FISHERIES TRAINING PROGRAMME
P.O. Box 1390, Skulagata 4
120 Reykjavik, Iceland

Final Project 2003

A CONCEPTUAL DESIGN OF A FIBRE REINFORCED PLASTIC FISHING BOAT FOR TRADITIONAL FISHERIES IN MALAYSIA

Mohamad Zawahid bin Shamsuddin
Fisheries Industry Development Division
Fisheries Development Authority of Malaysia (LKIM)
7 & 8 Floor, Wisma PKNS
Jalan Raja Laut, 50784 Kuala Lumpur
MALAYSIA

Supervisor
Emil Ragnarsson, V.E.R. Ship Consultant, Reykjavik, Iceland
emilr@simnet.is

ABSTRACT

Fibreglass commonly known in the business as fibre reinforced plastic (FRP) or glass reinforced plastic (GRP) has been used in boat building for over 60 years. In that time, vessels of various categories have been built using FRP. Faced with the problem of wood supply for boat building in the last few years, the Malaysian government decided to promote the building of new FRP fishing boats with up to 20 GRP boats to replace old wooden boats. The design of 12.75 m FRP boats produced by Majuikan Sendirian Berhad (MSB), a subsidiary company of the Fisheries Development Authority of Malaysia (FDAM) were chosen as a standard design for this purpose. This study is aimed to produce a conceptual design of an FRP fishing boat in the same category of design used by the MSB but with some improvements in construction methods and the general arrangement of the boat. The study is based on a small-scale fishing fleet, which is made up of FRP boats up to 14 m in length and the FRP boatbuilding industry in Iceland. A conceptual design of 13.11 m in length boat produced has a similarity in the physical features of an Icelandic boat. But some alterations on general arrangement and powering of the boat have to be done in order to suit the environment of the Malaysian fishery. The proposed design will go through a comprehensive study by competent bodies in Malaysia before endorsement as one of the standard designs for Malaysian FRP traditional boats.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Malaysian fisheries are categorised into two groups: commercial and traditional fisheries. According to Decoster (2001), the terms traditional, artisanal or small-scale fisheries have different meanings from one country to another. It can be fishing operation-specific like in Madagascar, craft-specific as in India or length-specific in Chile and France. For example, in Madagascar, the term traditional refers to unmotorized, kinship-based fishing for subsistence or for the local market, whereas artisanal refers to the motorized fishing sector and small-scale means small trawler sector. The Fisheries Department of Malaysia (DOF), the regulatory authority uses the term traditional in a gear-specific sense, which defines all fishing units excluding trawling and fish purse seining as traditional fishing units. Figure 1 shows typical traditional fishing boats in the east coast of Peninsular Malaysia.

Figure 1: Traditional wooden fishing boats in the east coast of Peninsular Malaysia.

In 2001, there were about 84,500 fishermen in Malaysia and out of those 52,900 (i.e.63%) worked in traditional fishing vessels (DOF 2001). Each fishing vessel is allowed to operate one fishing gear but there is an exception in traditional fishery, where some vessels are allowed to operate more than one fishing gear. Therefore the number of fishing gears normally exceeds the number of fishing vessels. There is no information on the number of fishing vessels by fishing gears; but the statistics on the number of fishing gears licensed and the landing of marine fish in 2001 as shown in Table 1 can be used as an indicator of the minimum number of fishing vessels.

Table 1: Number of fishing gears licensed and the landing of marine fish (DOF 2001).

Fishing Gear Groups	No. of Gears	Landings (tons)
Commercial		
Trawl nets	6,124	675,957
Fish purse seines	899	255,149
Sub total	**7,023**	**931,106**
Traditional		
Anchovy purse seines	146	13,209
Other seines	799	27,123
Drift/gill nets	16,191	131,978
Lift nets	460	18,213
Stationary traps	224	3,107
Portable traps	655	14,595
Hook & line	4,388	47,533
Miscellaneous	1,795	44,425
Sub total	**24,658**	**300,183**
TOTAL	**31,681**	**1,231,289**

Most of the fishing boats in Malaysia are made of wood. Chengal (*Neobalanocarpus heimii*), the local heavy hardwood is the most common wood used for construction of the hull because it is easy to work, durable and is well resistant to seawater (Malaysian Timber Council 2003). The boat building industry is currently faced with the problem of shortage supply of chengal wood and the consequent price increase. The price of chengal has increased every year from MYR 2,030.00 (US $ 534.00) in 1997 to MYR 3,100.00 per m^3 in 2001 (Bumiputra-Commerce Bank 2001). As a result, the cost of the construction of a new boat or any woodwork has increased and it also takes a longer time depending on the supply of the wood. Realising this situation, the Fisheries Department of Malaysia (DOF) together with the Fisheries Development Authority of Malaysia (FDAM) have been looking for some alternatives to replace wood with other materials for boat construction. Two materials, fibre reinforced plastic (FRP) and steel have been found to be the most suitable to replace wood as the boat building materials.

Fibreglass has been used in the traditional boat building industry in Malaysia since the 1980s. It began with the application of FRP to drape the whole wooden hull instead of replanting it. This technique gave good results in which the hull had less problems with leakage and attack of marine growths and hence increased the hull life. This led to more constructions of FRP boats with the whole hull made of fibreglass. There is no statistic available on the number of FRP fishing boats but at present, it is estimated to be less than 100 boats. Most of these boats are between 10 -13 m in length.

In May 2003, the government announced a stimulus package to strengthen the domestic economy. This new economic package is aimed at promoting private domestic and foreign investments, strengthening the nation's international competitiveness and developing new sources of economic growth. One of the measures in developing new sources of growth in the agriculture sector is building 1,000 fishing boats of metal and composite materials with modern equipments to replace wooden boats. These boats are to be leased to fishermen (Ministry of Finance Malaysia 2003). The working committee for the implementation of this measure led by the Fisheries Department of Malaysia has decided to use the design of 12.75 m FRP boat built by Majuikan Sendirian Berhad (MSB), a subsidiary company of FDAM as the standard design for the construction of about 20 boats.

Figure 2 shows the 12.75 m FRP boat built by MSB chosen by the Malaysian government as the standard boat design for the replacement of wooden boats. The design of this boat is similar to the wooden boat except fibreglass is used for the hull and superstructure construction. The boat was not built in accordance with the appropriate practices of FRP boat building. For example the unnecessary use of wooden frames and stems and extra number of frames, has increased the construction cost.

So far, this FRP boat performs well without any major problems of construction, seaworthiness or operation of fishing gears. Nevertheless some improvement to the design should be made in order to produce better quality boats. There should be a certain standard of construction, which includes all aspects of safety, scantlings and working condition on the boats. At present the government does not impose any such standard. The construction of a fishing boat only requires approval from the Fisheries Department of Malaysia.

The objective of this project is to study the possibility of improving the MSB's boat design, which was chosen as the standard design. The conceptual design will be sent to the competent authorities in Malaysia for consideration to be one of national standard designs for traditional boats.

Figure 2: 12.75 m FRP boat built by MSB chosen as the standard design for a new Malaysian traditional boat.

The Icelandic small scale fishery has been chosen for this study as the country is known for its comprehensive management of fisheries and most of the fleet in the small-scale fisheries sector are FRP boats.

The study was carried out through various methods such as observation and discussion on construction practices with FRP boat builders at Trefjar Ltd, Seigla, B. Samtak Ltd and Somi Boats; went on short fishing trips to observe the manoeuvrability and stability of the small FRP boat owned by Mr. Jon Sigurdsson and the unloading of fish at harbour. Discussion on design was held with Mr. Stefan Gudsteinsson a naval architect and with regard to engineering with Mr. Bjorn Bjornsson from Velasalan Ehf.. Reference to literature on the subject such as naval architecture, boat design, FRP boatbuilding industry etc. was also made as an additional input to the study.

2 TRADITIONAL FISHERY IN MALAYSIA

Traditional fishery is an important sector in Malaysian fisheries. It provides about 52,900 jobs for fishermen, which makes up 63 % of the total workforce in the fisheries sector (DOF 2001). In terms of the fishing fleet, there are about 24,700 (78%) boats ranging from 4 m to 16 m in length and from non-powered to about 300 hp powered. The majority of the inboard powered boats are wooden boats whereas outboard powered ones are FRP boats. The hull life of a wooden boat can be up to 20 years but requires high maintenance.. Figure 3 shows an example of a wooden boat in a traditional fishery in Malaysia.

Figure 3: An example of a wooden boat in a traditional fishery, which operates offshore in the South China Sea.

Among the fishing gears in this sector, gillnets, portable traps and hook and lines are being operated both in inshore and offshore waters. Gillnets comprise of bottom, drift, surrounding and trammel nets. Bottom longlines, handlines and trolling lines are grouped into hook and line categories. Portable traps are used to catch demersal fishes such as snappers, groupers and also cuttlefish. The duration of the fishing operation varies from 1 to5 days depending on what is being fished.

Most of the offshore going boats are equipped with fish finders, global positioning systems and radio-telephones. Net haulers are becoming popular among the gillnetters especially those in the west coast off Peninsular Malaysia.

Figure 4: Picture of a locally-made net hauler, which is widely used among gillnetters in Malaysia.

According to the DOF (2001), the majority of the traditional fishing boats operate in the inshore area, which has been heavily exploited. Hence issuing of new licences in this sector has been stopped. In line with the managemant policy, some inshore fishermen are encouraged to venture into offshore fishing. The government has also provided a special fund to replace wooden boats with FRP boats which include modern machineries such as automatic longline system.

3 FRP IN THE BOAT BUILDING INDUSTRY

Fibreglass reinforced plastic (FRP) is a rather new material in boat building. It is suitable for building vessels of various types, ranging from 2 m rowing boats up to an 80 m naval minesweeper (Coackley *et al.* 1991) with an estimated hull-life of about 20 years (Laszlo 1960). The first introduction of FRP in the boat building was in the late 1940s and was used for the military purposes in North America (Coackley *et al.* 1991). According to Eric Greene Associates (2003), the use of FRP extended into recreational boats and commercial marine vessels such as pilot boat and passenger boats in the 1960s. The first fishing vessel was built in 1967, operating in the North Sea and in the United States of America; the first FRP trawler was built in the early 1970s and is still in service. BOSTID (1988) reported that the Yamaha Motor Company of Japan had introduced a diesel powered FRP canoe in Senegal in the early 1980s and in the Comoro Islands and Malagasy Republic in 1983. In Iceland the first FRP boat was a pleasure boat brought in from Europe in 1960 and the first FRP fishing boat was built in 1977 (Adalsteinsson per.com.).

3.1 Common FRP materials used in fishing boat construction

There are two main components of FRP materials used in the construction of fishing boats; glass reinforcement in the form of chopped strand mat (CSM) or woven roving (WR) and resins (Coackley *et al.* 1991).

3.1.1 Chopped strand mat (CSM) and woven roving (WR)

The suitable CSM and WR for tropical marine use are of E-type. They are supplied in the form of continuous sheets of variable thickness and are specified by weight. The most common ones are 300, 450, 600 and 900 g/m^2 for CSM and 600 and 800 g/m^2 for WR.

3.1.2 Resins

Polyester resin is the main type used in fishing boat building. It comes in unsaturated form and becomes saturated when cured during the laminating process. The type recommended for boat building is isophtalic (Iso) or neopentyl glycol (Iso-NPG). These are resistant to water absorption; have strength and adhesive qualities; are resistant to ultra-violet radiation and bad weather; and do not react with other liquids and solids, e.g. drinking water and fuel oil or wet fish. Gelcoat resin is used as the first layer and is applied to the female mould during the laminating sequence. It is a polyester resin in a more viscous form and has greater weather and chemical resistance. As shown in Figure 5, a worker is laminating the reinforcement of the hull.

Figure 5: A worker at Seigla, boat building company in Iceland laminating the reinforcement of the hull.

3.2 Comparison between FRP and other building materials

Building materials commonly used for small fishing vessels are wood, steel, aluminium, ferrocement and FRP. Wood has a long history in boat building and even though it is still a popular material, the demand for wooden fishing boats especially in developed and some developing countries is decreasing. This may be due to the issues of deforestation and high cost of maintenance. Today, FRP is getting more popular in fishing boat building especially small size boats in small-scale, traditional or artisanal fisheries. The main advantages of FRP compared to other materials are strength, less maintenance costs and longer hull life. In the proceedings on fisheries technologies for developing countries prepared by the Board on Science and Technology for International Development (BOSTID) of the Office of International Affairs, a comparison in terms of construction and performance between common boat building materials are given as shown in Table 2 and 3.

Table 2 : Comparison of boat building materials in terms of construction (BOSTID 1988).

Material	Cost	Availability Of Materials	Skill Level	Time to Build	Hull Shape
Wood planking	2-3	1-5	5	5	1
FRP laminate	3-5	1-5	2	1	1
Aluminium	4-5	1-3	2-4	2-3	2
Steel	1	1-3	2	2-3	2-3
Ferrocement	2	1-2	1-3	2-3	1

Scale:
Cost: 1 = lowest cost
Availability: 1 = readily available
Skill: 1 = lowest level of skill needed
Time: 1 = least time required to build a boat
Hull: 1 = highest flexibility in design.

As shown in Table 2, FRP laminate requires the least time to build and more flexibility in hull design. Semi skilled workers are sufficient to build the boats, as it does not involve high technology. The construction cost for an FRP boat is higher than for wood, steel or ferrocement boats but the cost will be reduced through mass production.

Table 3: Comparison of boat building materials in terms of performance (BOSTID 1988).

Material	Strength-Weight Ratio	Hull Weight Fuel Consumption	Resistance To Chafe	Longevity	Maintenance
Wood planking	3	4	2	1-3	4
FRP laminate	2	3	2-3	1-2	1-2
Aluminium	1	1	1-3	1	1-2
Steel	3	4	1	1-3	2-4
Ferrocement	5	5	2-3	3	2

Scale:
Strength-Weight: 1 = high ratio
Hull weight and Fuel consumption: 1 = low weight and low fuel consumption
Chafe: 1 = high resistant
Longevity: 1 = long life
Maintenance: 1 = low cost and less difficult to maintain

Table 3 indicates that FRP can be considered as the second most superior material to aluminium in terms of strength, consummation of fuel due and its long hull life of up to 20 years or more. Maintenance of an FRP boat is much less compared to wooden, steel or ferrocement boats because FRP does not corrode, leak or crack and has good resistance to marine growths such as barnacles.

4 SMALL SCALE FISHERIES IN ICELAND

Fisheries play an important role in Iceland. Fishing and fish processing contributed to about 12% of its national GDP in 2002 (Icelandic Ministry of Fisheries, 2003). Small-scale fisheries in Iceland can be defined by length-specific (Ben-Yami 2000 and Decoster 2001) as boats of 12 m and below in length.

4.1 The FRP fishing boat

The first FRP fishing boat was built in Iceland in 1977. According to Adalsteinsson (per. com.), this small boat was built according to the Standard Icelandic Maritime Authority (IMA) at that time. The construction of the boat was not due to any immediate problem at the time but rather due to the enthusiasm of one man to invest in a new business.

The boat performed well and since then the number of FRP boats in Iceland has increased over time. By 1 January 2003, the IMA had registered 1,586 FRP vessels of various categories and most of the boats are in the length groups of 7 m to 9 m. Table 4 shows the composition of these FRP boats according to length groups from 5m to 24m.

Most small scale fishing boats, also known as 'the part-time fleet' in Iceland are open-decked and decked types, owner- operated with crew size of one to three persons depending on the gears and fishery. Fishing gears used mostly are gillnets, handline and longline (Arnason 1995). The use of machineries like automatic long lining and hand jigging systems and net haulers are common practices in almost all boats. Fishing is commonly a one-day trip and is carried out seasonally. Figure 6 shows some of small-scale fishing boats in a harbour in Iceland.

Table 4: Composition of Icelandic FRP vessels of various categories according to length groups in 2003 (IMA 2003).

Length Group (metre)	Total No. of Boat	Average Dimension (LOAxBxD) metre	Average GT (GRT)	Range of Engine Power kW(HP)	Remark
5	4	5.55 x 2.14 x 1.07	1.84 (1.22)	12-140 (16-190)	
6	126	6.40 x 2.24 x 1.10	2.65 (1.77)	5-213 (6-289)	
7	284	7.36 x 2.32 x 1.05	3.62 (2.41)	5-257 (6-349)	
8	721	8.32 x 2.59 x 1.33	5.08 (3.39)	6-324 (8-438)	
9	223	9.05 x 3.12 x 1.40	6.51 (4.34)	12-560 (16-757)	
10	116	10.04 x 3.79 x 1.44	9.69 (6.46)	11-534 (15-742)	
11	57	11.14 x 3.38 x 1.38	12.68 (8.45)	17-622 (23-841)	
12	16	12.05 x 3.59 x 1.56	15.63 (10.42)	21-854 (28-1154)	
13	20	13.11 x 3.76 x 1.76	20.03 (13.35)	37-632 (50-854)	
14	8	14.32 x 3.99 x 1.75	23.24 (15.49)	37-748 (50-1011)	
15	9	15.80 x 4.67 x 2.79	34.60 (23.07)	350-1,248 (476-1696)	n.f.v.
17	1	17.00 x 5.36 x 2.34	34.00 (22.67)	133 (181)	n.f.v.
24	1	25.00 x 8.37 x 2.44	169 (112.67)	1,760 (2391)	n.f.v.
TOTAL	1,586				

Legends: LOA - length overall
B – moulded breadth
D – Depth
n.f.v. - non fishing vessel

Figure 6: FRP fishing boat 10-12 m in length in a fishing harbour in Iceland.

4.2 Common FRP boat construction practice

Generally, all the FRP boats are built using the female mould technique. This technique is applicable in mass production or the same design can be marketed for a long period of time. The mould can produce a minimum number of 15 boats and even more if proper handling is maintained during the production process. Basically, two main moulds are required: the hull and superstructure of the boat. The most common lamination technique among the builders is the hand lay-up technique. In this technique, pieces of the reinforcement materials (CSM or WR) for the lamination are laid up by hand. Then resin is applied on them and the process is repeated up to the required thickness. The hull mould shown in Figure 7 is a one-piece hull mould and it can produce a smooth outer surface of the hull.

A manufacturer of FRP boats is required to get approval from IMA before starting construction and must follow some rules and regulations concerning the set up of construction building and practices. One of the rules requires the manufacturer to have at least one qualified worker in the FRP works. The required qualification is obtained through a two week course in FRP boat and technology conducted by the Icelandic government and a four months working experience in the field (Adalsteinsson per.com.).

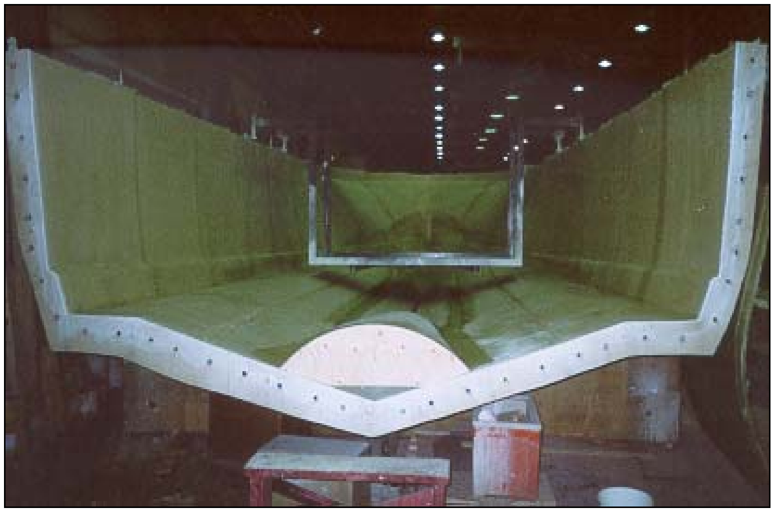


Figure 7: Female mould in one of the boat building workshops in Iceland.

The construction of new fishing boats is subject to the Ship Survey Act No.35/1993, (as amended) of Iceland and the Nordic Boat Standard for commercial boats less than 15 m. According to this Act the owner must get the approval from the IMA before being able to construct an FRP boat. During construction, the IMA will make regular inspections and on completion of the construction, approval will be endorsed by the IMA. The same rules also apply to any major repairs made which involve the main structure and safety of the boat.

4.3 General features of FRP boats

Most of the boats in Iceland are generally constructed with three compartments; superstructure in the forward section, fish hold at the centre and an engine room at the back.

Each of the compartments is separated by a watertight bulkhead as required in the construction standard. Figure 8 shows the construction of watertight bulkhead separating the engine room on the right side and the fish hold on the left side of the photo.

Figure 8: Watertight bulkhead in construction.

The accommodation for the crews such as berths, and toilets are located under the deck in the superstructure. Fish boxes (tubs) are put in and out of the fish hold through hatch openings (Figure 9), a compulsory fitting on a decked boat. The capacity of a fish hold varies according to the size of boat, for example a 9 m boat has a fish hold capacity for two units of 660 litres and four units of 380 litres fish tubs (Figure 10).

Figure 9: Construction of hatch coaming.

Most of these small-scale boats are highly mechanised. Automatic handliners, longliners or net haulers are very common features on deck. The boats are also fully equipped with electronic equipments such as fish finders, communication sets and radar.

Figure 10: Two types of fishing tubs are used on this boat.

The boats are either a planning or semi planning boat with v-shaped hulls. High-powered boats, which can reach up to 24-30 knots, are another common feature of the Icelandic small fishing boats. Some boats are equipped with two main engines to achieve high speeds. The main reason for this practice is due to the fisheries management system whereby the fishermen have to fish within given days/hours and seasons and also to market the fish as soon as possible for a better price.

5 DESIGN AND CONSTRUCTION CONSIDERATIONS

Marine fishery is one of the most dangerous civilian occupations (Ben- Yami 2000). Fishers frequently operate under hostile conditions, often using imperfect vessels and technology. A fishing boat can be described as a floating platform for transporting fishers, cargo and gears to and from the fishing ground and to support the fishers and equipment during the fishing operation (BOSTID 1988). To complement these conditions, the boat should be built in order to have a sufficient working area, good storage compartments for materials and fish, proper deck layout, convenient accommodation for fishers and be safe and seaworthy.

In building a fishing boat, some major factors that must be considered are:

- Design of boat
- Cost of boat
- Source of finance
- Suitability and acceptance
- Skill for building and maintenance

5.1 Boat design

One of the most important aspects in fishing boat design is the hull shape because it affects the boat stability and seaworthiness. Good stability and seaworthiness makes the boat easy to control (Vossers 1966)

Displacement, semi-displacement and planning are three terms used by most of the naval architects and boat builders in describing the operating conditions of small boats. These conditions are determined by the hull shape, the length and the speed of the boat (Fyson 1979). It is a common practice to use the speed-length ratio to determine the corresponding speed of the vessel to its length. This ratio was first put forward by William Froude (Comstock 1967) who described it as dividing the speed of the boat in knots by square root of the waterline length in feet (SL ratio = $V / \sqrt{L}$). According to Gerr (2001), a displacement boat has a speed-length ratio of 1-1.34 and is characterized by deep- load-carrying hull form with curving (round) buttock lines; a semi-displacement or semi-planning boat has a speed-length ratio greater than 1.34 but less than 3.0 with a V – shaped hull; and a planning boat with flat bottom or deep V-shaped hull is normally a high speed boat with a slender and long hull, operating at speed-length ratio over 2.9 or 3. The three categories of hull shapes as described above are shown in Figure 11.

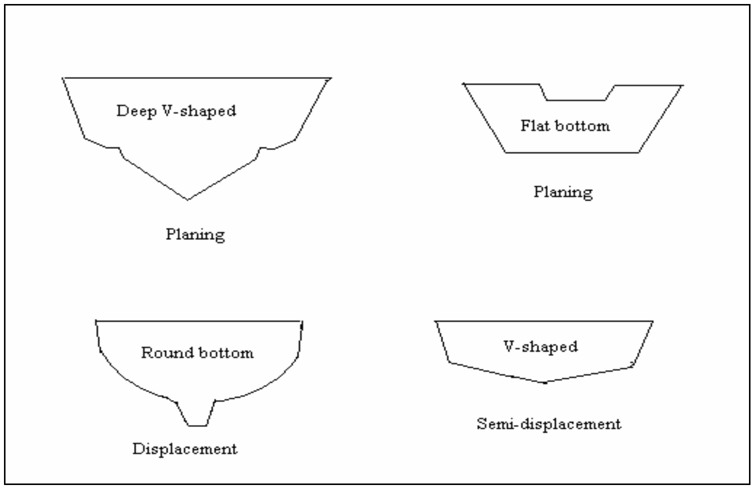


Figure 11: Types of hull shapes according to categories: planing, displacement and semi-displacement.

5.2 Construction cost

There are three factors that can be used to determine the construction costs of a boat: (1) the revenue earned from the boat, (2) its anticipated life span, and (3) available loans to finance the construction (Ritterbush 1979). The revenue can be derived from calculating the amount of catch, selling price, number of trips, operating and maintenance cost and wages. The life span of an FRP boat can be anticipated for 20 years and payback period of the loan should be longer with lower interest.

5.3 Source of finance

In Malaysia, loans are available from certain banks through certain loan schemes including the special fund as mentioned in the introduction and the Fishermen's Fund, which is managed by the FDAM.

5.4 Suitability and acceptance

In order to be accepted by the fishermen, any change or improvement in boat design and construction should not depart radically from traditional designs as what works well in one area will not necessarily work well in another (BOSTID 1988). The new design should keep some of the characteristics of the traditional design, which are more related to the custom of local fishermen. For example the galley (kitchen) on Malaysian boat is best located on the deck and not under to suit the way of cooking of foods.

New boats should be better in terms of fishing capabilities, seaworthiness, working conditions, accommodation and safety for the crews. With all these improvements, the boat will be able to go farther offshore to explore new fishing grounds.

5.5 Skills for building and maintenance

As shown in Table 2, the construction of an FRP boat does not require high skilled workers. Only one qualified worker is needed to supervise the work. Qualified workers in the fibreglass industry are available in Malaysia. They are either from training centres or skilled workers trained by their working experiences.

The fishing industry in Malaysia is progressing over time. Most of the fishing fleet is powered by engines from well-known makers such as Cummins, Yamaha and Caterpillar. These companies provide reliable back-up services all over the country. Besides them, there are also many private workshops and service centres with qualified workers available within the fishing communities areas.

6 PROPOSED DESIGN FOR MALAYSIAN TRADITIONAL FISHING BOAT

The design of the boat was prepared based on the Icelandic FRP boat design but with some alterations to suit the condition of Malaysian fisheries. The design is in a conceptual form, giving more emphasise on the technicality of the construction than the economical aspects. Main factors considered in the design are: (1) types of fishing gears to be used (2) fishing areas (3) duration of fishing trip and (4) the number of crews.

The boat is designed to operate traditional fishing gears such as gillnets, portable traps and hook and line. The use of machineries such as an automatic hand jigger and a long liner will be recommended. The fishing operation will cover 12 to 150 nautical miles in the Straits of Malacca, South China Sea, Zulu Sea and Celebes Sea (Figure 12). The boat is also designed to operate during a five-day period with four crew members.

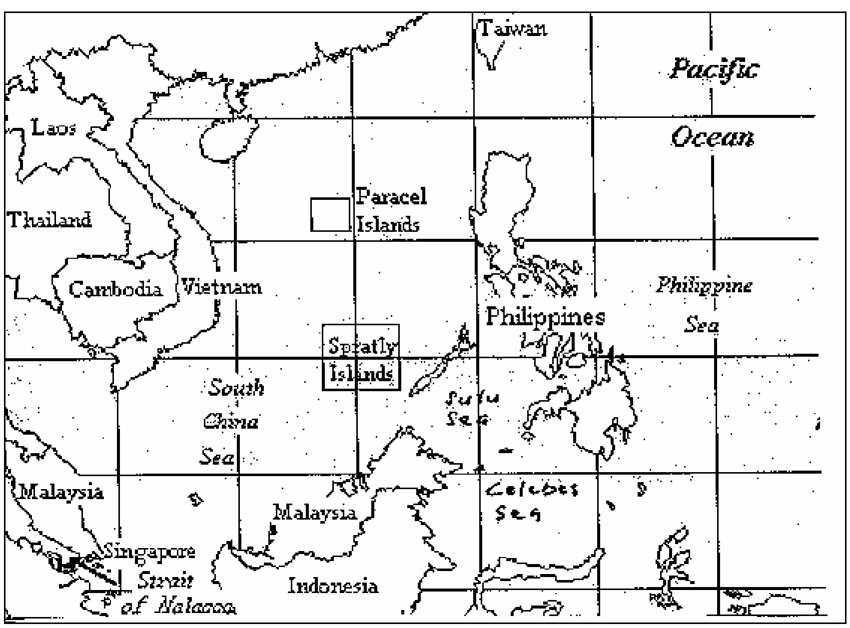


Figure 12: Seas around Malaysia (EIA 2004).

6.1 Specifications

In deciding the suitable length of the design, references were made on the common length of traditional boats in Malaysia as shown in Table 5 and the Icelandic small scale boat of similar length (see Table 4). Observations were also made on some of the Icelandic small-scale boats and discussions held with some boat builders at Trojan Ltd, B. Samtak Ltd, Seigla and Somi Boats and with fishermen. According to some of these boat builders, more fishermen are interested in bigger boats around 13 m in length. For this design, the proposed length is 13.11 m which is the length used by many these boat builders.

Table 5: Length overall (LOA) of three major traditional fishing boats in Malaysia (Munprasit 1989).

Fishing Groups	Range of LOA (m)
Gillnets	4-15
Portable traps	4-15
Hooks and lines	3-15

Full specification of the boat is as listed below:

Length overall	- 13.11 m
Length registered (approx.)	- 12.45 m
Length waterline	- 12.45 m
Length between perpendiculars	- 11.40 m
Breadth moulded	- 3.76 m
Depth moulded	- 1.76 m
Draught moulded	- 0.85 m
Gross tonnage (Icelandic rules)	- 18.07 GT
Displacement (full loaded)	- 24.3 tonnes
Crew cabin	- 4 berths
Galley	- 1 unit
Toilet	- 1 unit
Fish hold capacity	- 5 tonnes
Fresh water tank capacity	- 2,000 litres
Fuel oil tank capacity	- 3,200 litres
Top speed	- 12 -13 knots
Working speed	- 6-10 knots
Main engine (continuous)	- 190 kW (255 bhp) at 1,800 rpm
Gear box & reduction ratio	- V-drive type with ratio of 2.06:1

Figure 13 shows the drawing plan of the proposed 13.11 m FRP traditional fishing boat for the Malaysian fishery. It shows the three main compartments: (1) superstructure, located in the forward end in which wheelhouse and accommodation facilities are situated, (2) the fish hold in the mid section and (3) the engine room in the aft section.

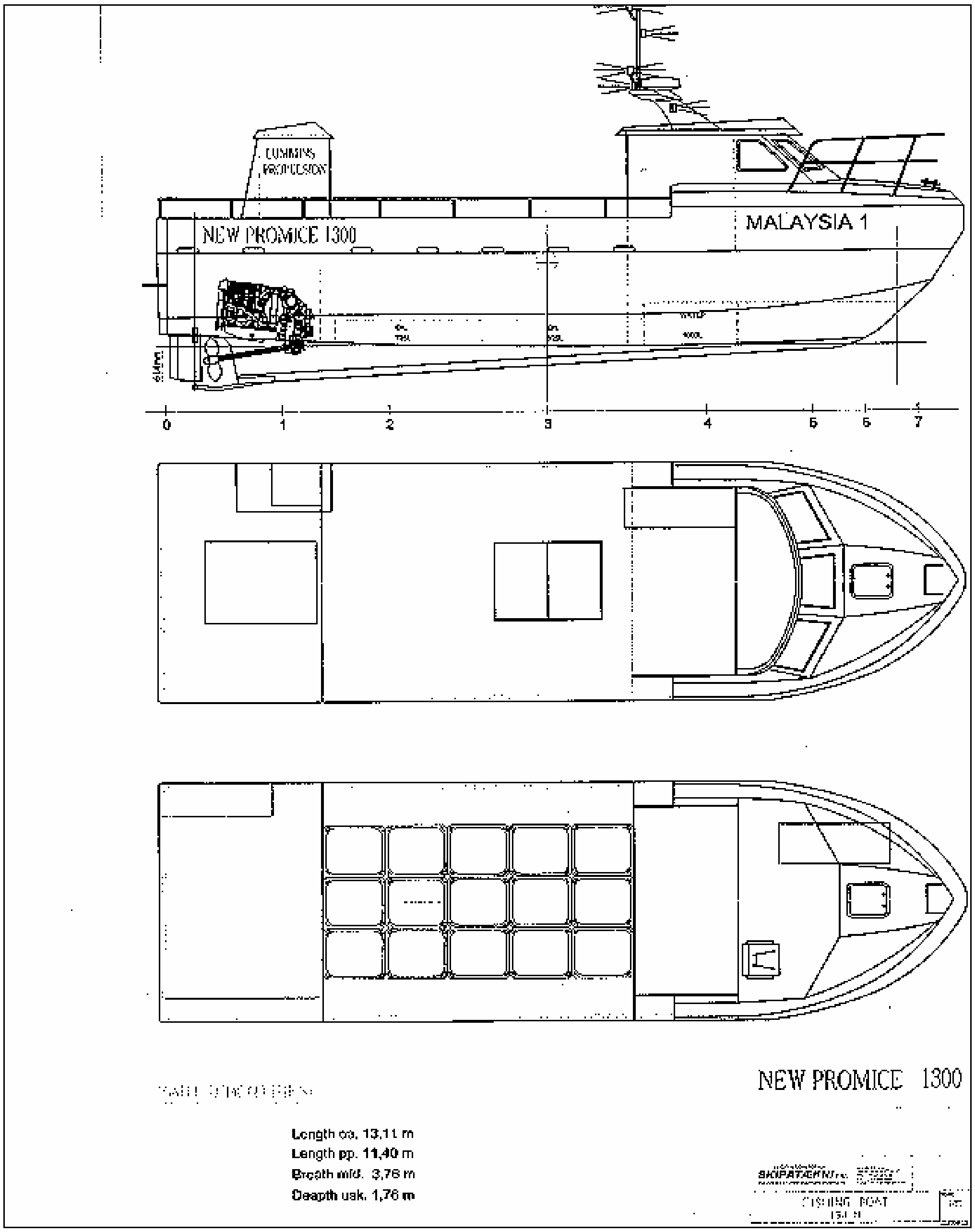


Figure 13: Drawing plans of conceptual design of 13.11 m FRP boat.

Details of the design including the result of the stability calculations at two different load conditions are shown in Appendix 1.

7 DISCUSSION AND CONCLUSION

7.1 Selection of Icelandic FRP boat design

At the moment, there is still no approved international standard for the design, construction and equipment of small vessels of less than 24 m in length (the range of length overall of the small-scale fishing vessels). The 1980 FAO/ILO/IMO voluntary guidelines for the design, construction and equipment of small fishing vessels are meant to address vessels of 12-24 m but are still being revised by the IMO subcommittee on stability, load lines and fishing vessels through a correspondence group led by Iceland (Petursdottir *et al.*2001). The only international standard known to be imposed by some countries for construction and stability for fishing vessels under 15 m is the Nordic boat standard for commercial boats. This standard is jointly produced by Denmark, Finland, Iceland, Norway and Sweden and applicable among these countries (Ben-Yami 2000).

The design is based on the 13.11 x 3.76 x 1.76 m (length x breadth x depth) design of Icelandic boat. Main features of the boat such as hull shape and number of main compartments are similar. However, some alterations with the general arrangement are made in order to suit the Malaysian environment. As has traditionally been practised, all the accommodation areas should be located on deck and not under the forward deck as in an Icelandic boat. For example Malaysian fishermen are more accustomed to using the wet kitchen because of the way the foods are prepared. They also prefer to sleep in open area where air is blowing freely from the outside. In this proposed design, one berth and resting room are located under the deck as in the Icelandic boat. The purpose is to introduce some new changes in phases so that fishermen can adapt to the changes gradually and are more likely to accept them.

7.2 Comparison between Malaysian traditional boats and the proposed design

Some common features of Malaysian boats are: (1) the hull shape is round, (2) the superstructure is located from the amidships up to the transom (3) the engine room is at the amidships and (4) all accommodation is situated on deck. As shown in Figure 14, the superstructure covers about 66% of the total deck area, leaving about 34% as a working area. The proposed design has about 58% working area, which means a bigger working area and hence can accommodate more machinery and better working conditions. The fish hold capacity of the new design is bigger by about 0.5 tonnes than existing boats. The superstructure is located forward, similar to most Icelandic boats and this will give better working conditions because fishermen are protected from the wind and water flash from the waves. It is also less affected by the trimming action of the boat and gives a better view for the manoeuvrability of the boat.

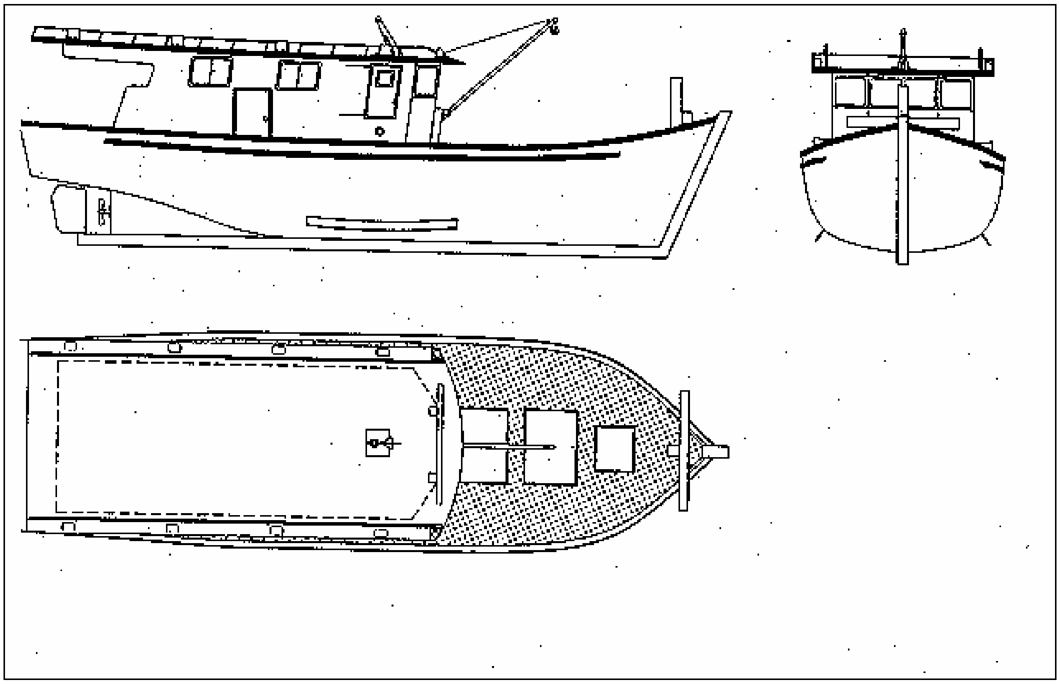


Figure 14: Body plans of MSB's 12.75 m FRP fishing boat (MSB 2003).

It is important to use the reliable and good performance engine for the boat as to hinder any serious failure with the engine, which will affect the fishing effort. Another important factor is the price of the engine including the spare parts. Some familiar engines in the Malaysian market are Cummins, Caterpillar and Yanmar. Also many of the small boats use small truck engines like Mitsubishi and Hino, which are converted into marine propulsion engines. The main reason for using this converted engine is because it is cheaper and easy to handle and maintain.

For this design, a V-drive propulsion system is required due to space limitation of the engine room. This will be a new propulsion system introduced into the traditional Malaysian fishery. According to one of the supplier of Cummins engine in Reykjavik, Iceland (Bjornsson (per.com) 2003), this propulsion system is commonly used in FRP boats in this country and without any major problems. Attached in Appendix 2 are the performance curves and data sheets of Cummins engine 190 kW (255 bhp) /1,800 rpm which is one of the suitable engines for this design. In Appendix 3, some explanations about the selection of suitable engines and propulsion systems for this design are discussed.

Another new improvement in the proposed design is the fish hold. The fish hold in MSB’s boat (Figure 14) is made of four insulated compartments. In the proposed design, the fish hold is a single compartment which can hold about 15 insulated fish boxes of 1143 mm x 966 mm x 762 mm in dimension. There are two types of insulated fish boxes commonly used in Malaysia: (i) 300 litres (990 mm x 760 mm x 710 mm) and (ii) 500 litres (1143 mm x 966 mm x 762 mm).

Instead of putting fish in a PVC bag first before soaking or directly mixed with crushed ice in the fish hold as in MSB's design, the fish will be preserved in the boxes. As shown in Figure 15, insulated fish boxes are used in small boats operating longline. Graham (1992) recommended the ratio of ice: fish on a fishing vessel operating in a tropical climate to be 1.0:1 and 2.0:1 for prawn. In order to prevent heat transfer from outside seawater, the engine room or forward compartment, the fish hold will be insulated. The use of fish boxes will reduce the post harvest losses in term of quality because less handling of fish is needed. After landing, the boxes can be taken straight to the market or maybe need some more ice before do so.

Beside this, if the fishes are stored in boxes, it is also easier to handle the unloading of the fish and reduce the time for handling.

Figure 15: Insulated fish box onboard small fishing boat (FDAM 2003).

7.3 Approval of design

This design is only a conceptual form. A comprehensive study on the design in the aspects of suitability to the local fisheries, acceptance of fishermen and construction cost should be done in order to produce a standard design for local fisheries. This study should involve some government agencies like the Department of Fisheries, Fisheries Development Authority of Malaysia (FDAM) and other competent parties like naval architectural firms, ship classification society and fishermen.

7.4 Acceptation by fishermen

Obviously, most of the fishermen are reluctant to accept something new, especially when it involves investment of money. To accept it, they must first see the proven result because of the "seeing is believing" attitude. So in order to convince them, the government should take the lead to build the boat and then introduce it to the fishermen.

The relevant agency to play this role is the FDAM because one of its functions is to develop and modernise the national fishery industry. Fishermen are expected to accept this design in a short time since it is not totally contrast to the traditional design.

The estimated price of the boat is about MYR 263,000 (USD 71,000) and fishermen should be able to repay this amount within 10 years. Calculation for estimating the cost of construction, income of boat owner to pay back the loan is given in Appendix 4.

7.5 Introduction to Malaysian fisheries

The construction of the first boat should be done by using the mould less technique. As shown in Figure 16, foam sheets are laid over an open framework and then covered with FRP skin. After the removal of wooden framework, the interior surface will be covered with FRP skin, forming the sandwich hull. According to Steward (1994) this "one-off" hull construction can be done using C-flex planking, made from parallel rods of fibreglass reinforced polyester and continuous roving or sandwich method using foam or balsa materials. This technique is advisable because it is used for the construction of only one boat and will therefore save on costs. Even though the outer surface of the hull is not as smooth as a hull produced using mould, the quality is almost the same. Figure 17 shows the 15.85 m FRP boat build by MSB using the mould less technique.

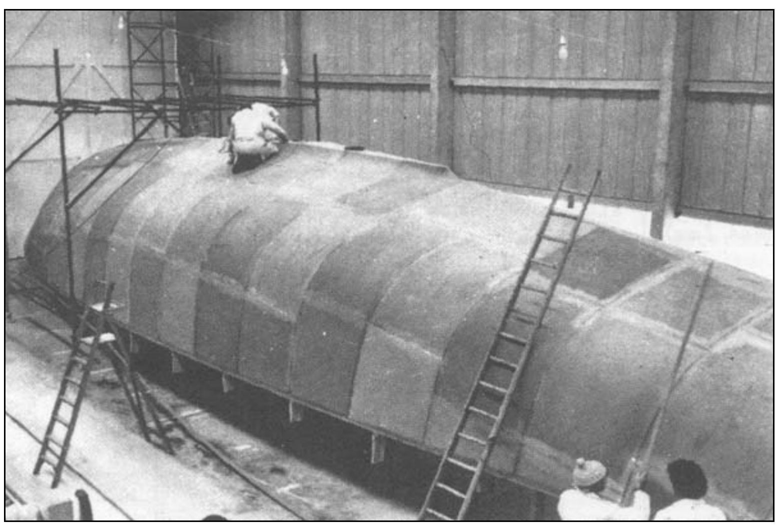


Figure 16: Laying of foam sheets on wooden framework in mouldless technique (Coakley 1991).

This boat should be equipped with the latest deck machineries available in the market. Operation trials should be carried out in three different fishing grounds, namely: South China Sea, Straits of Malacca and Sulu/Celebes Seas. In the first trial, the boat is proposed to operate portable traps and hook and line fishing. Deck machineries such as automatic long lining and automatic fish jiggers should be introduced at the same time. The base for this project is at FDAM Kuantan Fishery Complex, in the east coast of

Peninsular Malaysia. This complex is one of the most productive fishery complexes in Malaysia today. There are also sufficient fishery supporting services in this town. The fishing ground is in the South China Sea about 12-150 nautical miles from shore. Targeted fishes are red snapper (*Lutjanus malabaricus/ L. sebae*), grouper (*Epinephelus sp*), horse mackerel (*Carangoides spp.*), trevally/ Indian threadfish (*Alectis indicus/ Carangoides spp*) and Spanish mackerel (*Scomberomorus spp*), which fetch the highest prices and also some less value fishes like sea catfish (*Arius spp/Osteiogenoisus spp*) and small sharks (*Carcharhinus spp*).

Figure 17: Hull of 15.85 m FRP boat built by MSB using the mould less technique after completion.

The boat should be operated by Asas Ombak Sendirian Berhad, a subsidiary company of FDAM, which is currently operating some off shore trawlers and purse seiners and also some small boats operating hooks and lines and traps. This company is one of the best fishery companies with years of experience. Besides doing the normal fishing operation, this boat will also be used as a training boat whereby some fishermen will join the operation trip to learn how to operate the machineries and familiarize with new deck arrangement, especially the under deck facilities.

Working committee on the project comprising at least FDAM and Fisheries Department of Malaysia should be formed to implement the project.

7.6 Future development in FRP fishing boat industry in Malaysia

In the next few years, more FRP fishing boats will be constructed to replace wooden boats and this will need more FRP boat builders to meet the demand. When the standard on boat building complies with international standard such as the 1980 FAO/ILO/IMO voluntary guidelines for the design, construction and equipment of 12-24 m small fishing vessels or Nordic Boat Standard and is enforced the quality of the boats will be assured. Two groups of people will get the most benefits from this implementation; the boat owner who can be assured that the boat built is safe and seaworthy and the boat builder who can sell the boat to a bigger market and can have a fair chance in bidding of contracts because of the fixed standard of construction scantlings (Simpson 1966).

ACKNOWLEDGEMENTS

I wish to thank Dr. Tumi Tómasson, the Programme Director of the United Nations University – Fisheries Training Programme (UNU-FTP) for his help and support in this project. I also appreciate the help and support I received from Mr. Thor Asgeirsson, the Deputy Programme Director of the UNU-FTP. I thank my supervisor, Mr Emil Ragnarsson, from V.E.R. Ship Consultants for his assistance and guidance during the project. I also want to thank Mr Larus Palmasson for his teaching and cooperation, Mr. Olafur Adalsteinsson from the Icelandic Maritime Administration, Mr Jon Sigurdsson, Mr Stefan Gudsteinsson from Skipataekni, Mr. Hogni Bergthorsson from Trefjar Ltd., who has given much help in doing this project. Also thanks to all the UNU-FTP and librarians in MRI. Last but not least, thanks to all UNU fellows especially the fishing gears technology group, Mr Alfredo Emmamuel Olivares Vazqu, Mr. Jorge Paul Faife, Mr. Mathews Emma Chirwa and Mr. Tobias Ndeshipanda Nambala for their input and company during this programme.

LIST OF REFERENCES

Arnason, R. 1995. *The Icelandic Fisheries. Evolution and Management of a Fishing Industry*. Cornwall: Fishing News Books.

Ben-Yami, M. 2000. *Risks and dangers in small-scale fisheries: An overview- Part 2*.International Labour Organization (ILO). Sector Publications No. SAP 3.6/WP.147. Geneva. 26 November 2003
< http//:www.ilo.org/public/English/dialogue/sector/papers/fishrisk/index.htm >

Board on Science and Technology for International Development (BOSTID) 1988, *Fisheries Technologies for developing Countries*. Report of an Ad Hoc Panel of BOSTID. Washington DC: National Academy Press. 7 December 2003
< http:// books.nap.edu/books/0309037883/html/index.html >

Bumiputra-Commerce Bank 2003: *Special Industry Issue: Wood & Wood Products Industry Vol 4/2001*. Kuala Lumpur. 14 January 2004.
<http//www.bcb.com.my/corporate_info/2003reports/DEC2001/WOOD_AND_PRODUCTS.PDF>

Coackley, N. 1991. *Fishing Boat Construction: 2 Building a fibreglass fishing boat*. FAO Fisheries Technical Paper. No 321. Rome: FAO

Comstock, J.P. 1967. *Principles of Naval Architecture*: New York: The Society of Naval Architects and Marine Engineers.

Decoster, J. 2001. *Proposal Booklets: Challenges facing Artisanal Fishery in the 21st Century*.13 January 2004
< http://www.alliance21.org/en/proposals/finals/final_peche_en.pdf >

Department of Fisheries Malaysia 2001: *Annual Fisheries Statistics 2001, Volume 1*. Kuala Lumpur.

Eric Greene Associates. *Marine Composites*. Second Edition. Maryland. 26 October 2003
<http://www.marinecomposites.com/>

Fyson, J. 1979. " Small Fishing Boat Designs for Use in the South Pacific Region: Displacement and Medium Speed Fishing Boats. In Reinhart J.M. edt. *Small Boat Design*. Manila: International Center for Living Aquatic Resources Management (ICLARM) 22 January 2004 <http://www.worldfishcenter.org/dbtw-wpd/textbook/iclarm/Pdf/Pub%20cPb%201.pdf>

Gerr, D 2000. *The Elements of Boat Strength for Builders, Designers, and Owners*. International Marine/McGraw-Hill. ISBN: 0070231591

Gerr, D 2001. *Propeller Handbook: The Complete Reference for Choosing, Installing and Understanding Boat Propellers*. Maine: International Marine

Graham, J., Johnston,W.A. and Nicolson,F.J. 1992. *Ice in Fisheries*. FAO Fisheries Technical Paper 331. FAO:Rome

Guldhammer, H.E. and Harvald, S.A. 1965. *Ship Resistance: Effect of Form and Principal Dimensions.* Copenhagen: Akademisk Forlag

Icelandic Fisheries in Figures 2003. Reykjavik: Ministry of Fisheries Iceland

Laszlo, P.D.D. 1960. Glass Reinforced Plastic Hulls. In Traung, J.O edt. *Fishing Boats of the World: 2.* London: Fishing News (Books) Ltd.

Malaysian Timber Council 2003: *Heavy Hardwood – Chengal*. Kuala Lumpur. 16 January 2004. <http//www.mtc.com.my/publication/library/mt100/hard/chengal.htm>

Ministry of Finance Malaysia, 2003: *New Strategies towards Stimulating the Nation´s Economy Growth. 21 May 2003*. Putrajaya. 13 November 2003 < http://www.treasury.gov.my/englishversionbaru/index.htm >

Petursdottir, G., Hannibalsson, O. and Turner, J.M.M 2001. *Safety at Sea as an Integral Part of Fisheries Management*: FAO:Rome

Ritterbush, S 1979. “Guidelines for Selecting Boat Design and Motors for Small-scale Fisheries Programs in Isolated Island Communities”. In Reinhart J.M. edt. *Small Boat Design*. Manila: International Center for Living Aquatic Resources Management (ICLARM). 22 January 2004 <http://www.worldfishcenter.org/dbtw-wpd/textbook/iclarm/Pdf/Pub%20cPb%201.pdf>

Simpson, D.S.1966. Suggested Standards Scantlings. In Traung, J.O edt. *Fishing Boats of the World: 2.* London: Fishing News (Books) Ltd.

Southeast Asian Fisheries Development Center (SEAFDEC) 1989. *Fishing Gears and Methods in Southeast Asia: II Malaysia*. By Munprasit, A., Theparoonrat Y., Sae-ung, S., Soodhom, S., Matunaga Y., Chokesanguan, B. and Siriraksophon, S. TD/RES/24. Bangkok: SEAFDEC.

Steward, R.M. 1994. *Boat Building Manual 4th Edition*. Maine: International Marine/Ragged Mountain Press

Vossers, G. 1966. New persespectives in Sea Behaviour. In Traung, J.O edt. *Fishing Boats of the World: 2.* London: Fishing News (Books) Ltd.

APPENDIX 1: STABILITY CALCULATION FOR 13.11 M FRP BOAT

As required by the Nordic boat standard, design of boat must follows all rules of the standard such as scantling, i.e. one of the principal methods of specifying boat construction. It is used by some classification societies such as American Bereau of Shipping (ABS), Llyod's and Det Norske Veritas. (Gerr 2000). The stability of boat must complies with the International Maritime Organization (IMO) requirements as follows:

The area below the GZ-curve is to be :

1. the area under the righting lever curve (GZ-curve) should not be less than 0.055 m-rad up to 30 degree of heel.

   the area under the GZ-curve should not be less than 0.090 m-rad up to 40 degree

   or the angle of flooding φ_f if this angle is less than 40 degree.

   the area under the GZ-curve between a heeling angle of 30 degree and the minor of φ_f and 40 degree should not be less than 0.030 m-rad.

2. the righting lever GZ shall be at least 0.20 m at an angle of heel equal to 30 degree or greater.

3. the maximum righting lever GZ should occur at an angle of heel preferably exceeding 30 degree but not less than 25 degree.

4. the metacentric height GMo should not be less than 0.35 m

5. Icing on hull, calculated in accordance with the Det Norske Veritas inspection services, calculated weight is 30 kg/m horizontal and 7.5 kg/m vertical.

As for the requirement no. 5, icing on hull is calculated as extra load on hull.
Attached are examples of calculation for stability for the boat made by Skipataekni ehf., a naval architectural firm in Reykjavik, Iceland. The first calculation (refer to page 31) is made on Loading Condition No: 5 (i.e. at light load condition) and the result shows that the boat is still stable even though at heeling angle of more than 40 degree. In the second calculation (refer page 33), which is made on Loading No: 3 (i.e. full load condition) also shows that the boat is stable up to about 70 degree angle of heeling.

Sheet: 5 | WEIGHT ITEMS

Vessel: MALAYSIA 1

Loading Cond.No: 5.0
HEIMKOMA FRÁ MIÐUM

Compartment	A Weight Ton	B VCG ab.BL (m)	C V.mom (tm)	L LCG fr.OX (m)	M Lg.mom (tm)	D Fsm (tm)
10% WATER	.2	.35	.1	-2.30	-.5	.75
CREW	.4	2.25	.9	-2.60	-1.0	0.00
FISHING GEAR	2.2	1.95	4.3	3.50	7.7	0.00
FISH BOXES IN HOLD	.4	.90	.4	.10	0.0	0.00
20% CATCH IN HOLD	1.0	.90	.9	-.50	-.5	0.00
ICE IN FISH BOXES	2.0	.90	1.8	.10	.2	0.00
10% OIL MIDSHIP FOR	.3	.20	.1	-.20	-.1	.10
Dead weight	6.5	1.29	8.4	.91	5.9	.85
Light ship	12.9	1.46	18.9	1.02	13.2	0.00
Displacement	19.4	1.41	27.3	.98	19.1	.85
Sum Fsm			.8			
Actual VCG and VCG*W		1.45	28.1	Free surf.corr. incl.		
Max.perm. VCG and VCG*W		1.63	31.6	NOT TO BE EXCEEDED		

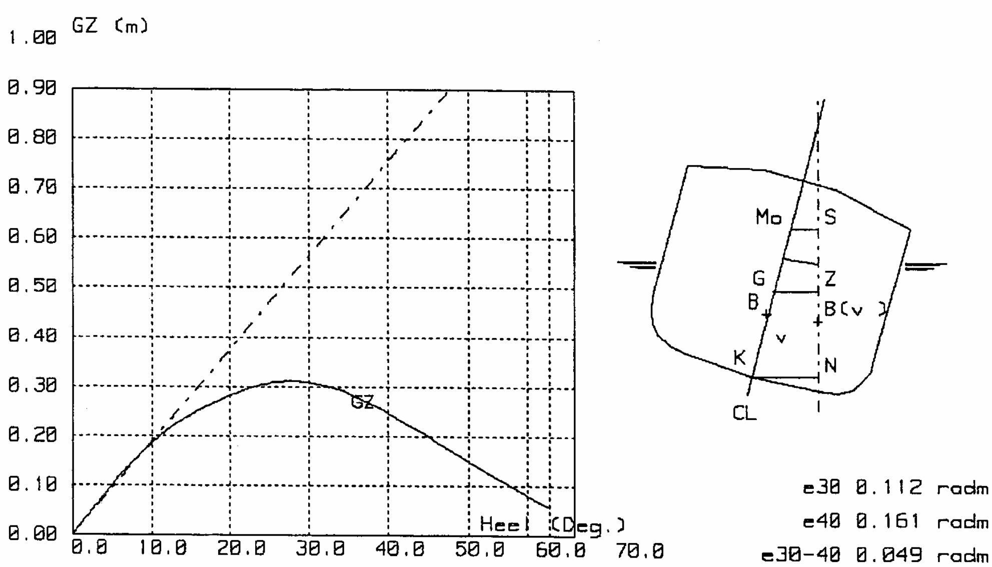
##################

---------- Skipatækni ehf, 105 Reykjavík, (354) 5341443 ----------

STATICAL STABILITY CALCULATION | Sheet 5

Length pp	11.400 m	Displacement	19.4 Ton
KMo ab.BL	2.533 m	MCT.	.39 Tm/cm
VCG ab.BL	1.450 m	Trim	.16 m
GMo (Fsm Corrected)	1.083 m	Draught mean(Rwl)	.73 m
LCB fr.OX	.668 m	Draught at AP	1.42 m
LCG fr.OX	.984 m	Draught at FP	.01 m
LCF fr.OX	.651 m	Draught OX	.72 m

Heel (V°)	10°	20°	30°	40°	50°	60°
Sin(V°)	0.173	0.342	0.500	0.643	0.766	0.866
GMo *sin(v°)	0.188m	0.370m	0.541m	0.696m	0.830m	0.938m
MoS	-0.003m	-0.088m	-0.233m	-0.450m	-0.680m	-0.882m
GZ=GMo*sinV+MoS	0.185m	0.282m	0.308m	0.246m	0.150m	0.056m



Loading Condition No: 5.00 HEIMKOMA FRÁ MIÐUM

ARRIVAL HOMEPORT
20% CATCH 10% BUNKERS

Drwg: 2560 -120-0000
Date: 15 01 04 Sign SG

Skipatækni ehf, 105 Reykjavík, (354) 5341443

Sheet: 3 | WEIGHT ITEMS

Vessel: MALAYSIA 1

Loading Cond.No: 3.0
BROTTFÖR AF MIÐUM

Compartment	A Weight Ton	B VCG ab.BL (m)	C V.mom (tm)	L LCG fr.OX (m)	M Lg.mom (tm)	D Fsm (tm)
30% WATER	.6	.35	.2	-2.30	-1.4	1.20
CREW	.4	2.25	.9	-2.60	-1.0	0.00
FISHING GEAR	2.2	1.95	4.3	3.50	7.7	0.00
FISH BOXES IN HOLD	.4	.90	.4	.10	0.0	0.00
100% CATCH IN HOLD	5.0	.90	4.5	1.20	6.0	0.00
ICE IN FISH BOXES	2.0	.90	1.8	.10	.2	0.00
30% OIL MIDSHIP FOR	.8	.30	.2	-.20	-.2	.15
Dead weight	11.4	1.08	12.3	.99	11.4	1.35
Light ship	12.9	1.46	18.9	1.02	13.2	0.00
Displacement	24.3	1.28	31.2	1.01	24.6	1.35
Sum Fsm			1.3			
Actual VCG and VCG*W		1.34	32.6	Free surf.corr. incl.		
Max.perm. VCG and VCG*W		1.46	35.4	NOT TO BE EXCEEDED		

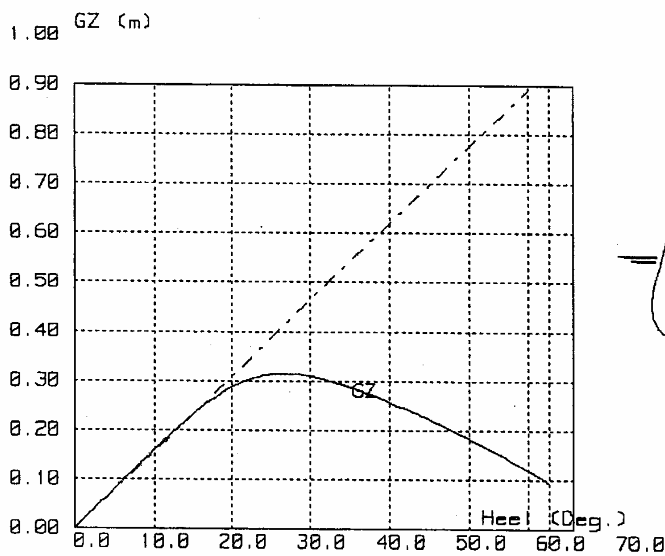
##################

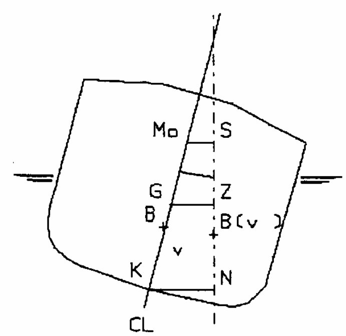
--------- Skipatækni ehf, 105 Reykjavík, (354) 5341443 --------------

STATICAL STABILITY CALCULATION | Sheet 3

Length pp	11.400 m	Displacement	24.3 Ton
KMo ab.BL	2.228 m	MCT.	.40 Tm/cm
VCG ab.BL	1.338 m	Trim	.21 m
GMo (Fsm Corrected)	.890 m	Draught mean(Rwl)	.85 m
LCB fr.OX	.659 m	Draught at AP	1.56 m
LCG fr.OX	1.009 m	Draught at FP	.10 m
LCF fr.OX	.604 m	Draught OX	.84 m

Heel (V°)	10°	20°	30°	40°	50°	60°
Sin(V°)	0.173	0.342	0.500	0.643	0.766	0.866
GMo *sin(v°)	0.155m	0.305m	0.445m	0.572m	0.682m	0.771m
MoS	0.005m	-0.016m	-0.136m	-0.316m	-0.499m	-0.677m
GZ=GMo*sinV+MoS	0.160m	0.288m	0.309m	0.256m	0.183m	0.094m





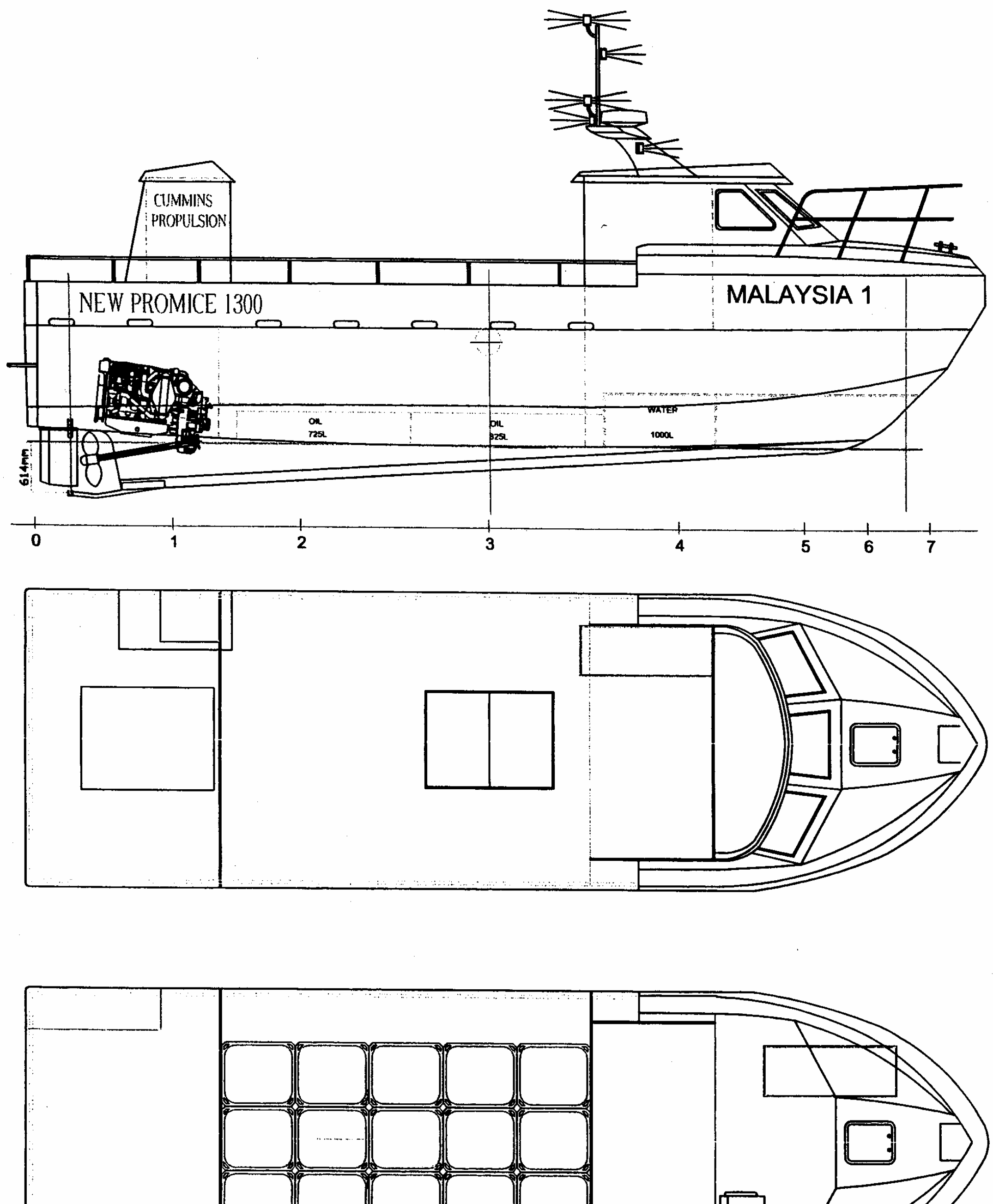
e30 0.108 radm
e40 0.158 radm
e30-40 0.050 radm

Loading Condition No: 3.00 BROTTFÖR AF MIÐUM

DEPARTURE FISHING GROUND
100% CATCH 30% BUNKERS

Drwg: 2560 -120-0000
Date: 15 01 04 Sign SG

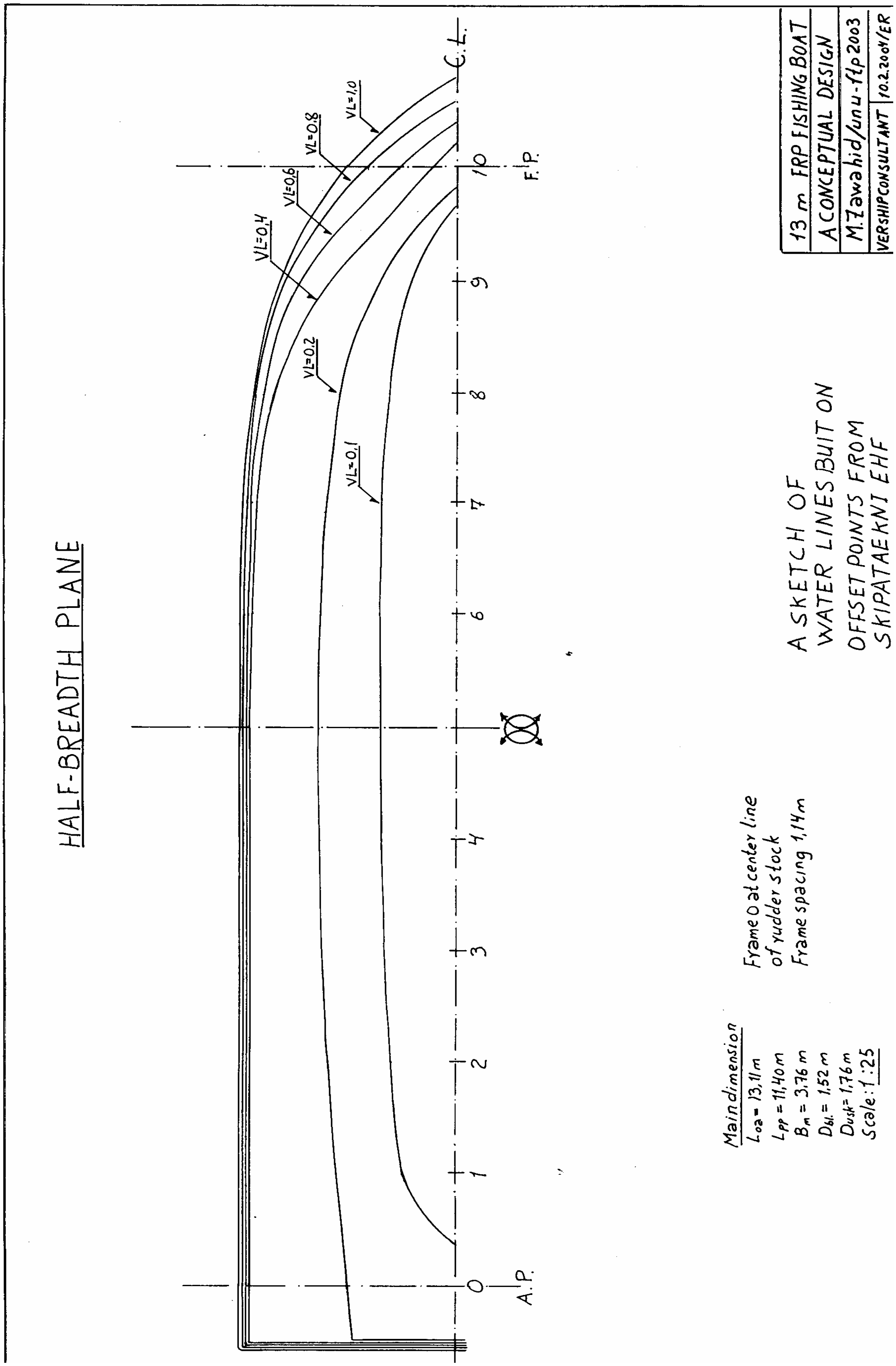
Skipatækni ehf, 105 Reykjavík, (354) 5341443

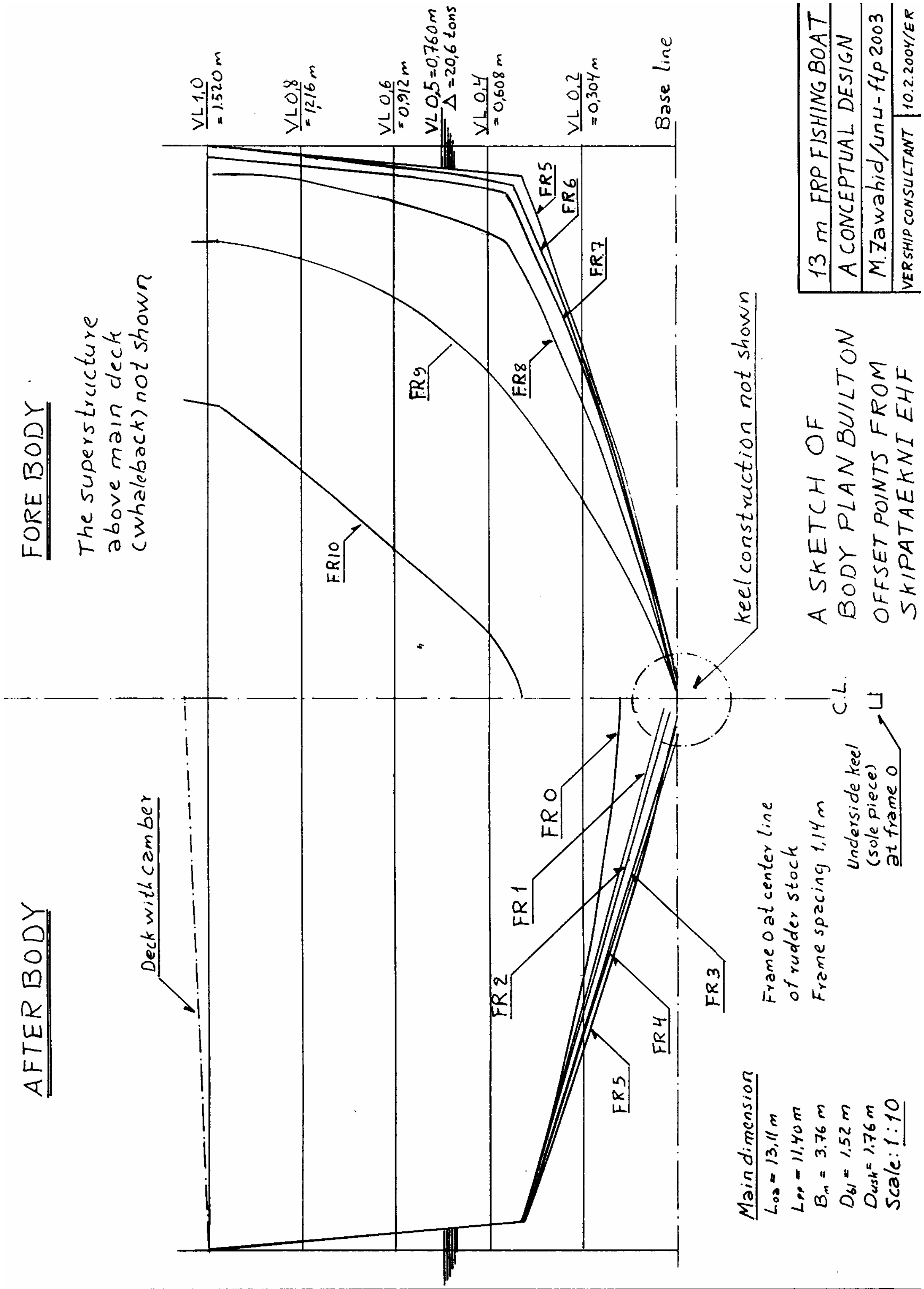


MAIN DIMENTIONS:

NEW PROMICE 1300

Length oa. 13,11 m
Length pp. 11,40 m
Breath mld. 3,76 m
Deapth usk. 1,76 m


HALF-BREADTH PLANE
13 m FRP FISHING BOAT
A CONCEPTUAL DESIGN
M.Zawahid/unu-ftp2003
VERSHIPCONSULTANT 10.2.2004/ER
C.L.
VL=1,0
VL=0,8
VL=0,6
VL=0,4
VL=0,2
VL=0,1
F.P.
A.P.
0
1
2
3
4
6
7
8
9
10
A SKETCH OF
WATER LINES BUIT ON
OFFSET POINTS FROM
SKIPATAEKNI EHF
Frame 0 at center line
of rudder stock
Frame spacing 1,14m
Main dimension
Loa = 13,1 m
Lpp = 11,40 m
Bm = 3,76 m
Dbl = 1,52 m
Dusk = 1,76 m
Scale: 1:25


AFTER BODY
FORE BODY
The superstructure above main deck (whaleback) not shown
Deck with camber
VL 1.0 = 1.520 m
VL 0.8 = 1.216 m
VL 0.6 = 0.912 m
VL 0.5 = 0.760 m
Δ = 20.6 tons
VL 0.4 = 0.608 m
VL 0.2 = 0.304 m
Base line
C.L.
FR 0
FR 1
FR 2
FR 3
FR 4
FR 5
FR 6
FR 7
FR 8
FR 9
FR 10
Keel construction not shown
Frame 0 at center line of rudder stock
Frame spacing 1,14 m
Underside keel (sole piece) at frame 0
Main dimension
Loa = 13,11 m
Lpp = 11,40 m
Bm = 3.76 m
Dbl = 1.52 m
Dwsk = 1.76 m
Scale: 1:10
A SKETCH OF BODY PLAN BUILT ON OFFSET POINTS FROM SKIPATAEKNI EHF
13 m FRP FISHING BOAT
A CONCEPTUAL DESIGN
M.Zawahid/unu-ftp 2003
VERSHIP CONSULTANT 10.2.2004/ER

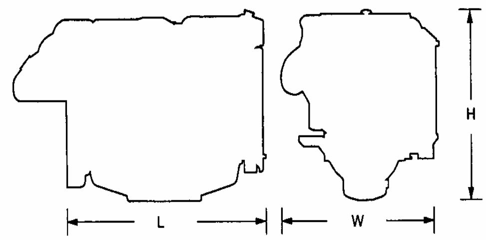
APPENDIX 2: MARINE PERFORMANCE CURVES AND DATA SHEETS OF CUMMINS ENGINE 190 KW (255 BHP) @ 1800 RPM

Worldwide Marine Power Solutions

ENGINE DIMENSIONS

	Length		Width		Height		Weight	
	mm	in	mm	in	mm	in	kg	lb
JWAC*	1177.3	41.02	848.9	33.42	953.6	37.54	712	1570
SWAC	1161.5	45.7	908.8	35.78	921.5	36.28	856	1885

*Keel Cooled



PERFORMANCE DATA

Rating	Continuous Duty 255 bhp*				Intermittent Duty 350 bhp*				Intermittent Duty 430 bhp*			
rpm	1800	1600	1400	1200	2500	2100	1700	1300	2600	2200	1800	1400
kW	190	138	97	64	261	163	92	44	321	204	119	60
g/kW-hr	224	209	208	210	224	214	222	244	239	212	218	228
L/hr	50.9	34.4	23.7	15.9	69.7	41.6	24.4	12.8	91.6	51.5	30.9	16.3
bhp	255	186	129	85	350	218	123	59	430	274	159	81
lb/hp-hr	.368	.343	.342	.346	.368	.353	.370	.403	.394	.347	.361	.372
gal/hr	13.4	9.1	6.3	4.2	18.4	11	6.5	3.4	24.2	13.6	8.2	4.3

**Ratings are IMO emissions compliant*

Above data represents performance along a 2.7 fixed pitch propeller curve. Fuel consumption has a tolerance of +5% and is based on fuel of 35° API gravity at 16 °C (60 °F) having an LHV of 42, 780 KJ/KG (18,390 BTU/lb) when used at 29 °C (85 °F) and weighing 838.9 g/liter (7.001 lb/US gal). Observed horsepower is certified within ± 5% of rated horsepower. Cummins has always been a pioneer in product improvement. Thus specifications may change without notice. Consult your local Cummins professional for further information.

Rating Definitions
Ratings are based on ISO 8665 conditions of 100kPa (29.612 in Hg) and 25°C (77°F) and 30% relative humidity. Propeller shaft power represents the net power available after typical gear losses and is 97% of rated power. Power rated in accordance with IMCI procedures.

Continuous Duty
Intended for continuous use in applications requiring uninterrupted service at full power. This rating is an ISO 3046 standard power rating.

Intermittent Duty
Intended for intermittent use in variable load applications where full power is limited to two hours out of every eight hours of operation. Also, reduced power operations must be at or below 200 rpm of the maximum rated rpm. This rating is an ISO 3046 fuel stop power rating and is intended for applications that operate less than 1,500 hours per year.

www.cmdmarine.com
4500 Leeds Ave. #301
Charleston, SC 29405
email: wavemaster@cummins.com
1-800-DIESELS
Bulletin Number: 4000073 Rev 7/03

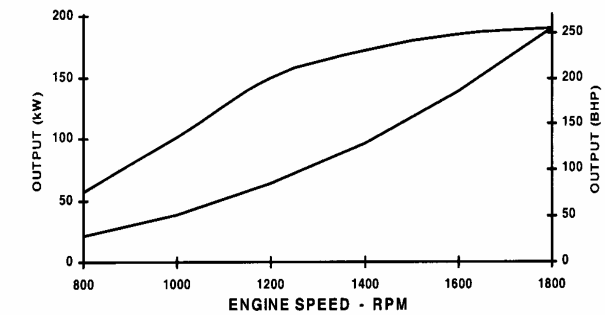
CUMMINS ENGINE COMPANY, INC Columbus, Indiana 47201 **Marine Performance Curve**	Basic Engine Model: **6CTA8.3-M (JW)**		Curve Number: **M-90726**	*Marine* *Pg. No.* **6C** **61**
	Engine Configuration: **D413046MX02**	CPL Code: **2833**	Date: **08Mar01**	

Displacement: **8.3 litre** **[504.5 in.^{3}]**
Bore: **114 mm** **[4.49 in.]**
Stroke: **135 mm** **[5.32 in.]**
Fuel System: **Inline Bosch P3000 RSV**
Cylinders: **6**

Advertised Power: kW [HP] @ RPM **190 (255) @ 1800**

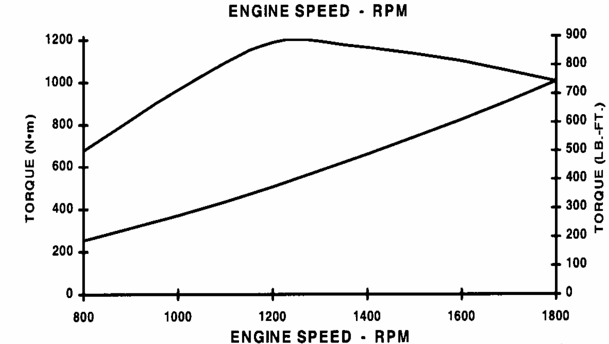
Aspiration: **Turbocharged / Jacket Water Aftercooled**
Rating Type: **Continuous**

CERTIFIED: This marine diesel engine conforms with the NOx requirements of the International Maritime Organization (IMO), MARPOL 73/78 Annex VI, Regulation 13 as applicable.



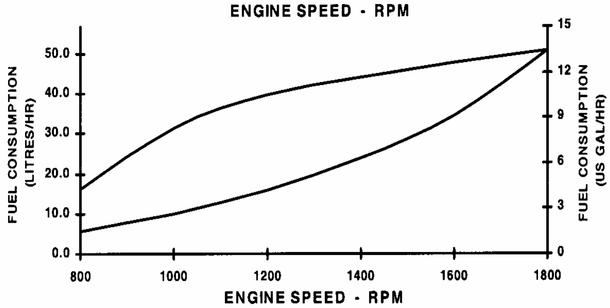
RATED POWER OUTPUT CURVE

RPM	kW	HP
1800	190	(255)
1600	185	(248)
1400	172	(230)
1200	150	(201)
1000	101	(136)
800	57	(76)



FULL LOAD TORQUE CURVE

RPM	N•m	lb.-ft.
1800	1010	(745)
1600	1102	(813)
1400	1170	(863)
1200	1193	(880)
1000	967	(713)
800	677	(499)



FUEL CONSUMPTION - PROP CURVE

RPM	Litres/hr	Gal/hr
1800	50.9	(13.4)
1600	34.4	(9.1)
1400	23.7	(6.3)
1200	15.9	(4.2)
1000	9.8	(2.6)
800	5.6	(1.5)

Rating Conditions: Ratings are based upon ISO 8665 and SAE J1228 reference conditions; air pressure of 100 kPa [29.612 in. Hg], air temperature 25°C [77°F], and 30% relative humidity. Power is rated in accordance with IMCI procedures. Member NMMA.

Rated Curves (upper) represent rated power at the crankshaft for mature gross engine performance capabilities obtained and corrected in accordance with ISO 3046. Propeller Curve (lower) is based on a typical fixed propeller demand curve using a 2.7 exponent. Propeller Shaft Power is approximately 3% less than rated crankshaft power after typical reverse/reduction gear losses and may vary depending on the type of gear or propulsion system used.

Fuel Consumption is based on fuel of 35° API gravity at 16°C [60°F] having LHV of 42,780 kj/kg [18390 Btu/lb] and weighing 838.9 g/liter [7.001 lb/U.S. gal].

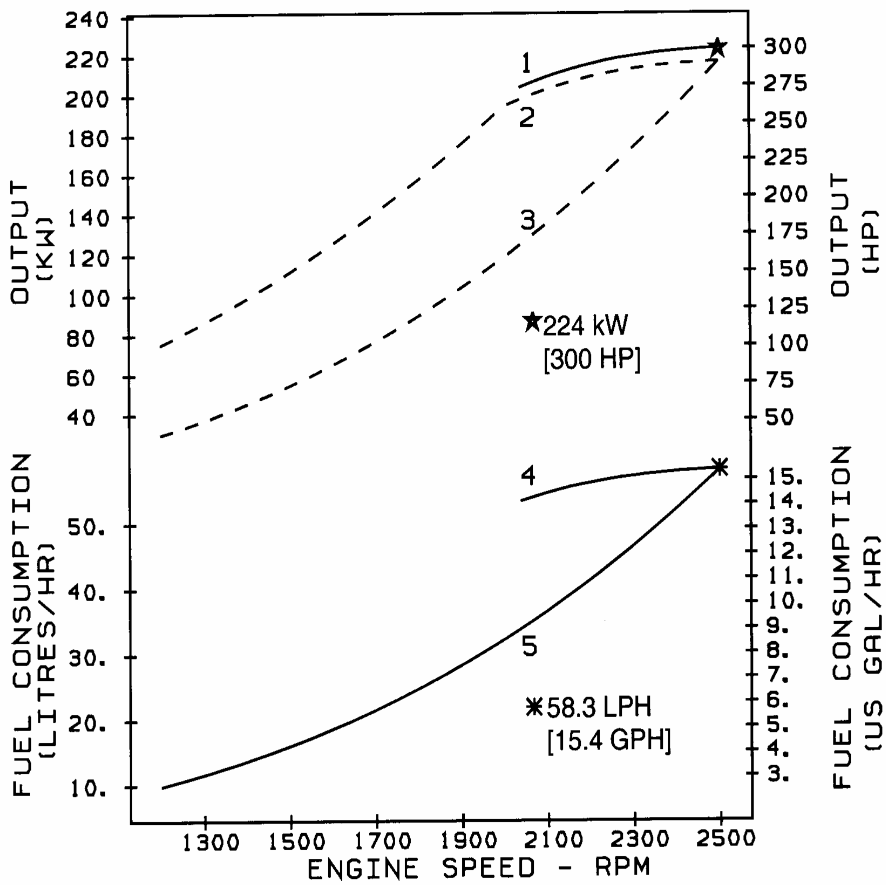
Continuous Rating: This power rating is intended for continuous use in applications requiring uninterrupted service at full power. This rating is an ISO 3046 Standard Power Rating.

CHIEF ENGINEER

CUMMINS ENGINE COMPANY, INC Columbus, Indiana 47201 **Marine Performance Curve**	Basic Engine Model: **6CTA8.3-M (JW)**		Curve Number: **M-9438**	Marine Pg. No. **C** **57**
	Engine Configuration: **D413009MX02**	CPL Code: **1221**	Date: **12May99**	

Displacement:	**8.3 litre**	**[504.5 in.³]**	Aspiration:	**Turbocharged/Jacket Water Aftercooled**
Bore:	**114 mm**	**[4.49 in.]**		
Stroke:	**135 mm**	**[5.32 in.]**		kW [HP] @ RPM
Fuel System:	**Inline Bosch- MW**		**Advertised Power**	**224 [300] @ 2500**
Cylinders:	**6**			

Medium Continuous Rating



Rating Conditions: Ratings are based upon ISO 8665 reference conditions; air pressure of 100 kPa [29.612 in. Hg] air temperature 25°C [77°F] and 30% relative humidity. Power is rated in accordance with IMCI procedures.

Fuel consumption is based on fuel of 35° API gravity at 16°C (60°F) having LHV of 42,780 kj/kg (18,390 Btu/lb) and weighing 838.9 g/liter (7.001 lb/U.S. gal).

Propeller Shaft Power represents the net power available after typical reverse/reduction gear losses and is 97% of rated power.

1. Brake power kW / (HP)
2. Shaft power kW / (HP) with Reverse / Reduction Gear
3. Typical Propeller Power Curve (2.7 exponent)
4. Fuel Consumption for Brake and Shaft power.
5. Fuel Consumption for Typical Propeller.

Medium Continuous Rating: This power rating is intended for continuous use in variable load applications where full power is limited to six (6) hours out of every twelve (12) hours of operation. Also, reduced power operations must be at or below 200 RPM of the maximum rated RPM. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate 3,000 hours per year or less.

CHIEF ENGINEER

APPENDIX 3: DETERMINING SPEED AND PROPULSION SYSTEM REQUIRED FOR A GIVEN POWER OF ENGINE

Many methods are available to calculate the speed and propulsion system required for any displacement or semi displacement type of boat. The methods used in this calculation are as given in Propeller Handbook written by Dave Gerr (2001).

The characteristics of the boat are as follow:

LOA	- 13.11 m (43 ft)
LWL (95% LOA)	- 12.45 m (40.85 ft)
Breadth (B)- moulded	- 3.76 m(12.33 ft)
BWL (beam on the waterline)	- 3.76 m (12.33 ft)
Draft (d) or H_d	- 0.85 m (2.79ft)
Displacement in fully light condition	- 19.4 tonnes
In fully loaded contion	- 24.3 tonnes

The estimated speed of the boat is calculated by using the **Displacement – Speed Length Ratio Formula which is:**

SL RATIO = 10.665 ÷ $\sqrt[3]{LB/SHP}$ (1)

Where:

SL RATIO = Speed – Length ratio

and also,

SL RATIO = Kts ÷ $\sqrt{WL}$

Kts = Boat speed in knots

SHP = Shaft horsepower at propeller (at 90%)

LB = Displacement of boat in pounds

WL = Waterline length in feet

The suitable engine power for 13.11 m length FRP boat is 300 BHP /288 SHP (2,500 rpm) as recommended by Velasalan Ehf, a diesel engines and marine equipments supplier in Reykjavik, Iceland (Bjornsson (pers. com) 2003). The shaft horsepower value used in the calculation is at 90% running as normal practice, the boat should not run at full speed.

To calculate the speed using the formula (1):

Given,

SHP = 259 hp. (288 x 90%)

Displacement, LB_{min} = 19.4 tonnes = 42,769 lbs. (1 tonne = 2,204.6 lbs)

$_{max}$ = 24.3 tonnes = 53,572 lbs.

WL = 40.85 ft.

SL RATIO at LB_{min} = $10.665 \div \sqrt[3]{LB/SHP}$
= $10.665 / (42,769/259)^{0.334}$ = <u>1.94</u>

SL RATIO at LB_{max} = $10.665 / (53,572/259)^{0.334}$ = <u>1.80</u>

Also,

SL RATIO = Kts / WL $^{0.5}$ (2)

From this formula (2), to find speed, Kts:

Kts = SL RATIO x WL $^{0.5}$ (3)

kts_{min} at SL Ratio 1.80 = $1.80 \times 40.85^{0.5}$ = <u>11.50 knots</u>

kts_{max} at SL Ratio 1.94 = $1.94 \times 40.85^{0.5}$ = <u>12.40 knots</u>

The boat is recommended to use three-bladed propeller with fixed pitch which is a common type in Malaysia. The calculation of propeller dimension is based on this type of propeller but with two different reduction gear; 1.65:1 and 2.06:1; as recommended by the same supplier (Bjornsson (pers. com) 2003).

Crouch's propeller method is used in determining the pitch, slip and diameter of the propeller.

<u>Step 1: To calculate shaft rpm after reduction gear</u>

Shaft rpm after reduction = maximum shaft rpm/reduction ratio (4)

Given,

Maximum shaft rpm = 2500 rpm (288SHP)

(1) Shaft rpm after 1.65:1 reduction = 2500 /1.65 = 1,515 rpm

- at 90% operation = 1515 x 0.9 = <u>1,364 rpm</u>

(2) Shaft rpm after 2.06: 1 reduction = 2500/2.06 = 1,214 rpm

- at 90% operation = 1214 x 0.9 = <u>1,093 rpm</u>

Step 2: To calculate pitch without slip

Pitch = speed (ft/min**)/shaft rpm (5)**

For this calculation,

Speed of the boat is the maximum speed = 12.40 knots = 1,256.1 ft/min
Shaft rpm is at 90% operation = (1) 1,364 rpm and (2) 1,093 rpm

Pitch (1) = 1256.1/1364
= 0.92 ft = 11.1 in.

Pitch (2) = 1256.1/1093
= 1.15 ft = 13.8 in.

Step 3: To calculate slip

SLIP = 1.4 / Kts $^{0.57}$ (6)

Given,

kts = maximum speed in knots = 12.40 knots

SLIP = 1.4/12.40 = 33.3%

Step 4: To calculate pitch with slip

By increasing the pitch value derived in Step 2 by 33.3 % in Step 3

Pitch (1) = 11.1 x 1.333 = 14.8 in.

Pitch (2) = 13.8 x 1.333 = 18.4 in.

Step 5: to calculate maximum diameter of propeller

Using DIA-HP-RPM formula: $$\mathbf{D} = \frac{\mathbf{632.7 \times SHP^{0.2}}}{\mathbf{RPM^{0.6}}} \qquad \mathbf{(7)}$$

Where:

D = propeller diameter in inches
SHP = maximum shaft horsepower at the propeller
RPM = shaft RPM (after reduction) the propeller

Given,

SHP = 288 hp
Shaft rpm after 1.65:1 reduction = 1,515 rpm
Shaft rpm after 2.06: 1 reduction = 1,214 rpm

$D_{max\,(1)} = 632.7 \times 288^{0.2} / 1515^{0.6} = \underline{24.3\text{ in.}}$

$D_{max\,(2)} = 632.7 \times 288^{0.2} / 1214^{0.6} = \underline{27.7\text{ in.}}$

Step 6: To calculating minimum diameter of propeller

Using formula: $\mathbf{D_{min} = 4.07 \times (BWL \times H_d)^{0.5}}$ **(8)**

Where:

D_{min} = minimum acceptable propeller diameter in inches
BWL = beam on the waterline in feet
H_d = Draft of hull from the waterline down (excluding keel, skeg or deadwood) in feet

Given,

BWL = 12.33 ft
H_d = 2.79 ft.

$D_{min} = 4.07 \times (12.33 \times 2.79)^{0.5} = \underline{23.9\text{ in.}}$

SUMMARY:

This 13.11 m boat with engine power of 300 BHP /288 SHP (2,500 rpm) and gear box of reduction ratio 1.65:1 or 2.06:1 has the engine speed and propeller property as in Table 6 below.

Table 6: Speeds and properties of propeller

Particular	Figure 1	Figure 2
Speed-length, SL ratio	at minimum displacement = 1.94	at maximum displacement = 1.80
Speed , knots	at 19.4 t displacement =12.4	at 24.3 t displacement= 11.5
Propeller slip	33.3%	-
Propeller pitch	with reduction 1.65:1= 14.8 in.	with reduction 2.06:1= 18.4 in.
Propeller maximum diameter	with reduction 1.65:1= 24.3 in	with reduction 2.06:1= 27.7 in.
Propeller minimum diameter	23.9 in.	-

The boat is a semi-displacement (semi-planning) boat because it has SL ratio higher than 1.3 but below 2.5. Speed-length ratio for displacement boat is 1-1.3 and planning hull operates at 2.9 or 3 ratios (Gerr 2001).

From Table 6, further calculations on the predicted resistance and thrust of the boat at different speeds have been done using standard formulas in hydrodynamics (Guldhammer and Harvald 1965). Table 7 shows resistances of the boat at her fully displacement light condition and thrusts required to overcome them at five different speeds.

Table 7: Predicted resistences and thrusts at different speeds in fully displacement light condition (Guldhammer and Harvald 1965)

Speed (V) kn	Speed (v) m/s	Speed-/ length ratio	Log(Rn)	Frict. resist. coeffic. (C_F)	Residual resist. coeffic. (C_R)	Total resist. coeffic. C_T)	Resistance (R) kg	Thrust (T) kg
4	2,056	0,632	7,3238	0,00265	0,00113	0,003776	32	36
6	3,084	0,948	7,4999	0,00248	0,00607	0,008549	164	186
8	4,112	1,264	7,6249	0,00237	0,00864	0,011010	376	439
10	5,140	1,581	7,7218	0,00229	0,01866	0,020951	1119	1344
11	5,654	1,739	7,7632	0,00226	0,02645	0,028708	1856	2263

L_{pp} = 11.40 m
L_{vl} = 12.2 m = 40.0 ft
B = 3.76 m
T = 0.85 m
Δ = 19.4 tons
∇ = 18.93 m^3
$L/\nabla^{1/3}$ = 4.28

Block coefficient, δ = 0.52
Midship coefficient, β = 0.72
Prismatic coefficient, φ = 0.72
Wetted surface, S = 38.7 m^2
where,

$$S = 1.7 \text{ x} L_{pp} \text{ x } T + \frac{\nabla}{T}$$

Reynold's number, Rn = v x L/ν
ν = kinematic viscosity of seawater = 1.19 x 10^{-6} m^2s^{-2}

R = 0.5 x ρ x C_T x S x v^2
ρ = 104.4 kgs^2/m^4
C_T = $C_F + C_R$
T = R/(1-t)

t , thrust deduction fraction.
Assume as:
t = 0.04 at V = 0 kn
t = 0.18 at V = 11 kn
interpolation btw 0 and 11 kn

Graph in Figure 18 shows the predicted total resistance faced by the boat at various speed. The total resistance is made up of frictional resistance and residual resistance.

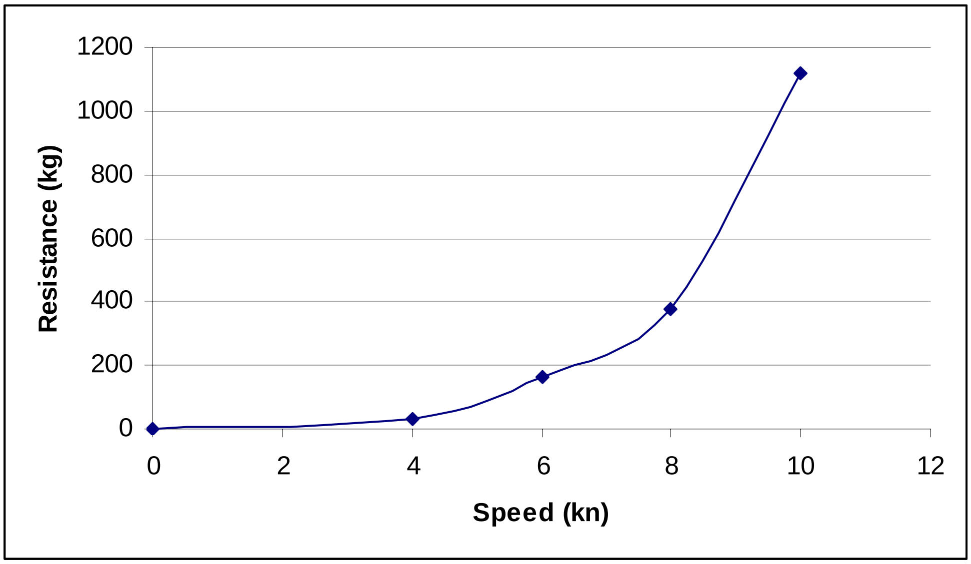


Figure 18: Predicted resistence of the boat in calm weather and sea

Graph in Figure 19 shows the predicted thrust that the boat requires to overcome the total resistance occurred on the boat at different speeds.

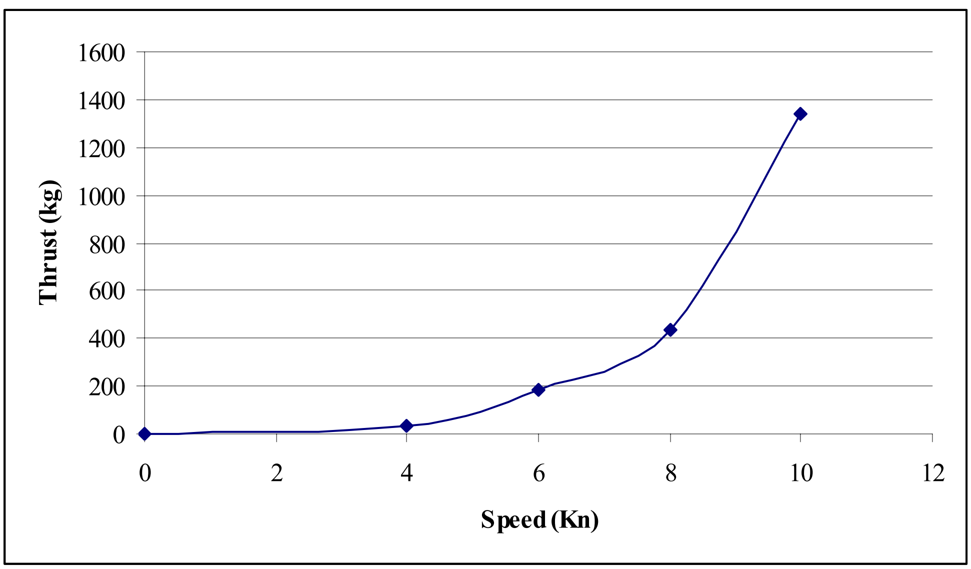


Figure 19: Predicted thrust needed to overcome the resistence in calm weather and sea

The final step is to determine the suitable propeller to move the boat at it's fully displacement light condition on the various predicted thrust calculated before (Figure 18). The calculation is based on the Wageningen B-series: The Netherlands Ship Model Basin (NSMS) at Wageningen (Comstock 1967).Table 8 shows the properties of the propeller in relation to various speeds, engine powers and fuel consumption.

Table 8: Propeller calculation based on predicted thrusts as fully displacement hull light condition

1	2	3	4	5	6	7	8	9	10	11	12
1	Propeller type		B3-50	B3-50	B3-50	B3-50	B3-50	B3-50	B3-50	B3-50	B3-50
2	Diameter	mm	617	704	711	617	617	617	704	704	704
3	Propeller speed	rpm	1515	1214	1214	1271	981	789	990	770	626
4	Speed of vessel	knots	12,4	12,4	12,4	10,0	9,0	8,0	10,0	9,0	8,0
5	Wake coeffic. (assum.)		0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
6	Shaft power	hp	288	288	288	172,9	74,1	36,4	157,5	68,3	34,3
7	Thrust	kgs	1869	2005	2008	1344	732	439	1344	732	439
8	Torque	kgm	136	170	170	97	54	33	114	64	39
9	Pitch/Diameter-ratio		0,7335	0,7487	0,731	0,7335	0,7335	0,7335	0,7487	0,7487	0,7487
10	Thrust power	hp	127,2	136,4	136,6	73,7	36,2	19,3	73,8	36,2	19,2
11	Advance ratio		0,3276	0,3583	0,3547	0,3149	0,3672	0,4058	0,3541	0,4100	0,4483
12	Thrust coefficient		0,1936	0,1908	0,1837	0,1977	0,1808	0,1678	0,1921	0,1732	0,1569
13	Torque-coefficient		0,0229	0,023	0,029	0,0232	0,0217	0,0205	0,0231	0,0213	0,0199
14	Propeller efficiency		0,4417	0,4737	0,4744	0,4264	0,4881	0,5298	0,4683	0,5297	0,5612
15	Gear ratio		1,65	2,06	2,06	1,65	1,65	1,65	2,06	2,06	2,06
16	RPM of engine	rpm	2500	2501	2501	2097	1619	1302	2039	1586	1290
17	Brake horsepower	bhp	300	300	300	180,1	77,2	37,9	164,1	71,1	35,7
18	Specific fuel cons.	l/hph	0,194	0,194	0,194	0,192	0,209	0,260	0,194	0,210	0,265
19	Fuel consumption	l/h	58,2	58,2	58,2	34,6	16,1	9,9	31,8	14,9	9,5
20	Fuel pr. naut. Mile	l/nm	4,69	4,69	4,69	3,46	1,79	1,23	3,18	1,66	1,18

At first, a comparison is made between the two maximum diameters, 24.3 in. (617 mm) and 27.7 in. (704 mm), calculated earlier (see Table 6) at maximum speed, rpm and power (refer column 4 and 5). In column 4, the rpm is based on gear ratio 1.65:1 and in column 5 on gear ratio 2.06:1. It can be seen that the propeller efficiency (row 14) is about 7-8% better for a less propeller speed and bigger diameter. In column 6, the diameter is rounded to a value of 28 in. (711 mm) and this gives the same efficiency. Some calculations have also been made for bigger diameters such as 750 mm for a gear ratio 2.06:1, and it gives no better efficiency.

For a working speed interval of 8-10 knots, a comparison has been made for both alternatives; gear ratio and diameter (refer to column 7-9 and 10-12). The result shows that less fuel consumption and power with bigger diameter at about 7%.

From this table, it is concluded that the best propeller for the design is 27.7 in (704 mm) diameter and should run at speed of 8-10 knots.

APPENDIX 4: ECONOMIC RETURN FOR TRADITIONAL FISHERIES IN MALAYSIA

The simple analysis which follows is to estimate the price of the proposed boat based on the scantling calculation of the boat. Scantling can be defined as a guideline of rules for building boat. It is used for determining the size, shapes, materials and weight of structural components of a boat (Gerr 2000). The calculation is made according to the Nordic Boat Standard for commercial boats less than 15 metres. Estimated income is based on the annual landing of hook and line and portable trap fishing gear groups with 20% increase (DOF 2001).

Given below is an example of the calculation used to determine the lamination thickness of the keel using the formulas:

Thickness, tk = 1.15 (2.9 + (0.9 * f1 * Loa) + (0.1 * V)) mm (1)
Section modulus W = 3.45 * G * Loa mm^3 (2)
length of keel lamination = 80*B (3)

where,

f1= factor for laminate thickness
Loa = length overall in metre
V = boat speed in knots
G = lightweight of the boat in kg
B = breadth moulded in metre

given,

f1 = 1	B = 3.76 m
loa = 13.11m	G = 12,900 kg
V = 13 knots	

To calculate lamination thickness:

tk = 1.15 (2.9 + (0.9 x 1 x 13.11) + (0.1x 13)) = 18.40 mm

To calculate section modulus:

W = 3.45 x12,900 x 13.11 = 583,461 mm^3

To calculate length of lamination:

length of keel lamination = 80x 3.76 = 300.80 mm on each side
Table 9 shows the particulars of the lamination required at variuos parts of the boat. From this table, amount of materials can be estimated.

Table 9: Lamination thickness of 13.11 m FRP boat

Section of boat	Thickness (mm)	Length (m)	Breadth (m)	Volume (m^3)
Keel	18.4	11.4	0.6	0.14
Stem and bulwark	18	2.76	0. 6	0.03
Bottom	12	30	0.8	0.29
Side	10	26.22	2.02	0.53
Superstructure side	10	7.2	5.2	0.37
Superstructure roof	10	3.6	5.2	0.19
Bilge (chine)	16	26.22	0.2	0.08
Deck	10	13.11	3.76	0.49
Floor	10	13.11	3.76	0.49
TOTAL				2.62

Density of lamination CSM/WR with 35% glass content is 1,538 kg/m^3

Volume of lamination with 35% additional for wastage or extra lamination = 3.54 m^3

Weight of CSM/WR and resin = 3.54 m^3x 1,538 = 5,445 kg
Weight of CSM/WR = 35% x 5,445 = 1,906 kg
Weight of resin = 65% x 5,445 = 3,539 kg

The estimated cost of boat as shown in Table 10 is based on the recent market price of FRP materials and average wage of skilled and unskilled workers in Malaysia.

Table 10: Estimated cost of 13.11 m FRP boat built in Malaysia

Materials and works	Quantity	Total cost (MYR)
CSR/WR	1,906 kg	17,200
Resin	3,539 kg	17,700
Other FRP materials e.g. catalysts		1,800
Other building materials e.g. plywood		11,000
Wages	7,200 manhour	36,000
Engine and propeller system		120,000
Auxiliary engine and equipments		40,000
Sub total		243,700
Profit 8%		19,300
TOTAL		263,000 (USD71,000)

For estimating the income and operation cost of boat, it is based on 3 trips/month x 10 months/year operation because normally traditional fishermen do not go to the sea in months of December and January, due to monsoon season. In Table 11, the annual income is estimated from annual catch of hook and line and portable trap in 2001 (See Table 1) with 20% increment (DOF 2001)

Table 11: Estimated annual earning from traditional fishery (hook and line and portable trap) in Malaysia

Income and operation		Unit price/cost (MYR)	Value (MYR)
Income:			
Catch - hook & line =13 t - trap =27 t	40 tons	5,000	200,000 (USD 53,000)
Operation cost:			
Fuel	33,120 litres	0.80	26,500
- to & from fishing round = 150 nm/9knots x 2 ways x 3 trips/mth x 10 mth/yr x 18 l/hr = 18,000 litres - during fishing = 14hr/day x 4 days/trip x 3 trips/mth x 10 mth/yr x 18 l/hr x 50% consumption = 15,120 litres			
Ice (at fish: ice =1:1)	40 tons	70	2,800
Lube oil 10% fuel			2,650
Bait 3,000kg		2	6,000
Food			3,000
Fishing gears			40,000
Maintenance and repairs			9,000
Wages 3 persons @ MYR 4,000/month		11 months	44,000
Total operation cost			133,950 (USD 35,250)
Revenue of boat owner			66,050 (USD 17,750)

Considering the loan for purchasing the boat is only approved up to 90 % of the boat's price, the calculation on the payback amount and period as estimated below:

	MYR
Price of boat	263,000
Loan approved	236,000
Payback period 10 years	
Interest 6% per annum	142,000
Total amount of loan	378,000
Payback instalment per month	MYR 3,200
Boat owner's revenue per month	MYR 5,500

From this calculation it concludes that the boat owner can afford to purchase the boat at the price of MYR 263,000 with payback instalment of MYR 3,200 for 10 years.