, whereas in North India Burma Teak, Indian Teak and Ven Teak are commonly used. Aynee has been found to be a good boatbuilding timber and much cheaper than teak, however, its durability is often questioned.

Generally, boats are built of unseasoned timber. Logs are purchased, sawn up and immediately used for building. This practice is probably due to the very low financial resources of the average builder, who simply cannot invest in a timber yard. Often, he is even dependent on advance payments when receiving orders. On the other hand, builders are never sure of a continuity of work mainly because of the ordering system of the various Governments.

Very little use has been made so far of marine plywood, which is manufactured in India in good quality. Similarly, only one firm has experience in handling plastics and resin-bonded fibre glass. These materials have not so far been used for fishing boat work.

Recommendations: It will be most important to impart training to local boatbuilders. This should consist of both instructions in modern boatbuilding methods, as well as in reading blue prints. It would be desirable if the C.F.T.R.S. could maintain a skeleton staff of good boatbuilding carpenters to be sent out to various local boatyards for short periods to help with orders for modern boats. These carpenter-instructors should then teach the local men blueprint reading and advanced construction methods, while supervising the work at hand. Similar skeleton staffs of instructors could be maintained by the State Boatyards, once they start functioning properly. These latter yards should not, in any case, be considered as commercial boatbuilding yards, but should be reserved for experimental work, training schemes and maintenance work of Government vessels.

More emphasis should be placed on supervising boatbuilding. Builders should learn to follow specifications and scantling tables, and only change items after formal approval of the appointed surveyor.

Engine installations and other mechanical work should be of a higher standard. For this purpose, the addition of a qualified marine engineer to the staff of the C.F.T.R.S. would be highly desirable. If possible, a FAO marine engineer, with experience in small boat work, should be attached to the Station to be in charge of training schemes and to conduct periodic surveys of boats in various localities.

Experiments with new timbers should be carried out, preferably in collaboration with the Forest Research Institute at Dehra Dan. Simplified construction methods should be tried, such as hard chine strong back construction, and use of plywood. It would be desirable for the C.F.T.R.S. to undertake the construction of a hard chine version of the 32 ft. multi-purpose boat, featuring also the use of plywood panels for bulkheads and wheelhouse construction.

Increased use of teak should be encouraged, even if first cost of boats would thereby increase. Inspection of boats built of Aynee three years ago revealed that this wood is probably of insufficient durability, thus not justifying the somewhat lower cost of construction. Teak keels, planking and decks would definitely result in considerably longer life for the boats.

Builders should be encouraged to establish timber yards so that seasoned timber becomes available for the main constructional members of new boats. This emphasizes the desirability of indicating well in advance the probable volume of required boat construction for each State (see below).

Equipment: (Engines, winches, rigging, navigational equipment).

Due to the current import restrictions, it is often difficult to know what engines will be available for future boats. This creates certain difficulties when planning the boats, as different engines often require different installations and accessories, such as exhaust lines, pumps, remote control gear, etc. Unless suitable marine diesels can be manufactured in India in the near future, the question of obtaining good engines is likely to become more and more a limiting factor in the expansion of the fleets.

Often, very little care is exercised in ordering the engines. Standard equipment is too frequently ordered without reference to the boat it has to go into, and a result is that engines are often found to lack some components when the time comes to install them. A peculiar and common deficiency is that the shafts delivered with the engines are too short for the intended boat and new shafts have to be ordered, resulting in delay and increased cost. Standard propellers, as delivered with the engines, are sometimes found to give low performance. This is especially true if the boats are intended for trawling where, normally, propellers with smaller pitch than standard are necessary.

Little use is made of the wide range of reduction gears available. Generally speaking, reduction should give lowest possible r.p.m. to allow the use of the largest possible propeller. Engines for small gillnet boats should be ordered with fuel lift pump because it is very difficult to arrange fuel tanks for gravity feed in these small craft with their restricted space.

No standard fishing winches are as yet available in India. Winches are ordered individually, if required, and vary considerably from order to order. Most winches at present in use have been provided under technical aid schemes. Unless standard winches can be ordered from catalogues, it is of little use to specify the winches required for boats of new design: thus, very often make-shift arrangements are found on boats which are not entirely satisfactory and reflect a lack in planning. The positioning on deck of the different mechanical fishing aids is often not consistent with the best practice for any special fishing method.

Rigging of masts and lifting tackle is grossly neglected in the bigger boats now building. Fittings are often of unsatisfactory design which could easily be improved.

As there are no uniform regulations available as yet regarding navigational and safety equipment, they are too often omitted. Most small boats are insufficiently equipped, but the larger boats so far delivered from foreign yards have normal equipment. This equipment is rarely maintained properly and, consequently, is of little use in an emergency. The report of the Fisheries Investigation Committee, when published, will be of great help, and legislation on an All-India basis is needed in this respect.

Recommendations: Much more care should be taken when ordering engines. The State Departments should specify clearly, when asking for tenders, any additional accessories required and any difference from standard to be supplied. Resulting orders should be as complete as possible to avoid disappointment later. It would be very valuable if the C.F.T.R.S. or the experts were consulted before tender notices and orders are posted. However, this can only be done if, at the same time, the types of boats are known for which the engines are required and the types of fishing that the boats will do. The selection of proper propeller sizes, especially, could then result in an appreciable increase in the efficiency of the fleets. The services of a well qualified marine engineer are again indicated here.

With the coming of more efficient boats, a great demand will arise for winches and similar gear. The question of using standard sizes should be considered and suitable types should be selected for mass production. The C.F.T.R.S. should, for this purpose, prepare construction drawings for such items of equipment and circulate them to well-known engineering firms. State Departments should also have these drawings and use them as much as possible in ordering such equipment. This would make it profitable for manufacturers to produce greater numbers of one item. If it is known that next year some ten 32 ft. trawlers will be built, the orders for winches should be combined and placed as one large order, resulting in appreciable savings in manufacturing costs. Such coordination of orders could perhaps also be effected through the C.F.T.R.S., provided the States notify their requirements well in advance.

Sketches, showing optimum positioning of winches and gurdies for different methods, should be prepared in collaboration with the master fishermen experts in the field.

Rigging fittings for a variety of purposes should be designed at the C.F.T.R.S. and the respective drawings made available to all State departments. The expert proposes to devote considerable time to these problems next year.

It is most desirable that reasonable regulations regarding navigational and safety equipment are prepared and put into effect shortly. These should be taken into account in any new design and should be strictly enforced. Lists of recommended and suitable items of equipment (preferably all made in India) should be prepared and circulated. Periodic inspection of such equipment should ensure its functioning efficiently at all times.

Model Tests:

While the great number of tests ordered in 1958, and partly concluded at the time of writing, show that the importance of conducting such tests is clearly understood in India, it may be of advantage to point out once more the great help they are for the designer.

There is actually a dearth of background information for designing a boat in the 20 to 40 ft. class. By sanctioning the present series of tests and, it is hoped, further tests, the Government of India has made it possible to collect a wealth of information regarding this size and class of boat. Careful design, based on results from model tests, can ensure great savings in fuel costs and can result in greatly increased performance of the boats. However, certain important observations must be made here. A boat once tested in a tank is not necessarily the best, nor necessarily good. Only re-testing and the application to new designs of the results obtained can bring improvement. Furthermore, it must be ensured that tests are run under comparable conditions so that the resulting deductions made from the data for similar boats are valid.

Recommendations: After completion of the present series, it is recommended that the new lines prepared for the 32 ft. multi-purpose boat be re-tested to see whether the minor changes have resulted in an improved hull. Further tests during 1959 should include a complete series with the new 40 ft. trawler/purse seiner to ensure that this design is only released if it offers an optimum hull shape. All the available results will then be worked up into a technical paper for presentation at the Indian Shipbuilding and Shipping Conference or at another technical meeting interested in the development of fishing boat design.

Training:

The efforts to impart a broad base of knowledge concerning fishing boat design and present day building practices to a wide section of Government officers and private individuals were very successful in 1957/1958. More training courses with a somewhat advanced curriculum are planned for the second half of 1959 and State Governments have been asked to release the 1957 trainees for this course.

Not much headway has been made during the period under review with the training of carpenters in the cottage boatbuilding industry.

Recommendations: It should be continuously borne in mind that any of the counterpart workers and other officers who have received training by FAO naval architects, directly or in formal training courses, may not be considered fully-trained boat designers. They have received a valuable basic training and still need as much varied experience as possible: this can only be had through continuous practical work and home studies. A short period of six to ten months without being in touch with the particular subject of their training will normally suffice to let them forget most of what they have been taught.

Relationship Between the C.F.T.R.S. and the State Departments of Fishery:

Craft and Gear officers of the respective State Departments should take fuller advantage of the services offered by the C.F.T.R.S. In the interests of a uniform development of the technical services being made available to the fishing industry in India it would seem to be advisable that the C.F.T.R.S. should be consulted as often as possible, especially regarding designs of boats for specified purposes, the selection of engines and propellers, equipment and layout of boats of all types. Such consultations should be initiated at an early stage of project planning by the States and should be as specific as possible to ensure sufficient time being available at the C.F.T.R.S. to deal with them fully.

In particular, selection of engines should be made after type and number of boats to be built have been determined, and in good time to allow for early delivery of the engines and additional parts to the builder's yard.

To cater for this important service to the whole fishing industry, the C.F.T.R.S. will have to be appreciably expanded. It will have to acquire comprehensive data on boats, engines and equipment. It needs a speedy and accurate duplicating section to disseminate the needed information. Its drawing office must be better equipped than at present so as to handle all possible requests for detail drawings; in particular, an efficient blueprinting section with a good stock of copy paper is required.

The boatbuilding facilities of the C.F.T.R.S. should be improved to allow for experimental work with new types of boats and new building materials to be carried out. For this purpose a small, permanent building shed is required; a few good carpenters should be kept permanently employed and a number of simple power tools (electric drill, circular saw, tool sharpener) should be at hand to speed up construction work. Space must be provided for mechanical work, engine overhauls and testing.

An easily accessible waterfront is required, with mooring facilities for a number of boats.

In this connection it should be pointed out that space is also needed to hold training courses in various specialised fields. This space should not, if possible, be in the same room as administrative offices or testing laboratories and general workshops, if concentrated work at such courses is required.

VII. RECOMMENDED PROGRAM FOR FUTURE WORK

While most points of reference in the expert's technical instructions were covered to some extent during the report period, very little was done with respect to I) d). This is mainly due to the fact that the boatyard schemes of most States are lagging behind schedule and are only now slowly materialising. The next period of assignment will see greater activity in this field.

As before, great emphasis will be put on training and cooperation, and it is especially hoped that very active cooperation with INP, TCM, Colombo Plan and, of course, the other FAO fishery experts will follow the many attempts now under way to organise it effectively.

The following main program points are planned on the basis of continuation of the assignment till the end of 1960:

a) Boat Design: All initiated projects under this heading (see Chapter IV) will be finalised, and the beach boat development program should enter in its last phase before the final planning of the 3rd Five Year Plan.

Two new designs for small boats are planned to bring the series of available designs to a close:

- 36 ft. Multi-Purpose Boat, and
- 30-35 ft. boat for extremely shallow water in inlets with not more than 2'-6" draft.

Further new designs will comprise:

- Vessels for the Government of India Deep Sea Fishing Fleet, replacement program during the 3rd Plan.

  These vessels should be so designed that they are also useful for private operators who wish to build a deep sea fishing fleet.

- Tuna vessels: With the advent of more detailed investigations into the possibilities of the tuna fisheries off the Laccadive and Minicoy Islands, as well as in the off-shore regions of the Arabian Sea, it is likely that some specialised vessels for this trade will be required by the end of 1960 or early 1961.

  Fish carrier for Laccadive Islands: The fishing industry in this island group is greatly expanding and there may soon be the need for a very fast transport vessel to bring the catches to Calicut or Cochin.

- Research Vessels: To help the expanding deep sea fishing fleets, it seems important to employ a number of efficient research vessels, mainly for exploratory fishing, but at a later stage also for research into the resources of the three oceans.

b) Boat Building: Apart from the usual ad hoc advice in this field, and the training imparted in formal courses (see below), the following work is planned:

- Building of an experimental 32 ft. V bottom fishing boat at the C.F.T.R.S. in connection with the advanced course in boat design.

- The possibilities of building steel medium size fishing vessels in Indian shipyards will be studied, together with the maintenance problems arising from the use of steel vessels. It is clear already that Indian shipyards are very much interested in obtaining such orders as gap fillers. However, very careful consideration of the different problems arising out of steel vessel use must precede any decision in this connection.

- A study of the development of boatbuilding facilities and boatbuilding prices during the last five years will be undertaken. This will include such detailed items as timber prices and availability, prices of metals and alloys in various localities, and wages in boatyards. Alongside with this study, the productivity of the different boat types now available should be investigated to gain a clear idea of their suitability and efficiency. Much of this work will be undertaken by the staff of the C.F.T.R.S., the expert coordinating their work and drawing the final conclusions.

c) Training: A third training course in boat design and building, but on somewhat advanced lines, is planned for 1 August to 31 October 1959. It is hoped that all trainees of the 1957 course will be released by their respective State Governments for this course. The course will be essentially practical, and only a few formal lectures will be given on selected subjects.

To attack successfully and conclude the large design program outlined above, there is a need for a full-time assistant with good theoretical background. Such an assistant would receive day-to-day training in the special field of fishing boat design, and should be ready to assume responsibility on an all-India basis for further work when the expert leaves India. Similarly, a good draftsman will be required, who could later serve on the staff of the C.F.T.R.S. where his knowledge of the special drafting requirements for fishing boat designs would be most valuable.

d) Model Tests: Work under this heading foresees, first, the completion of the testing program as outlined above (chapter IV). Further tests with the final lines of the 32 ft. Multi-Purpose Fishing Boat, as well as the new 40 ft. Trawler-Purse Seiner and the planned 36 ft. Multi-Purpose Boat, should follow.

The results of all the model tests undertaken since 1957 should then be worked up into a technical paper.

e) Performance: To gain a better idea of the performance of small boats, it is suggested that data on different boats should be collected. Much of this work can be done by the present staff at C.F.T.R.S. by sending out questionnaires and tabulating the results in convenient form.

All new fishing boat types in India should, furthermore, be subjected to rigorous trials, not only covering speed range, but also to find fuel consumption relative to speed and engine output, stability (GM) through inclining experiments under various conditions of loading, measurement of rolling periods and pitching, and general observation of sea behaviour. It is suggested that a number of such complete trials should be conducted with new boats during the forthcoming training course at Cochin. A trial sheet should be worked out on the basis of the work done, and the trainees requested to submit trial results of specified boats in their States after return home.

f) Equipment: Considerable time will be spent in preparing detail drawings of various items of equipment, such as winches, gurdies, trawl gear, purse seine davits, deck sheaves, side rollers, net and line chutes, etc., as well as rigging fittings, such as goose necks, mast rings, stay and shroud fittings, lifting tackle, outrigger poles, anchor davits, etc.,

g) Publications: A set of publications is planned for 1960 to supplement the formal reports by FAO to the Government. These publications should give only technical data and should be as widely circulated as possible. The following two seem to be most urgently required at present:

1) Collection of recommended boat designs for various regions, complete with specifications, scantlings, list of recommended materials and equipment, notes regarding construction, etc.

2) Collection of detail drawings of various items of equipment and rigging, together with outline sketches of ideal layouts for different fishing methods, etc.

The text of these booklets should be produced in various local languages, apart from English, so that they can be understood by the practical man in the boatyards. It might be feasible for the Central Government to publish the booklets in English, then release a specified number of copies of the drawings section to the State Governments, who, in turn, could add a text in the local language and assemble the publication for circulation within the State. It is felt that such publications would be most helpful and very eagerly sought by artisans everywhere in India. Formal reports to the Government could then be solely concerned with recommendations for Government action. It is common knowledge that the present type of formal report is very rarely read and understood by the craftsmen, who should ultimately benefit from the Expert's work.

Further publications planned are:

- A paper on trawler design for the Indian Coasts, to be presented to the Second Indian Shipping and Shipbuilding Conference in Kharagpur in November 1959.

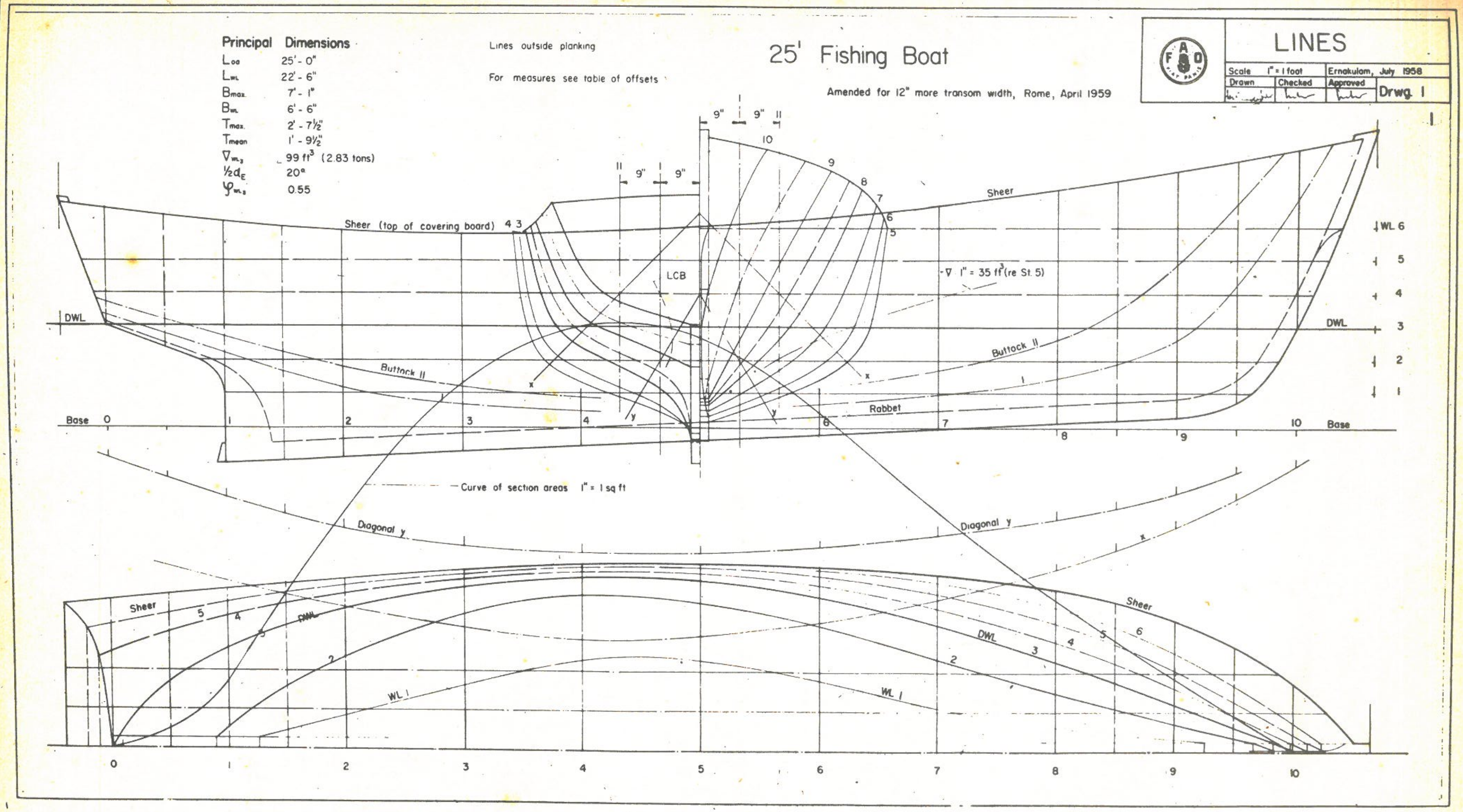
- A paper on the various series of model tests conducted at Poona.

- A summary report on the results of the Beach Boat Development program, to be presented to the Ninth Meeting of the Indo-Pacific Fisheries Council in late 1960, as recommended by Technical Committee II at the Eighth Meeting in December 1958.

- Report No. 3 to Government of India on Fishing Boats.

VIII. LIST OF ILLUSTRATIONS AND DRAWINGS

No.	Type of Boat	Type of Illustration or Drawing
1	25 ft. Fishing Boat	Lines
2		Offsets, stem and stern assembly
3		Construction
4		Sections 1, 3, 5, 7, 9
5		Profile
6	32 ft. Multi-purpose Boat	Lines of Feb. 1959
7		Back-bone, Offsets
8		Construction
9		Sections, Scantlings
10		Layout: Trawler
11		Layout: Purse Seine, Gillnets, Longline
12	38 ft. Fishing Training Vessel	Lines
13		Arrangement
14		Midship section
15		Profile
16	40 ft. Trawler - Purse Seiner	Lines
17		Hydrostatic curves
18		Backbone, Offsets
19		Scantling, Sections
20		Construction
21		Mediterranean Stern Trawl Rig
22		Mexico Trawl Rig
23		Purse Seiner Rig
24	24 ft. 7 in. "Pablo" with	Arrangement for Stern Trawling
25	30 ft. Fishing Boat	Layout as Trawler-Gillnetter
26	31 ft. 9 in. Fishing Boat	Layout as Trawler-Purse Seiner
27	63 ft. Pearl Fisheries Vessel	Profile
30) 31) 32)	24 ft. 7 in. "Pablo"	Photo of model
33)	25 ft. Fishing Boat	" " " (Drwg. 1-5)
34)	25 ft. Fishing Boat (left)	
35)	27 ft. 7 in. "Pablo" (right)	
36	32 ft. Fishing Boat	Rasmussen Design (Report 1)
37	32 ft. " "	Gurtner Design (Drwg. 6-10)


Principal Dimensions
L_{oa} 25' - 0"
L_{wl} 22' - 6"
B_{max} 7' - 1"
B_{wl} 6' - 6"
T_{max} 2' - 7½"
T_{mean} 1' - 9½"
∇_{wl_3} 99 ft³ (2.83 tons)
$½ d_E$ 20°
φ_{wl_3} 0.55
Lines outside planking
For measures see table of offsets
25' Fishing Boat
Amended for 12" more transom width, Rome, April 1959
LINES
Scale 1" = 1 foot
Ernakulam, July 1958
Drawn
Checked
Approved
Drwg. 1
Sheer (top of covering board)
Sheer
LCB
∇ 1" = 35 ft³ (re St. 5)
DWL
Buttock II
Rabbet
Base
WL 6
Curve of section areas 1" = 1 sq ft
Diagonal y
WL 1

Monsoon weather.

Scale 1" = 1 foot		Ernakulam, July 1958
Drawn	Checked	Approved
		Drwg. 2

Backbone Scantlings

Keel	4½" × 6"
Stern post	4½" sd, molded as shown
Propeller post	4½" × 8" (5" sd, in way of shaft)
S log	5" × 6"
Dead wood	5" sd, molded as shown
Stem knee	4½" sd, molded as shown

All Back bone members of Indian Teak or similar timber

Offsets in inches and eight

	STATION	T	0	1	2	3	4	5	6	7	8	9	10
Heights above (below-) Base Line	Keel	23·0	23·0	−8·0	−6·6	−5·4	−4·1	−3·7	−1·4	−0·2	1·0	2·4	23·0
	Rabbet	24·0	23·7	14·0	−2·5	−1·2	0·0	1·2	2·6	4·0	5·2	6·6	31·3
	But. I	25·2	25·9	16·7	8·7	5·0	3·4	3·6	5·3	7·5	11·3	20·0	51·0
	But. II	28·3		20·7	13·6	9·2	7·0	7·0	9·1	13·1	20·1	37·1	—
	Sheer	51·0	49·6	46·7	44·6	44·0	44·3	45·5	47·4	50·2	53·7	58·0	63·0
Half-Breadth from Centre Line	WL 1	—	—	—	7·5	14·6	20·4	20·5	14·0	9·7	5·5	2·6	—
	2	—	—	5·0	20·6	31·0	35·3	33·6	28·5	21·0	13·3	6·2	—
	3	-		22·7	32·1	37·1	39·3	38·7	35·1	28·6	20·4	10·6	—
	4	18·2	22·0	30·2	35·5	38·7	40·4	40·3	37·6	32·5	25·0	14·4	2·0
	5	27·3	28·2	33·4	37·4	40·0	41·5	41·6	39·7	35·7	29·2	18·4	4·0
	6	—	—	-	-	—	—	—	41·2	38·4	32·7	22·4	6·4
	Sheer	33·0	33·7	36·4	38·7	41·0	42·3	42·5	42·0	40·2	37·0	29·7	15·5

Amended for 12" more transom width

Bolting of Backbone

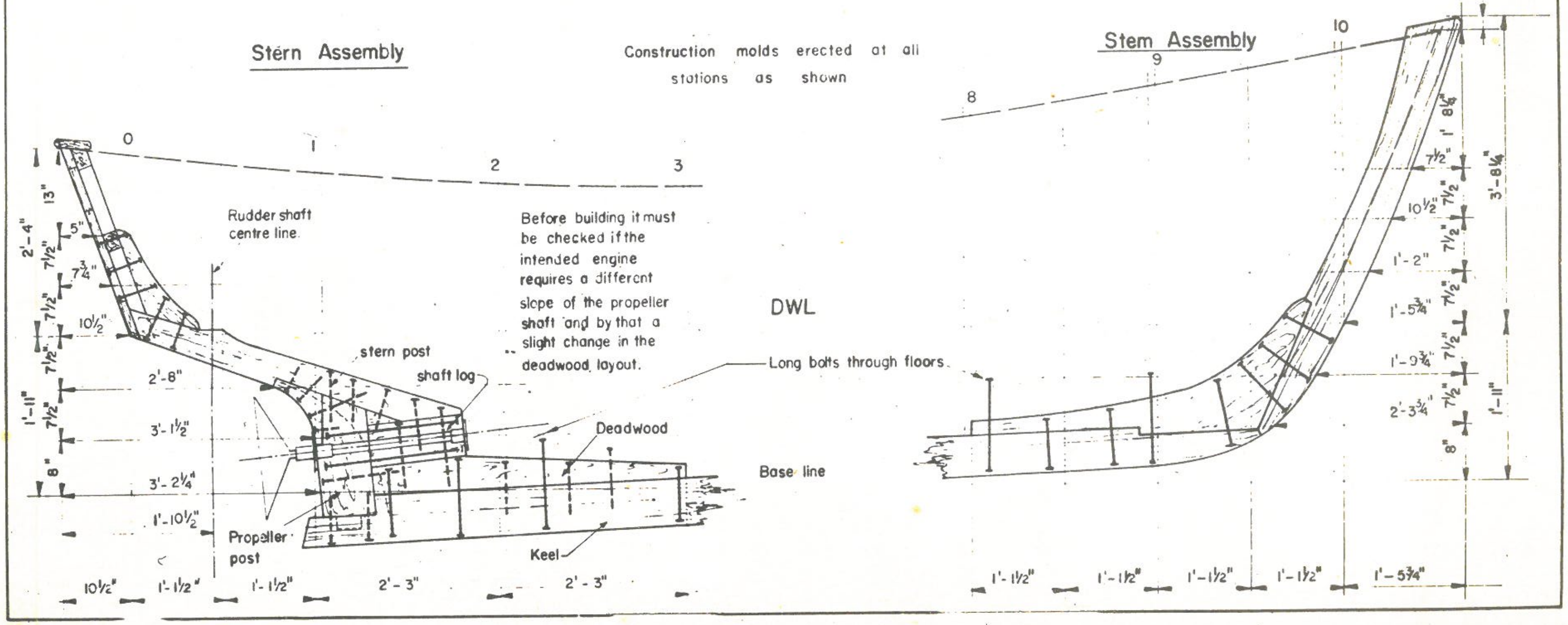
├───┤ Through bolts

├ – – – Drif bolts

All bolts to be ½" galvanized iron, heads out side

Drift bolts to be driven in interlocking pairs wherever possible (floors to keel, deadwood etc.)

Bolts through propeller post only in center line to allow for effective sharpening of post.



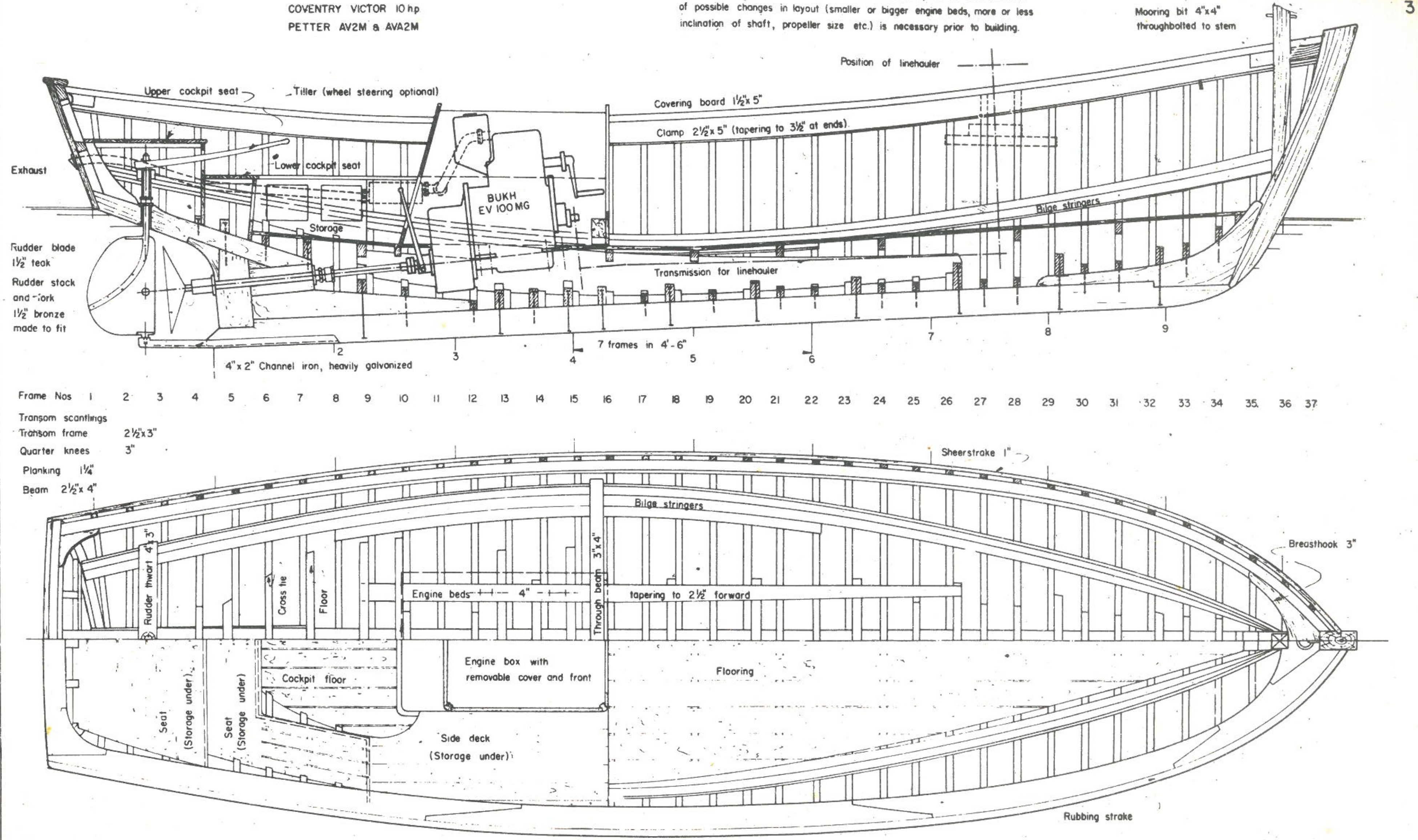
Engines suitable for installation
- BUKH EV100MG & MV
- LISTER FRM I
- LISTER LDM 2 (aircooled, low h.p.)
- PARSONS "Goosander" (aircooled, requires more inclination)
- COVENTRY VICTOR 10 hp
- PETTER AV2M & AVA2M

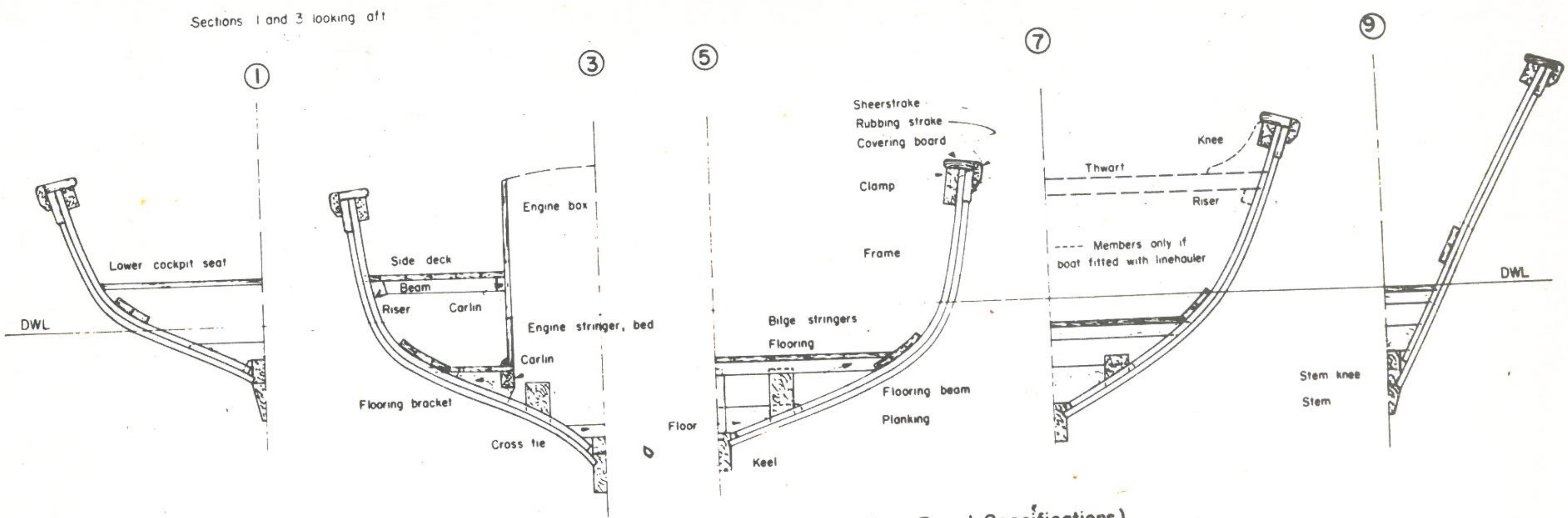
For explanation and further details on construction see Specifications and Drwg. 4: Sections, Scantlings

NOTE: When proposing any other engine but BUKH EV100, careful consideration of possible changes in layout (smaller or bigger engine beds, more or less inclination of shaft, propeller size etc.) is necessary prior to building.

CONSTRUCTION		25 ft. Fishing Boat
Scale 1" = 1 foot	Ernakulam, July 1958	
Drawn	Ch'cked	Approved	Drwg. 3

3





(further details see Drwg. 3 and Specifications)

Scantlings

Backbone scantlings see Drwg. 2

Frames	$1\frac{1}{2}$" x 1" all steam bent ; 7 frames on 4'-6" as shown on Drwg 3
Planking	$\frac{3}{4}$" finished ($\frac{7}{8}$" when building)
Sheerstrake	1" finished
Clamp	2" x 5" tapered to $3\frac{1}{2}$" ford and aft
Covering board	$1\frac{1}{2}$" x 5" cut to shape
Rubbing strake	$1\frac{1}{2}$" x 4" continuous
Bilge stringers	$1\frac{1}{4}$" x 3" nos 2 throughout, 3 from St 2 - 6

Engine stringers and bed 4" sided under engine, tapering to $2\frac{1}{2}$" forward, notched for all frames and floors and cross ties

Floors $2\frac{1}{2}$" sided at frames 5 7 9 13 14 15 16 18 20 23 26 29 32

Cross ties $1\frac{1}{2}$" sided on all other frames except 1 2 3 8 11 35 36 37

Flooring forward $\frac{3}{4}$", set on Flooring beams 2" x $2\frac{1}{2}$"

Cockpit flooring (and at side of engine box) $\frac{1}{2}$", set on beams and brackets

Side deck $\frac{3}{4}$", on beams 2" x $2\frac{1}{2}$", Riser 2" x $2\frac{1}{2}$" and Carlin 2" x $2\frac{1}{2}$"

Cockpit seats (lower and upper) and storage closets $\frac{1}{2}$"

Engine box $\frac{3}{4}$" with removable top and front

Engine box carlin $2\frac{1}{2}$" x 3"

Thwart $2\frac{1}{2}$" x 12"
Knees $1\frac{1}{2}$" set on frames
Riser 2" x 3"
} fit only if boat equipped with mechanical linehauler

Mast step 4", removable mast thwart 3" x 8"

SECTIONS SCANTLINGS	25 ft. Fishing Boat
FAO	
Scale = 1" = 1 foot	Ernakulam, July 1958
Drawn	Drwg. 4

Awning spread on ½" gas pipe (all easily removable to store either side of engine box).

When sailing, the awning should be stored.

Sail should be used with fair winds.

Type of sail and arrangement of rigging according to local custom in place of use

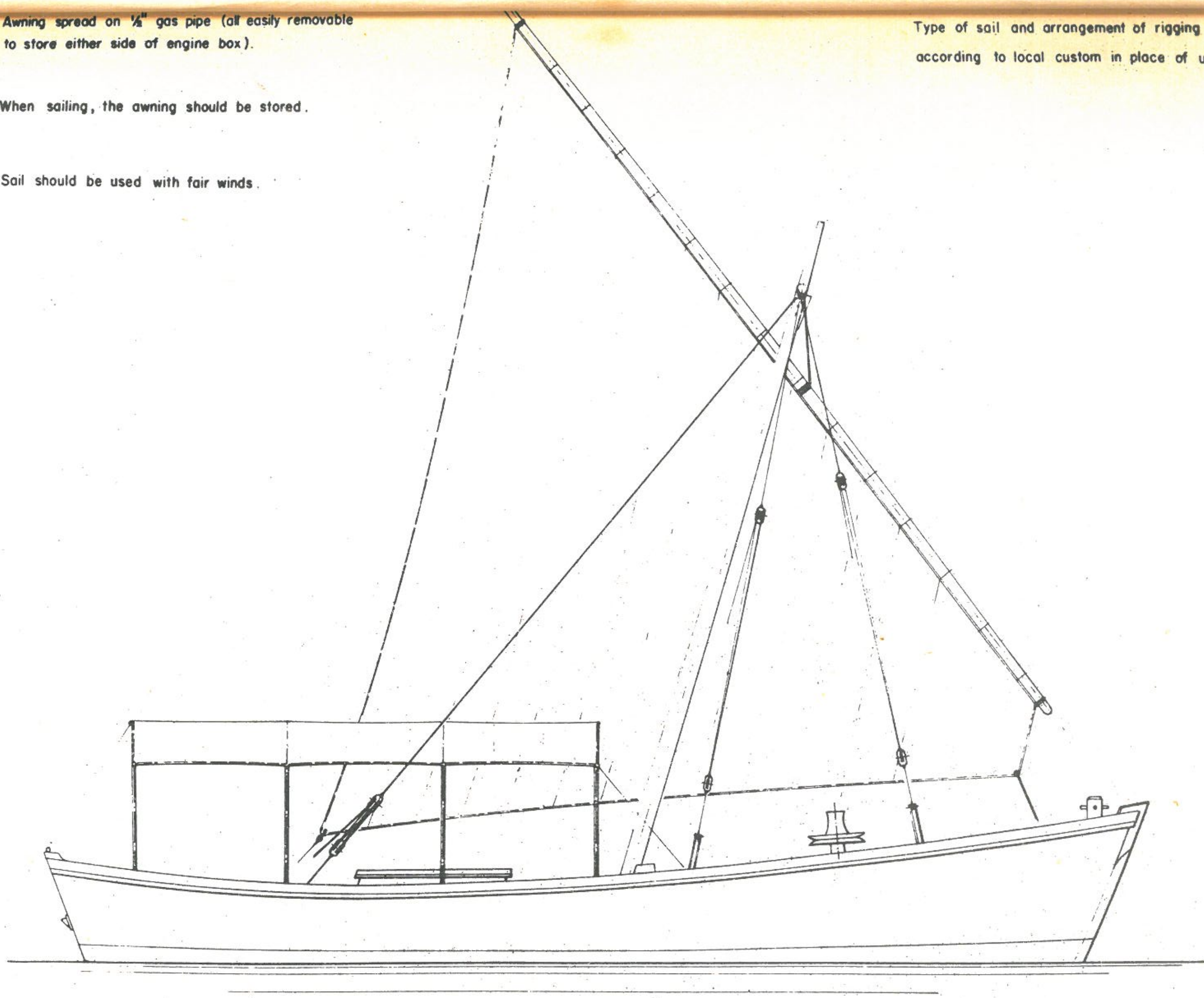
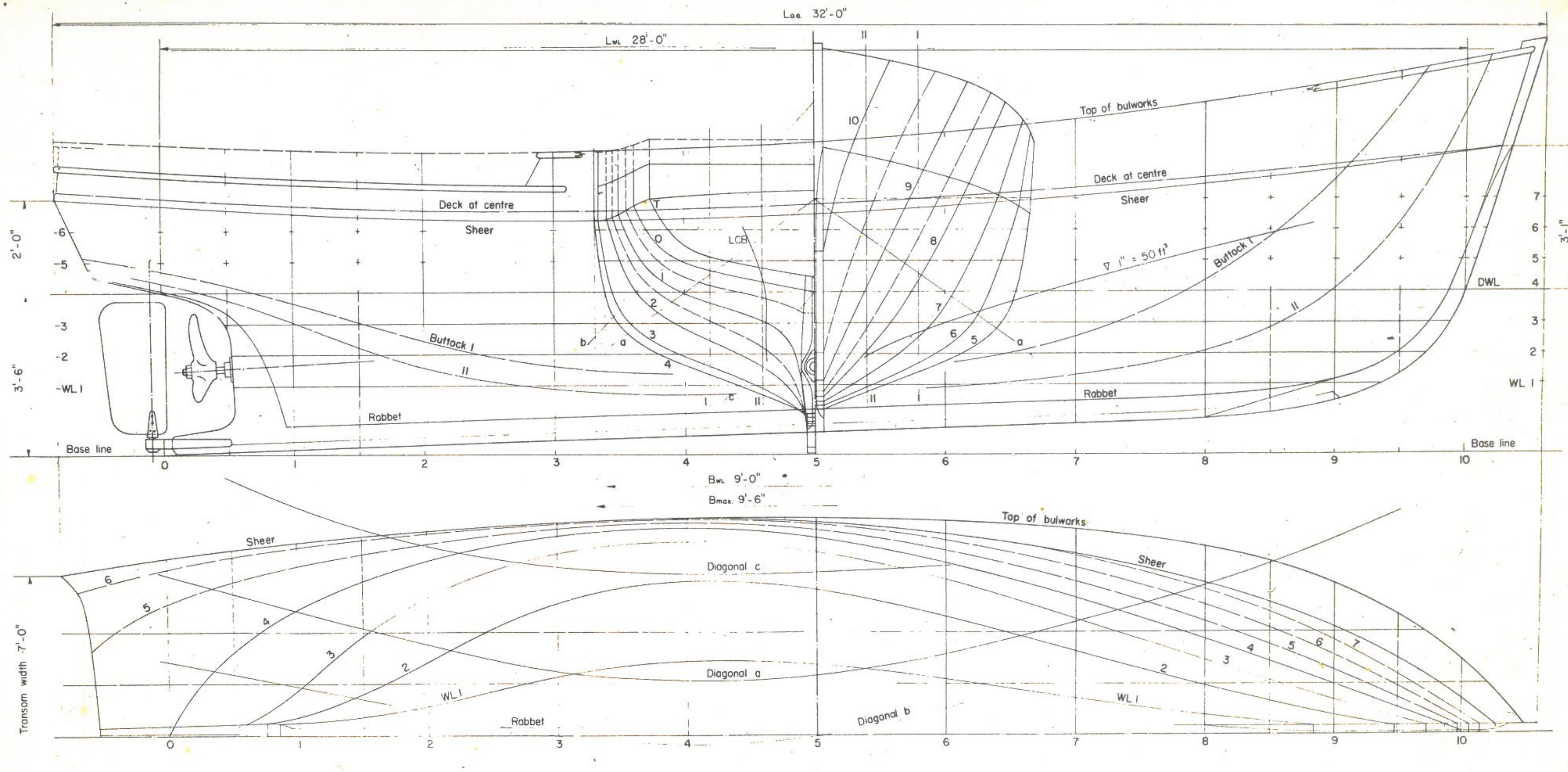


Fig 4

PROFILE	25 ft. Fishing Boat	
Scale ½" = 1 foot	Ernakulam, July 1958	
Drawn		Drwg. 5



Second amendment after Tank Tests

32 ft: Multi-Purpose Fishing Boat

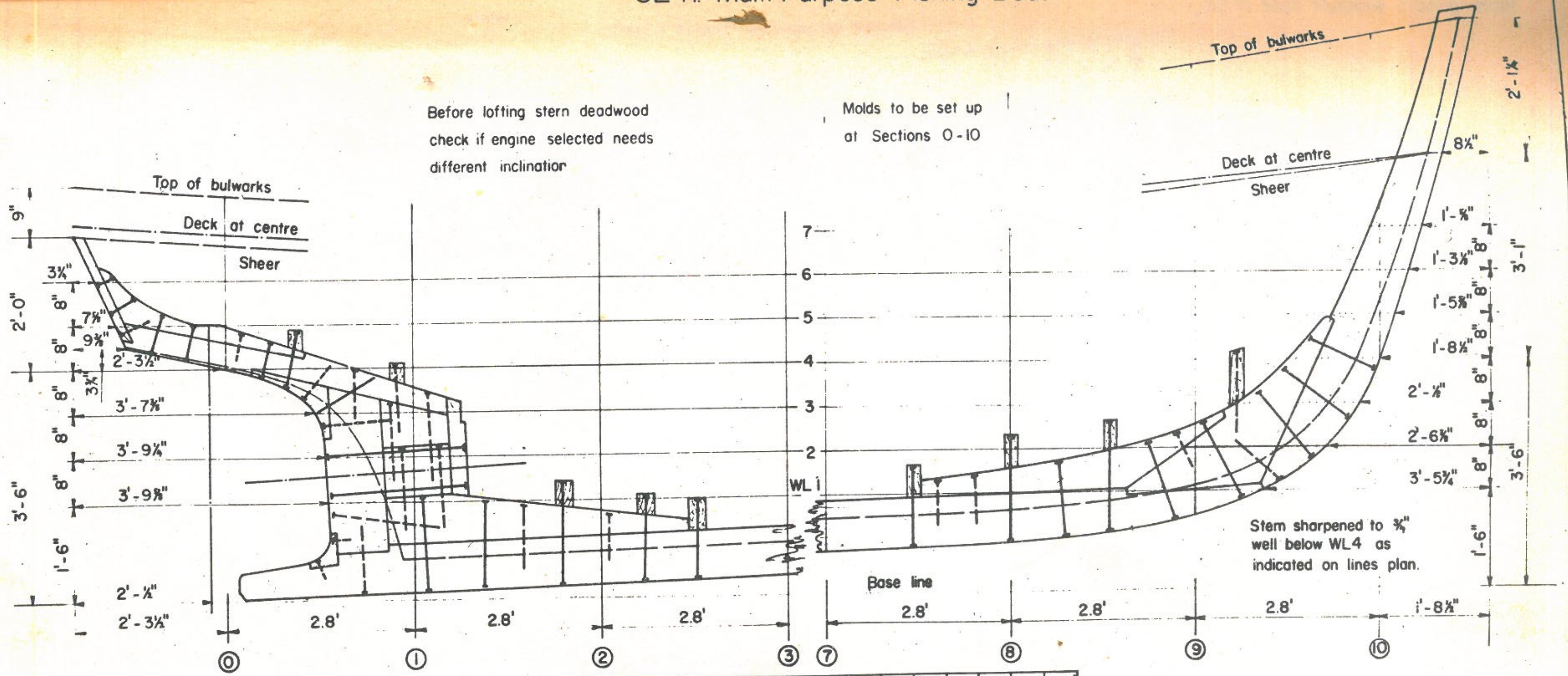
FINAL LINES

Scale 1" = 1 foot | Ernakulam, February 1959

Drawn

Drwg. I

32 ft. Multi Purpose Fishing Boat



Section		T	0	1	2	3	4	5	6	7	8	9	10
HEIGHTS ABOVE BASE LINE	Keel	456	420	1·2	←				→	8·0	9·2	13·6	42·0
	Rabbet	46·1	42·3	7·3	←				→	13·7	15·2	19·2	52·3
	But. I	51·0	47·5	39·1	29·4	22·7	20·5	21·3	23·6	30·3	45·0	70·5	
	II	48·2	44·5	34·4	22·5	17·1	15·3	16·1	17·4	20·4	26·7	43·2	88·1
	Sheer	66·0	64·1	62·1	60·6	60·2	60·7	62·1	64·0	66·5	69·7	73·5	77·7
	B'warks	75·0	72·7	71·0	69·7	78·0	79·0	80·4	83·1	86·4	90·7	96·0	101·5
HALF BREADTHS FROM CENTRE LINE	WL. 1			3·5	7·7	15·6	20·3	18·2	15·0	9·5	5·2		
	2			5·0	19·5	35·0	40·1	38·0	31·1	21·6	12·6	5·3	
	3			12·5	36·4	48·0	51·1	48·2	40·7	30·4	19·5	9·1	
	4			34·4	46·0	52·1	54·0	52·0	45·2	36·1	25·0	12·7	
	5	23·0	34·4	44·5	50·1	54·0	55·4	53·7	48·3	40·3	29·7	16·7	
	6	37·5	43·3	48·7	52·6	55·2	56·3	55·0	50·7	44·0	34·1	20·5	3·3
	7							55·7	53·1	47·3	38·1	24·5	5·3
	Sheer	42·0	46·3	50·3	53·3	55·4	56·6	55·6	52·5	47·4	39·6	28·1	9·1
	B'warks	42·0	46·3	50·3	53·3	55·4	56·6	56·7	56·0	53·6	49·2	39·4	19·4

Offsets in inches and eighths

Backbone Scantlings

Keel	4½" x 9" (if 2" shoe fitted, 4½" x 7")
Propeller post	4½" at keel, 7" at shaft, 6" joining horn timber
Shaft log	7" x 9"
Filler	to fit
Deadwood	4½" at keel, 7" at shaft log
Front piece	3"
Horntimber	6" forward, tapering to 5" at transom
Transom knee	5"
Transom planking	1⅜"
Stem	4½" outside, 5½" inside robbet
Knee	5½" fore half
	4½" aft half

Bolting

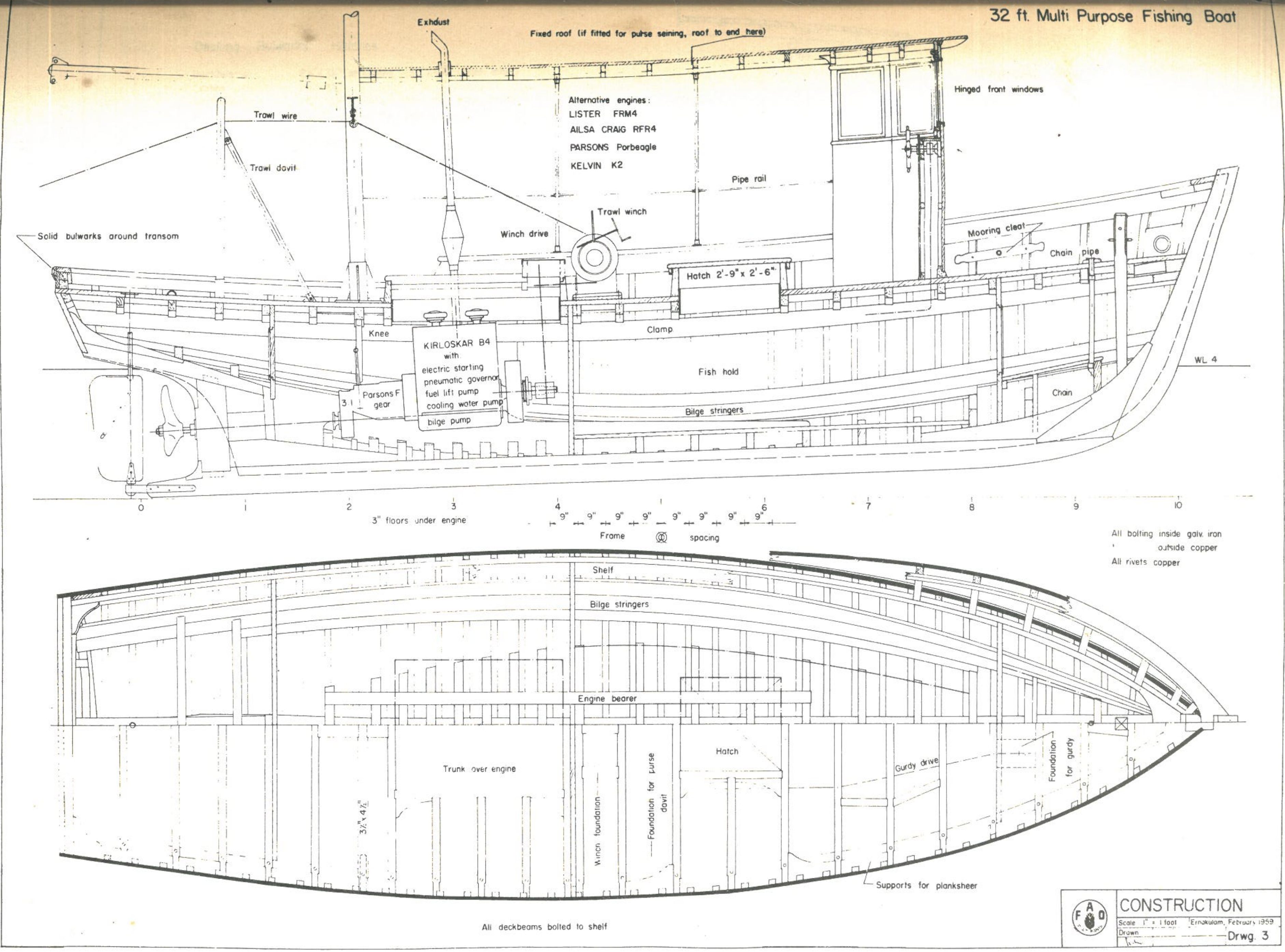
|—| Throughbolts
|- - - - Driftbolts

all ½" galv. iron (⅝" if copper rod)

Principal Dimensions

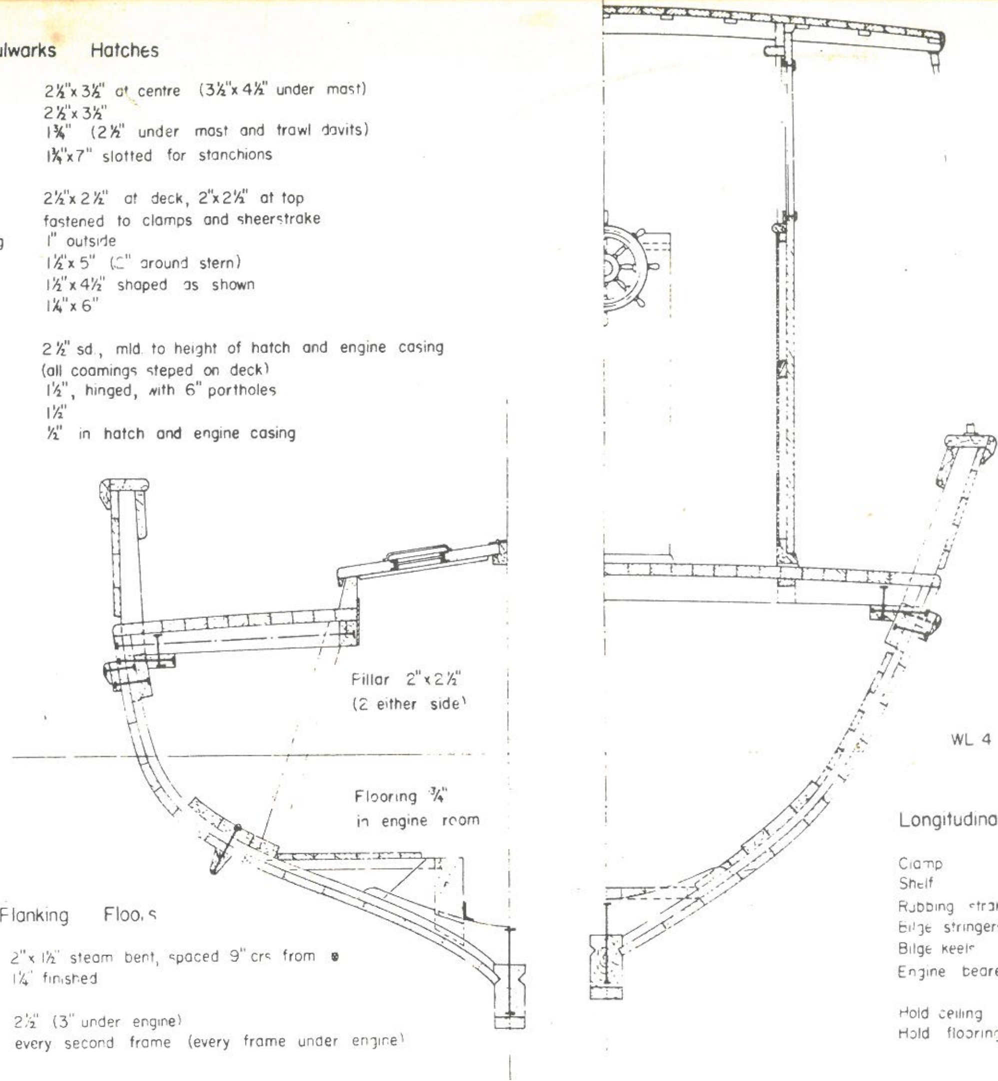
$L_{o.a.}$	32' - 0"
L_{WL_4}	28' - 0"
$B_{max.}$	9' - 6"
B_{WL_4}	9' - 0"
T_{aft} (max.)	3' - 6"
T_{mean} (to rabbet)	2' - 6½"
∇_{WL_4}	247 ft^3
LCB_4	-1.05'
φ_4	0.575
δ_4	0.385
$\frac{1}{2}\, \alpha_{E_4}$	20°
Power	40 hp.
Carrying capacity	5.5 tons.

FAO FIAT PANIS	**Backbone - Offsets**		
	Scale 1" = 1 foot	Ernakulam, February 1959	
	Drawn		Drwg. 2


32 ft. Multi Purpose Fishing Boat
Exhaust
Fixed roof (if fitted for purse seining, roof to end here)
Hinged front windows
Alternative engines:
LISTER FRM4
AILSA CRAIG RFR4
PARSONS Porbeagle
KELVIN K2
Trawl wire
Trawl davit
Pipe rail
Trawl winch
Winch drive
Solid bulwarks around transom
Mooring cleat
Chain pipe
Hatch 2'-9" x 2'-6"
Knee
Clamp
KIRLOSKAR B4
with
electric starting
pneumatic governor
fuel lift pump
cooling water pump
bilge pump
Parsons F
gear
3:1
Fish hold
Bilge stringers
Chain
WL 4
0
1
2
3
4
6
7
8
9
10
3" floors under engine
9" 9" 9" 9" 9" 9" 9" 9"
Frame @ spacing
All bolting inside galv. iron
outside copper
All rivets copper
Shelf
Bilge stringers
Engine bearer
Trunk over engine
3½" x 4½"
Winch foundation
Foundation for purse davit
Hatch
Gurdy drive
Foundation for gurdy
Supports for planksheer
All deckbeams bolted to shelf
CONSTRUCTION
Scale 1" = 1 foot
Ernakulam, February 1959
Drawn
Drwg. 3
FAO

Decking Bulwarks Hatches

Deckbeams	2½"x 3½" at centre (3½"x 4½" under mast)
Carlins	2½"x 3½"
Deck planking	1¾" (2½" under mast and trawl davits)
Planksheer	1¾"x 7" slotted for stanchions
Stanchions	2½"x 2½" at deck, 2"x 2½" at top fastened to clamps and sheerstrake
Bulwark planking	1" outside
Railcap	1½"x 5" (2" around stern)
Rubber	1½"x 4½" shaped as shown
Rail	1¼"x 6"
Coamings	2½" sd., mld. to height of hatch and engine casing (all coamings steped on deck)
Engine cover	1½", hinged, with 6" portholes
Hatch cover	1½"
Liners	½" in hatch and engine casing



Wheelhouse Roof

Coaming	3"x 4" as shown (drain hole every 12")
Outside panel	1" teak
Lining	½" plywood
Frame	1"x 2"

Buildup of wheelhouse as shown

Front windows hinged
Side windows fixed

Roof beams	1½"x 2½" at centre
Planking	¾" strips
Battens	½"x 1½"
Stanchions	1" pipe

Framing Planking Floors

Frames	2"x 1½" steam bent, spaced 9" crs from ⊗
Planking	1¼" finished
Floors	2½" (3" under engine) every second frame (every frame under engine)

Bulkheads 1½", engine room blkhd insulated

Long vertical knee under mast beam 2½" sd

Further details Drwg 2, 3

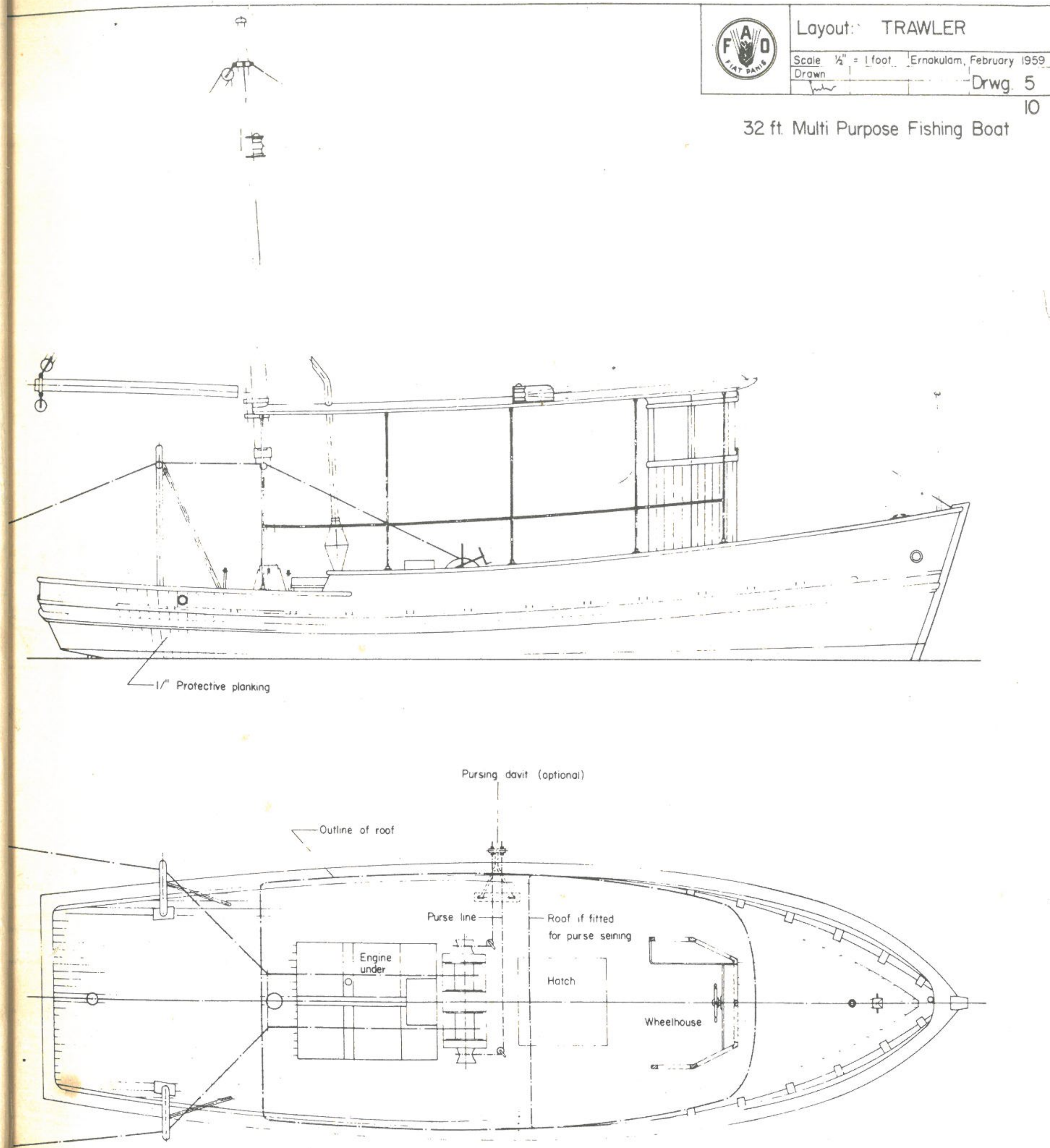
Longitudinals

Clamp	1¾"x 6"
Shelf	2"x 4"
Rubbing strake	1½"x 4" and 1"x 3"
Bilge stringers	1½"x 5" (2), 1½"x 4" (1)
Bilge keels	1½"x 3" from St 2 - 7
Engine bearers	4" sd with floor brackets, 2½"x 1½" angle iron inside
Hold ceiling	1" strips
Hold flooring	1½"

Backbone scantlings Drwg 2

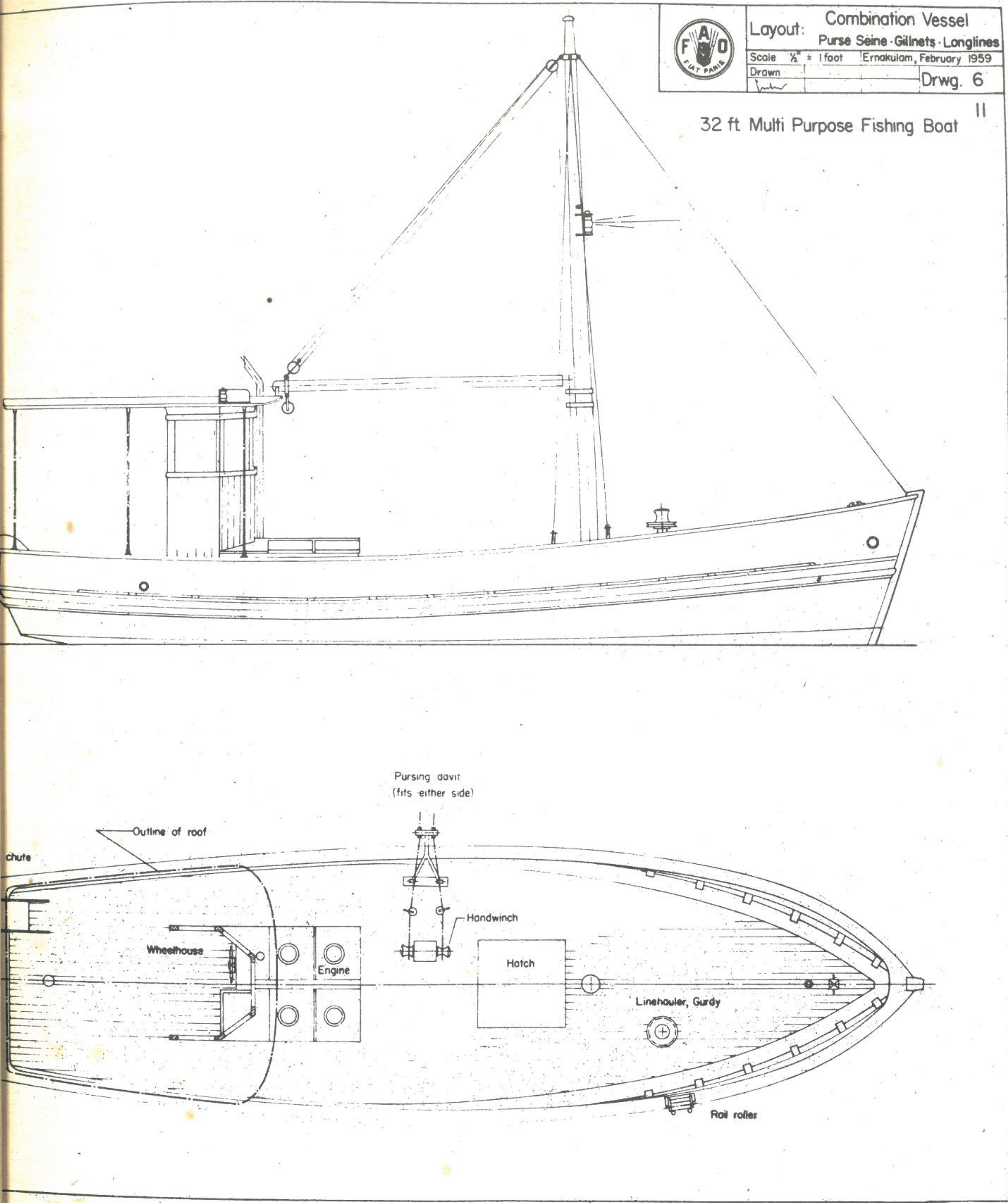
32 ft. Multi Purpose Fishing Boat

SECTIONS SCANTLINGS	
Scale 1" = 1 foot	Ernakulam, February 1979
Drawn	Drwg. 4



10

32 ft. Multi Purpose Fishing Boat



Layout: Combination Vessel
Purse Seine · Gillnets · Longlines
Scale 1/8" = 1 foot
Ernakulam, February 1959
Drawn
Drwg. 6
32 ft Multi Purpose Fishing Boat
Pursing davit
(fits either side)
Outline of roof
chute
Handwinch
Wheelhouse
Engine
Hatch
Linehauler, Gurdy
Rail roller

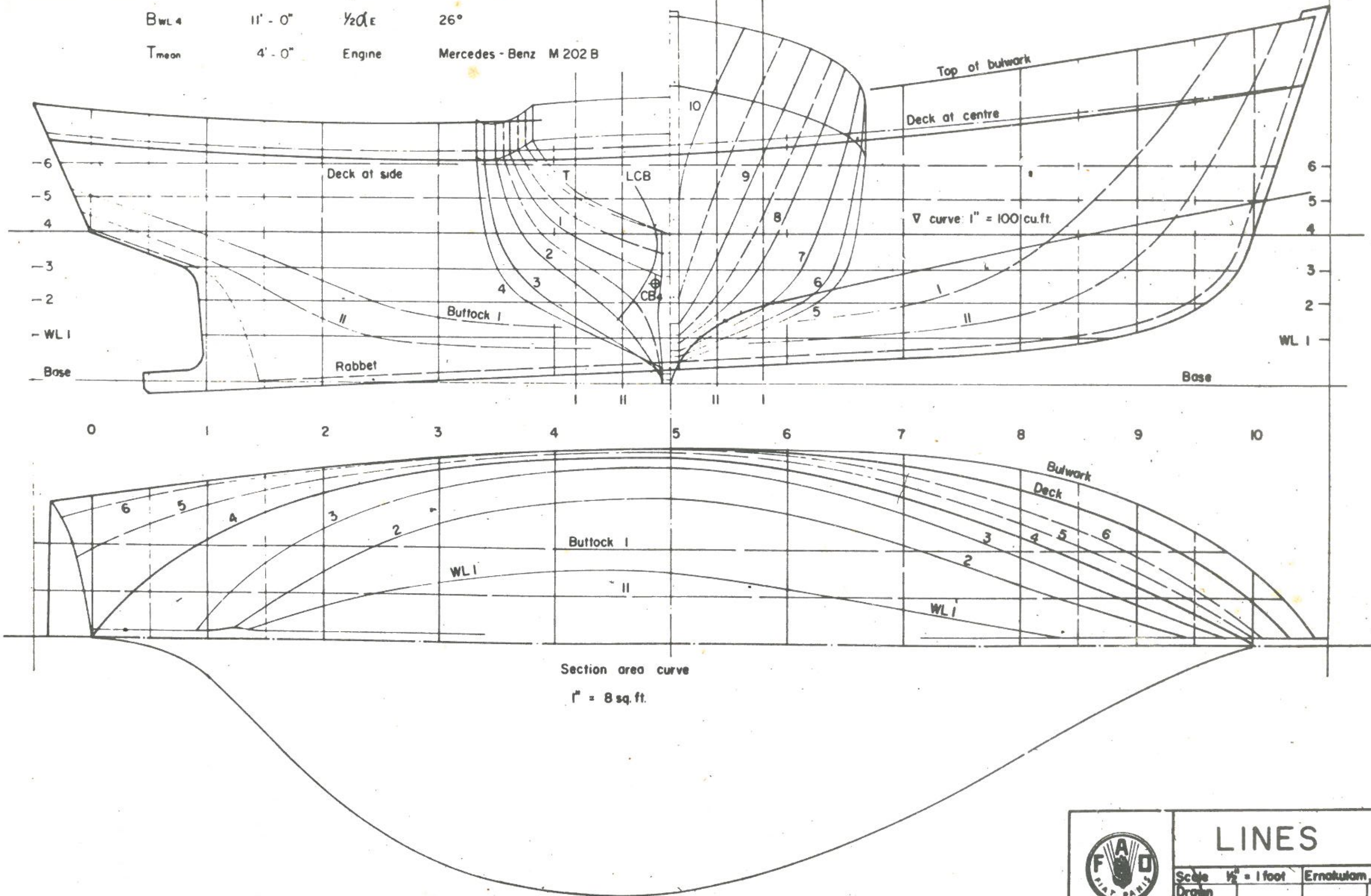
38 ft. Fishery Training Vessel

for

Madras Polytechnic

Principal Dimensions

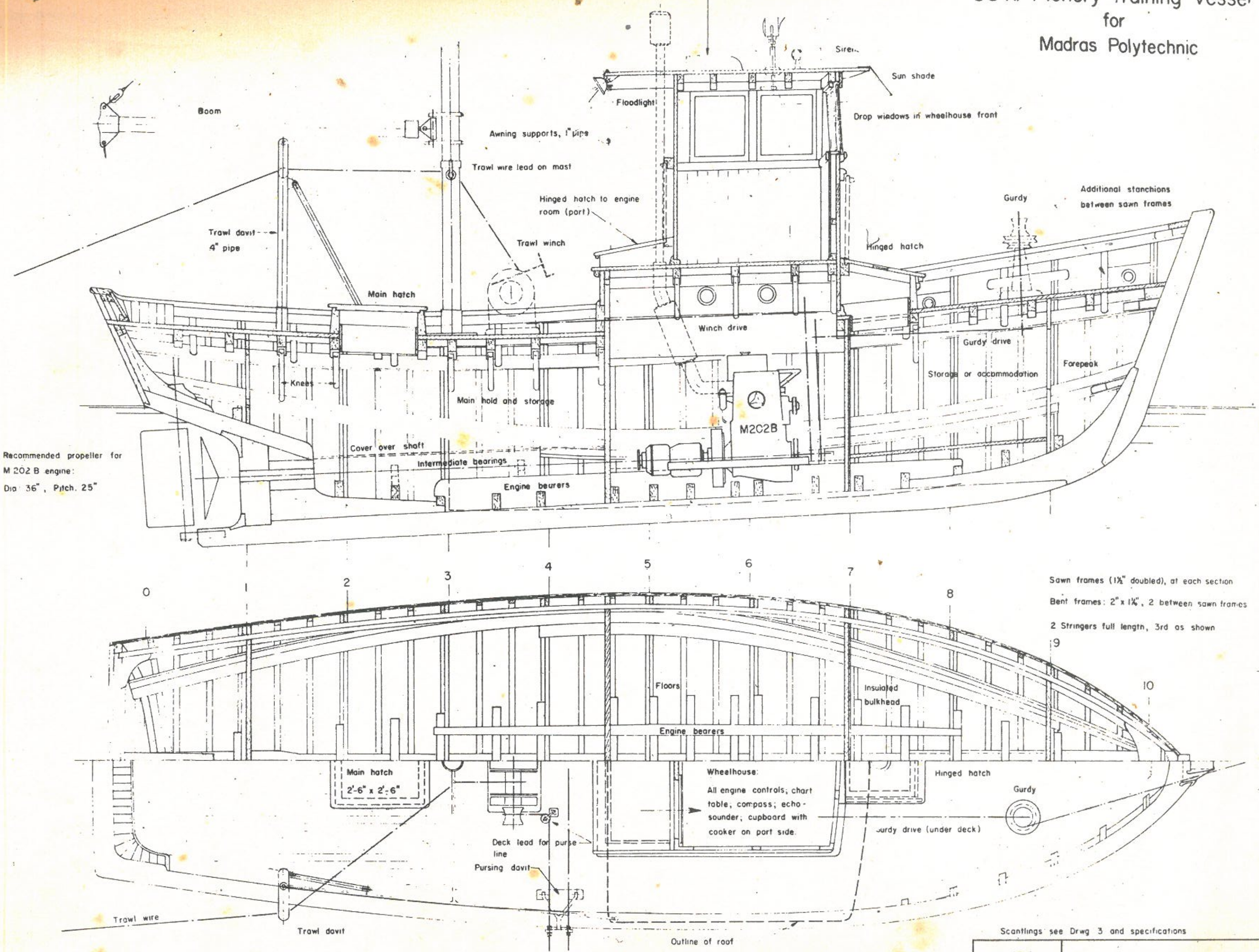
L_{oa}	38' - 0"	T_{max}	4' - 9"
$L_{WL\,4}$	34' - 0"	$\nabla_{WL\,4}$	610 cu ft , 17.4 tons
B_{max}	11' - 6"	φ_4	0 61
$B_{WL\,4}$	11' - 0"	$\frac{1}{2}\alpha_E$	26°
T_{mean}	4' - 0"	Engine	Mercedes - Benz M 202 B



LINES

Scale ½" = 1 foot	Ernakulam, Oct. 1958	
Drawn		Drwg. 1

38 ft. Fishery Training Vessel for Madras Polytechnic



Recommended propeller for M 202 B engine:
Dia 36", Pitch 25"

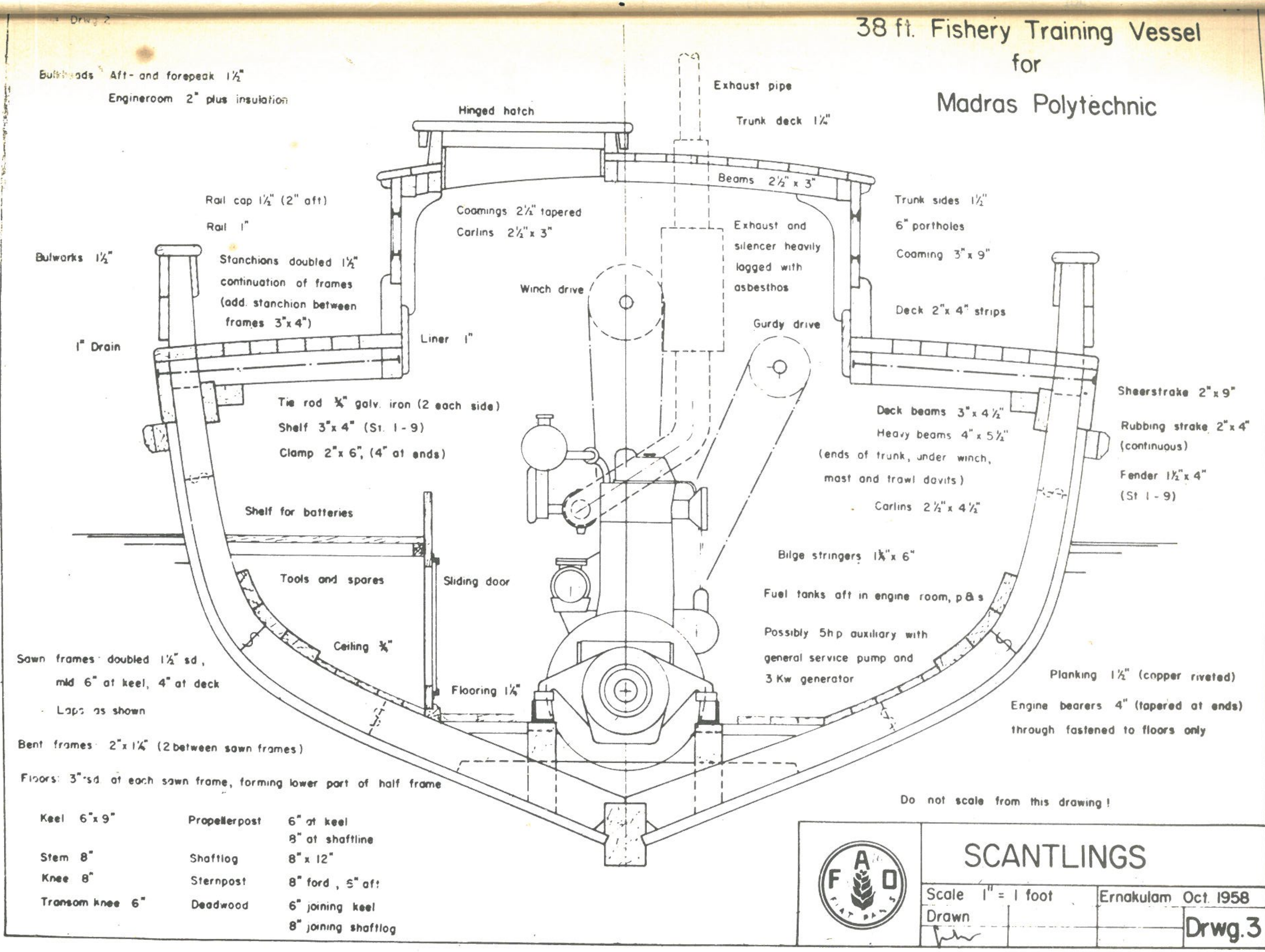
Sawn frames ($1\frac{3}{4}$" doubled), at each section

Bent frames: 2" x $1\frac{1}{4}$", 2 between sawn frames

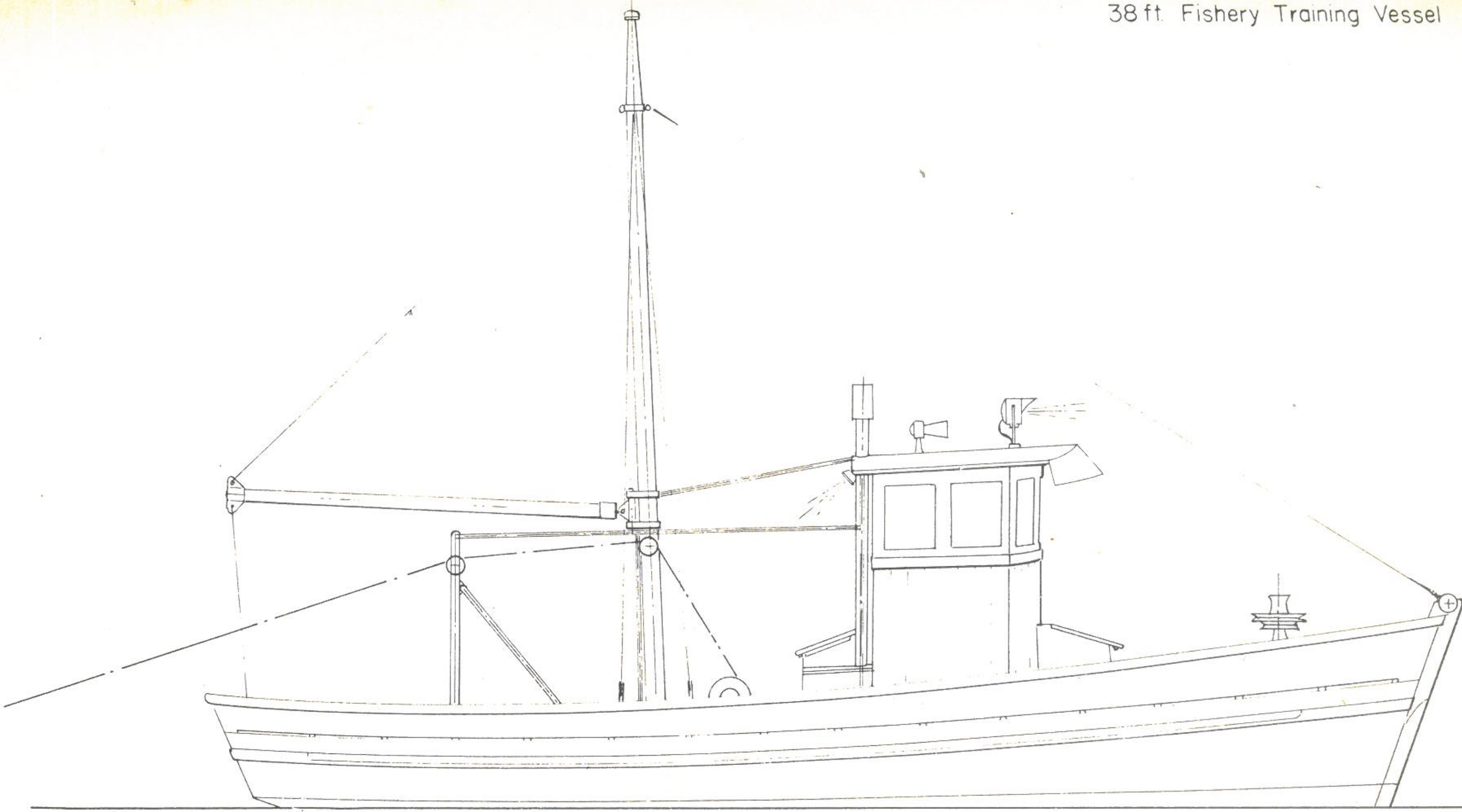
2 Stringers full length, 3rd as shown

Scantlings see Drwg 3 and specifications

FAO	**ARRANGEMENT**
	Scale ½" = 1 foot — Ernakulam, October 1958
	Drawn — Drwg 2

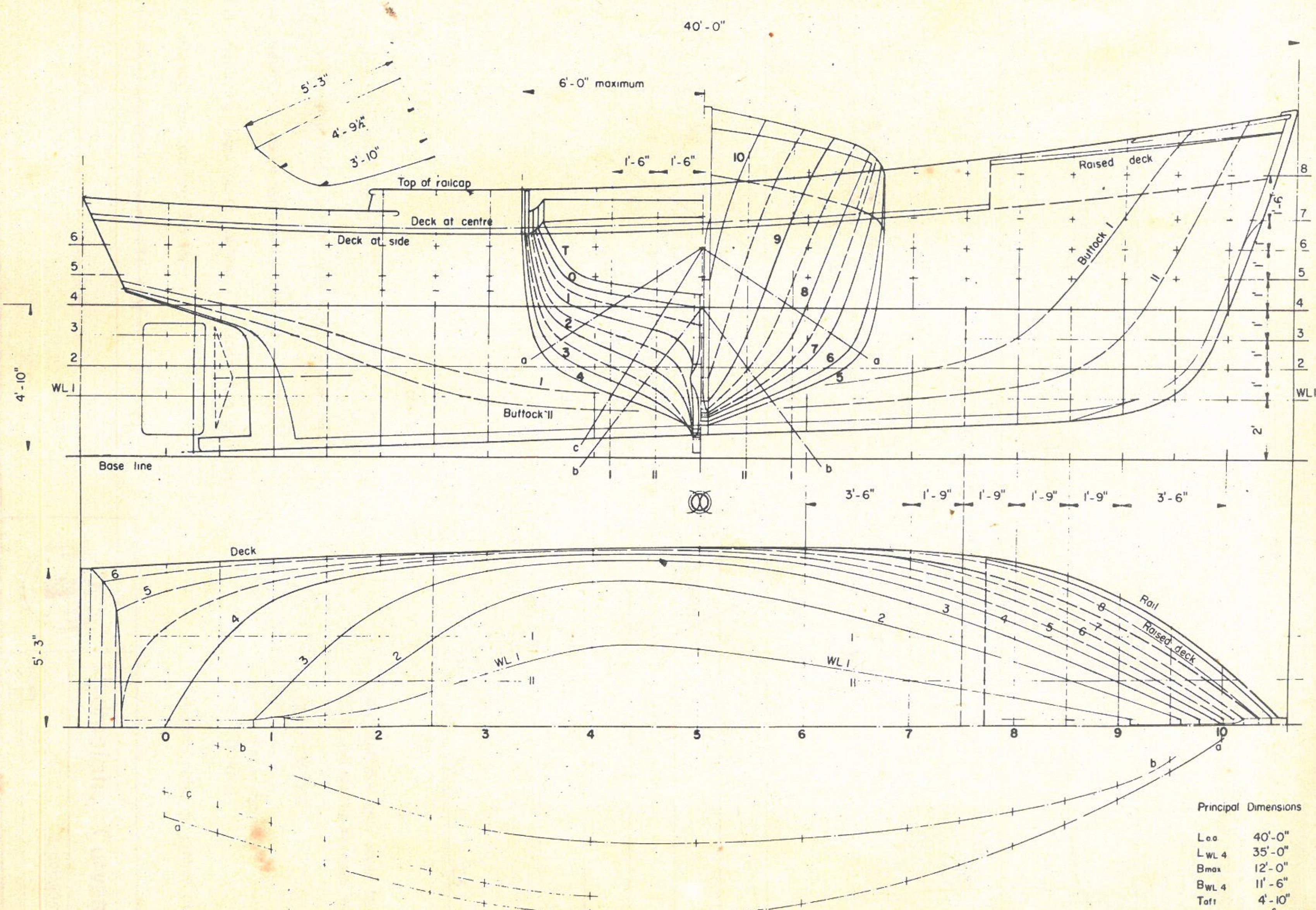

38 ft. Fishery Training Vessel
for
Madras Polytechnic
Drwg. 2
Bulkheads Aft- and forepeak 1½"
Engineroom 2" plus insulation
Hinged hatch
Exhaust pipe
Trunk deck 1¼"
Beams 2½" x 3"
Rail cap 1½" (2" aft)
Rail 1"
Coamings 2½" tapered
Carlins 2½" x 3"
Exhaust and silencer heavily lagged with asbesthos
Trunk sides 1½"
6" portholes
Coaming 3" x 9"
Bulwarks 1½"
Stanchions doubled 1½" continuation of frames (add. stanchion between frames 3"x 4")
Winch drive
Deck 2" x 4" strips
Gurdy drive
1" Drain
Liner 1"
Sheerstrake 2" x 9"
Tie rod ⅜" galv. iron (2 each side)
Shelf 3" x 4" (St. 1 - 9)
Clamp 2" x 6", (4" at ends)
Deck beams 3" x 4½"
Heavy beams 4" x 5½"
(ends of trunk, under winch, mast and trawl davits)
Rubbing strake 2" x 4" (continuous)
Fender 1½" x 4" (St 1 - 9)
Carlins 2½" x 4½"
Shelf for batteries
Bilge stringers 1⅜" x 6"
Tools and spares
Sliding door
Fuel tanks aft in engine room, p & s
Possibly 5hp auxiliary with general service pump and 3 Kw generator
Ceiling ⅞"
Sawn frames doubled 1½" sd, mld 6" at keel, 4" at deck
Laps as shown
Flooring 1¼"
Planking 1½" (copper riveted)
Engine bearers 4" (tapered at ends) through fastened to floors only
Bent frames 2" x 1¼" (2 between sawn frames)
Floors: 3" sd at each sawn frame, forming lower part of half frame
Do not scale from this drawing!
Keel 6" x 9"
Propellerpost 6" at keel
8" at shaftline
Stem 8"
Shaftlog 8" x 12"
Knee 8"
Sternpost 8" ford, 5" aft
Transom knee 6"
Deadwood 6" joining keel
8" joining shaftlog
F A O
FIAT PANIS
SCANTLINGS
Scale 1" = 1 foot
Drawn
Ernakulam Oct. 1958
Drwg. 3

38 ft. Fishery Training Vessel



PROFILE	
Scale 1/4" = 1 foot	Ernakulam, Oct. 1958
Drawn	Drwg. 4

40 ft. Trawler - Purse Seiner



Hydrostatic data and section areas see Drwg 3

Lofting measurements see Drwg 3

Principal Dimensions

L_{oa}	40'-0"	12.2 m.
$L_{WL\,4}$	35'-0"	10.65
B_{max}	12'-0"	3.66
$B_{WL\,4}$	11'-6"	3.51
T_{aft}	4'-10"	1.475

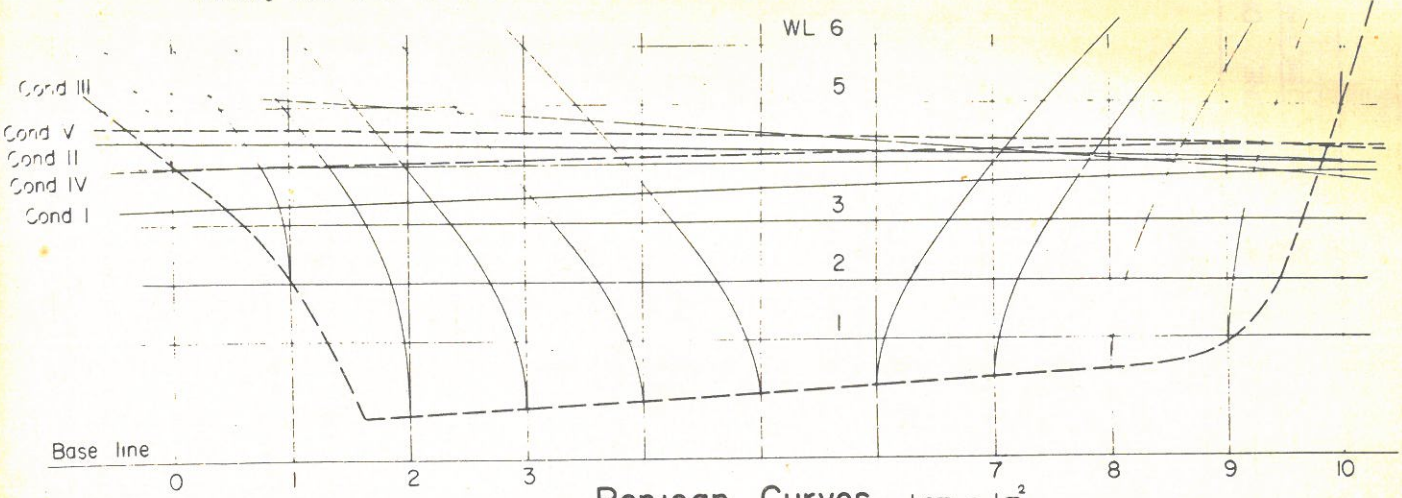
φ 0.582 δ 0.42 $\frac{1}{2}\alpha_E$ 27° (all WL 4)

LINES

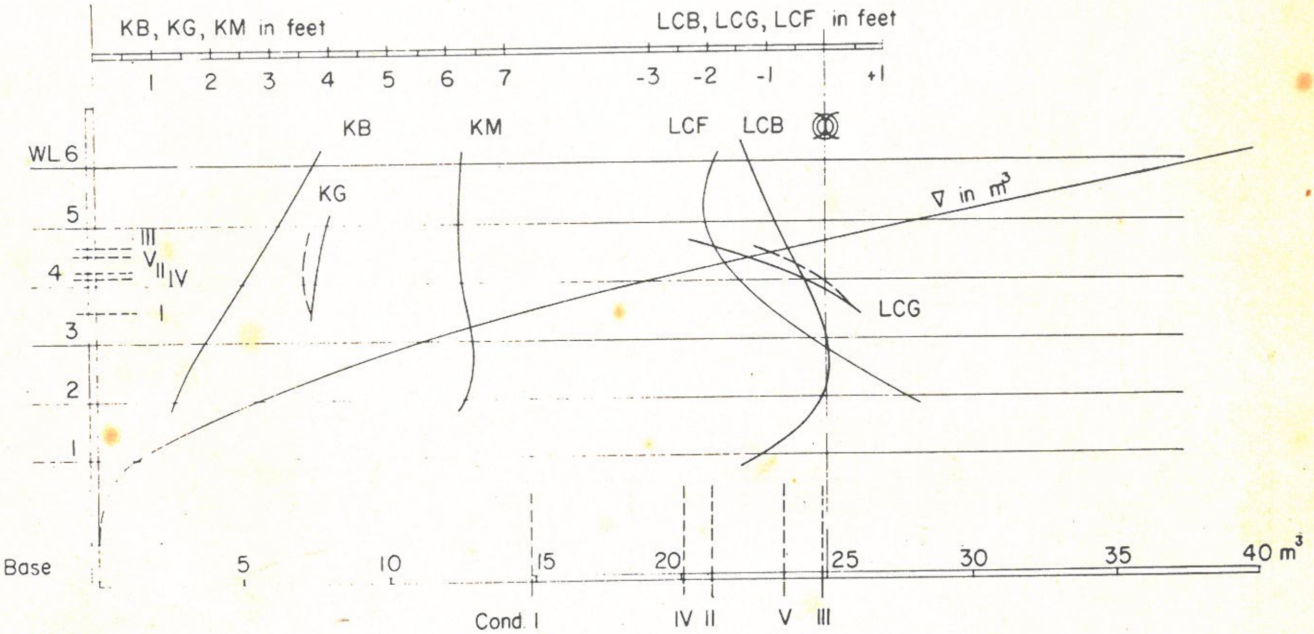
Scale ¼" = 1 foot	Ernakulam, January 1959	
Drawn		Drwg. 1

40 ft. Trawler - Purse Seiner

Showing float lines for 5 extreme conditions without trim control



Bonjean Curves 1 cm. = 1 m²



Conditions investigated

I Empty ship (wood weight and basic equipment)

II Ready for purse seining (3 tons ice in hold)

III Returning from purse seining (7.5 tons fish and ice)

IV Ready for trawling (3 tons ice)

V Returning from trawling (7.5 tons fish and ice)

KB, KM are only given for "Even Keel" (they will slightly increase with stern trim)

GM = KM - KG

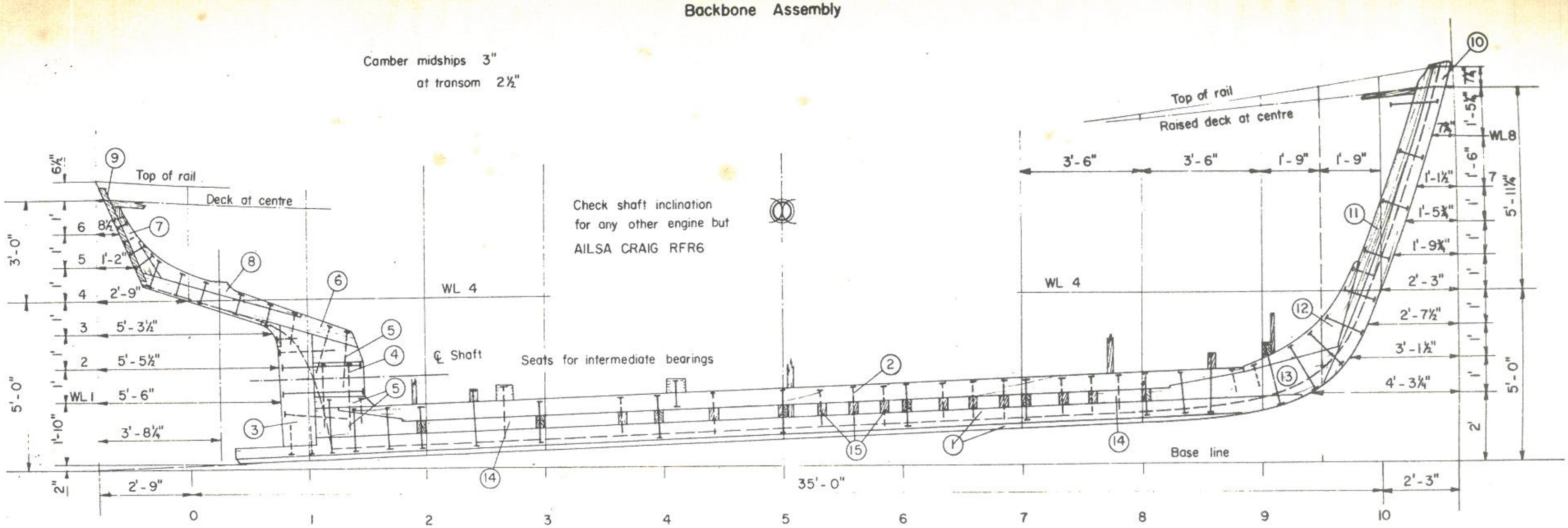
—— Purse Seining
---- Trawling

Heights refer to rabbet at St. 5

FAO FIAT PANIS	**Hydrostatic Curves**
	Ernakulam, January 1959
Drawn	Drwg. 2

40 ft. Trawler - Purse Seiner

Backbone Assembly



Backbone Scantlings

1	Keel	6"x 6" with 2"x 6" shoe
2	Keelson	8"x 6"
3	Propellerpost	6" at keel, 8" at shaft, 7" at horntimber
4	Shaftlog	8" x 12" straight grain
5	Deadwood	lower to fit, upper 8" at log, 7" at horntimber
6	Horntimber	7" forward, 5½" at transom
7	Transompost	5"
8	Transomknee	5" with 1" cheeks at rudder stock
9	Transom planking	2"
10	Stem	5"
11	Apron	7"
12	Knee	7"
13	Stem deadwood	to fit
14	Fillers	to fit
15	Floors	3" sd. positioned as shown

	Station	T	0	1	2	3	4	5	6	7	8	9	10
HEIGHT ABOVE BASE	Keel	5·5·0	5·0·0	0·2·7	—	—	—	—	—	—	1·2·0	1·6·2	5·0·0
	Rabbet	5·5·6	5·0·6	3·1·3	0·8·2	—	—	—	—	—	1·6·1	1·10·7	5·11·0
	Deck at side	7·9·4	7·7·7	7·5·7	7·4·6	7·4·6	7·5·3	7·7·2	7·10·0	8·1·2	8·5·2	8·9·6	9·3·0
	Raised deck										9·11·0	10·3·4	10·8·7
	Top of rail	8·6·4	8·4·2	8·2·3	8·10·1	8·10·2	8·11·3	9·1·0	9·4·2	9·8·6	10·2·1	10·8·3	11·3·0
	Buttock I	5·9·3	5·5·1	4·7·3	3·6·7	2·6·7	2·1·4	2·2·0	2·4·7	2·10·1	4·1·2	8·1·1	
	II	5·6·7	5·2·3	4·2·5	2·10·3	1·10·1	1·6·5	1·6·7	1·9·0	1·11·4	2·5·1	4·1·5	10·1·1
HALF-BREADTH	Deck	5·3·0	5·4·5	5·6·7	5·8·5	5·10·1	5·11·2	6·0·0	5·11·2	5·7·3	4·9·4	3·3·5	1·1·3
	Raised deck										5·4·2	4·0·5	1·8·3
	Top of rail	5·3·0	5·4·5	5·6·7	5·8·5	5·10·1	5·11·2	6·0·0	6·0·0	5·10·6	5·6·0	4·3·4	1·11·6
	WL 1				0·7·2	1·8·7	2·8·0	2·7·0	2·1·2	1·7·0	0·11·4	0·4·0	
	2				1·9·0	4·0·0	4·10·0	4·8·5	4·1·3	3·3·0	2·2·0	0·11·7	
	3			0·11·1	3·11·3	5·2·2	5·6·3	5·6·0	5·1·1	4·1·7	2·11·1	1·5·2	
	4		0·0·4	4·2·4	5·2·0	5·6·3	5·9·0	5·9·0	5·5·2	4·7·7	3·5·0	1·10·1	
	5	3·10·0	4·6·1	5·1·7	5·6·0	5·8·5	5·10·3	5·10·5	5·8·0	5·0·1	3·9·7	2·2·5	0·3·3
	6	4·9·4	5·1·6	5·5·5	5·8·1	5·9·7	5·11·2	5·11·5	5·9·7	5·3·5	4·2·4	2·6·7	0·5·6
	7							6·0·0	5·11·1	5·6·7	4·7·2	2·11·4	0·8·7
	8									5·10·0	5·2·5	3·7·4	1·2·7

Offsets in feet, inches and eighths.

Backbone Bolting

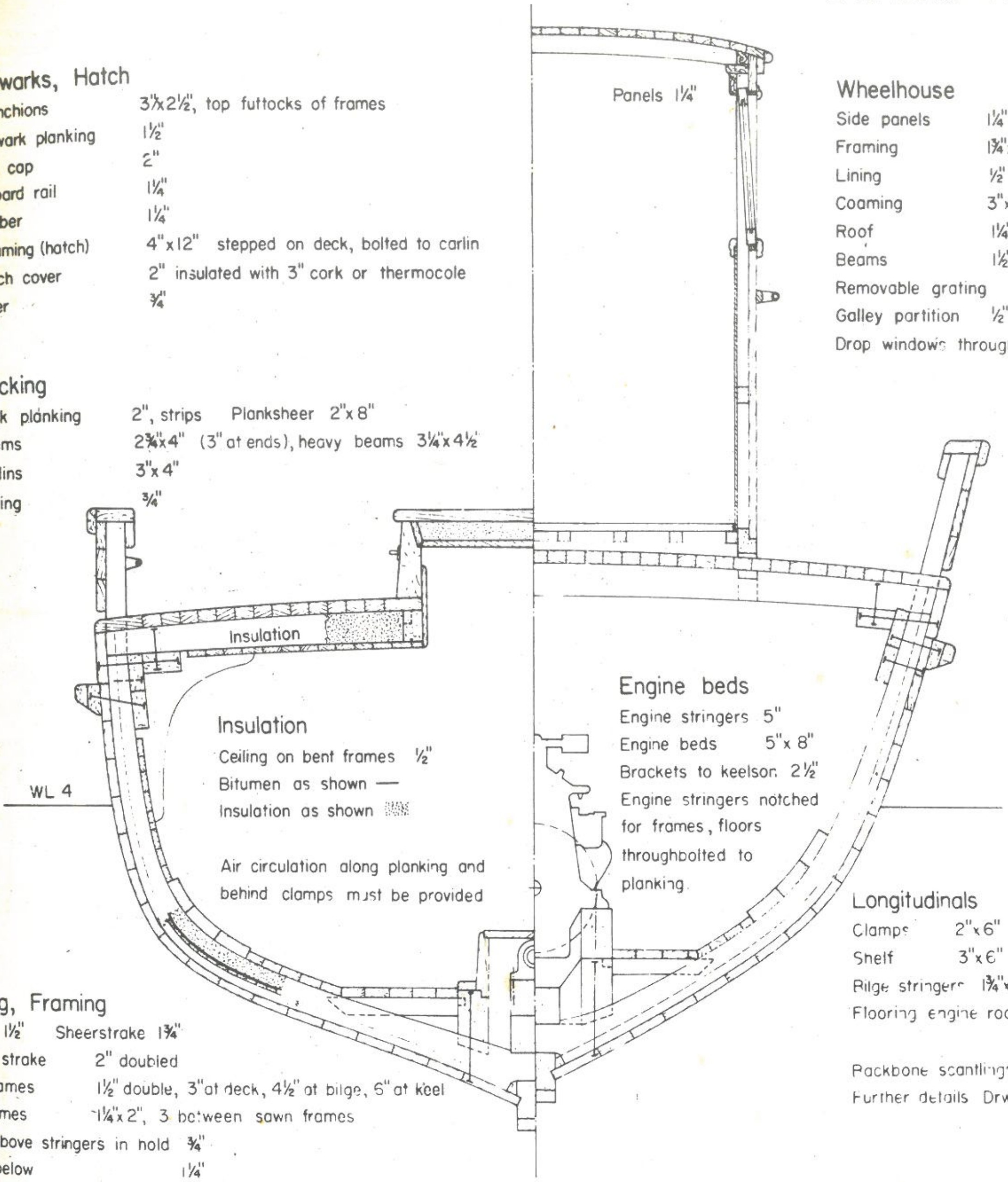
———	Throughbolts	⅜" galv. iron (⅜" copper)
– – – –	Driftbolts	

NOTE : In propellerpost bolts only in centre line to allow for effective sharpening of post.

BACKBONE OFFSETS

Scale ½" = 1 foot	Ernakulam, March 1959	
Drawn		Drwg. 3

40 ft. Trawler - Purse Seiner



Bulwarks, Hatch

Stanchions	3¼x2½", top futtocks of frames
Bulwark planking	1½"
Rail cap	2"
Inboard rail	1¼"
Rubber	1¼"
Coaming (hatch)	4"x12" stepped on deck, bolted to carlin
Hatch cover	2" insulated with 3" cork or thermocole
Liner	¾"

Decking

Deck planking	2", strips Planksheer 2"x8"
Beams	2¾x4" (3" at ends), heavy beams 3¼"x4½"
Carlins	3"x4"
Ceiling	¾"

Wheelhouse

Side panels	1¼" (¾" plywood)
Framing	1¾"x 2"
Lining	½" plywood
Coaming	3"x4½"
Roof	1¼" strips
Beams	1½"x2½"
Removable grating	
Galley partition	½" plywood
Drop windows throughout	

Insulation

Ceiling on bent frames ½"
Bitumen as shown —
Insulation as shown

Air circulation along planking and behind clamps must be provided

Engine beds

Engine stringers 5"
Engine beds 5"x 8"
Brackets to keelson 2½"
Engine stringers notched for frames, floors throughbolted to planking.

Longitudinals

Clamps	2"x6" double
Shelf	3"x6" throughout
Bilge stringers	1¾"x 6", 7 from St. 3-8
Flooring engine room 1", hold 1½"	

Backbone scantlings see Drwg. 3
Further details Drwg. 5

Planking, Framing

Planks 1½"	Sheerstrake 1¾"
Rubbing strake	2" doubled
Sawn frames	1½" double, 3" at deck, 4½" at bilge, 6" at keel
Bent frames	1¼"x 2", 3 between sawn frames
Ceiling above stringers in hold	¾"
below	1¼"

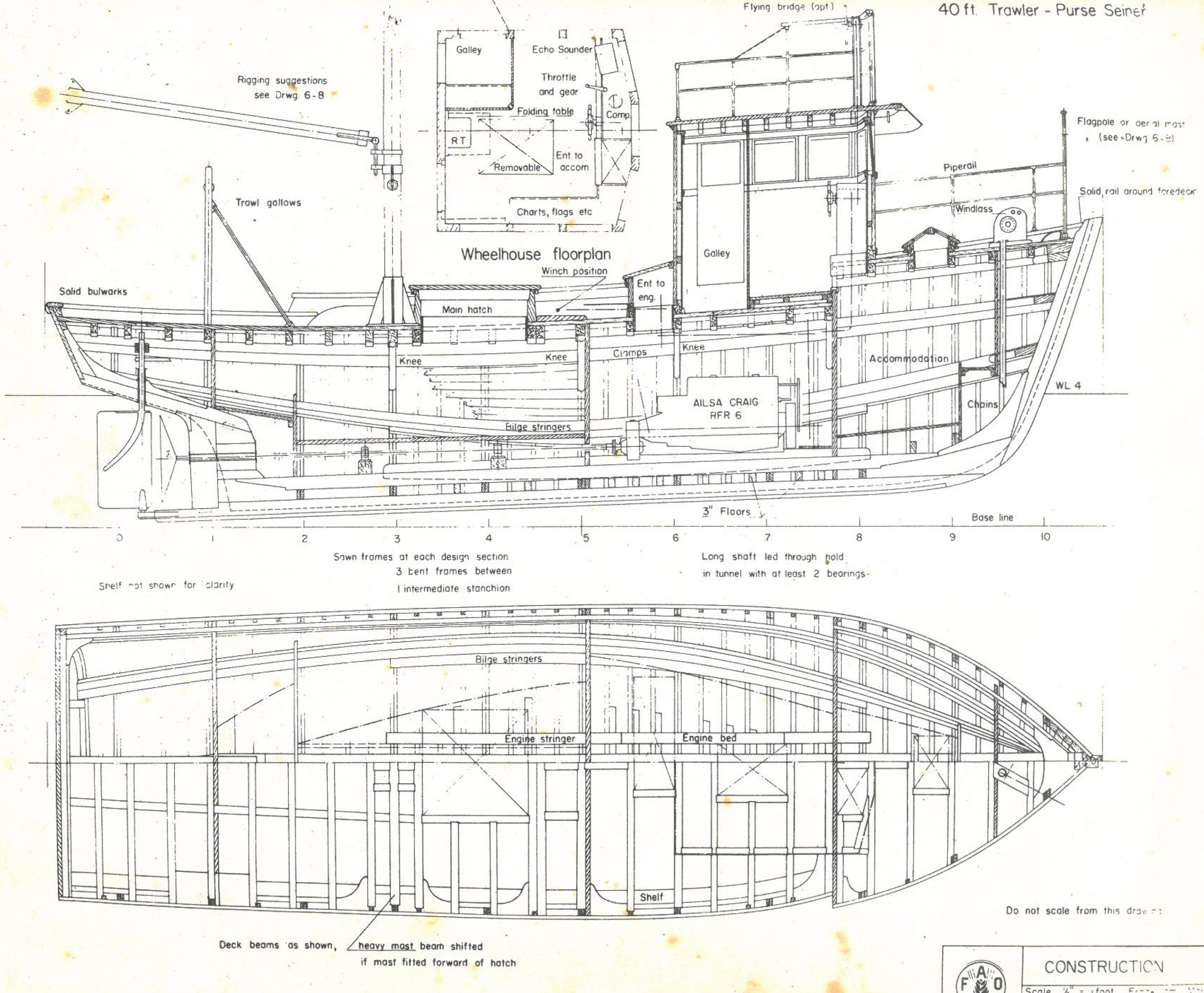
Shaft tunnel sides 2"
cover 1½"

FAO

SCANTLING SECTIONS

Scale 1" = 1 foot — Ernakulam, March 1959
Drawn
Drwg. 4

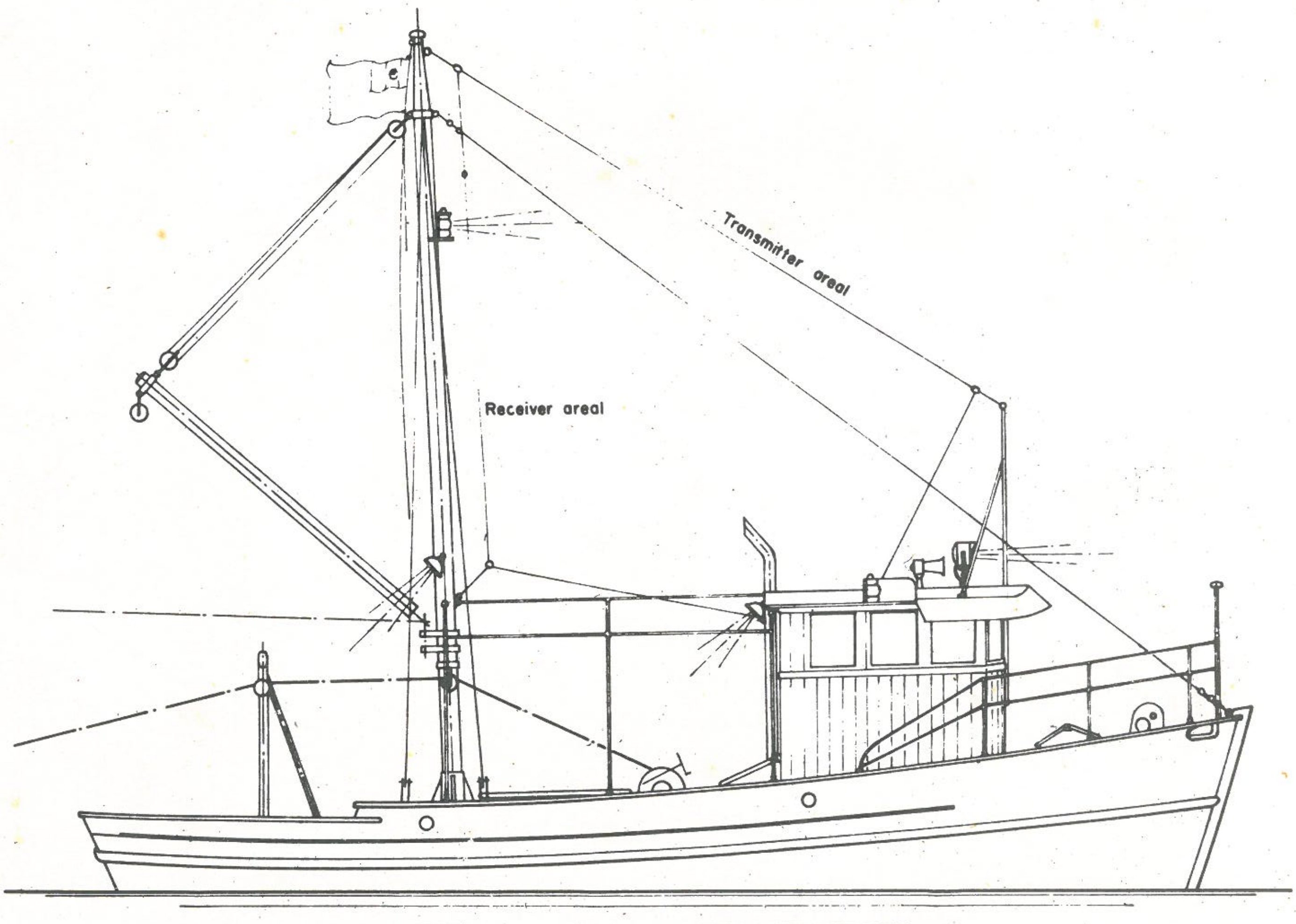
40 ft. Trawler - Purse Seiner



Do not scale from this drawing

FAO	CONSTRUCTION
	Scale ½" = 1 foot
	Drawn
	Drwg 5

40 ft. Trawler - Purse Seiner

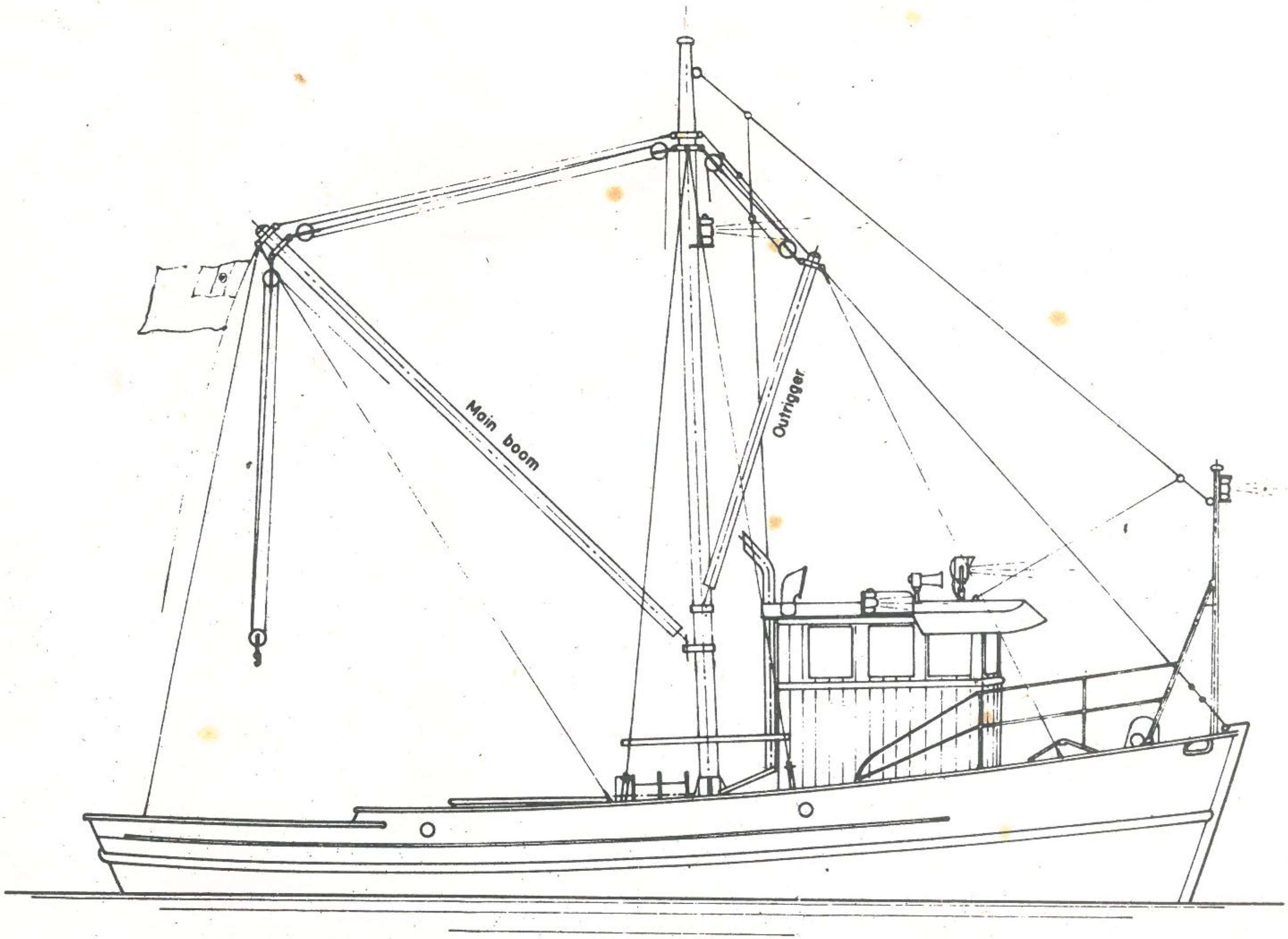


Mediterranean stern trawl rig shown.

Trim when trawling (hold half full)

PROFILE I		
Scale ¼" = 1 foot	Ernakulam, March 1959	
Drawn		Drwg. 6

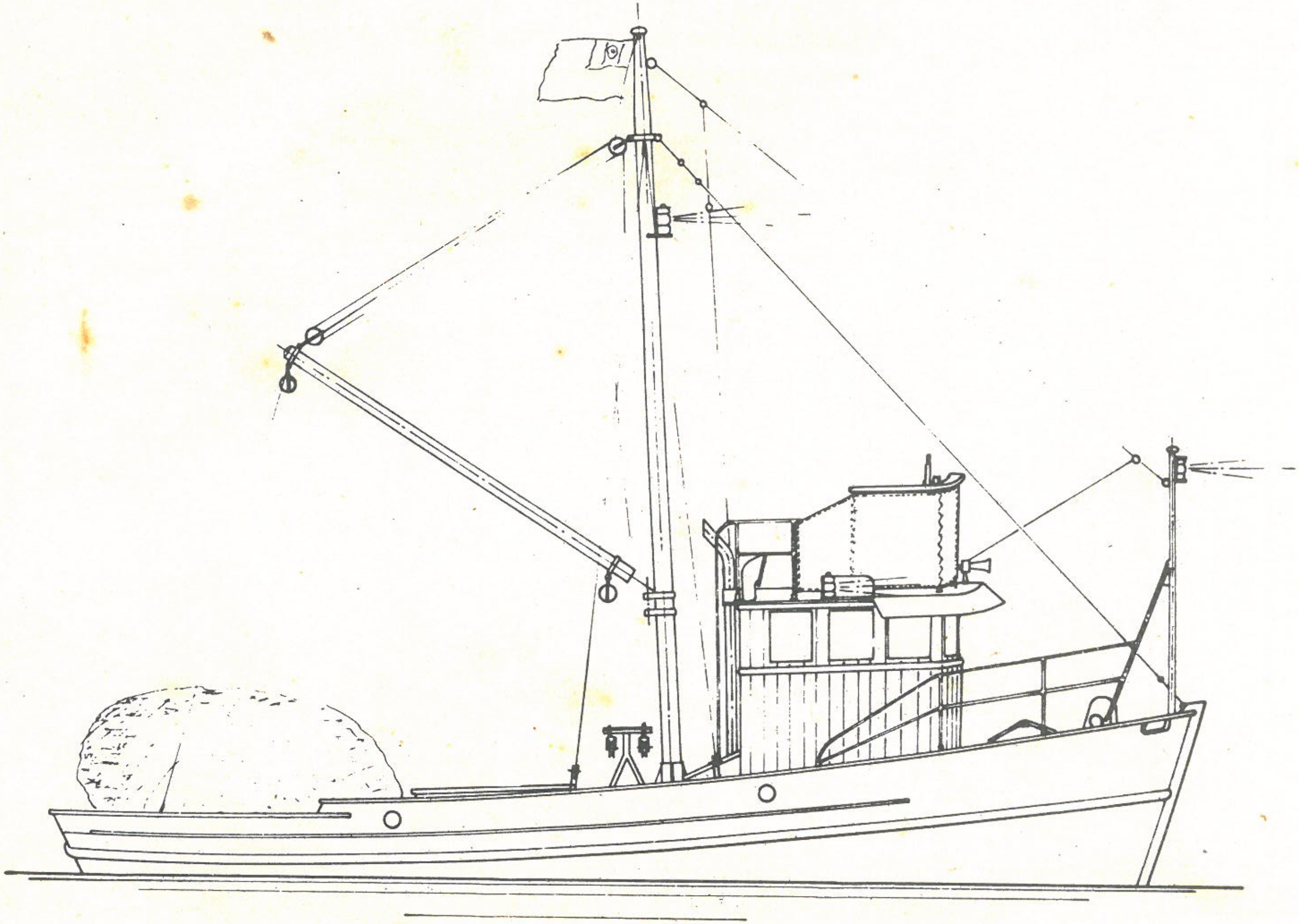
40 ft. Trawler - Purse Seiner



Gulf of Mexico rig for one or two net trawling (Shrimp)

PROFILE II		
Scale ¼" = 1 foot	Ernakulam, March 1959	
Drawn		Drwg. 7

40 ft. Trawler - Purse Seiner



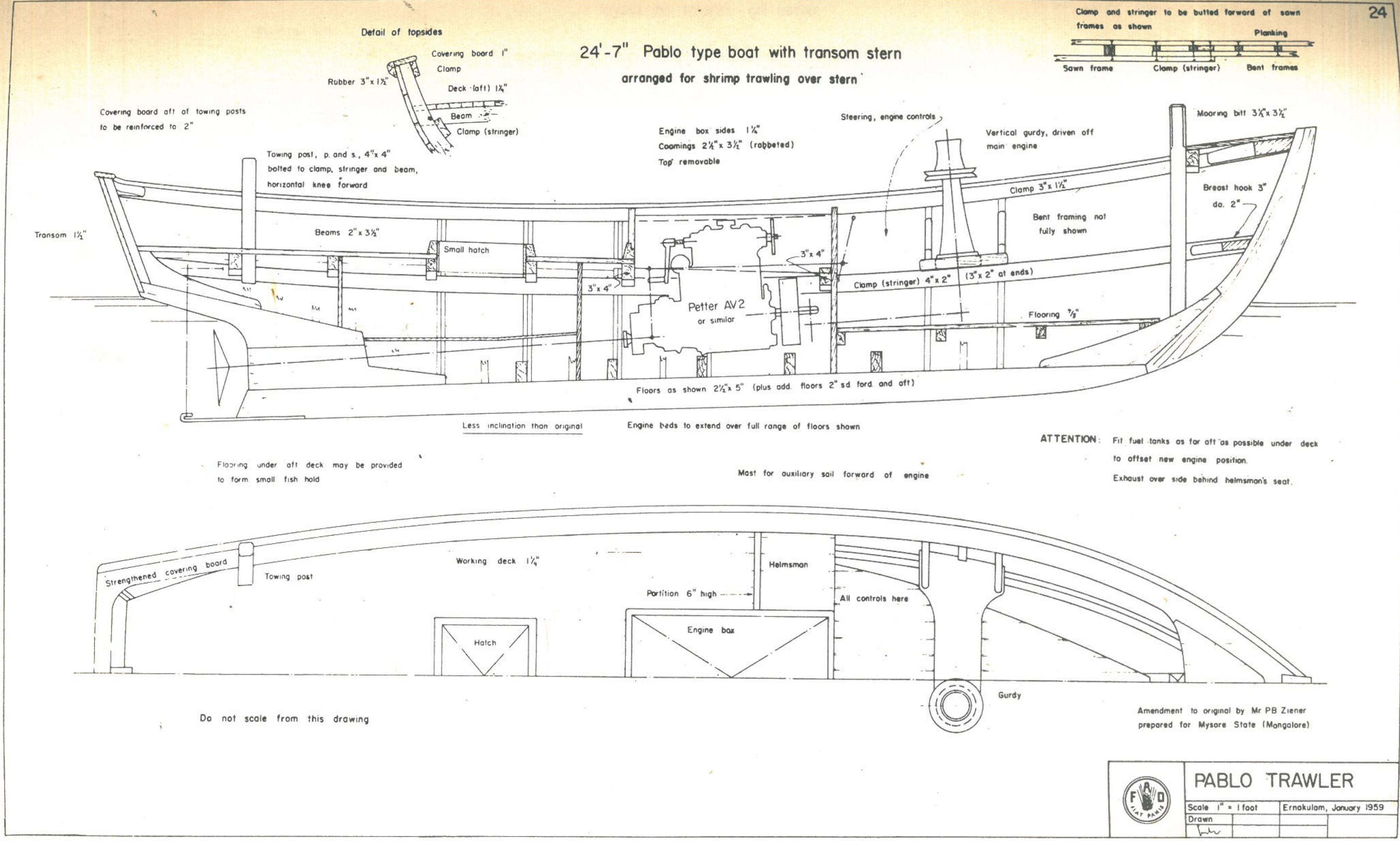
Rigged for purse seining

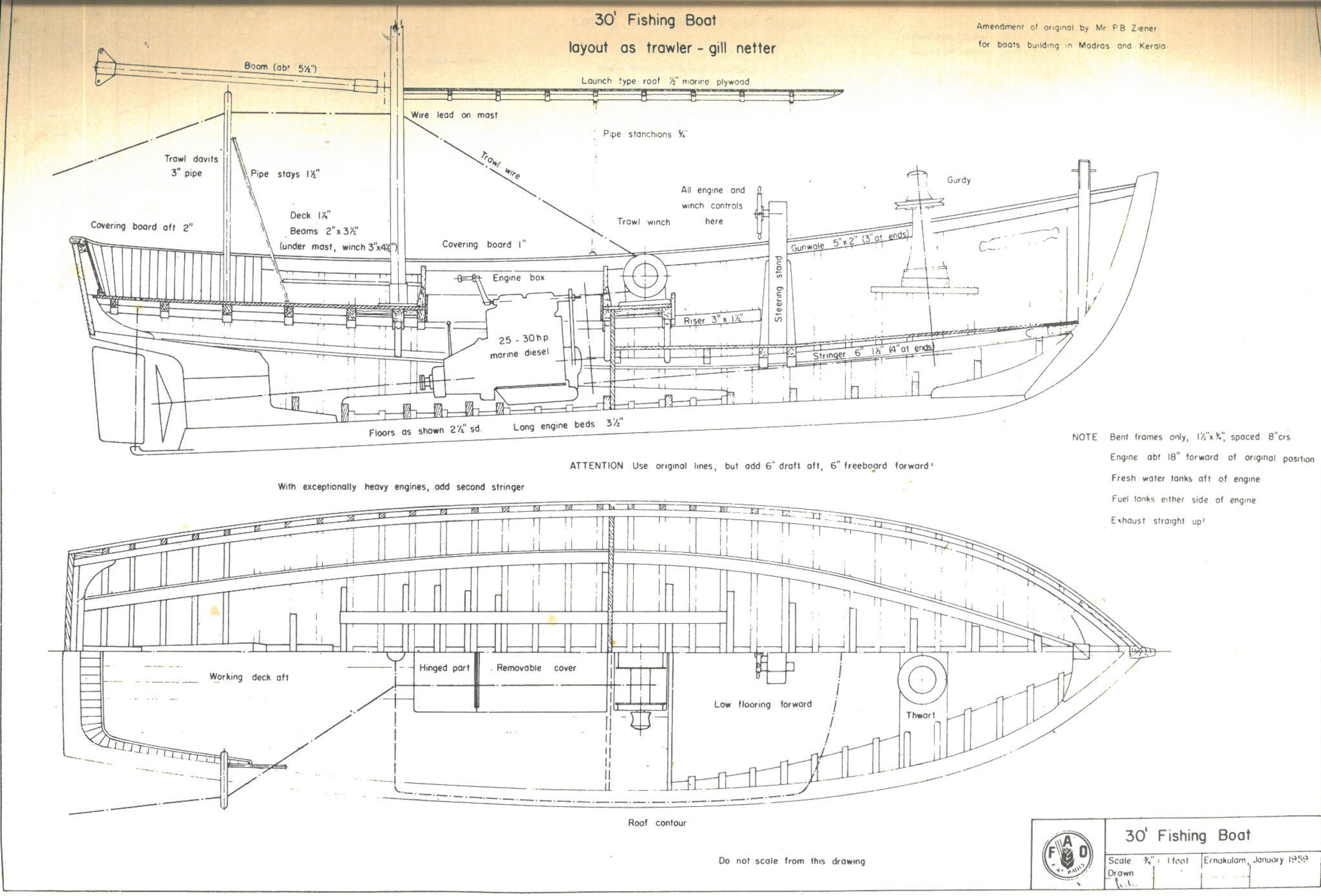
Trim as loaded

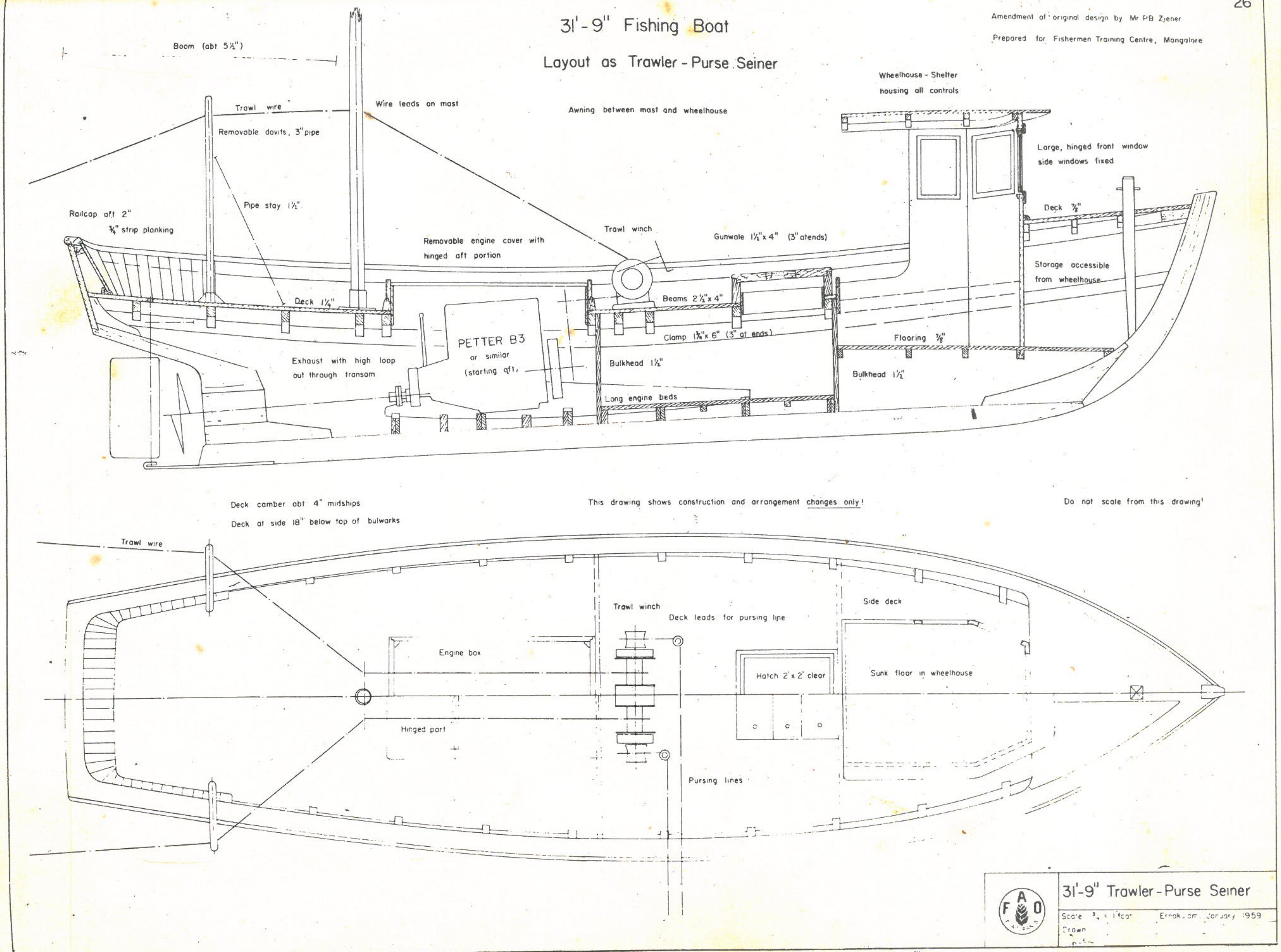
FAO FIAT PANIS	PROFILE III
Scale ¼" = 1 foot	Ernakulam, March 1959
Drawn	Drwg. 8

24'-7" Pablo type boat with transom stern

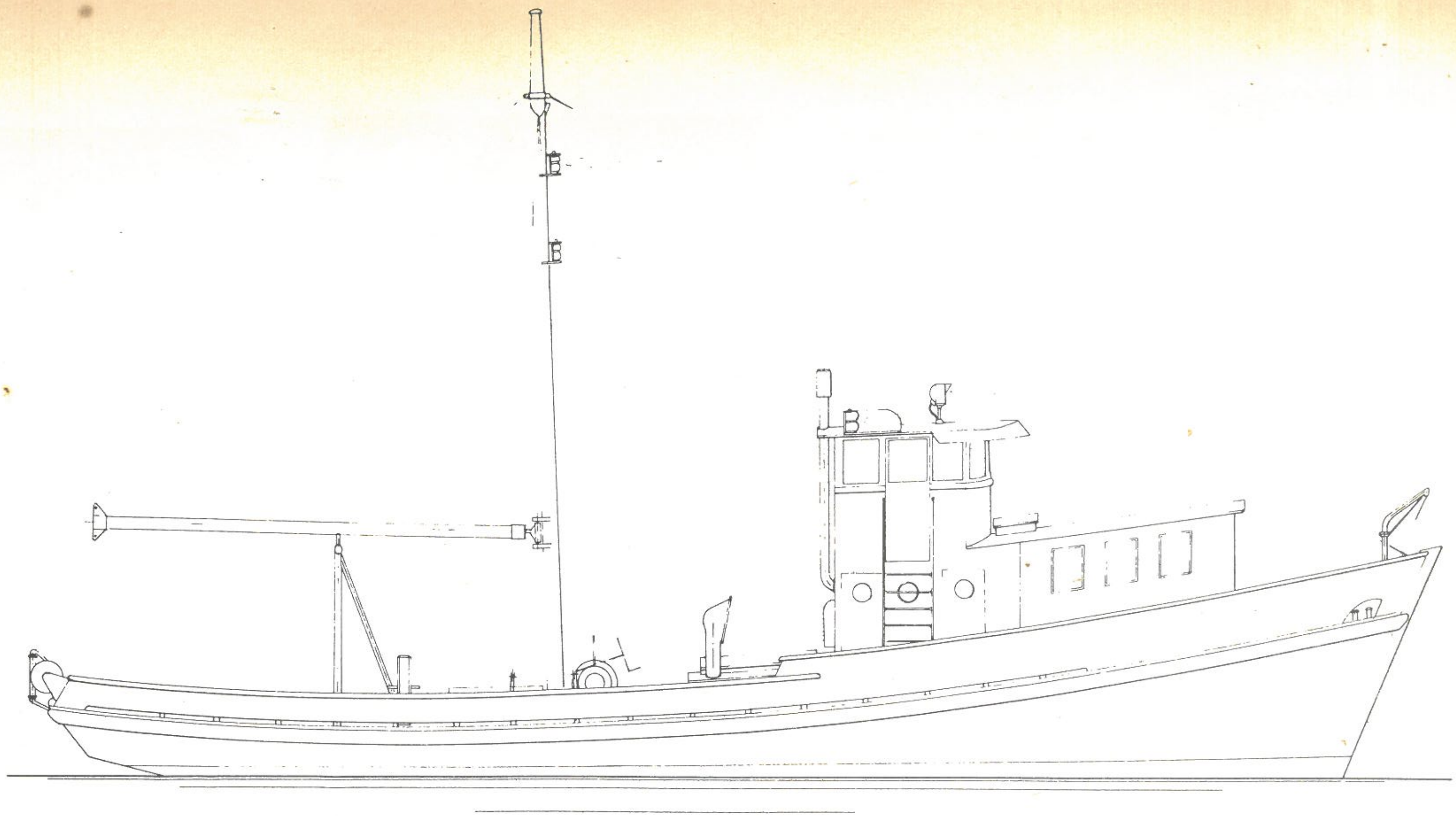
arranged for shrimp trawling over stern




30' Fishing Boat
layout as trawler - gill netter
Amendment of original by Mr P B Ziener
for boats building in Madras and Kerala
Boom (abt 5½")
Launch type roof ½" marine plywood
Wire lead on mast
Pipe stanchions ¾"
Trawl wire
Trawl davits
3" pipe
Pipe stays 1½"
Gurdy
All engine and
winch controls
here
Trawl winch
Deck 1¼"
Beams 2" x 3½"
(under mast, winch 3"x4½")
Covering board aft 2"
Covering board 1"
Gunwale 5" x 2" (3" at ends)
Engine box
Steering stand
Riser 3" x 1½"
25 - 30 h.p.
marine diesel
Stringer 6" 1½" (4" at ends)
Floors as shown 2½" sd.
Long engine beds 3½"
NOTE Bent frames only, 1½" x ¾", spaced 8" crs
Engine abt 18" forward of original position
Fresh water tanks aft of engine
Fuel tanks either side of engine
Exhaust straight up!
ATTENTION Use original lines, but add 6" draft aft, 6" freeboard forward!
With exceptionally heavy engines, add second stringer
Working deck aft
Hinged part
Removable cover
Low flooring forward
Thwart
Roof contour
Do not scale from this drawing
30' Fishing Boat
Scale ¾" = 1 foot
Ernakulam, January 1959
Drawn



31'-9" Fishing Boat
Layout as Trawler - Purse Seiner
Amendment of original design by Mr PB Zjener
Prepared for Fishermen Training Centre, Mangalore
Boom (abt 5½")
Trawl wire
Removable davits, 3" pipe
Wire leads on mast
Awning between mast and wheelhouse
Wheelhouse - Shelter housing all controls
Large, hinged front window side windows fixed
Pipe stay 1½"
Railcap aft 2"
¾" strip planking
Removable engine cover with hinged aft portion
Trawl winch
Gunwale 1½" x 4" (3" at ends)
Deck ⅞"
Storage accessible from wheelhouse
Deck 1¼"
Beams 2½" x 4"
Clamp 1⅞" x 6" (3" at ends)
Flooring ⅞"
PETTER B3 or similar (starting aft)
Exhaust with high loop out through transom
Bulkhead 1½"
Long engine beds
Bulkhead 1½"
Deck camber abt 4" midships
Deck at side 18" below top of bulwarks
This drawing shows construction and arrangement changes only!
Do not scale from this drawing!
Trawl wire
Trawl winch
Deck leads for pursing line
Side deck
Engine box
Hatch 2' x 2' clear
Sunk floor in wheelhouse
Hinged part
Pursing lines
31'-9" Trawler - Purse Seiner
Scale ¾" = 1 foot
Ernakulam, January 1959
Drawn

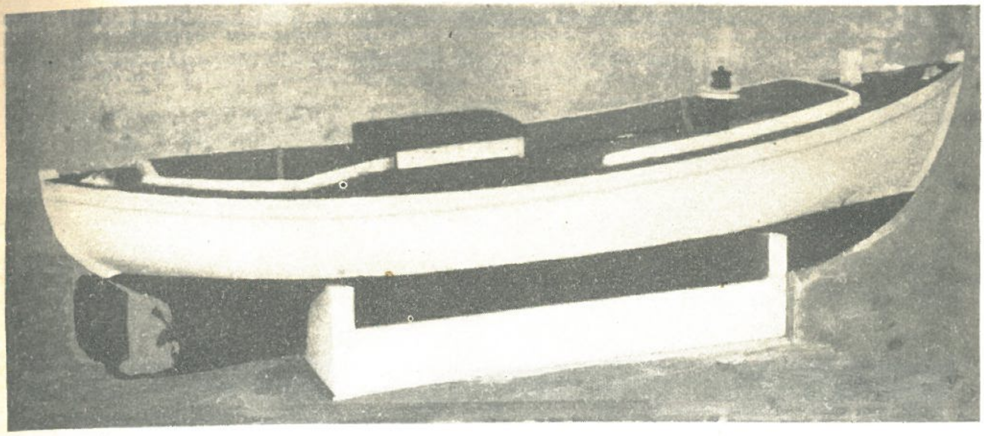


PROFILE 63 ft. Pearl Fisheries Vessel

Scale 1/4" = 1 foot Ernakulam, August 1958

Drawn

Drwg. 1



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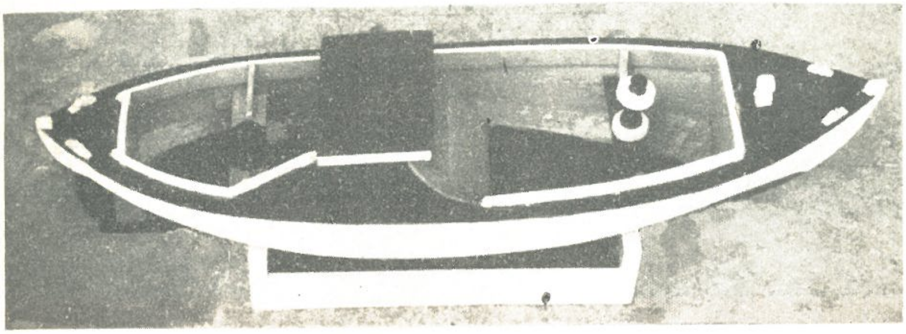

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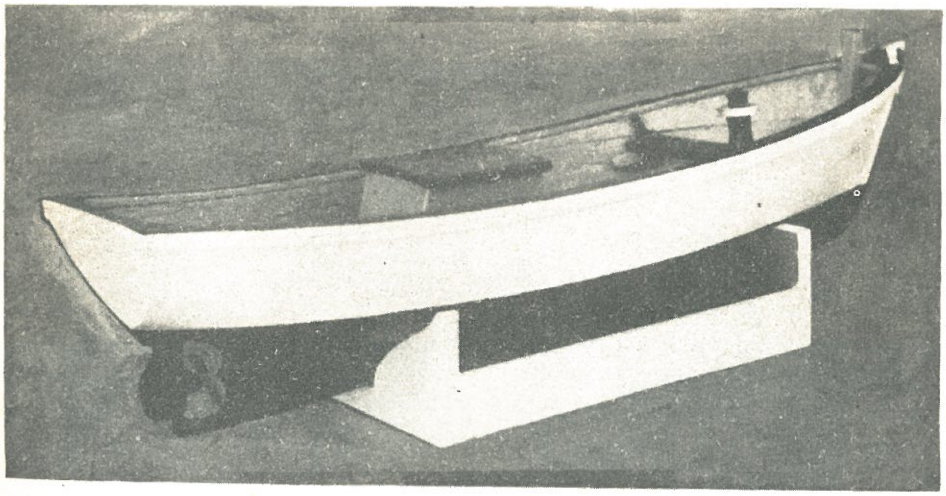

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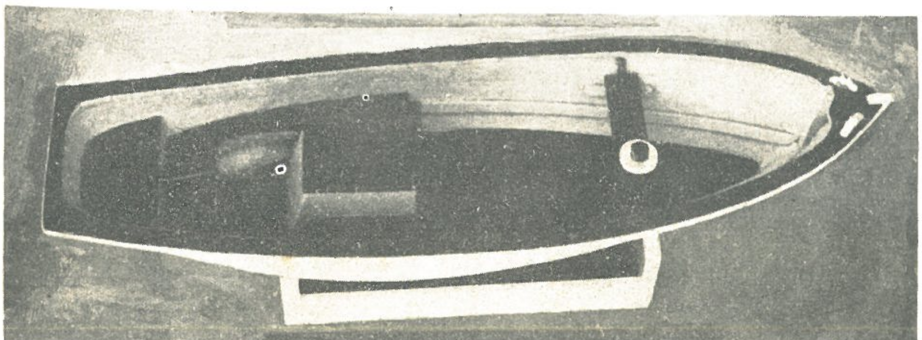

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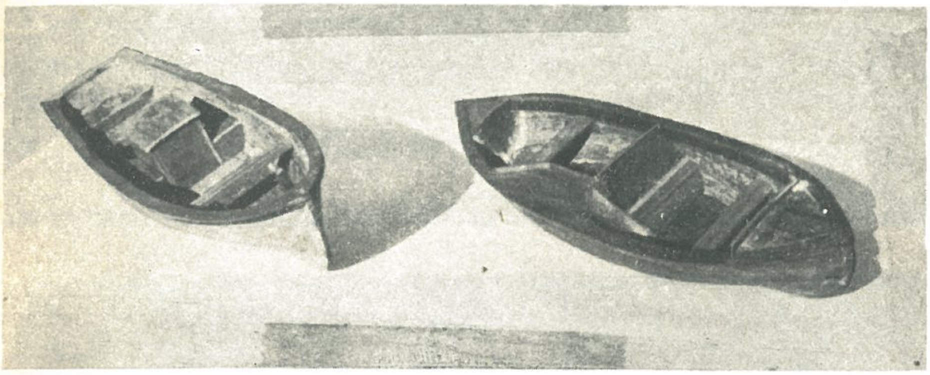

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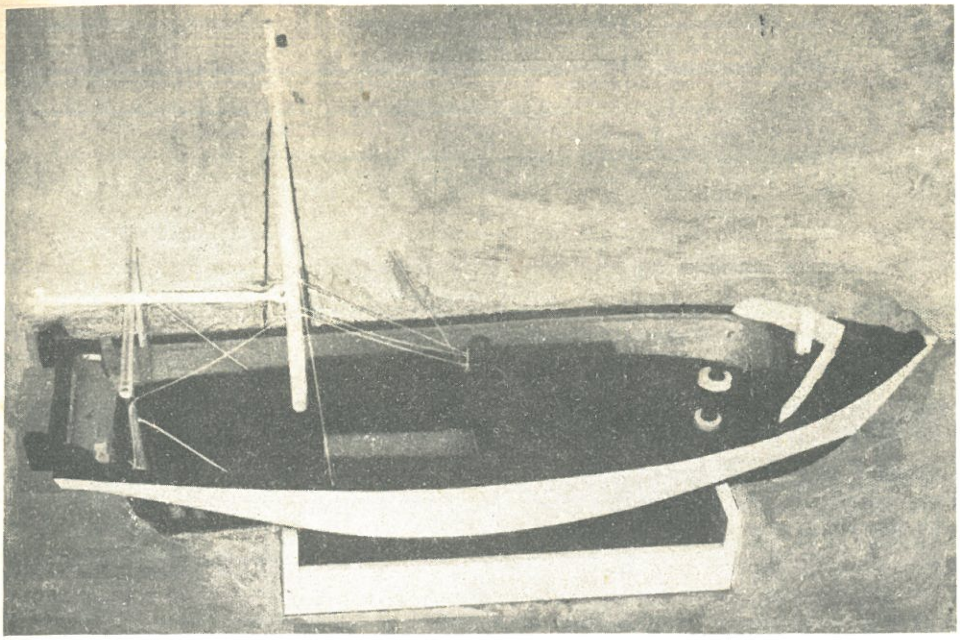

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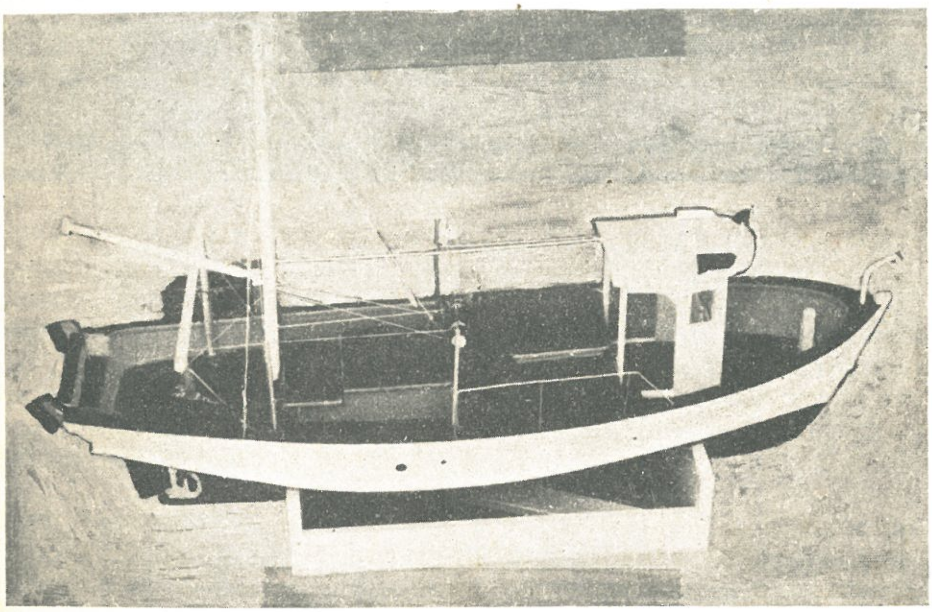

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Appendix I

DEVELOPMENT OF A BOAT FOR INDIA'S SURF COASTS

Introduction

India has a coastline of about 2,900 miles which is, to a large extent, open and surf-beaten. Fig. 1 shows the main areas under consideration.

While it is generally recognized that fishing activities will ultimately be concentrated in sheltered places and harbours, the widespread fishing communities on the beaches must as an intermediate step be provided with an efficient mechanized boat until such sheltered places are readily available. This has long been recognized and provision has been made in the development programmes of the maritime states, as well as the Central Government, to support such efforts.

Some 60,000 indigenous craft in these four states are regularly used from the beaches by about 200,000 fishermen.

The bulk of these craft are catamarans, with dugout canoes and simple built-up boats of distinct local characteristics completing the number.

The economical and social aspect of the problem, apart from being a technical one, is sufficiently illustrated by the above figures.

Fig. 3 and 4 show fishermen at work with their catamarans on the beach.

Catamarans and dugout canoes are difficult to mechanize. They are of small capacity and radius of action, especially the dugouts, and even if an engine could be installed it would not result in a substantial increase of the craft's earning power. The sewn boats and the majority of the planked boats are likewise not suitable for mechanization, with the exception of the vallams in South Madras State.

Hence the imperative need is to develop a small, open or half-decked mechanized boat for regular beach fishing, capable of operating through moderate surf. This paper endeavours to relate this development up to March, 1959.

Surf conditions along the coast of India

Wave height and period. It is almost impossible to measure the height of breakers in surf, but by estimating the height of deep-water waves before they break, a sufficiently accurate estimate can be made. A record of mean maximum wave heights has been kept in India and its results are presented graphically in Fig. 2, the data being contributed by Mr. P.K. Kulkarni, Chief Research Officer, Central Water and Power Research Station, Poona, Bombay State. The Meteorological Observatory has set up 24 observation posts, 13 on the west and 11 on the east coast, recording twice daily deep-water wave heights, periods, directions and wind speeds. The graph gives the results for the first five-year period of observation in 12 localities. The number of days for which a wave height of 0 to 1 ft. (0 to 0.30 m.) prevailed were grouped together for each post and expressed as a percentage of the whole five-year period. Wave heights of 1 to 2.5 ft. (0.30 to 0.76 m.), 2.5 to 4 ft. (0.76 to 1.22 m.), 4 to 5.75 ft. (1.22 to 1.75 m.), 5.75 to 7.15 ft. (1.75 to 2.18 m.) and 7.15 to 9 ft. (2.18 to 2.74 m.) were similarly grouped. These wave height ranges are shown on the graph as blocks from left to right. Observation indicates that waves up to 2.5 ft. (0.76 m.) would not result in breakers too severe to be regularly negotiated by a specially designed boat. Blocks 1 and 2, summed up, give the percentage of days on which wave heights of 0 to 2.5 ft. (0 to 0.76 m.) prevail. Table I gives similar percentage figures for wave heights up to 4 ft. (1.22 m.)

TABLE I

Wave heights from 0 to 4 ft. (0 to 1.22 m.)
Percentage of five years

	%			%	
Porbandar	73.8	Bombay	Cuddalore	97.3	Madras
Dahanu	99.7	Bombay	Madras	100.0	Madras
Honaver	95.6	Bombay	Kakinada	42.4	Andhra
Kozhikode	95.5	Kerala	Calingapatam	27.4	Andhra
Pamban	100.0	Madras	Gopalpur	100.0	Orissa (Questionable)
Nagapattinum	98.8	Madras	Puri	99.3	Orissa (Questionable)

Along the West coast, up to Bombay, sea conditions are relatively calm: only during the monsoon months are wave heights over 2.5 ft. (0.76 m.) registered. The Saurashtra coast (Porbandar) has somewhat rougher conditions. Along the East coast, wave heights, and thus surf, become generally worse going North, and are very unfavourable along the Andhra coast. The Orissa coast is even more surf-beaten than Andhra, although the data available shows diminishing wave heights.

Wave periods were generally between 7 and 10 sec.

Types of wave   Patrick and Wiegel (1955) distinguish between three main types of breakers:

(a) Spilling: In general associated with steep deep-water waves on flat beaches (ratio wave height to wave length, h/ , between 0.06 and 0.03).

(b) Plunging: h/ ratios of 0.03 to 0.009 on all beaches, but mainly steeper ones.

(c) Surging: Waves with h/ ratios below 0.009 on steep beaches.

In addition to the h/ ratio and the beach slope, winds, currents and the presence of an offshore bar will also influence the breaker characteristics.

When waves run from deep into shallow water, their period will generally not change, while their length and speed decrease and the height increases. A trochoidal wave would break on the beach when the wave face slope becomes 90° (Patrick 1955, Kent 1958). This usually occurs at a depth of water between 1 and 1.5 times the height of the wave. On moderately steep beaches waves tend to break farther out at low tide and near the shore line at high tide. The presence of a bar would be indicated by one line of breakers at high tide, but several diminishing lines at low tide.

Waves usually approach the shore at an angle. They will also break at an angle on the beach, and a current is set up parallel to the beach. This longshore current is a very treacherous phenomenon when landing a boat through surf, and is largely responsible for the tendency to broach.

Many factors tend to influence the shape of a beach, and thus the kind of breakers that will be encountered, such as the geomorphology of the land and the local hydrography, the type of beach material, the quantity of material and the interaction between waves and beach (Patrick 1955). The last is of particular interest in this connection.

Waves of an h/ ratio around 0.03 tend to flatten the beaches and produce an offshore bar. Flatter waves (h/ less than 0.02) tend to steepen the beach face a little and deposit sand; bars tend to disappear and a distinct step is formed in the beach face.

For a given deep-water wave steepness, the breaker height will increase with a bigger bar and with its distance from the beach face. Bars also tend to increase in height with decreasing beach steepness.

Personal observation, and a scrutiny of the scanty material available, indicate that surf in India consists mainly of plunging breakers, sometimes with a tendency to spill.

Development - first phase

Since 1950, when FAO employed its first naval architect, there has been a constant search for a suitable type of boat which could be used under surf conditions such as those in India. In 1952, FAO made a thorough survey of beach fishing boats used in Europe (Zimmer 1955). At the same time, enquiries were made about similar boats used in North America. Later visits and enquiries have been made in Australia, California, Hawaii, Japan and West Africa. Similarly, military landing craft were studied, especially in the U.S.A.

On the whole, existing motorized beach boats are large and expensive at first cost, especially the military ones. Efforts to interest freelance naval architects brought about a number of useful ideas, but no concrete designs, which could be considered ready to be introduced. It therefore became necessary to develop a new design.

1. Prototype 1954 The first prototype was built in Madras in 1954 to the design of Mr. P. B. Ziener, then FAO Naval Architect in India. Fig. 5 gives an idea of this boat, which measured 20 ft. (5.09 m.) overall, 5 ft. 9 in. (1.75 m.) max. beam, and 2 ft. 1 in. (.61 m.) depth. The boat was equipped with a water-cooled engine, and difficulties were experienced with sand getting into the cooling system. While the boat was successful in negotiating moderate surf, she was found to be a bit heavy for beach handling, in spite of the fact that she was of light construction. Apparently the intention was to lift and carry the boat.

2. Prototype 1955 A second but lighter prototype was designed, essentially of the same shape as shown in Fig. 5 but only 18 ft. 3 in. (5.56 m.) overall length, 5 ft. 5 in. (1.65 m.) beam and 2 ft. (6.1 m.) depth. Altogether five boats were built, two by State Fisheries Departments and three by FAO. In late 1955, the first boat, equipped with a 3½ h.p. air-cooled diesel engine, was tried. The 3½ h.p. proved to be only just sufficient for very moderate surf, and the danger of the boat being pushed back by the breaking wave was apparent. Fishing trials showed that a 18 ft. 3 in. (5.56 m.) boat was not an attractive economical proposition to the fishermen, as it could not take sufficient gear on board for a profitable catch.

Extensive trials were held early in 1956 with all three FAO boats, mainly to compare engines of different power, stern gear, and to simplify beach handling. Even if the type was too small for commercial fishing, it was felt that the tests should be made as a kind of model test to gain experience for a larger type. The engine tests indicated that 6 h.p. was adequate for going out through moderate surf; it also became clear that bigger boats could be handled on the beach, provided suitable gear was available. During the trials it became obvious that the boats were of too light construction and would have to be considerably reinforced. They also showed a marked tendency to be rough and wet at sea due to the flat bottom, which had been devised to prevent capsizing in a breaker, taken at an angle. Tests with a deep keel indicated that there was no such danger.

After the trials, local fishermen were encouraged to use the boats from the open beach near Madras. Gudjon Illugason, one of the FAO's Master Fishermen, gave a series of demonstrations. The fishermen, however, would not use the boats from the beach, but preferred to operate them from a sheltered cove. One reason might have been that the fishermen were not sufficiently acquainted with the technique of taking a mechanized boat through surf and were afraid to lose the boat and their catches. Further trials were then discontinued, mainly due to lack of funds and personnel.

Conclusions from the first experiments

Sea and surf Fig. 2, supplemented by Table I, indicates that mean maximum waves, and their resulting breakers, of up to 2.5 ft. (0.76 m.) height must be safely negotiated by the boat. Setting the standard higher, i.e. at 4 ft. (1.2 m.), as required by Andhra and Orissa, would unnecessarily penalise a design for the remaining areas with regard to required strength of construction and safety. It was suggested that Andhra and Orissa should be treated separately, and a special boat developed for these States.

Beaches Most beaches considered for mechanized boats are only moderately steep and will not prove too diffiault for beaching. Narrow, flat beaches, with a marked step near the water, will be the most difficult. A careful study of simple, effective beaching gear is, however, required for all beaches.

The majority of beaches consist of fine sand, forming a soft surface. This will have to be remembered when deciding the bottom shape of the boat, and when designing beaching gear.

Operation A boat that has to be handled in breakers requires its centre of gravity as far aft as possible. The forebody should have maximum reserve buoyancy. To minimise broaching risks, the boat must have the best possible directional stability. Sensitive steering is of the utmost importance. Draught must be as small as possible to keep the boat afloat near shore. Clean waterflow is essential to make the most of the small propeller that can be fitted in a shallow draught boat. The propeller has to be well protected as frequent grounding will occur; this necessitates a strong stern construction. Due to severe slamming when going out, the forebody must also be extremely strong. Air-cooled engines are preferable as the boat will frequently operate in very silted waters, and the engine has to be kept running on the beach before taking off. Closed circuit fresh-water cooling systems could also be adopted, but they mean added cost and possibilities of failure.

Handling The weight of the boat must be restricted to allow handling by man power only. The engine must have a low weight/h.p. ratio. A maximum weight of 2 tons was considered suitable.

Economics Low initial cost is essential, should the boat be made available to the majority of the coastal fishermen. This means a careful study of all possible methods of mass production, including such modern techniques as fibre glass moulding.

Due to its greater initial cost compared with existing craft, the boat will have to carry a larger number of fishing gear to bring home a larger catch. The boat should not be too small, because a bigger boat is safer provided there is sufficient depth of water.

Development - second phase

The first experiments were followed closely by FAO's headquarters, which also endeavoured to interest some of the bilateral technical assistance organizations to take up the task. These bodies had much greater financial resources and did not always require the receiving country to match the expenses from their own funds. There were no immediate responses, but in the meantime the author, who at that time worked at FAO headquarters, was given the task of developing a new design. In this work he received valuable assistance, especially from H. I. Chapelle, who worked as FAO naval architect in Turkey.

Prototype 1957 - BB-57

The outcome was a preliminary design of a boat 24 ft. (7.31 m.) long, 6 ft. $4\frac{1}{2}$ in. (1.94 m.) wide and 2 ft. 7 in. (0.79 m.) deep. She was to be equipped with a 15 h.p. air-cooled diesel engine, installed off-centre, giving her sufficient reserve power when going out and even allowing the use of a small trawl. The drawings were sent for comments to a number of FAO field workers and to naval architects in many countries. As a result of the comments received, a new design was prepared in May 1957, called BB-57.

The main dimensions and scantlings were:

The length to remain at 24 ft. (7.31 m.), with 6 ft. $10\frac{1}{2}$ in. (2.09 m.) beam and 2 ft. 10 in. (1.86 m.) depth. The same engine as before.

The backbone to be made up of a $1\frac{1}{2}$ x 8 in. (38 x 203 mm.) hog keel, keel plank of 3/4 x 3 in. (19 x 76 mm.) and a shoe of 1 x 3 in. (25 x 76 mm.). The hog continuous fore and aft, the keel plank stopped short about 2 ft. (609 mm.) aft of midships, where the heavy 3 in. (76 mm.) centre skeg begins. This skeg to be tongue-and-groove joined to a 3 in. (76 mm.) stern post just forward of the transom. The transom to be conventionally built up over a transom frame and joined to the hog with a heavy transom knee. A single piece 3 in. (76 mm.) stem, joined to the hog by a long knee, to complete the backbone assembly.

Planking to be in clinker (lapstrake) fashion, using 11 planks of 5/8 in. (16 mm.) thickness per side. Frames to be steam bent, $1\frac{1}{2}$ x $\frac{1}{2}$ in. (38 x 13 mm.), spaced 5 in. (127 mm.) centre to centre. $1\frac{1}{2}$ in. (38 mm.) floors set on every third frame (each frame under engine), reaching up to the bilge stringer and covered by a half frame from stringer to stringer.

Longitudinal strength members to include 1 x 3 in. (25 x 76 mm.) gunwale, 1 x 3 in. (25 x 76 mm.) covering board, 3/4 x 2 in. (19 x 51 mm.) rubbing strake, 3/4 x 3 in. (25 x 76 mm.) short stringer carrying the outside grab rail, 3/4 x 4 in. (19 x 101 mm.) bilge stringer and very long, $2\frac{1}{2}$ in. (63 mm.) engine bearers. Transverse stiffening to be added by a 2 in. (51 mm.) thwart forward, forming a base for the gurdy, thwarts aft for the helmsman and $1\frac{1}{2}$ x 3 in. (38 x 76 mm.) beams at either end of the engine box. A well cambered foredeck of $\frac{1}{4}$ in. (6 mm.) marine plywood with an oversize, raked splash board to provide protection against spilling waves.

An air-cooled diesel engine of 15 to 18 h.p. was proposed on the port side with shaft parallel to the centre line, and the propeller on the side of the skeg, thus protected by the skeg. There were two main reasons for this unconventional engine disposition:

(a) A rigid centre line installation, with shaft tube through the skeg, is expensive and would be subject to severe shocks when the skeg hits the bottom. These shocks would create misalignment and might result in damage to the crankshaft bearings and the propeller shaft. The shaft was now only to be supported by a single strut bracket with rubber bearing at the propeller end, being led through the hull planking in a copper tube with flexible stuffing box. The shaft bracket was to be fastened to the hull side and not to the skeg.

(b) With this arrangement it was possible to use a larger diameter screw well tucked away under the stern of the boat. Earlier trials with the 18 ft. (5.48 m.) boats indicated the desirability of having the propeller as far forward as possible, to prevent it from loosing its grip when the stern came out of the water.

A further advantage was considered to be that a solid skeg could be built without aperture and consequent weakening at its lower edge. The probabe unbalanced steering was foreseen, but it was left to see what could be done about it. The engine was, however, placed so that the turning moment of the propeller would neutralize the turning moment of the off-centre thrust to some extent.

The air cooling of the engine would require a complex system of ducts built into the removable engine cover. The engine box was to be spray tight to protect the engine when crossing the surf. Both gear and throttle controls would be in the helmsman's cockpit. A simple hand bilge pump, arranged on the forward engine bulkhead to discharge directly overboard. The rudder was designed in the centre line on the stern post, to hang on long pintles and allow it to lift without coming adrift when hitting the bottom. A grab rail to be fitted about 15 in. (380 mm.) below the sheerline, running from station 2 to 8.

When the design was ready, FAO succeeded in interesting the Indo-Norwegian Fisheries Project (INP), to build one boat in Norway, for subsequent testing at their project area in India, and from funds saved another was ordered by FAO and built at Sekondi, Ghana, West Africa. Fig. 7 shows one of the boats on the beach.

West African tests   Tests were run at Sekondi, Ghana, in January-February, 1958. It was immediately found that the steering arrangement was unsatisfactory, and the rudder was moved to port and hung directly in the propeller wash. Steering then became easier, although it was still an effort to turn the boat in a tight circle to port.

Very good speeds are recorded, 8 knots at 1400 r.p.m. and 8.1 knots at 1700 r.p.m. **A marked tendency** to squat was noticed under speed and the stern wave was great. It was obvious that 15 to 18 h.p. was too much and that 10 to 12 h.p. would be sufficient for normal sailing.

The boat's behaviour in breakers was studied by running her through the breakers in deep water at the harbour entrance. She behaved very well there; no tendency to broach was found and her directional stability was exceptional. She proved to be very dry slamming across the waves, due to her very sharp forebody and the extreme flare of the topsides.

Few beaching trials were made on hard, flat beach, with shallow water extending far out. To move the boat up the beach without great difficulty 16 men were needed, while 10 strong men were required to haul her with rope and tackle. The same number could easily handle her on slide ways and turntable. But all these tests were made with an empty boat; with fishing gear and catch it would have been more difficult.

Few landings were made in moderate surf. In the hands of an experienced helmsman the boat came in and out easily, and it was evident that much higher breakers could safely be negotiated. The builders reported successful surf crossings in much higher seas during subsequent trials in the summer of 1958. The following changes to the design were found desirable:

(1) 3 in. (76 mm.) higher freeboard midship, to prevent following waves from spilling in.

(2) Drain plugs in each compartment to facilitate draining the boat on the beach.

(3) One additional hand pump and if possible an engine-driven bilge pump to speed baling after crossing the surf.

(4) A passageway between aft cockpit and main cockpit. This should be done by lowering the side deck on the off-engine side.

Complete watertightness of the compartments was not felt to be of top importance, provided sufficient pumping capacity could be built in.

<u>Quilon tests</u> A symposium, "The Boat and the Beach", was held in March 1958 at the INP camp in Quilon, Kerala, to discuss general beach boat problems, to compare boats of various designs and to reach conclusions on how to improve these boats. The practical part, trial of the boats, was hampered by the absence of moderate surf, and only general observations could be made.

Various design aspects were discussed, and the FAO team explained the features of its off-centre engine installation, while the INP experts expected better results from a centre line installation. The outcome was that INP and FAO should cooperate and that both systems should be tried, preferably in the same type of boat. This is at present under consideration by INP.

Three boats were used for practical work during the Symposium, a 22 ft. (6.70 m.) INP built boat with canoe stern, a 25 ft. (7.62 m.) INP boat and the FAO designed BB-57, 24 ft. (7.31 m.) long. BB-57 proved to be superior in all respects, the 25 ft. (7.62 m.) INP boat being much heavier and too cumbersom on the beach, while the 22 ft. (6.70 m.) INP boat showed similar deficiencies as the FAO 18 and 20 ft. (5.48 and 6.10 m.) boats of earlier years.

Several landings and take-offs were made with BB-57 and she showed definite possibilities. Again, the need for higher freeboard and the necessity of providing side keels for easy beach handling was felt. The side keels should run from about station 3 to 7 - approximately 18 in. (457 mm.) out from the centre line - and should be at least 3 in. (76 mm.) deep and 2½ in. (64 mm.) thick at the base. These keels, apart from helping to keep the boat upright on the beach, would also further protect the propeller.

The rudder was moved from the centre line of the boat into the propeller race and was equipped with a balance being about one-fifth of the rudder area. This made the steering completely satisfactory; as a matter of fact, the turning circle proved to be the same both starboard and port, which is rarely the case with centre line installations.

Tuticorin tests Beaching trials were held in June, 1958, south of Tuticorin, under the guidance of INP's beach landing specialist. The boat was at that time tackling surf conditions nearly approaching those normally encountered. Her behaviour left no doubt that she was capable of coping with much worse conditions in experienced hands. Fig. 8 to 10 give an idea of the ease with which the boat was driven through the breakers. Maximum breaker height during these trials was estimated at about 4 ft. (1.22 m.). As many local fishermen assisted in beaching the boat, the handling was quite easy. It became once more obvious, however, that she could not be managed manually by only ten men. The response of the local fishermen was very positive.

Nagapatinam tests The boat was operated at Nagapatinam for a few weeks on fishing trips. Although the locality is not conspicuous for its surf, it was important to have experienced fishermen use the boat for some time and comment on her suitability for fishing operations. The fishermen complained mainly of the low freeboard and the lively motion in heavy seas. The latter will probably be difficult to remedy without sacrificing the good surf-going characteristics of the boat. Some criticism was heard about the engine, which the fishermen found to be very complicated and requiring detailed maintenance.

The exhaust, taken straight over the side from each of the opposed cylinders, was a source of trouble, as water entered the silencers and even the cylinders.

Beach fishing trials were also to be made at Madras and the boat was moored outside the harbour in shallow water, together with six other fishing boats. A very short, powerful storm ripped her off her moorings early in October and she was thrown on to the boulders outside the harbour breakwater, becoming a total loss. Examination of the wreckage did not indicate that constructional weaknesses played any part in the loss. Three heavily built 25 ft. (7.62 m.) fishing boats were also lost under similar circumstances. The impact on the boulders must have been tremendous, as all boats were shattered to pieces.

Experiences from the tests with BB-57

Reaching the shore Fig. 11 attempts to give a schematical idea of how to, and how not to, bring a mechanized boat through the breakers when reaching the sea shore. Arrows to the right of the boat image roughly indicate the direction of the boat's motion in each phase. Correct beaching procedure through plunging breakers is considered to be as follows:

While nearing the beach or inlet, the helmsman will carefully observe the local wave pattern and count the number of small waves and the following single or multiple big wave. He will then try to locate the breaking point of the inrolling waves, a task that can be very difficult from a small boat with practically no height of observation. Approaching this point at low speed, the boat should be kept just off the breaking point until the last big wave of the pattern runs in. As soon as this wave has passed the centre of gravity of the boat, i.e. when the forebody starts to lift, full speed ahead will bring the boat riding in behind the wave like a surf board. Any tendency to overshoot the wave can easily be controlled by the throttle. During the riding in, the helmsman must be very careful to counteract any broaching tendency of the boat in the longshore current. This is not easy, as the boat will make very little speed through the water, with consequent loss of manoeuvrability.

The wrong way of beaching is shown in the right half of Fig. 11. It is seen that a boat with its centre of gravity forward of the breaking point of the wave will tip head over, with the breaker very likely swamping her and broaching in the longshore current following.

Beaching a catamaran in surf may be equally, if not more difficult, as the raft has no means of correcting its position relative to the breaking point of the wave. Thus overturning of catamarans occurs quite frequently on the East coast.

The sequence of taking off is shown in Fig. 12. If there is sufficient deep water between the shore face and the breaker line for the boat to pick up speed, this operation is not very difficult. There is a critical point again, however, when the boat crosses the second inrunning wave. It must be well over the crest before this wave starts to break, otherwise the released energy will tend to push the boat back and under, swamping it. This is indicated in broken lines in phase III and IV. Crossing the second wave will always be followed by severe slamming of the boat, indicating the need for very strong forebody construction.

With breakers almost on the shore line, and a fairly steep beach, for example, at high tide, launching is somewhat difficult. The boat will have to be steadied against the onrush of the breakers, grounded to a standstill, with engine running and gear in the ahead position. Immediately after the biggest wave in the pattern breaks, the boat must be pushed clear and pick up speed to clear the next wave before it breaks. This is not easy with a wave period of 7 to 10 sec.

<u>Difficulties of beaching</u> While there are no great difficulties when the boat is hauled by winches or a tractor, beaching is an irksome business when the boat has to be handled by man power alone. This is the present position in India, and it is doubtful whether even a successful mechanized boat will bring many mechanical beaching aids into use.

The power to drag a boat up the beach depends primarily on the weight of the boat, but to no small extent also on the composition of the beach and the surfaces of the boat in contact with it. Table II gives the results of measurements taken with a spring balance hooked into the towing line while different boats were towed up the beach by a tractor at Quilon. It illustrates the effect of simple beaching aids in minimising the necessary pull.

(See Table II on p. 13)

TABLE II

B O A T			P U L L		
Type	L.O.A.	Weight (ton)	on sleepers lb. (kg.)	on rollers lb. (kg.)	on sand lb. (kg.)
INP - 5	22 ft. (6.70 m.)	1.2	772 to 1,587 (350 to 720)	441 to 551 (200 to 250)	1,322 to 1,764 (600 to 800)
FAO BB-57	24 ft. (7.32 m.)	1.5	772 to 1,146 (350 to 550)	———	1,874 to 1,984 (850 to 900)
INP - 1	25 ft. (7.62 m.)	2.1	1,433 to 2,204 (650 to 1,000)	1,102 to 1,543 (500 to 700)	2,204 (1,000)

Speed of advance was 1 to 1½ ft./sec. (0.30 to 0.46 m./sec.). Rollers had to run on planks or beams as otherwise they dug into the sand. The results were obtained on moderately soft sand.

The earlier observations in West Africa gave the impression that much less pull was needed, but the beach was very hard. The figures in Table II, substantiated by earlier experience in West Africa, would indicate that the boat should not weigh more than 2 tons when being handled by men without any mechanical assistance; if it does, rollers would be necessary. The maximum effort is required as soon as the forefoot of the boat touches the beach. She must then be manually moved as fast as possible up the beach so as to bring her out of reach of any following breakers.

The development of suitable beaching gear must be given priority and keep in step with the development of the boat. It is reasonable to believe that a mass production model of the selected boat will be considerably lighter than the present, conventionally built prototypes. Then, simple wooden rollers, rolling on planks or beams, together with a heavy rope and tackle fixed to a palm tree or anchored a good way up the beach, should be adequate beaching aids for a gang of 8 to 10 men. Another system, as tried in West Africa, would be to have two slide ways, each about 12 ft. (3.66 m.) long, one with a pivot hole in the centre, as well as a simple turntable. With this system the boat is hauled up on the first slide way, the second one, with the turntable under, is placed in front and the boat hauled. Turning the boat with this system is exceedingly easy. The use of ladder-like roller conveyors will also have to be tried.

In many localities the boats could be anchored in deep water during part of the year when there is little or no surf; or existing river inlets with a surf bar offshore should be used, reducing the need for beaching whenever possible.

Prototype 1958 - BB-58

As a result of the Symposium, "The Boat and the Beach", and the trials described above, certain improvements were suggested. It was decided that the boat should have more beam, and more freeboard aft. As 15 h.p. was considered too much power for sailing, and trawling not being likely, it was decided to instal only 10 to 12 h.p. in future boats. Furthermore, the fairly marked deadrise in the boat's bottom did indicate that side keels would be a great advantage for beaching. At the same time, it was felt that such keels might help somewhat to dampen the lively motions of the boat in a seaway.

New lines were prepared with these improvements in mind, and Fig. 6 shows BB-58. One boat has been built to this design in Madras, but no trials have as yet been made. It is of carvel construction, as no carpenters experienced in clinker building were available in Madras, and it will be interesting to see if this will be strong enough for surf work. A second BB-58 is at present being built in the INP's yard at Quilon and should be commissioned early in April 1959. Both boats will be equipped with 10 h.p. air-cooled diesel engines, the Madras one with reduction gear and 16 in. (406 mm.) propeller, the INP one with direct drive and 13 in. (330 m.) screw. In addition, INP will take over the FAO owned BB-57, built in Ghana, which has just arrived in India, and test her.

It is hoped that the Madras built BB-58 can be sent to Quilon for trials, thus there will be three boats available for comprehensive testing. The main object of these trials will be to find any possible structural weakness in the design, and the boats will be driven as hard as possible. The tests will also show whether the shape can be improved.

Model tests

At the suggestion of the Central Water and Power Research Station, Poona, it was decided early in 1958 to try to simulate surf conditions in a wave channel and test various designs there. The task proved to be very difficult, and to date there are no conclusive results available.

The tests are run in a long, narrow channel, all waves approach the beaches at 90°, thus not creating any longshore current. The models are self-propelled, speed and rudder being controlled by overhead cable. It seems that the main difficulty is to simulate "real" operating conditions. Due to the model scale, manoeuvring has to be done very fast and is exceedingly difficult, the helmsman's touch on the tiller is simply missing.

Future work - mass production of BB-59

On the bases of the BB-57 and BB-58 designs, a new design has recently been made for plywood construction, and a hard chine hull. Fig. 13 gives the lines of BB-59, while Fig. 14 gives an idea of its layout. The first boat will be built by bonding together with fibre glass reinforced plastic the ½ in. (12.5 mm.) marine plywood panels. The boat will have longitudinal framing and watertight buoyancy compartments forward and aft. A 10 h.p. diesel engine will be installed off-centre, and it will be possible to move past it from midships to the aft cockpit. One such boat will be built in 1959 to the order of the Indian Ministry of Food and Agriculture, and INP and the Madras Government have tentatively decided to build one more each. The INP boat will be built of marine plywood without plastic bonding, and it is planned to re-design the aft body, giving it a hollow keel line to permit the installation of a bigger propeller in the centre line. To protect the propeller, and still keep the shaft line shock free, it is proposed to use a propeller guard such as those on recent types of LCVP in the U.S. Navy (Moore 1958). The Madras boat will be conventionally planked, and it is intended that she should have a centre line installation, too, and the new propeller guard. The plywood boats will be considerably lighter than those built so far, and they should allow reasonable conclusions with regard to beaching gear to be drawn.

Later in the year, probably during October, it is proposed to move the available BB-59's to Orissa for the North-East monsoon to make a series of tests.

A wealth of information should be available by the end of 1959, on the basis of which one or two final prototypes could be built during early 1960.

Trials can only be run when surf conditions are right at the testing place. Any improvement or change as a result of trials means building a new boat. Normally about one year lapses before changes can be tried. This will explain the dearth of reliable, exact data, and the belief that it will take at least another two years until a suitable, economical design can be finalised.

With the start of the third Indian Five Year Plan in 1961, it should be possible to start mass production of a thoroughly tested, suitable type of boat. The first production models would only be given to trained fishermen, who in turn would have to train other men in their localities. During the first year about 100 boats may be made available. This fleet would no doubt furnish further specific ideas for improvements to be incorporated in the next production batches.

The main difficulty of getting this ambitious programme through will perhaps not be the boats. The real hurdle is the financing and getting engines in large numbers. The latter will most likely only be possible if good air-cooled marine engines of suitable type can be produced in India, as imports are severely restricted due to the difficult foreign exchange situation.

Table III gives the principal dimensions as adopted for boats now being built.

TABLE III

L.O.A.	... ...	24 ft. 0 in. (7.32 m.)
B max.	... ...	7 ft. 6½ in. (2.3 m.)
T max.	... ...	1 ft. 10 in. (0.56 m.)
Weight unloaded	...	Conventional construction: approx. 1.8 tons Plywood boat " 1.3 "
Loading capacity	...	Conventional construction: " 1.0 " Plywood boat " 1.5 "
Engine	... ...	10 h.p. air-cooled diesel, direct drive at approx. 1500 r.p.m.
Propeller	...	13 in. (330 mm.) diam. 8, 9 and 10 in. (203, 228 and 254 mm.) pitch to be tried.

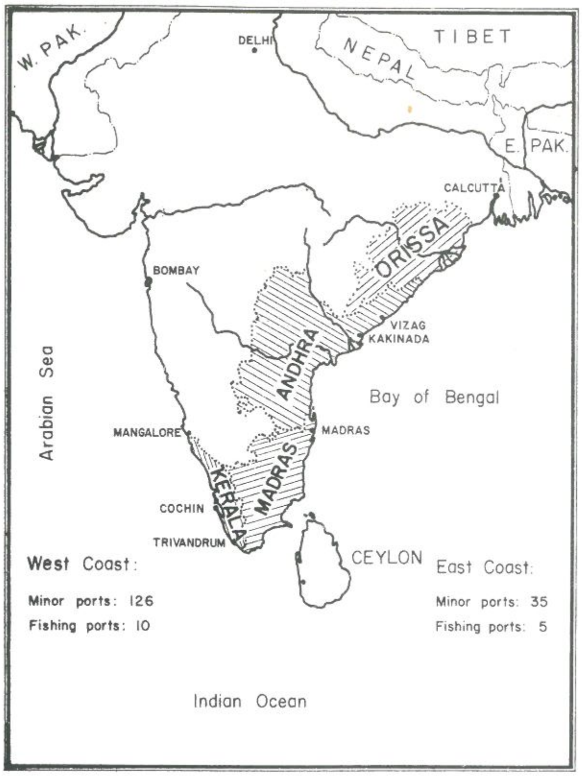


FIG. 1

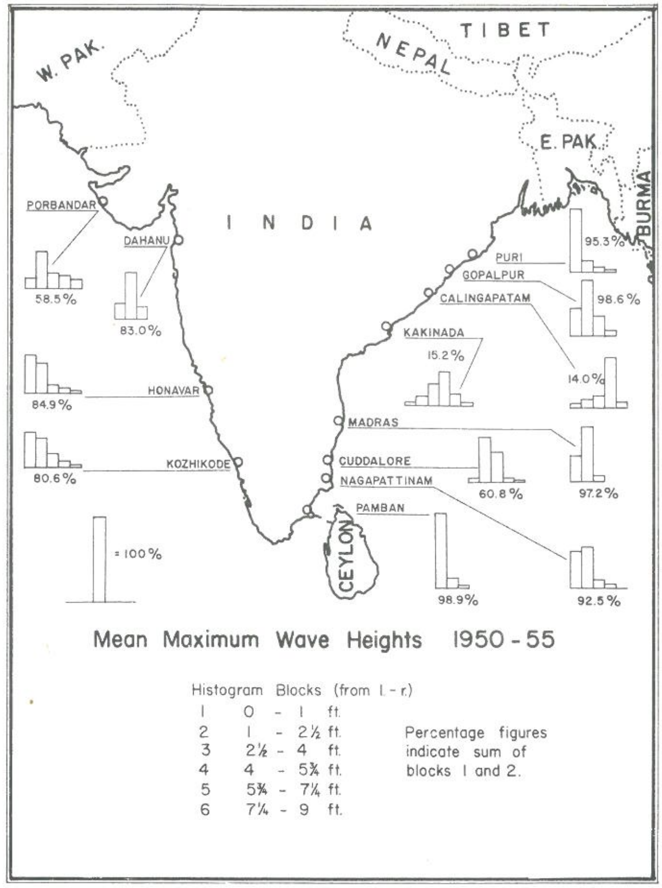


FIG. 2

FIG. 3

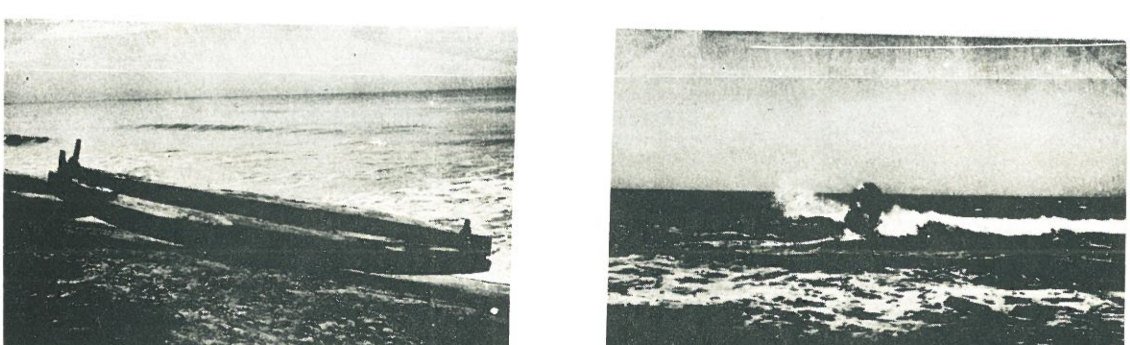


FIG. 8

FIG. 9

FIG. 10

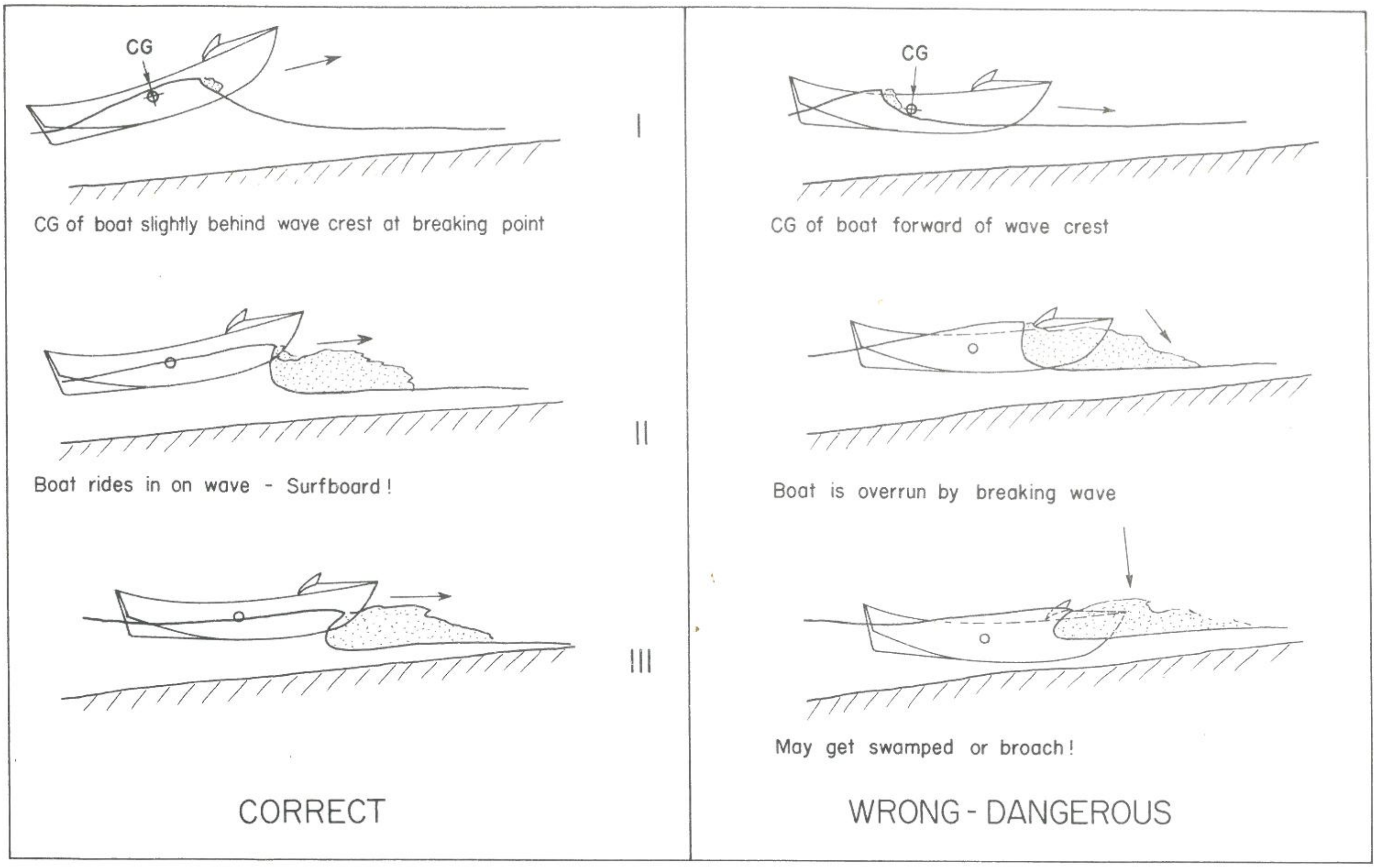

CG
CG of boat slightly behind wave crest at breaking point
I
CG
CG of boat forward of wave crest
Boat rides in on wave - Surfboard!
II
Boat is overrun by breaking wave
III
May get swamped or broach!
CORRECT
WRONG - DANGEROUS

FIG. 11

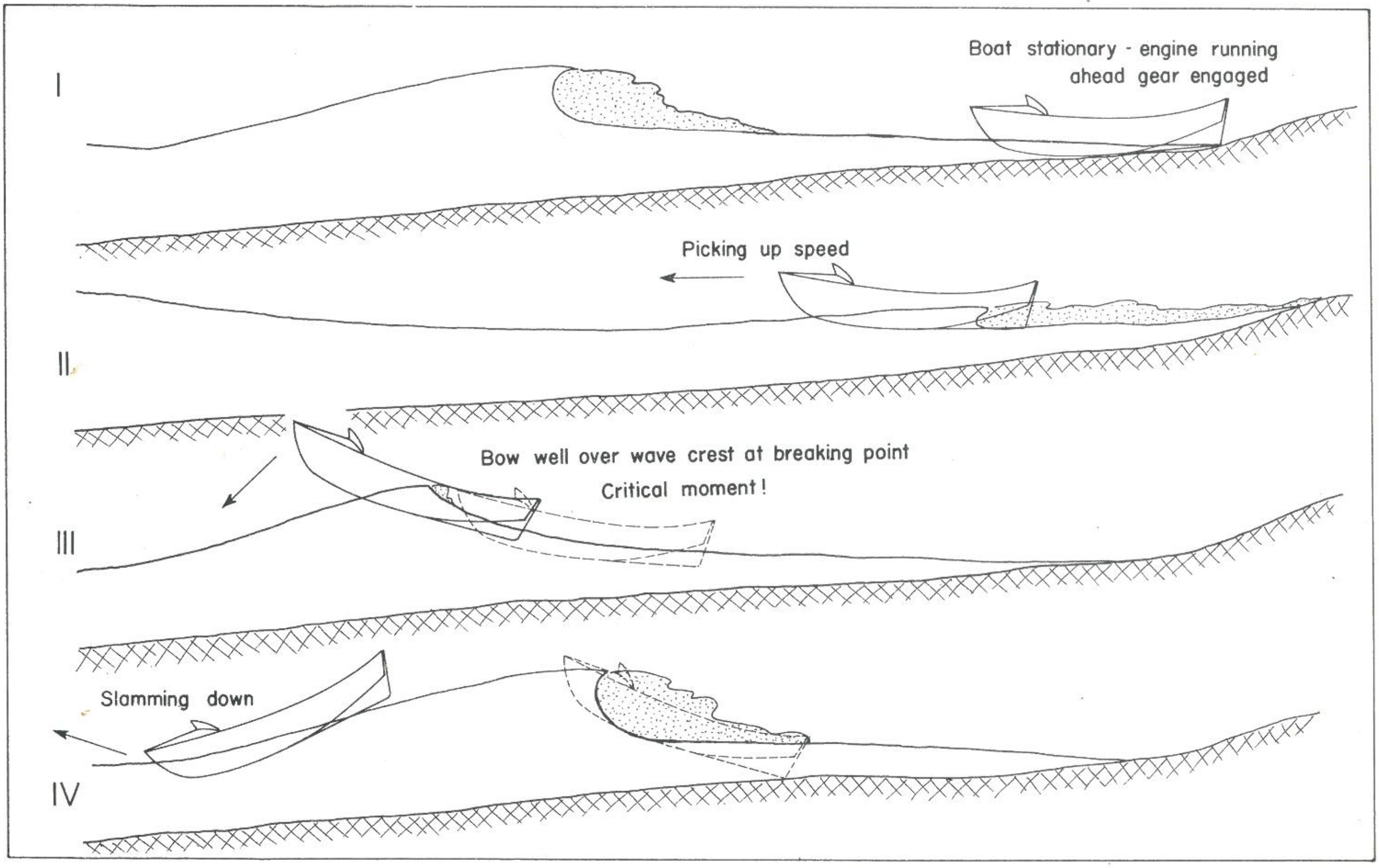

I
Boat stationary - engine running
ahead gear engaged
Picking up speed
II
Bow well over wave crest at breaking point
Critical moment!
III
Slamming down
IV

FIG. 12

Vo. 38. 2ND OF 4.

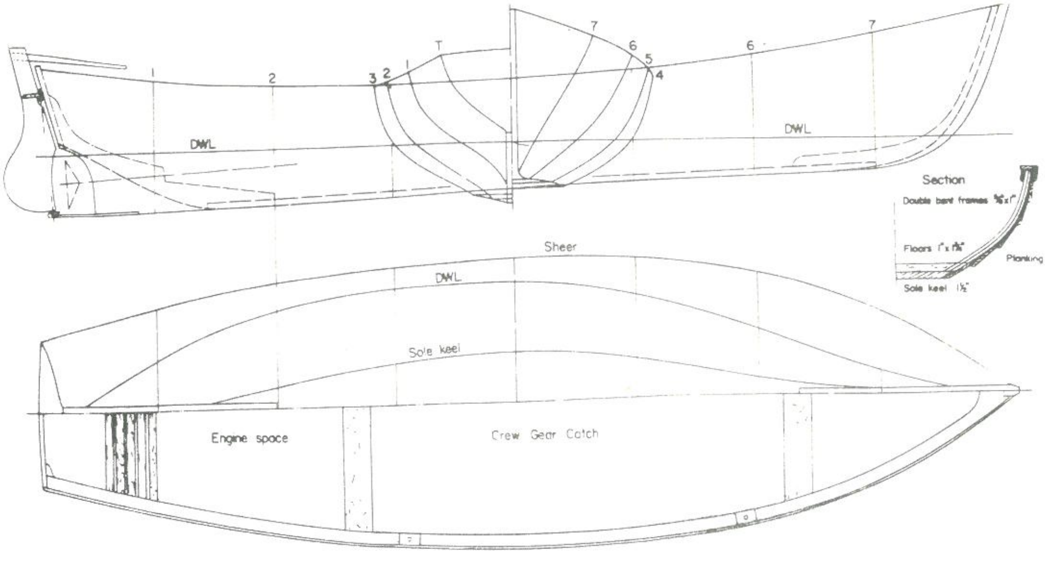


FIG. 5 18 ft (5.49 m) and 20 ft (6.10 m) FAO Surfboat

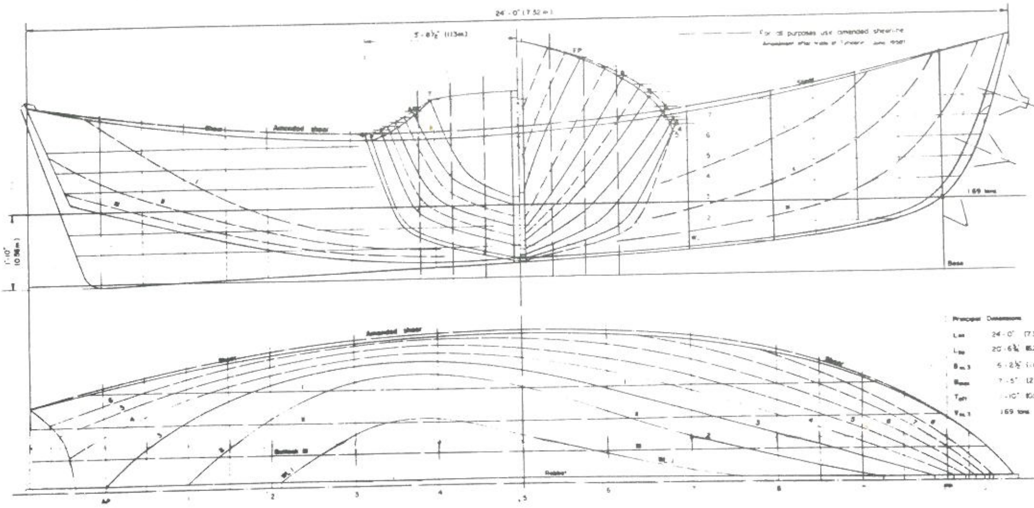


FIG. 6

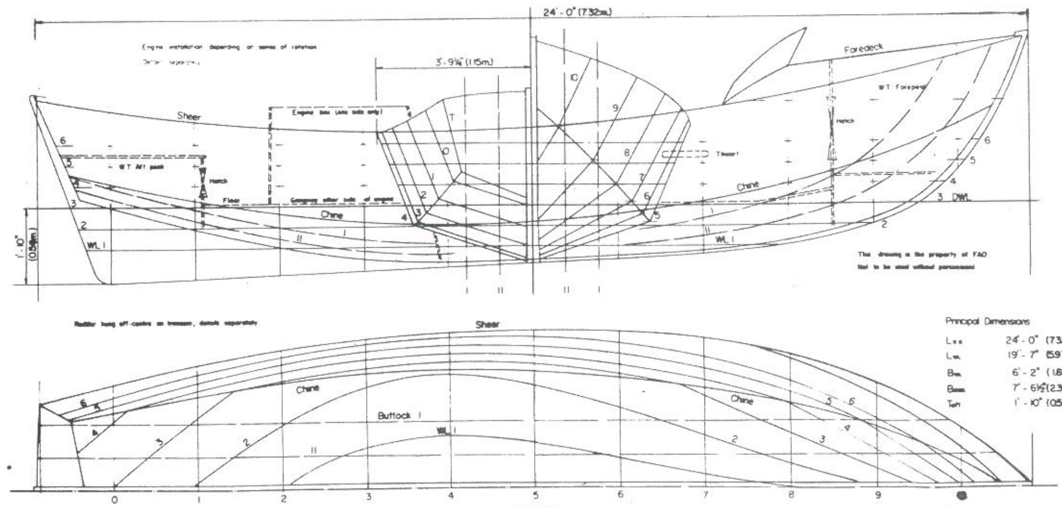
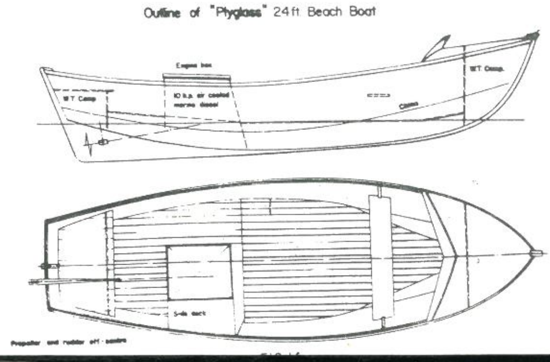


FIG. 13

Outline of "Plyglass" 24 ft Beach Boat



Appendix II

SYLLABUS MARINE ENGINEERING DURING TRAINING CENTER 1957*

As many of the trainees will in the future be concerned with the installation and maintenance of diesel engines, the main emphasis was placed on this aspect of diesel engineering. The first part of the course was devoted to a description of the main parts of diesel engines and an account of the functions of these parts, while the latter part of the course was taken up by constructing a fault-finding scheme, and developing the outlines of a servicing and maintenance schedule.

An outline of the topics discussed is given below -

1. Classification of Heat Engines

(a) Steam engines
(b) Steam turbines
(c) Gas turbines
(d) Internal combustion engines:

1. Spark ignition engines
2. Hot Bulb engines
3. Semi Diesels
4. Diesels

2. Classification of Diesel Engines

(a) Cycle of operation - two stroke - four stroke
(b) Speed - low, medium, high speed

Definition of speed factor (Piston speed times r.p.m. /100000)

Speed factor	Speed classification
1-3	Low
3-6	Medium
6-9	High
9-81	Super high

(c) Normally aspirated - super charged
(d) Single acting - Double acting
(e) Cylinders-in-line-in Vee, horizontal, vertical, opposed piston, radial

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* by Mr. E. Kvaran, FAO Marine Engineer (Ceylon)

3. Engine Elements

(a) Frames - A type; B type; block type
(b) Cylinders - liners, wet and dry types; reboring; factors influencing liner wear
(c) Cylinder Heads - Valves
(d) Running Gear - Pistons: trunk, barrel types;
Piston rings: compression rings, oil control rings;
connecting rods; connecting rod bearings;
Piston pins: fixed, semi-floating, fully floating,
Crankshafts; Main bearings; Fly wheels;
Balancing; Lubrication of running gear; Firing order.
(e) Valve gear; camshafts; cams; timing; push rods; valve rockers; valve clearance
(f) Fuel injection system; fuel pumps; fuel injectors; nozzle types
(g) Speed control - Governors - Centrifugal hit or miss; pneumatic.

4. Engine Faults

(a) Faults found by preliminary inspection:

1. Loose or improper connections -
Loose bolts or nuts
Leaking gaskets, unions or pipes
Improper valve clearance

2. Engine cannot be readily turned by hand:
Insufficient clearance at piston crown
Decompressor adjustment incorrect
Valve sticking
Oil too thick
Handstarting gear defective
Piston, bearing, gear, etc. stuck
Part left inside
Load connected

3. Starting
Air Pressure or Batteries low
Recharge - CO_2 may be used for starting air but not O_2

4. No fuel injected when engine is cranked:
Fuel supply defective:
Insufficient fuel
Valve closed
Water and smudge in fuel
Fuel tank air vent blocked

Air in fuel system - bleed
Filters - clean if necessary
Fuel pump
Injector pipe
Injectors - adjust if necessary

Blocked or leaking pipes
Defective pump
Replace plunger and barrel
Grind valves and seats
Replace springs
Defective injector
Adjust spray pressure
Clean nozzle
Lap needle or grind valve (if applicable)
Replace nozzle

5. Lubricating oil supply not functioning
Oil level wrong
Oil pump out of order
Lubricator out of order
Incorrect lubricating oil (too heavy)

6. Engine turns too freely:
Handstarting gear defective
Flywheel loose
Poor compression
Decompressor not releasing
Valve stuck
Valve seat leaking
Cold Starting Arrangement leaking
Injector house leaking
Cylinder head gasket leaking
Cylinder head cracked
Piston rings stuck or broken
Piston crown clearance excessive
Piston liner clearance excessive
Liner leaking
Air filter clogged
Air scavenging not correct
Air Ports clogged
Air valves leaking
Crankcase leaking
Crankcase full of oil

(b) Faults interfering with operation of engine:

1. Engine will not start
Engine does not turn over
(See relevant section in prestarting faults)
Faulty electrical or air starting system
Batteries low
Air pressure low
Starting motor defective
Solinoid defective
Loose or poor connections
Incorrect wiring circuit
Sticking air valve

Mechanical hindrance permitting some movement
- Decompressor adjustment incorrect
- Valve stuck
- Part left in cylinder

Completely tight engine
- See prestarting faults

Engine does not turn with sufficient speed
- Batteries, starting air, low
- Poor electrical contacts
- Air starting valve out of order
- Air timing incorrect
- Excessive friction in bearings or piston
- Thick lubricating oil

Engine turns freely
- No fuel - see prestarting faults
- Fuel injection turning wrong
- Poor compression (see prestarting faults)
- Low temperature of compression
  - Auxiliary Starting Aid required

2. Engine will not come up to speed
   - Insufficient fuel delivered
   - Governor linkage defective
   - Cylinder misfiring
     - Injection defective
     - Timing wrong
     - Poor compression in one cylinder
     - Excessive cooling (especially at light loads for low compression ratio)
     - Water leaks into cylinder
       - Cylinder head cracked
       - Liner cracked
       - Gasket leaking
   - Poor Combustion (often smoke)
     - Poor scavenging
       - For 2 stroke see prestarting faults
       - For 4 stroke
         - Valve lift insufficient
         - Clearance wrong
         - Parts worn
     - Timing wrong
       - Too early - knocking
       - Too late - smoking
     - Injection poor
   - High exhaust back pressure
     - Clogged pipes on silencer
     - Blocked parts
     - Exhaust valve lift insufficient
       - Clearance wrong
       - Parts worn

High friction
  Piston about to seize
    (Cooling water and oil temp. may continue
     to rise, knocking will increase with time)
    Scored liner
    Broken ring
    Scale in water jacket
    Piston head cooling oil supply defective
    Lubricating oil supply low
  Bearing about to seize:
    Dirt in lubricating oil
    Lubricating oil supply low
    Worn bearing or journal
  Lubricating oil too thick or level too high
Overload (especially if engine started satisfactorily
  and then speed dropped)
  Incorrect propeller selection
  Increased resistance due to weather or unusual
    loading of boat or towing gear box defective

3. Engine will not develop full power
    Some defects as above, but in milder form

4. Engine speed irregular
    Water or impurities in fuel
    Air in fuel
    Valves sticking (or needles) in injection system
    Governor or linkage not working properly
    Fuel oil too viscous

5. Engine Overspeeds (highly dangerous; engine must be stopped if defect is not located at once)
    Governor or linkage sticking
    Fuel by-pass clogged (if applicable)
    High volatile fuel (used to assist start) in system

6. Engine stops suddenly
    No fuel injected
    Inlet or Exhaust valve not working properly
      Valves sticking
      Spring broken
      Timing gear or camshaft broken
    Governor defective
    Bearing seizure
    Piston seizure
    Other broken parts

(c) Faults noticeable when engine is running

1. Smoky exhaust
   - Overload
   - Fuel nozzle valve leaking
   - Fuel nozzle tip plugged or worn (fuel may strike metal surface)
   - Poor compression
   - Fuel injection pressure low
   - Timing retarded
   - Slow igniting fuel
     - Low Cetane number - often knocking as well
     - High Cetane number - usually in knock
     - Low viscosity - poor penetration - block smoke
     - High viscosity - drops may reach walls - blue smoke, pungent exhaust
   - Excessive consumption of lubricating oil
     - Oil control rings blocked or stuck
     - Oil level too high
   - Overcooling of engine
   - Engine dirty (needs decarbonizing)
   - Indications from color of smoke:
     - White low temperature due to poor compression or excessive cooling
       Water leak into cylinder
     - Light grey to black - poor combustion
     - Blue - Lubricating oil burning
       Fuel oil striking cool surface

2. Abnormal exhaust temperature or cylinder pressure:

Cylinder Pressure	Ex- Temp.	Remarks
Low Compression	Low	Clearance too great, comp. ratio too low
	Normal	Air inlet clogged, insufficient scavenging
	High	Air leak through valves, past rings
High Compression	High	Clearance too small comp. ratio high
Low Firing	Low	Fuel rack too far out
	Normal	Air inlet clogged, low cetane fuel
	High	Injection late, nozzle dirty, high back press
Normal Firing	Low	Light load
	High	Overload, high back pressure
High Firing	Low	Injection early
	Normal	Worn
	High	Fuel rack too far in

3. Cooling Water Temperature incorrect:
    - Too low
        - Water supply excessive
        - Termostat or by-pass defective
    - Too high (gradual change)
        - Water supply insufficient
        - Thermostat or by-pass defective
        - Water pump or valves defective
    - Too high (rapid change)
        - Water supply insufficient
        - Piston about to seize

4. Engine Overheats:
    - Insufficient Cooling Water (see above)
    - Scale in Water Jackets
    - Too much recirculation of cooling water
    - Insufficient piston lubrication
    - Lubricating oil poor quality, dirty or diluted
    - Lubricating oil filters clogged
    - Lubricating oil pump worn or defective
    - Timing wrong
    - Fuel nozzle carbonized
    - Fuel nozzle dribbling
    - Fuel spray striking hot surface

5. Engine Operation Noisy:
    - Mechanically caused noise
        - Worn piston pin or pin bearing
        - Worn big end or main bearing
        - Worn piston or liner
        - Piston striking valve
        - Loose fly wheel
        - Other loose or worn parts
    - Fuel Knock
        - Timing too early
        - Fuel injection faulty
        - Fuel oil unsuitable
    - Gas flow incorrect
        - Silencer or exhaust pipe defective
        - Air filter defective

6. Engine Vibrates
    - Loose foundation or foundation bolts
    - Misfiring
    - Loose vibration damper
    - Resilient mounting defective
    - Alignment poor

(d) Faults found on dismantling engine

1. Piston rings gummed up
   Poor lubricating oil
   Excessive lubrication
   Poor combustion
   Excessive working
   Defective piston or ring design

2. Fuel injector or exhaust valve carbonized
   Poor combustion
   Incorrect fuel oil
   Excessive back pressure
   Excessive period between cleaning

3. Water in Crankcase
   Cylinder head cracked
   Head gasket leaking
   Liner leaking
   Liner seal leaking
   Excessive cooling

4. Worn and defective parts

5. Operation of diesel engines -

   a) Preparations for starting -
      Check lubricating oil level
      Check fuel supply
      Lubricate hand lubricated parts
      Fill grease cups
      Check bolts, nuts, connection, wiring
      Open sea water valve
      Turn over by hand (if applicable)
      Bleed air from fuel system
      Work governor linkage and pump racks
      Check adjustments (first start)
      Check tools
      Check air pressure or batteries and starter motor
   Faults located to be treated as indicated in section on prestarting faults.

   b) Starting
      Engine should start in 4-5 revolutions
      Starter button must not be pressed for more than 15-20 seconds at a time
      If engine fails to start trace fault as indicated under section on failure to start.

c) Warming up period -
- Listen to firing to ensure that all cylinders are working - If necessary cut out one at a time
- Observe cooling water flow - Check temperature rise, adjust by-pass if necessary
- Observe lubricating oil pressure and lubricator operation - count drops, if possible
- Check warming up temperature of cylinders etc.
- Listen for signs of unlubricated part
- Observe exhaust colour and sound
- Check for leaks or loose fastenings during warm-up period

d) Running - same observations as during warming up period, repeated at 15-20 minute intervals. Also:
- Screw down grease cups as required (2 hours)
- Hand oil as required (2 hours)
- Clean filters - water and fuel - if applicable while running
- Keep engine clean
- Maintain engine log. - This will vary with circumstances - Minimum: operating time, fuel and lubricating oil consumption, remarks
- Check fuel supply as required.

6. Care of Engines:
- Servicing - Done while engine is in operation, although not necessarily running. Carried out by driver.
- Maintenance - Periodic attention to vulnerable parts; carried out by shore staff or driver as circumstances dictate.
- Overhauling - Periodic complete dismantling and inspection of all parts; replacement or reconditioning of all parts requiring it.

A few possible schemes for schedules for servicing, maintenance and overhauling were discussed.

Typical values of allowable or required clearances of various parts were given, and allowed wear on pistons etc. The importance of following the manufacturers instructions in preference to general instructions was stressed throughout the course, with illustrations from instruction books.

The main reference used was:

"Diesel Engine Operation and Maintenance" by V.L. Maleev, McGraw Hill Book Co. 1954