JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

INDIA
MINISTRY OF AGRICULTURE

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR ACQUISITION OF FISHING VESSELS FOR DEEP SEA AND OFFSHORE FISHERIES IN INDIA

NOVEMBER, 1992

OVERSEAS AGROFISHERIES CONSULTANTS CO., LTD.

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BASIC DESIGN STUDY REPORT

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IN

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PREFACE

In response to a request from the Government of India, the Government of Japan decided to conduct a basic design study on the Project for Acquisition of Fishing Vessels for Deep Sea and Offshore Fisheries and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to India a study team headed by Hiroshi Saito, Deputy Director, Training Division Kanagawa International Fisheries Training Center, JICA and constituted by members of Overseas Agrofisheries Consultants Co., Ltd., from July 30th to August 13th, 1992.

The team held discussions with the officials concerned of the Government of India, and conducted a field survey at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to India in order to discuss a draft report and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of India for their close cooperation extended to the teams.

November 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

Mr. Kensuke Yanagiya,
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Acquisition of Fishing Vessels for Deep Sea and Offshore Fisheries in India.

This study has been made by Overseas Agrofisheries Consultants Co., Ltd., based on a contract with JICA, from 22th, July, 1992 to 24th, Nov., 1992.

Throughout the study, we have taken into full consideration of the present situation in India, and have planned the most appropriate project in the scheme of Japan's grant aid.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, Ministry of Agriculture and Embassy of India in Japan. We also wish to express our deep gratitude to the officials concerned of Integrated Fishies Project, JICA Office in India, Embassy of Japan in India for their close cooperation and assistance during our study.

At last, we hope that this report will be effectively used for the promotion of the project.

Very truly yours,

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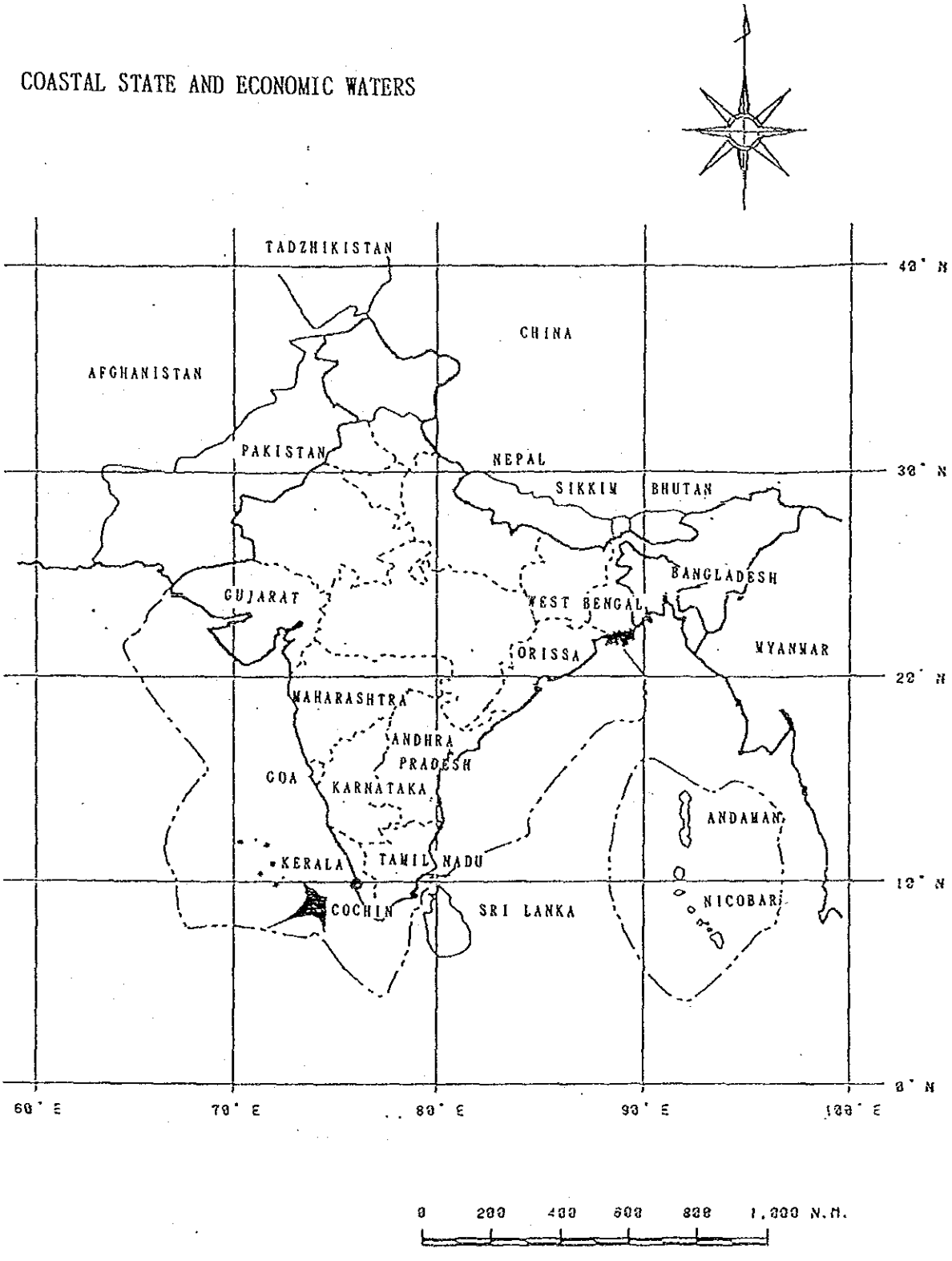
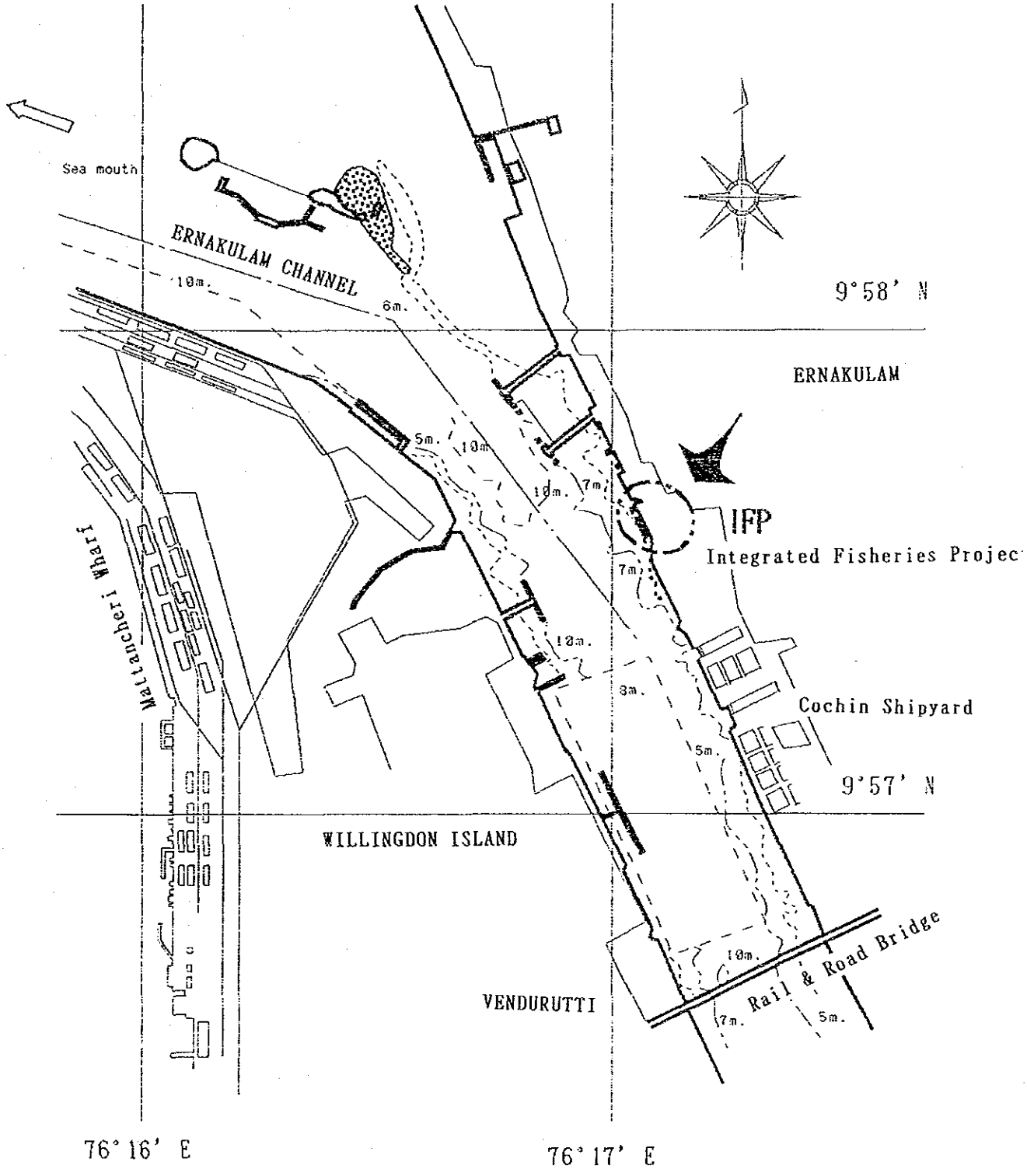
Satoru Hirashima
Team leader,
Basic design study team on
The Project for Acquisition of Fishing
Vessels for Deep Sea and Offshore Fisheries,
Overseas Agrofisheries Consultants Co., Ltd.

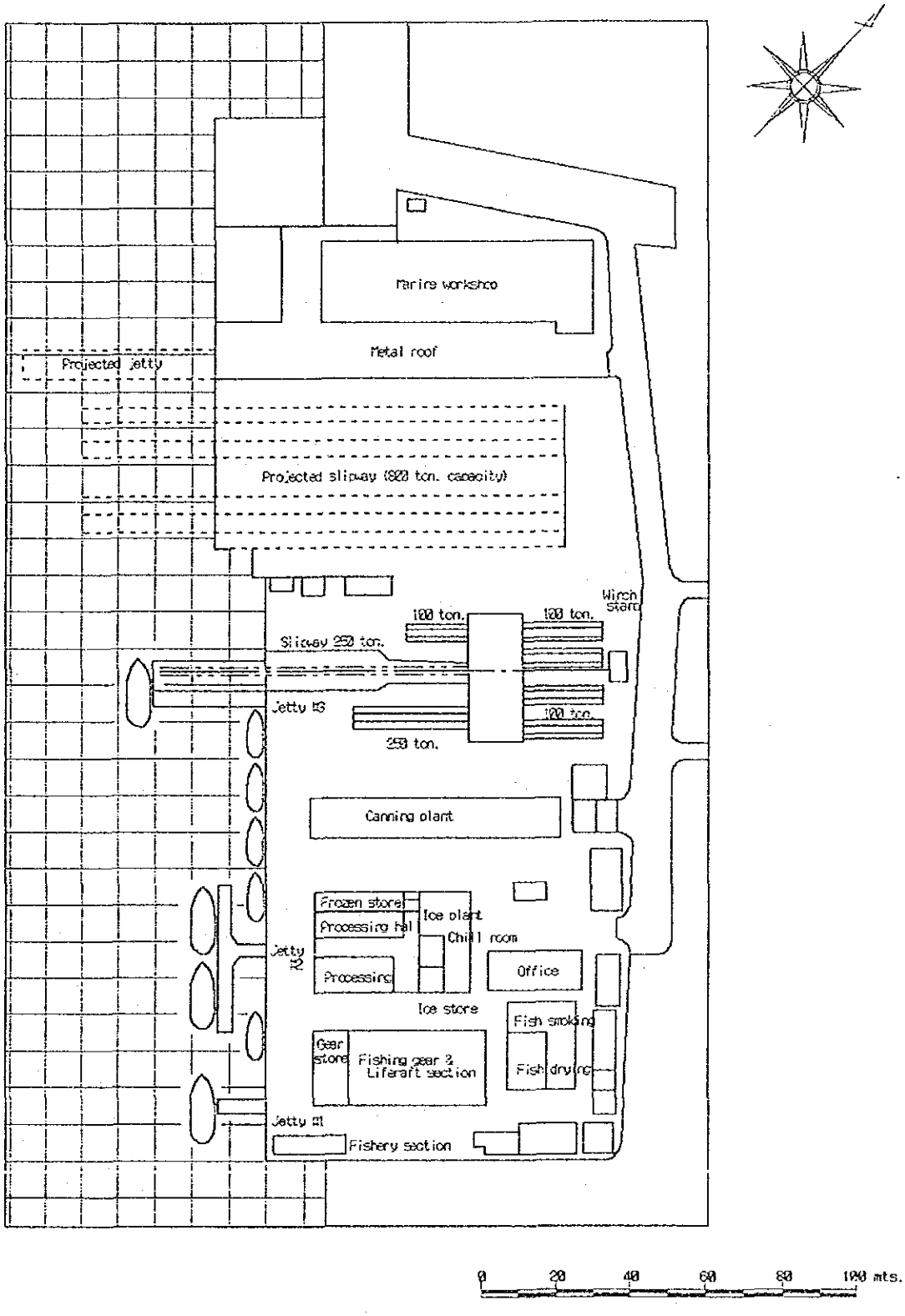
COASTAL STATE AND ECONOMIC WATERS



LOCATION OF PROJECT SITE AND COCHIN PORT



SITE MAP : IFP (Integrated Fisheries Project)



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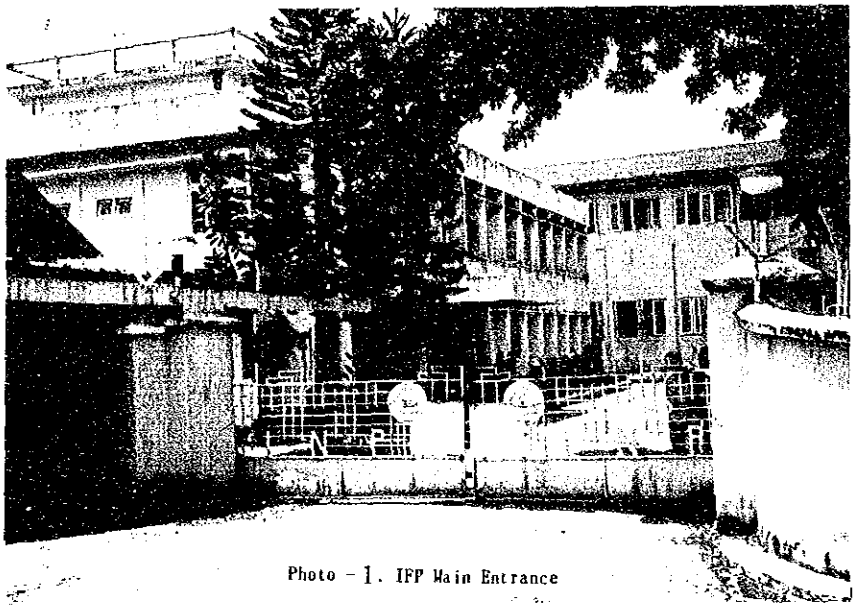


Photo - 1. IFP Main Entrance

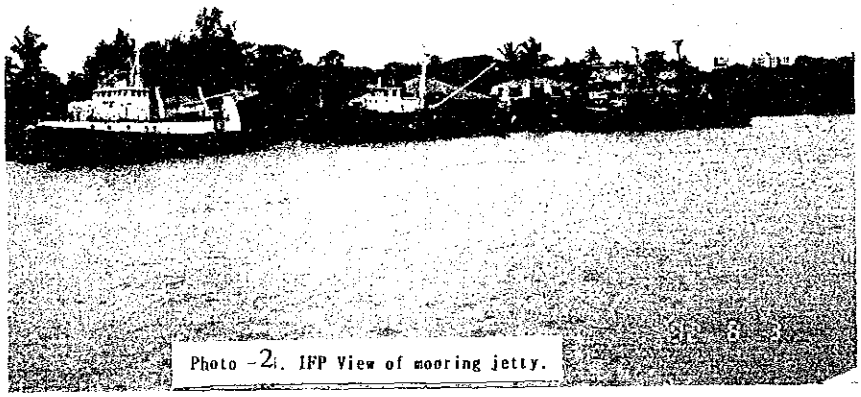


Photo -2. IFP View of mooring jetty.

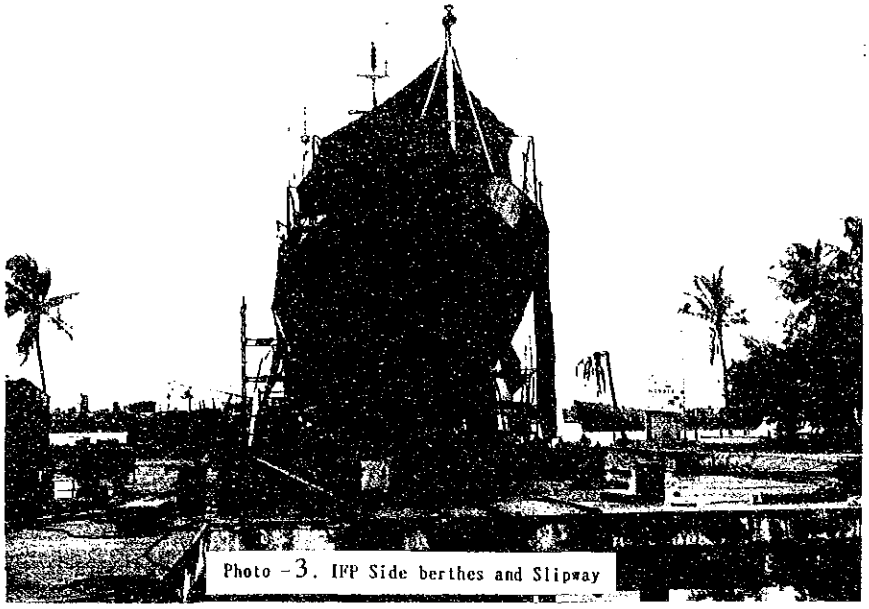


Photo -3. IFP Side berthes and Slipway

Photo -4. IFP Slipway and side berthes

Photo -5 IFP Workshop

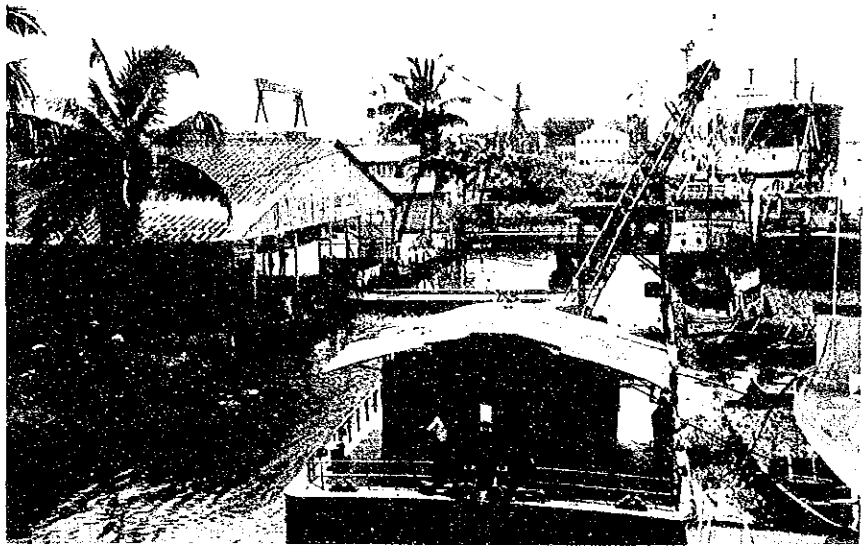


Photo -6. IFP Dredger

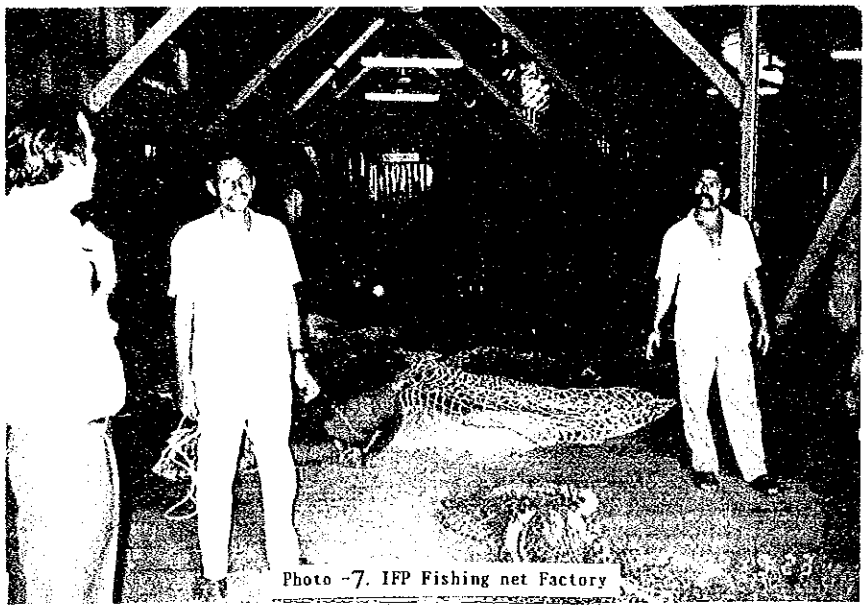


Photo -7. IFP Fishing net Factory

Photo -8. IFP Processing factory

SUMMARY

India is rich in fish resources as its coastal line stretches 8,100 km and faces the Arabian Sea, Indian Ocean, and Bay of Bengal all of which are important in terms of fish stock. This helps explain why India has ranked seventh in the world in total catch, including inland catches since 1951. Fisheries of India have provided employment to 9.5 million fishermen as well as supplied good, inexpensive animal protein to inhabitants of the coastal areas. Bringing a total export, value of $700 million, fishing is also one of the key industries of the country.

Under these circumstances, the Government of India has designed a program to increase fish product by the appropriate development of sea and inland fish stock in its eighth Five-Year National Plan. The target average increase rate is 7% per annum as compared to the average annual increase rate of 6.25% in the seventh Plan. India's landing from coastal waters less than 50m deep accounts for 90% of the total landing. Although the total catch is increasing year after year by mechanized fishing boats, and fishing beyond potential yield is already seen at some areas, while a drastic drop of landing by small-scale fishermen with non-mechanized fishing boats in the coastal area is apparent according to the transition of catch by type of fishing boats. The data is a clear indication of fish stock exhaustion at coastal zones.

The potential yield in India's economic zone of Ocean water depth of over 50m is estimated at about 1.2 million tons, and fish stock including demersal and pelagic fish in water depths of 50 to 100m is estimated at 800,000 tons. This means that two thirds of the unexplored fish stock exists in waters relatively easy to develop.

This is the background of the request that India asked Japan for assistance under a Grant Aid Cooperation in constructing off-shore fishing boats for the development and promotion of its off-shore fishing. The Government of Japan, upon their request, decided to carry out a preliminary study in respect to the construction of off-shore fishing boats for India and dispatched a study team to India from Apr. 8 to 23, 1992. The team, assigned to understand the background of India's request and the present conditions of their fishing industry, conducted a field survey in order to confirm whether the requested Project would be appropriate for Japan's Grant Aid Cooperation.

As an implementing organization of the Project, IFP (the Integrated Fisheries Project), an organization under the Central Government of India, and MATSYAFED (Kerala State Cooperation Federation for Fisheries Development) were listed as recipient organization of the Grant Aid. Based on judgment criteria such as operation experience, budget, maintenance capability, and organization, IFP was narrowed down as an implementing organization of this

Project after our discussion with the Ministry of Agriculture of the Central Government. The Project was then approved as appropriate for grant aid cooperation.

Based on the results of the Preliminary study, the Japanese government decided to carry out a Basic Design Study regarding the Project, and the Japan International Cooperation Agency (JICA) sent a Basic Design study team to India from Jul. 30 to Aug. 13, 1992 in order to confirm the Request contents, discuss the Project details, and understand the fishing boat operation system of IFP and IFP's facilities. Although three off-shore trawlers were requested in the Application Letter, after a discussion with IFP's technical staff, the team and IFP agreed that two fishing boats would suffice the objective. JICA made a final study of the Basic Design Study results, and sent a Draft Report Explanation Team to explain the draft report to India from Sep. 17 to 26, 1992 in order to confirm the contents of the Basic Design Study Report.

The objectives of the Project are to build and operate off-shore fishing boats, conduct feasibility studies, provide data from the studies to public corporations and, by doing so, to develop and promote off-shore fishery, improve fish production as well as to preserve the coastal fish stock of India. Low-value by-catch fish to be netted at off-shore fishing grounds plans to be subject to processing experiments to manufacture marine products with various added values at the processing division of IFP so that they could be used for research of consumer demand for marine products and fresh fish and promotion of fish eating. For that purpose, we came to the conclusion that it would be most appropriate to introduce off-shore trawlers as described below. Principal particulars of the fishing boat requested in the Application Letter and those of the boat proposed in our Basic Design are compared as follows:

Principal particulars	Basic Design proposal	Boat requested in the Application Letter
No. of vessel	Two	Three
Type of vessel	Stern trawler	Stern trawler
Length overall	28.8 m	26.8 m
Width molded	7.2 m	6.7 m
Depth molded	3.3 m	3.6 m
CN(length x width x depth)	684	646
Complement	16	17
Fish hold capacity	85 m^3	120 m^3
Fuel tank	60 m^3	60 m^3
Fresh water tank	30 m^3	30 m^3
Main engine	600 H.P.	600 H.P.
Generator capacity	80 KVA x 2	100 KVA x 2
Fishing gears	Bottom trawl (plane) 1 set (rough) 1 set Mid-water trawl 1 set	Surface trawl 1 set Mid-water trawl 1 set Bottom trawl 1 set Bull trawl 1 set

It will require approximately four months for preparation of the detailed design of the Project ship and approximately 11 months for constructing two Project ships until their handing-over.

The Project aims at constructing off-shore trawlers, conducting feasibility studies by using them, and widely distributing the data from the study to the public for development and promotion of off-shore fishing, and is expected to obtain the following results by its implementation.

① Improvement of catch will be expected as a result of effective utilization of off-shore fish resources.

② Promotion of off-shore fishing will eventually remove excessive burdens from coastal fishing, resulting in recovery and preservation of coastal fishing resources.

③ As a result of the above, the livelyhood of small-scale fishermen, 97% of the total 9.5 million fishers, will be ensured.

④ The number of fishing boats to be benefited by off-shore fishery development will be:

= Direct beneficiaries :

Shrimp trawlers (about 18m in length overall)	:	200
Small powered fishing boats (mainly mini trawlers of 10m in overall length)	:	23,000

= Indirect beneficiaries:

Small fishing boats with inboard engines	:	150,000
Small unpowered fishing boats	:	1,680,000

Now it is obvious that this Project will benefit both off-shore and small-scale fishers as well as improve the lives of a great number of fishermen. Therefore, it is judged that it is significant for Japan to carry out the Project as a grant aid cooperation. To further promote off-shore fishing, it is suggested that would also be important not only to research fishing grounds, develop fishing technologies, such as fishing gear; and open fishing-related information to the public; but also to study and establish proper fishing laws. Especially laws designed to preserve coastal fish resources so that the coastal zone (water depths of less than 50m) could be continuously and effectively utilized should be looked at. Recommendations and suggestions in this respect should be included in implementation of the Project.

It is also desired that the implementation of this Project should accompany, through dispatching of experts, (1) instructions on operation and maintenance of fishing boat engines and refrigerators by fishing boat engine experts and (2) study of processing methods for low-value fish by marine product processing experts and technical instructions by the same for promotion of fish eating.

CONTENTS

LIST OF APPENDIX

Chapter 1 Introduction

Chapter 1 Introduction

In India, the fishing industry is greatly expected to grow mainly in order to supply animal protein and improve nourishment of the people, increase employment opportunities, and obtain foreign currencies through exports. The Government of India, therefore, took up a fishing production increase as one of the most important issues of the nation in its eighth Five-Year National Plan and aimed at an average annual growth of the fish production of 7% against the 6.25% in the seventh Plan.

However, 90% of the country's landing of fish is carried out in the coastal zones of less than 50m in depth, and fishing beyond potential yield is already seen at some areas, accelerating exhaustion of coastal fishing resources. Catch by small-scale fishers operating at coastal areas was 220,000 tons, 65% of the total catch, in 1986, but their catch plunged to about 30,000 tons, only 5% of the total catch, in 1989.

The potential yield in India's economic zone of over 50m is estimated at about 1.2 million tons, and fishing stock including demersal and pelagic fish in water depths of 50 to 100m is estimated at 800,000 tons. This means that two thirds of untouched fish stock exists in waters relatively easy to develop.

The Government of India is keenly aware of the necessity of the immediate development and promotion of off-shore fishing and has planned a program to build and operate off-shore fishing boats, and provide data to be obtained from feasibility studies to the public for development and promotion of off-shore fishery as well as the preservation of coastal fishing resources. With this understanding India asked Japan for a grant aid cooperation in constructing off-shore fishing boats.

In reply to the request, the Japan International Cooperation Agency, JICA, sent a preliminary study team headed by Hiroshi Saito, Deputy Director, Training Division, Kanagawa International Fisheries Training Center of JICA, to India from Apr. 8 to 23, 1992. The team conducted a field study in order to understand the background of India's request, study the present condition of their fishing industry and predict possible effects of the Project. Based on their report, the Project was approved as appropriate for grant aid cooperation.

Based on the results of the preliminary study, the Japanese government decided to carry out a Basic Design study regarding the Project and JICA sent a Basic Design Study Team headed by Hiroshi Saito, to India from Jul. 30 to Aug. 13, 1992 in order to check the Request contents, discuss the Project details, and understand the fishing boat operation system of IFP and IFP's facilities.

JICA made a final study of the Basic Design study results, and sent a team to explain the draft report to India from Sep. 17 to 26, 1992 in order to confirm the contents of the study report.

Details of Basic Design Study

(a) Advance Preparatory Studies in Japan

1) Analysis and Study of Request.

2) Analysis and study of previously obtained data.

3) The establishment of investigation methods and the entire project.

4) Decide methodology to classify data obtained, planning of field investigation methods, and preparation of questionnaire to use.

5) Preparation of a Inception Report based on the above, together with a questionnaire.

(b) Field Investigations

1) Submitted Inception Report and questionnaire, explanations and discussions with India officials.

2) Explanation of the Japanese Grant-Aid Projects system and discussions.

3) Investigation of the project background and investigations.

4) Study of the project vessels and discussions.

5) Investigation of the project management and monitoring methods.

6) Investigation of the present India fishing industry and related problems.

7) Investigation of the natural conditions of the project site.

8) Investigation of the present condition of the project site.

9) Collection of related data.

(c) Analysis of the Project in Japan

1) Analysis of the Project in Japan

2) Clarification of the background of the project, the purpose and its position.

3) Determination of Conditions to fix the vessels major dimensions.

4) Analysis of the field investigation, and recommendations.

5) Determination of scope of the vessels and fishing gears, and preparation of basic design.

6) Study of schedules.

7) Project cost studies.

8) A study of the maintenance and operation of the vessels and fishing gears.

9) The effects of this project, and the justification for the studies.

10) The conclusions of the evaluation of the project, and recommendations.

11) Preparation of the Draft Final Report.

(d) Explanation of the Draft Final Report and discussions pertaining to the report.

(e) Preparation of the Final Report.

This report is based on the above studies and contains the Basic Design of the vessels and materials judged most appropriate for the design, the organization for implementing the Project, the Project evaluation and the Evaluation and Conclusion. The members of the delegation, the delegation schedule, a list of concerning party in India and conference minutes are given in appendices to the report.

Chapter 2 Background

Chapter 2 Background

2-1 Description of India

2-1-1 General Description of India

1) Geographical and climatic information

India is located on the Indian subcontinent and covers an area (3.29 million km^2) of about 9 times that of Japan. Shaped like a lozenge and extending for 3,200km from north to south and 3,000km from east to west, the country borders Myamar and Bangladesh in the east, Nepal in the north, Pakistan in the west, and the Indian Ocean in the south. Its coast line is as long as approx. 8,100km in total.

India is geographically divided into three major regions, i.e. the Himalayan mountains, the Hindustani plain, and the Indian peninsula. The mountainous region is dominated by peaks with an average height of 6,600m, including Himalaya and Karakoram. The Hindustani plain in the center of India is characterised by two major rivers, the Indus and the Ganges, which form a large alluvial plain widely used for forestry and agriculture. The peninsula part of India is the southland down the Bindia Mountains and is sandwiched by the mountains of the Western and Eastern Ghats. The coastal plains are inhabited by agricultural and fishing people while the inland area is thick woodland spreading on the Decan Plateau. The capital is New Delhi while Bombay and Calcutta are major commercial and industrial cities.

2) Climate

Ranging from the Himalayas which are snow-crested all the year around to the southern tropical jungle, India covers a large area and has various types of climates. In general, it has a tropical monsoon climate with spring between February and March, a sweltering summer between April and mid-June, a rainy season from the end of June to July, autumn between August and November and winter between December and January. Kashmir has a mild climate, while the Himalayan area has a frigid climate. The southern part of India is in the tropical zone.

Cyclones are generated off the Bay of Bengal in October and November, frequently causing serious damage in India.

3) Population

India's national census in 1991 found a total population of approximately 844 million with Indian Aryans and Dravidians the dominant races. The average life expectancy of men is 57 while that of women is 58. The shorter life span compared to advanced countries is attributed to a higher infant death rate.

2-1-2 Political and economic situation (Present status of India's liberation policy)

Following the assassination of former Prime Minister Rajib Gandhi in 1991, the National Parliamentarians, India's largest political party, held an extraordinary executive committee on May 22, 1991 and appointed Mrs. Sonia Gandhi as Prime Minister to take over from her late husband. Mrs. Gandhi rejected the appointment and Narasinha Lao, former Foreign Minister, was finally elected as Prime Minister at the central executive committee on May 29. The Lao Administration bases the nation's non-aligned diplomacy on no internal affair interference and equality and is trying to improve its economy through active communication with Western nations including the U.S.A.

Upon assumption of the premiership, Prime Minister Lao announced a series of new industrial policies, including relaxation of trade regulations to promote imports, 20% depreciation of the rupee and acknowledgment of the ownership of a maximum 51% of stocks of an Indian company by foreign corporations. This means a great change for India which has taken a seclusive attitude toward foreign investment since independence in August, 1947 and marks a great leap toward opening domestic industries to the world.

India's domestic economy showed a steady growth in the 1980s and the target economic growth rate of 5% stated in the 7th Five Year National Plan (1985 to 1990) is regarded as having been achieved. The end of the 1980s saw the nation with an external deficit, and expansion of the financial deficit and the decade of 1990s began with an aggravation of the foreign currency reserves partly due to the warring state in the Middle East. The Lao Government is taking active measures to improve its foreign currency reserves as a prime target in its effort to further economic liberalization.

India's annual revenue and expenditure in fiscal 1991 were 1,057 billion and 1,134.2 billion rupees respectively. Due to the Gulf Crisis which started in August, 1990, encouraged exportation, a drastic decline of foreign currency remittance from Indian workers overseas and an increase of the crude oil price and oil product prices

boosted India's external debt to $70 billion, further aggravating the nation's external deficit. To solve the problem, the Government of India sold gold to prepare money for reimbursement of the debt and obtained the World Bank's approval of a loan of $450 million in June 1991 as well as the International Monetary Fund's approval of a new loan of $2.2 billion in November, 1991.

Originally scheduled from April, 1990 to March, 1995, the enactment of the 8th Five Year National Plan was deleyed due to repeated political changes and was finally determined to start in April, 1992, ending in March 1997.

The total export and import volumes in 1990 were $17 billion and $24.8 billion respectively. The export-import balance has always been characterized by an excess of the latter over the former. Major export items include jewelry, clothes, black tea and machinery while major import items include crude oil, oil products and machinery. Major trade partners are the U.S.A., former U.S.S.R, U.K., Japan and Germany.

India's relationship with Japan is closer now than it has been since before since the conclusion of the bilateral peace treaty in 1952. In May, 1984, then Japanese Prime Minister Nakasone was the first Japanese prime minister to visit India in 23 years and in the following year, India's counterpart Rajib Gandhi visited Japan. The heads of the two nations visiting each other in two consecutive years reactivated communications between the two countries, which lead to a speech by Prime Minister Kaifu of Japan at the Indian Parliament during his visit to India in April, 1990.

In regard to for India's trade with Japan, major export items to Japan include prawns, iron ore and diamonds, yielding $2,075 million in 1990 and $2,190 million in 1991. Major import items are textiles, machinery, and chemical products, fetching $1, 708.2 million in 1990 and $1,528 million in 1991.

In the field of economic cooperation, Japan has been India's largest assisting country since 1987. According to the ranking of bilateral cooperation volume in 1989, India received economic aid cooperation of $3,130.4 million from Japan, $1,096.9 million from Sweden, $528.5 million from Germany, and $85.8 million from France. Multinational assistance received by India in 1989 included economic cooperation of $473 million from the IDA and $119.9 million from the EC.

2-2 India's Fisheries Industry

2-2-1 Outline of sea fishery

1) General

India is regarded as a subcontinent covering an area about 9 times that of Japan with a coastal line of 8100km. Coastal areas face the Arabian Sea, the Indian Ocean and the Bay of Bengal which are all important waters for fishing. Geographically, India is bestowed with vast and rich fish resources. 10 states out of a total of 27 are on the sea and enjoy prosperous fishing though their fishing styles are traditional. Some of these states also have a long history of marine trade. India has ranked as the world's 7th in terms of the total fish catch, (3% of the world total catch) including that of inland fishing, since 1951.

About 9,500,000 people are engaged in fishery. India's fishery supplies 8.5kg / capita / year of fishery products and is an important industry occupying about 4% of the country's total export value.

Sea fishery, however, whose catch has been considerably increasing in recent years, is troubled with delayed modernization of fishing technology. The main fishing methods of India's sea fishery people mainly operating in coastal waters are rather traditional with only few improvements in technology and equipment. As a result, the catch / person / hour is a mere 5kg. There is, therefore, much to be improved in India's sea fishery. Well aware of this situations the Government of India is putting emphasis on the development of marine resources to supply animal protein to the public in the hope of the resulting creation of employment opportunities and increase of foreign currency reserves.

Table 2-1 World Ranking of Fish Catch Unit ten thousand tons

Year	World total catch	India's total catch		Rank	Year	World total catch	India's total catch		Rank
1951	2350	75.2	3.2	7	1984	8382	286.4	3.4	7
1961	4361	96.1	2.2	9	1985	8626	282.6	3.3	7
1971	6610	185.1	2.8	7	1986	9262	292.3	3.2	8
1981	7460	244.8	3.2	7	1987	9341	290.8	3.1	7
1983	7673	236.9	3.1	7	1988	9799	314.6	3.2	7
1983	7749	250.9	3.2	7					

(Source: FAO)

2) Fishing grounds

India's economic sea zone covers an area of 2.02 million km^2 which roughly consists of 860,000km^2 off the West Coast, 560,000km^2 off the East Coast and 600,000km^2 around Andaman and Nicobar Islands. There are five main fishing grounds, i.e. the Northwest Fishing Ground in the Arabian Sea off from Gujarat to Maharashtra, the Southwest Fishing Ground also in the Arabian Sea off from Karnataka to Kerala, the Southeast Fishing Ground in Bay of Bengal off Tarminad, the Northeast Fishing Ground also in Bay of Bengal off from Andra Pradesh to West Bengal, and the Wedge Bank Fishing Ground in the Indian Ocean off Comorin Cape.

Features of some fishing grounds:

* Northwest Fishing Ground	It has India's largest continental shelf where trawling and gill netting are conducted and is the most promising fishery with rich fishing resources.
* Southwest Fishing Ground	This has seen the most vigorous development of coastal fishery in recent years and promises new resources for the future development of off-shore fishing.
* Northeast Fishing Ground	Most important for prawn fishery, this fishing ground is expected to provide marine stock other than praws.
* Wadge Bank Fishing Ground	This was an international trawling fishing ground before it was covered by India's economic zone. It is not fully utilized by Indian fishermen with their present fishing boats and equipment because of the unique sea bottom situation and the distance from the coast to the fishery. The off-shore fishing boats to be built through this Project are, therefore, expected to greatly assist the development of area.

Table 2-2 Areas of India's Five Major Fishing Grounds As Included in India's Economic Exclusive Zone (unit: km^2)

Waters	Area Depth of water 0-50m	Area Depth of water 50-300m	Area Depth of water 0-300mm	Total area
West Coast				
Northwest Fishing Ground	99.2	120.3	219.5	
Southwest Fishing Ground	28.3	50.6	78.9	
Sub total	127.5	170.9	297.4	860.0
East Coast				
Northeast Fishing Ground	39.3	34.6	73.9	
Southeast Fishing Ground	27.1	13.7	40.8	
Wadge Bank	11.7	13.8	25.5	
Sub total	78.1	62.1	140.2	561.4
Andaman Nicobar Islands	Unknown	35.0	35.0	596.5
Total	205.6	268.0	473.6	2,017.9

Source: Government India (Report of the Working Group on Revalidation of the Potential Marine Fisheries Resource of EEZ of India.)

3) General fishing boats and methods of Indian fishers

Fishing boats are categorized into small unpowered boats, small boats with an outboard engine and mechanized boats.

<Number of boats per type (1989)>

Prawn trawlers (approx. overall length 18m)	200
Small powered boat (Mainly with an overall length of 10m)	230,000
Small boat with outboard engine	150,000
Small unpowered boats	1,680,000

Most of above fishing boats operate in coastal areas. Only about 200 prawn trawlers (17.5m class) and 56 foreign chartered boats operate off-shore.

4) Fish production

India's total annual catch is 3,146,000 tons (1988) comprising 2,300,000 tons from sea fishery (1990) and 1,361,000 tons from inland fishery (1988). The sea fishery catch has increased by an average 100,000 tons every year since 1981. The total catch in 1988 ranks 7th in the world, occupying 3.2% of the world fish catch.

Table 2-3: India's total catch by year Unit : ten thousand tons

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Sea fishery	137.3	141.2	153.5	161.6	152.3	167.7	164.5	178.5	220.8	230.0
Inland fishery and others	107.5	95.7	97.4	124.8	130.3	124.6	137.7	136.1	-	-
Total	244.8	236.9	250.9	286.4	282.6	292.3	290.8	314.6	-	-

Source: Government of India (Ministry of Agriculture)

5) Export

The increased fish catch has resulted in a gradual growth of India's marine product exports which reached 76,000 tons worth 2,480,000,000 rupees in 1980 and further went up to 139,000 tons worth 8,930,000,000 rupees in 1990, an increase of 55% in volume and 28% in value. The 1990 export value accounts for about 4% of India's total export value.

6) Fishing ports and fishing boat related facilities

According February, 1991 data of the Ministry of Agriculture on the country's fishing ports relating to fish catch landing, there are 10 major ports (including two under construction), 53 small ports (including seven under construction) and 200 small landing places (including eight under construction). There are also many fishing villages all over the country which have their own landing places.

7) Types of consumption

Fish fresh from landing is reported to be intensively consumed in areas within a radius of 200km from landing places because distribution to other areas which are distant from such fishing places is prevented by a shortage of freezing facilities and refrigerated transport vehicles and a lack of freezing equipment at the local retailing end. People in inland areas for from fish landing places eat preserved fish which is canned, salted or dried although consumption is small. The types of fish consumed in

coastal areas are mainly sardines, horse mackerel, mackerel and such other fish as bonito, red bullseye, snapper, giant sea-pike, small squid, prawns and shrimps.

The fish price per kg when landed is around 10 rupees for ordinary fish and 50 to 120 rupees for such high class fish as harvest fish and prawns (according to field survey).

2-2-2 Outline of implementing organization (IFP)

The IFP started as the Indo-Norwegian Project (INP) which was established in cooperation with Norway and the United Nations in 1952 at Shatekrangra and Niendakara as a local development program to promote coastal fishery. The INP was under the control of the Central Government of India in 1963 and moved to Cochin where the IFP is presently located. The INP was over in 1972 and was reorganized as the IFP. The IFP, the implementing organization of this Project, is a comprehensive fisheries project managed by the Central Government of India and is engaged in initiative activities including off-shore marine life resource research off the West Coast and coastal fishery promotion. Its major activities are listed as follows:

1) Activities of IFP

(1) Development of fishing grounds by various types of fishing boats it owns; and development of fishing methods suitable for such development activity.

(2) Study of various types of effective fishing equipment for existing fishing grounds.

(3) Demonstration on the sea of various types of effective fishing gear and methods and the training of such use to fishermen and employees of fishing companies.

(4) Opening of fishing operation result reports to the public.

(5) Manufacture of trial processed fish products, including canned and surimi products, using low-priced fish to enhance their added-valve to them and market research on consumers preferences.

(6) Establishment and promotion of shark fin for small scale fishermen.

(7) Training of fish product processing technicians; and promotion of processing technologies.

(8) Designing of to maintain/repair vessel hulls and engines of fishing boats owned by itself as well as private fishermen and implementation of their adjustment and repair work.

(9) Operation, management and servicing of refrigerators, ice making machines and freezers.

(10) Training of CIFNET (Central Institute of Fisheries Nautical Engineering and Training.) students.

2) Past surveys and development of fishing grounds

(1) Development of prawn fishing grounds for small fishing boats, development of fishing gear for that purpose: and its promotion to the public.

(2) Introduction of purse seine for sardine and horse mackerel in coastal waters and its promotion to the public.

(3) Trial fishing operation of snapper in waters deeper than 50m using various fishing methods.

(4) Trial off-shore fishing operation of tuna.

(5) Survey, development of off-shore butterfly bream and its promotion to the public.

(6) Promotion of processing technology for export prawns and squids manufacturing of deep-sea prawn products: and their trial export.

(7) Trial manufacture of dried and canned fish, dried shark fin, squid rings, vinegared fish, fish pastes using low-price fish and edible meals and market survey of consumers preferences.

(8) Training and education of CIFNET students, fishermen, and employees of private fishing companies.

3) Scale and main facilities

(1) Number of employees: About 400

(2) Site: About 25,000 m^2

(3) Vessel repair facilities: One slipway and six side berthes (250 ton and five 100 ton,) engines, power unit, radio repair shop and Inflatable life raft inspection Room, etc.

(4) Processing and refrigerating equipment: Canning, freezing, ice making machine, and refrigerating equipment

(5) 1991-92 budget: 50,000,000 rupees (about ¥210 million)

4) Technology transfer to the public

The IFP regularly provides technical information to the public through annual reports, bulletins (irregular technological information) and technology P.R. magazines and conducts short-term training, on-the-job training, demonstration of actual fishing operation and consultations with fishermen and private company personnel. It is, ensured that therefore, the experience and information to be obtained through the operation of the Project ships will be disclosed to the public by the same means.

Although the IFP has suspended the training of CIFNET students due to the deterioration of the organization's ships, it is expected to resume the training of these students aboard the Project ships which is an advantageous incidental effect of the Project.

2-3 Outline of Related Plans

1) National development plans

The 8th Five Year National Plan (1992 to 1997) sets forth the targets of achievement in the field of fishery as follows:

(1) Increase of fishing production through the appropriate development of sea and inland fish resources. (An average annual growth rate of 7% is the set target of this Plan, compared to 6.25% set by the 7th Plan.)

(2) Construction of appropriate facilities capable of effectively handling fish resources.

(3) Improvement of the fish farming efficiency through the introduction of suitable technology and improvement of the social and economic status of fishermen by increasing their income.

(4) Increase of the catch to help increase the export volume of marine products.

(5) Growth of direct and indirect employment opportunities.

Budget

The 8th Five Year National Plan allocates 4,310 million rupees (about ¥18.1 billion) to the fishery field and includes in its actual development plan eight major items for the Central Sector and six major items to be sponsored by the Central Government.

The plan to which the IFP is assigned to carry out is one of the 8 items for which the Central Sector is responsible, and is provided with 20 million rupees (about ¥84 million) in 1992 independent of the regular budget allocated to the IFP and a total of 120 million rupees (¥500 million) in five years.

2) Development plans of IFP

The objectives of the IFP are defined in the 8th Five Year National Plan as follows:

(1) Effective operation of various types of fishing boats and fishing equipment and study of their cost efficiency.

(2) Opening of the above results to the public and their demonstration.

(3) Promotion and education to the public of various kinds of fishing methods to make the most of existing fishing resources.

(4) Introduction of various processed marine products to urban and local areas, market research of consumers' response to new processed marine products; and promotion of consumers' awareness of new marine products in order to promote products utilizing undeveloped marine resources.

(5) Training of fishing methods, marine product processing technologies and refrigerating technology and consultations in the fields of fishing, processing and distribution.

3) Projects of IFP

The IFP is planning the following projects in response to the 8th Five Year National Plan:

(1) Feasibility study and development of off-shore fishing grounds.

(2) Enhancement (to 650 tons) of slipways for Government-owned fisheries research vessels and private fishing boats

(3) Processing of low value fish for consumption by medium and small income households and addition of value to them, trial manufacture of dried and smoked fish using solar heat, promotion of processed marine products in local areas and market research on consumers preferences.

(4) Opening and promotion of research and study results to the public.

(5) Operation training of fish shoal sound detecting equipment for fishermen and private fishing companies; promotion of fishing facilities and off-shore fishing development.

One of the six major development plan items to be sponsored by the Central Government is the promotion of off-shore fishing, which is allocated a budget of 6 million rupees (¥25 million) in 1992 and a total of 197 million rupees (about ¥830 million) for a period of five years.

4) Subsidy systems for off-shore fishing promotion projects

A committee composed of members from the Ministries of Agriculture, Finance and Commerce is providing the following financial assistance as part of off-shore fishing promotion activities:

(1) Change and improvement of fishing methods

(2) Change and improvement of fishing equipment

(3) Change and improvement of fishing gear

(4) Installation of refrigerating equipment an board fishing boats

(5) Reformation of fishing boats to enable more than five day fishing operation in waters of more than 50m in depth.

(6) Subsidy system to compensate for fishing boats' fuel expenses (providing that 10% of the catch is exported overseas).

The Ministry of Commerce has established a foundation to promote the export of fishing products and, through the foundation, provides subsidies to small-scale coastal fishermen changing to off-shore fishing, processors for their facility investment, and fishing boats fishing export fishes, providing that subsidy receivers comply with the foundation's subsidy requirements.

2-4 Background and Contents of the Request

1) Background of the Request

India's sea fishery marine stock yield (MSY) is estimated to be 3.9 million tons, of which 2.21 million tons lie in coastal zones shallower than 50m with the remaining 1.69 million tons in off-shore zones deeper than 50m according to a survey results.

The catch of sea fishery in 1990 was 2.3 million tons, most of which came from coastal waters. It is estimated that the coastal fish catch already exceeded the estimated cacheable stock in waters shallower than 50m by 2.21 million tons and has reached the maximum. On the other hand, off-shore waters deeper than 50m remain undeveloped.

The Government of India has decided to utilize undeveloped off-shore waters of more than 50 deep and plans, in its 8th Five Year National Plan to increase the types of marine life to caught, alleviate the excessive fishing burden on coastal resources, increase the fish catch and expand the fish product export volume.

In response to the National Plan, the Central Government of India the devised a plan to research fishing grounds on the continental shelf at a water depth of more than 50m and on the continental shelf slope at a water depth of 200 to 400m, to determine marine stock and to develop effective fishing methods for trawlers. It has assigned implementation of the plan to the IFP, a subordinate organization of the Ministry of Agriculture.

However, two fishing boats owned by the IFP are unsuitable for off-shore operation, preventing the organization from conducting effective research necessary for off-shore fishing development.

Under these circumstances, the Government of India has officially asked the Government of Japan for cooperation for the construction of off-shore fishing boats.

Though the listed recipient organizations were narrowed down to IFP after our discussion with the Ministry of Agriculture of the Central Government and baced on judgment criteria such as operation experience, budget and organization.

2) Outline of the Request

Requested items: Three off-shore fishing boats (trawlers) with trawling equipment and spare parts.

(1) Contents of IFP's Request

① Off-shore Stern Trawlers:

Principle particulars

Overall Length	26.8m	Fuel capacity	$60m^3$
Width	6.7m	Lubricant capacity	$1m^3$
Depth	3.6m	Fresh water capacity	$30m^3$
Total tonnage	160 tons	Fish hold capacity	$120m^3$
Main engine	600 h.p.	Complements	17
Velocity	9.5 knots	Voyage length	21 days
Auxiliary engine	100kVA x 2	Vessel classification	International class

② Fishing gear

Surface trawl	1 set
Mid-water trawl	1 set
Bottom trawl	1 set
Bull trawl	1 set

③ Spare parts

(2) Contents of MATSYAFED'S request

① Off-shore fishing boat (Length overall:19.9m) 4

② Trawling gear for the above 1 set

③ Navigational equipment 1 set

④ Spare parts 1 set

⑤ Squid angling boat overall (Length :24.9m) 2

⑥ Fishing gear, navigational equipment and spare parts for the above

Chapter 3 Outline of the Project

Chapter 3 Outline of the Project

3-1 Objectives

The Government of India, in its eighth Five-Year National Plan, devised a project to increase fish production which, through the appropriate development of both sea and inland fisheries resources, aims to improve the annual average growth rate from 6.25% (the seventh plan) to 7%.

Approximately 90% of India's fishery depends on the coastal zone where the water is less than 50m deep. Some of India's waters are over-fished and it is feared that this will exhaust India's coastal resources.

Table 3-1

Catch and yield	Potential yield of water under 50m deep		Potential yield in water depth of over 50m		
Waters	Total landing	Catch	Sub total	Demersal fish	Pelagic fish
West coast					
(Northern part)	689,594 ton	620,635 ton	650,000 ton	377,000	273,000
(Southern part)	1,018,404 ton	916,564 ton	950,000 ton	361,000	589,000
East coast					
(Northern part)	206,940 ton	186,246 ton	220,000 ton	103,000	117,000
(Southern part)	293,660 ton	264,294 ton	390,000 ton	195,000	195,000
	2,208,598 ton	1,987,739 ton	2,210,000 ton		

Source: 1991, report of the working group on revalidation of the potential marine fisheries resources of exclusive economic zone. Table-3, Table-14

As indicated in the following table, landing by mechanized fishing boats is increasing while due to gradual dry-up of coastal fish resources that of small-size fishing boats is decreasing.

Table 3-2 Transition of Catch According to the Type of Fishing Boat

Year	Mechanized (industrial) fishing boats	Fishing boats (small-size) other than mechanized ones	Total catch
1986	117,565 (35%)	218,291 (65%)	335,856 ton
1987	95,843 (34%)	187,331 (66%)	283,154 ton
1988	436,463 (93%)	37,345 (7%)	468,808 ton
1989	613,960 (95%)	33,566 (5%)	647,526 ton
1989	3,742	37,511	41,253

Source: Government of Kerala

As a counter measure, the Government of India in its eighth Five-Year National Plan has proposed a project to increase off-shore fishing and to increase the landing of fish while protecting resources in coastal areas. IFP was assigned to conduct a feasibility study of off-shore fishing grounds.

This Project is intended to build and operate off-shore trawlers for conducting a feasibility study and development of off-shore fishing grounds and to provide the study results to private companies. Low-price fish to be caught by research ships at off-shore fishing grounds will be taken to the processing division of IFP, where processing of fish to increase various added values are to be experimented so that they will be used as marine products or eaten as fresh fish for research activities of consumers' preference and promotion of fish eating.

3-2 Study of the Request

3-2-1 Study of the Appropriateness and Necessity of the Project

Over exploitation has seriously damaged India's coastal fish resources. These resources have galled to dry-up and deteriorate already out of the 9.5 million fishermen in India, those involved in subsistence-level fishery in coastal areas amount to 9.2 million, 98% of the total number. These fishermen badly need protection, and the development of a coastal fish stock is necessary to sustain them.

Mechanization of coastal fishing has accelerated in recent years in India and most of such fishing operations are intensively carried out at the coastal zones. As a result, demersal fish stock below 50m depth is especially being exhausted. Potential yield in water depth of over 50m in India's economic waters is estimated at about 1.2 million tons, out of which potential yield of demersal and pelagic fish in water depths of between 50 to 100m is estimated at 0.8 million tons. This estimation indicates that two thirds of resources existing in the waters of 50 to 100m depth is unexploited, which could be easyly utilized, that is, 50 to 100m in depth.

Table 3-3 Potential yield by depth

unit: tonnes

Fishing area	Total catch	Catch in water below a depth of 50m	Potential yield in water of depth greater than 50m		
			Sub total	Demersal fish	Pelagic fish
West Coast					
(Northern part)	689,594	620,635	567,000	379,000	188,000
(Southern part)	1,018,404	916,564	357,000	112,000	245,000
East Coast					
(Northern part)	206,940	186,246	101,000	40,000	61,000
(Southern part)	293,660	264,294	164,000	118,000	46,000
Total	2,208,598	1,987,739	1,189,000	649,000	540,000

Source: 1991, report of the working group on revalidation of the potential marine fisheries resources of exclusive economic zone. Table-11(b), 11(c)

Table 3-4 Total potential yield in water between 50 and 100m depth and beyond

unit: tonnes

Fishing area	Potential yield in water between 50 and 100m deep			Total potential yield in water over 50m deep		
Area	Sub total	Demersal fish	Pelagic fish	Sub total	Demersal fish	Pelagic fish
West Coast (Northern part)	435,300	274,300	161,000	567,000	379,000	188,000
(Southern part)	246,200	63,200	183,000	357,000	112,000	245,000
East Coast (Northern part)	97,900	72,900	25,000	101,000	40,000	61,000
(Southern part)	45,400	13,400	32,000	164,000	118,000	46,000
Total	824,800	423,800	401,000	1,189,000	649,000	540,000

Source: 1991, report of the working group on revalidation of the potential marine fisheries resources of exclusive economic zone. Table-11(b), 11(c)

The ship, to be built in conjunction with the Project, is intended to promote off-shore fishing by conducting a feasibility study of the unexplored fish stock in water deeper than 50m, especially between 50 to 100m, and disclosing the study data to private companies. Waters off the northern and southern parts of the West Coast of India may be appropriate places for marine study since they have a large fish stock. Since the ship, requested by the project, is to be built to match the size of an ordinary off-shore fishing boat, it will be able to accurately carry out fishery development research through feasibility studies.

In conclusion, it is believed that the Project is necessary, and useful, to help achieve India's eighth Five-Year National Plan designed to secure fishing areas for 9.2 million subsistence-level fishermen and achieve an annual growth catch rate of 7%.

3-2-2 Operating Plans

The IFP is involved in the eighth Five-Year National Plan to help develop and promote off-shore fishing. The organization has a sufficient financial base to conduct these activities. It also has an adequate crew and the technical background, as demonstrated when it successfully operated fishing research ships, as large as or larger than the Project ship, that had been built under Norwegian support.

1) Examination of the Financial Base

In recent years the IFP's budget shows a steady annual increase. In 1991-1992 it totalled Rs.50 million (about ¥210 million). This amount is classified into the operating expense (general account) category and the project expense category. The operating expense remains in the vicinity of Rs. 20 million (about ¥84 million). (See the expenditures of the 1989-90 and 1990-91 terms. In the 1990-91 term the delay of payment in the project expense category produced the balance of about Rs. 30 million.)

Table 3-5 IFP's budget

Year	Budget allacation	Expenditure (Rs. in million)
1989 - 90	28.645	21.801
1990 - 91	48.100	19.810
1991 - 92	50.000	42.825
1992 - 93	50.000 (Scheduled)	

(Source: IFP)

The eighth Five-Year National Plan budgets Rs.20 million (about ¥84 million) for IFP in the 1992 term and allots a total of Rs. 120 million (¥500 million) for five years. This is a sufficient financial base for the Project.

An expense of about Rs.1.62 million (about ¥7 million) is estimated necessary for the planned operation length of 150 days a year of one Project ship (See Table 3-6), and about Rs.3.24 million will be then needed for two ships a year. (See APPENDIX-5: Calculations of Navigation Expenses) The operation expenses

for the two Project ships only occupy a little over 10% of the annual Project expense of Rs.30 million and no financial problem. Although IFP lost four fishing boats by a fire in 1991, their past experience in operating a total of six boats can support the financial feasibility of the Project ships' operation.

Note: Any earnings IFP makes from sale of its catch or marine processed products will be transferred to the National Treasury. The estimates of operation cost does not take such sales into account. However, if sales of catches were used to reduce the operating cost, the annual operation cost per ship would be about Rs.700,000 (about ¥3 million).

Table 3-6 Operation cost

	One voyage (Rs)	One year (Rs)
Operation cost	231,343	1,619,402
Sales of catch	139,536	976,752
Net operation cost	91,807	642,650

(Source: IFP)

2) Examination of the Ship's Crew

Employing a total of 397 people, IFP has a sufficiently experienced personnel to run the Project ships.

Table 3-7 Personnel necessary for the ships

Title	Current number of crew	Crew necessary for the Project ships	Existing ship Crew
Skipper/Master fisherman	5	(1) 2	3
First officer	4	(1) 2	2
Boatswain	5	(1) 2	3
Chief engineer	5	(1) 2	3
Engineer	11	(3) 6	5
Engine driver	11	(-) -	11
Room assistance	5	(-) -	5
Junior deck hands	33	(6) 12	21
Cook	6	(2) 4	2
Topaz	2	(1) 2	0
	87	32	55

(Source: IFP)

Note: The figures in parentheses are the number of crew necessary for one Project ship.

3) Maintenance capability of IFP

The IFP owns one slipway with six side berthes (one 250 ton and five 100 ton). Its vessel maintenance section owns various machine tools, related equipment, and about 100 experts, and has a history of forty years of servicing its own ships, various research vessels of other governmental organizations, and private vessels. According to our field observation and hearing survey, it has a high level of maintenance capability as outlined in the table below. IFP cannot handle maintenance and adjustment of some precision machinery at its own maintenance shop, but can turn to a specialized workshop in Cochin.

Table 3-8 Maintenance Capability

Contents of maintenance work	IFP capability	Remarks
Overhaul and maintenance of diesel engines (up to 2000 h.p.)	Capable	
Overhaul and maintenance of variable pitch propellers	Capable	
Change of exhaust and suction valve sheets:	Capable to change only	Installation is subcontracted
Overhaul, maintenance, and adjustment of built-type fuel injection pumps	Capable	Subcontracted
Overhaul and maintenance of independent type fuel injection pumps	Capable	
Overhaul and maintenance of turbocharger:	Capable	
Overhaul and maintenance of freezing machines	Capable	
Overhaul and maintenance of hydraulic machines:	Capable	
Maintenance of electric motors (Change of bearing)	Capable	
(Change of coil)		Subcontracted
Repair of power generator's control circuit (such as AVR)	Capable	
Maintenance of radio equipment	Capable	
Maintenance and adjustment of gyro compass		Subcontracted

(Source: IFP)

4) Setting of research waters

Based on the off-shore fishery development research plan prepared by the IFP, the Basic Design Study Team has had many discussions with the technical staff of the

IFP. The Group has taken into consideration the eighth Five-Year Plan and the IFP's past projects, and finally established an operation plan of higher feasibility, which is outlined in the following.

The base of IFP will be set at Cochin, and the waters off the West Coast where fishing is widely done will be the area of research. To be specific, the area from the boundary with Pakistan in the north to the Adams Bridge, including a wadge bank off Cape Comorin, in the south (the middle of the strait between Sri Lanka and India) will be covered.

Setting sea area reason: Total landing from fishing off the West Coast reaches 1.7 million tons, about 80% of India's total sea fishery landing of 2.2 million tons.

Potential marine resource stock in water depths over 50m are estimated to be around 1.2 million tons. Two thirds of this is found in water between 50 to 100m deep. Therefore, research will be conducted in water between 50 to 100m deep, or, at most, 150m deep, where the development is easier and resource potential is greater.

Setting sea area reason: The waters off the northern part of the West Coast of India rank first in potential yield of water depths over 50m (567,000 tons), followed by those off the southern part of the West Coast (357,000 tons).

5) Existing ships and research waters

The IFP is now building two iced storage boats at a shipyard in Bombay. They are about 10% smaller than the Project ship and are designed to cool the catch, with ice. They are scheduled for completion in April, 1993. Their size, and their equipment, is the same as that of the Indian fishing boats now engaged in off-shore fishing. The data obtained from these two iced storage ships will be directly and effectively used by private fishers. It is a great advantage in terms of feasibility study of off-shore fishing development. However, although depending slightly on the type of fish to be cooled, the duration of operation is limited by restrictions of the tropical climate to about one week. Thus, the extent of research carried out by the ice freezer ships using Cochin as their base port would be limited.

Taking this into account, a combined operation of the Project ships with freezing equipment and the locally built iced storage ships would be the optimum choice. The Project ships will handle off-shore fishery research in a wider area, while the locally built ships, whose data are easily utilized, will make detailed investigations, in a feasibility

study, once promising fisheries have been found. This combination will shorten the operation time required for product sample catch and will enhance the operation efficiency of the Project ships.

Only few of India fishing boats are equipped with rifregerating machines. However, the Government of India has already offered a financial assistance to boats for installing freezing equipment, and the basic conditions are almost sufficient to allow an increase in the number of these boats. From this point of view, the Project ships with freezing equipment will qualify as model ships.

(1) Navigation schedule of the Project ships

All the waters set in 4).

(2) Navigation schedule of IFP ships with ice freezing equipment

Feasibility study of promising fisheries found by the Project ships in the waters near Cochin.

Note: Four ships out of six, owned by IFP, were burned in a fire accident last year, the remaining ship is now out of service (it had served for about 20 years and now its crankshaft is broken). Three out of four of the burned boats are to be scrapped, while the remaining one is to be repaired and transferred to CIFNET.

6) Examination of hours steaming

Hours steaming of private fishing boats engaged in off-shore fishing in India are reported to be about one month. Hours steaming required of the Project ship, to sail to the research waters, are calculated as shown in the following table. A projected length of 21 days per voyage is judged appropriate.

Table 3-9 Hours steaming

Research waters	Distance	Hours steaming
Cochin to the northern part of the West Coast	About 850 nautical miles	About 4 days (8 days including return)
Cochin to Adams Bridge	About 300 nautical mile	About 1.5 days (3 days including return)

(Source: IFP)

Research waters	Hours steaming	Research operation days	Total
Cochin to the northern part of the West Coast	8 days (including return)	13	21
Cochin to Adams Bridge	3 days (including return)	18	21
Standard navigation	4 days (including return)	17	21

Notes : Fishing operations will be conducted only in the daytime, for about 12 hours a day.

: If days steaming per voyage are shortened, navigation days to and from a distant research area, such as in northern waters, become longer in proportion to the actual research operation length, consequently reducing research efficiency.

7) Projected catch

Although it is difficult to estimate the catch per hour in unknown waters, more than 50m deep, the past research data may be used for extrapolation. The average catch per hour of all trawling ships in shallow water depths (less than 50m) is 267kg, and the number of fishing boats per type is as follows:

Average catch of all trawlers in water less than 50m deep:	267 kg
Shrimp trawlers (main engine power: about 40 h.p.):	200 vessels
Mini trawlers (main engine power: about 150 h.p.):	23,000 vessels

Based on the above figures, the average catch per hour of a mini trawler (150 h.p.) in water less than 50m deep is assumed to be 250kg. Demersal fish stock according to the depth is reported as follows, and under the supposition that the catch is proportional to stock, average catch per hour of a mini trawler (150 h.p.) in waters more than 50m deep will be 250kg x 0.457 (proportion of stock) = 114 kg.

Table 3-10 Demersal fish stock according to the depth

Area	0-50mm	50-100mm	100-200mm	200-300mm	Total
West Coast (north)	377,000 ton	274,300 ton	104,300 ton	400 ton	756,000 ton
(south)	361,000 ton	63,200 ton	29,100 ton	20,000 ton	473,000 ton
	738,000 ton	337,500 ton	133,400 ton	20,400 ton	

Area	0-50mm	50-100mm	100-200mm	200-300mm
Proportion of stock	1.000	0.457	0.180	0.028

Source: 1991, report of the working group on revalidation of the potential marine fisheries resources of exclusive economic zone. Table-11c, Table-14

It is also known that the catch is proportional to the square root of horse power. Comparing the main engine of a mini trawler, 150 h.p., with that of a Project ship, 600 h.p., the Project ship is calculated to have fishing efficiency twice as great as the mini trawler.

Table 3-11 Fishing efficiency

Type of vessel	Main engine power	Square root of horse power	Fishing efficiency
Mini trawler	About 150 horse power	12.2	1.0
Project trawler	600 horse power	24.5	2.0

From the above calculations, the catch per hour of a Project ship is deduced to be 114kg x 2 (fishing efficiency) = 228kg.

8) Examination of research fishing method

The fish resources of off-shore fishing grounds may be categorized into demersal fish and pelagic fish. The first priority should be given to the research of demersal fish stock. Investigation of middle-water and pelagic fish stock is a second priority. Consequently, the Project ships will be equipped with fishing gear and equipment suitable for bottom trawling and middle-water trawling.

3-2-3 Similar Projects

1) Foreign aids and similar projects for fisheries sector

At the moment, there are no similar projects planned in any upper level regional development programs, fishery sector, or programs funded by foreign countries or international institutes. However, the following foreign aided projects are under way:

(1) Tedri District (Karnataka) Fisheries Project

Implemented by: Government of Karnataka

Aid granted by: Denmark

Project period: 1990 to 1997

Budget: Rs.63,832,000 (about ¥270 million)

(2) Sea Surface Fish Preserve Farming Project

Implemented by: MATSYAFED (Union of Kerala Fisheries Development Cooperations)

Aid granted by: Germany

Project period: 1990 to 1993

Budget: DM 490,000

(3) Trout Farming Project

Implemented by: Governments of Jammu and Kashmir

Aid granted by: EC

Project period: 1991 to 1993

Budget: Rs. 1,000,000 (about ¥4.2 million)

(4) Commercial Trout Farming Pilot Project

Implemented by: Government of Himachal Pradesh

Aid granted by: Norway (NORAD)

Project period: 1988 to 1993

Budget: NOK 8,000,000

(5) FAO-related fisheries projects

- Ferrocement coastal fishing boat promotion project

- Coastal area fish farm development

- Development of fishing boat production in Kerala

- Research on supply and demand of cultured fresh water fish and cheap marine fish

- Monitoring and evaluation of stored fish

- Project of small-scale cold water fish farming at high lands

(6) State level fisheries projects

- Bay of Bengal small-scale fishing union promotion project

- The fishing training project for the Bay of Bengal small-scale fishing unions

- The Bay of Bengal marine life economic small-scale fisheries promotion project

- Value added marine product export promotion project

- Fish farming center network in Asia

- The Indian Ocean and the Pacific Ocean tuna control development project

- Sea surface fish farming demonstration and development

2) Similar projects by domestic organizations

It has been confirmed that the other governmental organizations of India have no similar projects. India has two organizations other than the IFP engaged in the research and development of off-shore fishing. The Central Institute of Fishing Technology (CIFT; for development of fishing tools and techniques) and the Fishery Survey of India (FSI; for research of off-shore marine life resources). The nature of these organizations' duty was investigated and it was ensured that none of their projects overlap the Project in question. For reference, organizations related to fisheries, and their functions, are outlined.

Central Institute of Coastal Engineering for Fishery	(CICEF)	Consultancy and infrastructure support for caputre and culture fisheries.
Central Institute of Fisheries	(CIFNET)	Training of personnel for manning fishing vessels.

Integrated Fisheries Project	(IFP)	Study the commercial viability of the exploitation of unexploited/under-exploited Development of value added fishery products from low value fishes, introduction of diversified fishery products for internal and export marketing, maintenance and repairs of fishing vessels.
Central Marine Fisheries Research Institute	(CMRFI)	Biological research and resource potential study.
Central Institute of Fishery Technology	(CIFT)	Research on gear development and post harvest technology.
Central Institute of Fisheries Education	(CIFE)	Giving graduate and post graduate level training in fisheries.
Central Institute of Fresh Water Aquaculture	(CIFA)	Research and training in culture and farming of fresh water fishes.
Central Institute of Brackish Water Aquaculture	(CIBA)	Research and Training in brackish water aquaculture.
Central Inland Capture Fisheries Research Institute	(CICFRI)	Research on capture fisheries in rivers and reservoirs.
Fishery Survey of India	(FSI)	Survey for fishery resources of Indian waters.
Marine Products Export Development Authority	(MPEDA)	Agency for the development of Export market for the Indian marine products.
Export Inspection Council	(EIC)	Agency for quality assurance of marine products for export market.
Central Food Technological Research Insitute	(CFTRI)	Research on different types of food processing technology.
National Institute of Oceanography	(NIO)	Exploitation of the non-living resources of the Indian waters.

3-2-4 The optimum Number of Ships for the Project

The Request mentioned the necessity of three off-shore fishing boats for the development and promotion of off-shore fishing. The eighth Five-Year National Plan has already started, and to achieve its objectives it is necessary to develop off-shore fishing quickly. Naturally, if the number of ships is greater, the research period will be shortened. The optimum number of ships, necessary for the development research within the frame of Japan's grant aid, was examined. It was concluded that two ships would satisfy the Request.

India's Fishing area is classified by water area and depth, as shown in the following table. Marine zoning, used in past research of India's fishing areas, has been that one degree, of both latitude and longitude (60 nautical miles or about 111km each), is evenly divided into 36 sections (10 nautical miles or 18.5km), each of which is a square zone with an area of 343 square km. This zoning principle is applied to the waters off India's West Coast of depths between 0 and 50m, and 50 and 100m. The number of marine zones is then calculated as follows:

Table 3-12 Fishing area by depth (square kilometer)

Waters	0-50m	50-100m	100-200m	200-300m	Total of up to 300m
West Coast					
(Northern part)	99,200	97,700	16,500	6,100	219,500
(Southern part)	28,300	30,300	10,200	10,100	78,900
Wadge Bank	11,700	5,100	5,800	2,900	25,500
	139,200	133,100	32,500	19,100	323,900 Square kilometer
Number of marine zones	406	388			

East Coast	0-50m	50-100m	100-200m	200-300m	Total of up to 300m
(Northern part)	39,300	17,300	14,500	2,800	73,900
(Southern part)	27,100	6,700	4,800	2,200	40,800
	66,400	24,000	29,300	5,000	114,700 Square kilometer

(Source: S.F.I. Bulletin No. 8)

IFP conducted a series of marine life stock research from 1967 to 1979 using deep sea trawling (See Attachment –6 Deepsea resources off the South West Coast of India, Table 10), which covered 74 marine zones (100 square nautical miles or 343 square km each) in 3,971 hours. It took 54 hours on average for a marine zone. Out of 74 zone researches, 48 cases were when operation of less than 10 hours per zone was conducted, and their average research operation time is 3.73 hours. Zones which required 10 to 100 hours were 17, whose average operation time is 35.72 hours. These facts indicate that whether a fishing ground is worth development or not can be judged by a relatively short duration of experimental fishing operation. The average operation time exceeded 350 hours for the remaining 9 zones, which was probably because of product sample fishing was conducted. In this Project, sample fishing will be conducted by a ship currently being built at Bombay (Table 3-13).

Table 3-13

Number of marine zones	Research operation time	Total research operation time	Research operation time per zone
No. 48 zone	Less than 10 hrs.	179.16 hours	3.73 hours
No. 17 zone	10 to 99 hrs.	607.32 hours	35.72 hours
No. 9 zone	100 hrs. and above	3,185,38 hours	353.93 hours

If the above conditions can be appled to the Project research, water between 50 and 100m deep, then the research operation times required to cover the Project marine zones can be estimated as follows:

Total research marine zones (133,100 km^2, one zone: 10 square nautical miles around): 338 zones

Marine zones for which the research operation time is estimated to be less than 10 hours (according to proportion): 286 zones

Marine zones for which the research operation time is estimated to be between 10 and 100 hours (remaining zones): 102 zones

Then, the total operation time necessary for the Project research is calculated as follows:

Table 3-14

Research operation times of less than 10 hours:	286 zones x 3.73 = 1,067 hours
Research operation times between 10 and 100 hours:	102 zones x 35.72 = 3,643 hours
Total :	4,710 hours

The navigation schedule has each project ship running 150 days a year. Out of this, 121 days are scheduled for research operation, with 9 hour towing a day. From this schedule, the required number of days for the Project research is as follows:

Annual research operation time per Project ship: 121 days x 9 hrs. = 1,089 hours

Research operation time per Project ship in two years: 242 days x 9 hrs. = 2,178 hours

Research operation time per Project ship in three years: 363 days x 9 hrs. = 3,267 hours

Research operation time for two Project ships in two years: 484 days x 9 hrs. = 4,356 hours

Research operation time for two Project ships in 2.2 years: 523 days x 9 hrs. = 4,710 hours

These calculations indicate that the research of water depths of between 50 to 100m may be completed in 2.2 years with two Project ships. IFP's off-shore fishing development project started in 1992 for scheduled completion in 1997. If Japan's grant aid cooperation is offered to this Project, the estimated arrival of two Project ships in India would be 1994 at the earliest. In this case, it is judged that two ships will be necessary and sufficient to complete the Project in 1997.

The above calculations show research times to satisfy the minimum feasibility study needs for the moment. The Project ships will continue to serve off-shore fishery development research after the completion of the eighth Five-Year National Plan. Future major research is listed here:

(1) Fishing grounds change their resources as they are developed. So after the eighth Plan is over and off-shore fisheries in depths of 50 to 100m are developed, the Project ships will continue fishing research for the protection of marine resources and fishing ground control.

(2) Development research of off-shore fishing grounds between 100 and 150m in depth off the West Coat of India

(3) Development research of off-shore fishing grounds between 50 and 100m in depth off the southern part of the East Coast of India

(4) Development research of off-shore fishing grounds between 100 and 150m in depth off the southern part of the East Coast of India.

3-2-5 Contents of the Requested Ships

The contents of the Request are shown in the following. Proposed changes are made mainly as a result of the determination of capacity and performance of the ship, according to the navigation schedule. Detailed explanations, as well as design procedures, are given in Chapter 4 Basic Design, since many of the proposed changes are made to machines, and capacity and the performance of equipment is based on complicated interrelated factors.

Table 3-15 General Particulars

Principal particulars	Project vessel	Proposed basic design
Type of vessel	Stern trawl	Stern trawl
Length overall	26.8 m	about 28.8 m
Breadth molded	6.7 m	about 7.2 m
Depth molded	3.6 m	about 3.3 m
CN (length x breadth x depth)	646	about 684
Fish hold capacity	120 Cube meter	about 80 Cube meter
Fuel tank	60 Cube meter	about 60 Cube meter
Fresh water tank	30 Cube meter	about 30 Cube meter
Main engine	600 Horse power	about 600 Horse power
Generator	100KVA x 2 units	about 80KVA x 2 units
Complement	17	16

3-2-6 Examination of the Necessity of Technical Support

1) Fishing boat engine expert

The IFP has a lot of experience in the use and maintenance of fishing boats, including those of over 30 years in service. Most of the engines aboard these boats are manufactured in Europe. Although the engines work on the same system, there are some differences between them and those on Project ships in mechanism, structure, and the procedure for dismantling them. IFP personnel have handled freezing machines for many years, but they are all for use on land. The freezing equipment, including a refrigerant container aboard the ship, is smaller than that used on land, and it responds faster (liquid return, etc.), thus it requires special operation techniques. Therefore, it is necessary to despatch fishing boat engine specialists to the IFP to improve the technical level of the organization's engineers and specialists.

2) Marine processing expert

The IFP has facilities to process fish and sell marine products of up to 1,200 tons a year. The organization will study new processes to give added value to low-price fish caught by Project ships in order to promote fish eating among medium and low income people. Indian staff who have been trained in Japan are already taking leading roles at IFP, and the despatch of specialists from Japan will certainly help improve the technical competence of their staff.

3-2-7 Basic Policy of Implementation of Cooperation

The above discussion, regarding the implementation of the Project, examined the effect and feasibility of the Project, the implementation capacity of the recipient nation, and other factors. It was then confirmed that the Project complies with Japan's grant aid cooperation system. Therefore, it was judged appropriate to carry out the Project under the grant aid cooperation of the Government of Japan. Under the premise that Japan's grant aid is utilized, the outline of the Project is discussed in the following sections in order to carry out the basic design. With regards to the content of the Project, the appropriateness of modifications to the Request has already been reasoned out at the Examination of the Content of the Request.

3-3 Outline of the Project

3-3-1 Implementing Organization and Ministry in Charge

1) Implementing organization: IFP (Integrated Fisheries Project)

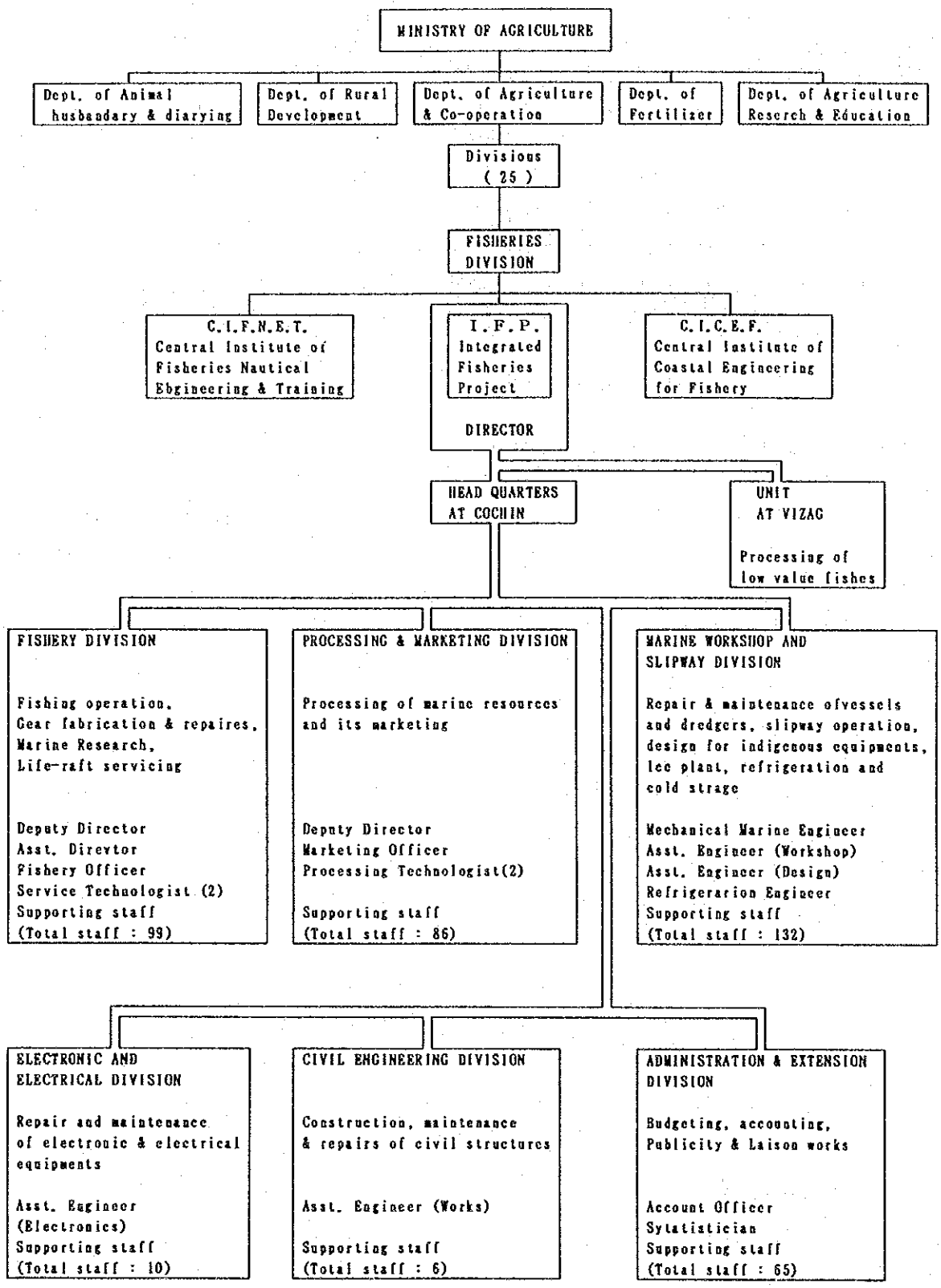
Place and port of registry: State of Kerala, Cochin

IFP, under direct supervision of the Fisheries Division of Ministry of Agriculture, is in charge of this Project. Fisheries wing of the project will carry out fishing operation of the Project ships. The Engineering wing will repair and maintain the Project ships and the Fishing Gear Section will develop and repair fishing gear. the Scientific Research Section and Statistics Division will handle research data collection and analysis.

2) Ministry in charge: Fisheries Department, Ministry of Agriculture

3) Organization Chart

ORGANIZATION CHART OF INTEGRATED FISHERIES PROJECT



3-3-2 Project Plan

1) Research area

The IFP will be based in Cochin, and the research area will be the waters off the West Coast, where fishing is highly concentrated in the area running from the Pakistan border, north off the West Coast of India, to Adams Bridge, including the Wadge Bank off Cape Comorin in the south. There is a rich fish stock in this region. Research will be conducted in the above area, especially in water between 50 and 100m, or at most 50 to 150m deep, where development is relatively easy.

2) Combined navigation scheduling with existing ships

Off-shore research, covering a wide range of the designated areas, will be conducted by Project ships equipped with refrigerating facilities and, whenever promising fishing grounds are located, their feasibility study will be conducted by the two ice-storage ships now under construction in a Bombay shipyard. Data obtained by those ships will be directly used by private fishermen.

(1) Navigation schedule for the Project ships: The entire area off the West Coast of India

(2) Navigation schedule for IFP's ice-storage ships: Feasibility study in areas off Cochin and promising fishing grounds located by the Project ships

3) Navigation days

The scheduled duration of 21 days per voyage is considered reasonable, allowing for the required navigation days of the Project ships sailing to a research area, ordinary navigation days of India's off-shore fishing boats, and other factors.

4) Catch

The average catch per hour by a Project ship in a research area is estimated to be 228kg. The operation duration, per voyage, of a Project ship is seventeen days, and there are nine full net towing hours per day. However, there are twelve operation hours including net shooting and hauling). The catch per voyage is thus calculated to be 35 tons.

5) Research fishing method

The primary research target of the Project ships is the demersal fish stock, with midwater and pelagic fish stock being treated as a secondary target. The Project ships

will therefore be equipped with fishing equipment capable of bottom trawling and midwater trawling.

3-3-3 Determination of Principal Particulars of the Project Ship

In the preliminary investigation, certain problems regarding the stability of the principal dimensions of the requested fishing boat were brought up. The stability of the basic design has been studied and the result of this study shows that the width of the hull has to be increased while the molded depth has to be decreased to raise stability. The dimensions of the fish hold, fuel oil tank, fresh water tank, engine room and crew accommodation will be as shown below as determined by the project plan. See Chapter. 4, "Basic Design" for further details.

1) Freezing capacity and fish hold capacity

For calculation of required fish hold capacity and quick freezing capacity, the following conditions are used. The average operation days per voyage are 17. Daily operation hours are 12, and hourly catch is 228kg. Net trawling time minus net hauling and casting time are 9 hours a day. Then, catch per day and per voyage is about 2.1 tons and 35 tons respectively. Thus, the following calculations are given:

Catch per hour	Net trawling hours	Catch per day	Catch per voyage
228kg	9	2,052kg	34,884kg

A quick freezer can freeze the catch in a cycle of about 6 to 8 hours (including 30 minutes each for putting fish in and out of the equipment) depending on the freezing capacity. Recent trawlers are generally equipped with freezers which can freeze the catch in a cycle of 6 hours to ensure quality of the catch and optimize efficiency. The Project ships will also have the same capacity.

Freezing equipment to be installed will be a plate type (using a cooling plate to freeze fish) which can produce frozen products of higher commercial value as exports and a air cooled type (semi-air blast freezer using cooled air circulation to freeze fish) which is widely used in India. These two freezers' capacities are specified as follows:

Daily catch	Freezing plate type Plate type freezing	Semi-air type Blast type freezing	Freezing capasity 6 hours	Freezing capacity 12 hours
2,052 kg	6 x 10 x 10 kg = 600	500 kg	1,100 kg	2,200 kg

The fish hold should have the following capacity in order to store the fish caught during one voyage. However, if aluminum fish crates are to store the fish, a stowage capacity of 0.4 is required.

Catch per voyage	Loading factor	Required fish hold capacity	Semi-air type room Blast capacity	Required fish hold capacity
35 ton	0.45	77 m^3	8 m^3	85 m^3

2) Fuel tank capacity

Fuel consumption of a fishing boat differs whether it's on a voyage or during fishing operation, and when during operation, it differs whether it's towing, hauling, or casting the net. Fuel consumption was calculated according to the operating conditions of the main engine (propelling engine) and generators (Attached Reference 5). The following tables give the outline of the calculations. The basis of calculation is a standard voyage of 21 days including 17 days of fishing operation.

Fuel consumption (liters) Items	Days	During operation	Voyage	Total
Fuel consumption per day		1,543	2,584	
Operating days	17	26,231		26,231
Hours steaming	4		10,336	10,336
Lay days/Preparation for the next voyage	10			
Lay days/Anchorage and leave	14			
Total	45	26,231	10,336	36,567

Unit: liter

Fuel tank capacity of 60 cubic meters is required according to the following calculations:

Items		Unit	Required capacity (liters)
Fuel consumption per voyage		36,567	36,567
Reserve fuel (for 4 days) margine	10%	2,584	10,336
Required fuel volume		3,6578	3,657
Loading factor	85%		50,560 ≒ 51kl
Required tank capacity			60 m^3

Note: A ship with a completely filled-up fuel tank is susceptible to spill of fuel during fuel loading and during navigation by rolling of ships. Greater loading factor means a greater capacity for fuel as well as a greater risk of fire and subsequent potential marine contamination.

3) Crew

The Project ship will conduct fishing operation for 12 hours a day. Although the requested size of a crew is 17, which is greater than a standard Japanese ship crew, we recommend the Project crew size be 16 considering the working conditions based on India's lifestyle and the IFP's policy of accepting CIFNET trainees as deck hands.

3-3-4 Maintenance Management Plan

1) Maintenance capability of IFP

The IFP owns a slipway with six side berthes and its vessel maintenance section owns various machine tools, related equipment, and they have about 100 experts. It has a forty year history of servicing its own ships, various research vessels of other governmental organizations, and private vessels. With its high level of maintenance capability, the IFP can ensure sufficient maintenance service to the Project ships after they have been handed-over.

2) Fishing gear maintenance capability

IFP owns a fishing gear repair section, which produces fishing gear for IFP's research vessels as well as for fishing research vessels of other governmental organizations and private fishing boats on a contract basis. Its capability is sufficient to handle repairing of trawl nets to be used by Project ships.

3) Mooring facilities

The IFP's base port is situated deep at the end of the Cochin back waters where no oceanic waves reach. The organization owns three piers of total tonnage of 220. The piers have loading hoists for the catch, power supply units, fueling units, and fresh water supply units.

The center route for large vessels in the bay is regularly dredged by the Government of India to ensure a constant depth of 40m. The water around IFP's piers is about 3.5m deep where silt sedimentation occurs by tidal currents. However, a small-

size grab dredger and a small-size pump dredger owned by IFP are commissioned to dredge and clear the waterway.

4) Operation and maintenance costs

Expenses are calculated according to the following conditions. Operation costs are outlined also in the table below.

① Fuel cost is calculated by multiplying a unit price by consumption given according to the navigation schedule. Lubricant cost is calculated as 3% of the fuel cost.

② Maintenance cost per voyage is estimated as 15% of the voyage's fuel and lubricant costs.

③ Under the condition that service life of fishing gear is 2 years, annual repair cost is estimated as 50% of the purchase cost of regularly used fishing gear.

④ The slipway cost is estimated to be the same as that for a similar ship owned by the IFP.

⑤ The salaries for the crew are to be paid from the general account of the IFP, and are not included in the operation cost.

⑥ Meal expenses, navigation allowances, and expendables are estimated based on those for a similar IFP vessel.

Table 3-17 Operation and Maintenance Cost

Costs	One voyage (Rs)		One year (Rs)
Salaries	47,730	Fixed cost	334,110
Fuel cost	153,581		1,075,070
Lubricant cost	4,607		32,252
Meal and voyage allowance	8,764		61,348
Expendables	10,000		70,000
Maintenance cost	15,819		110,732
Dry dock and maintenance	7,143	50,000 Per year	50,000
Fishing gear cost	31,429	220,000 Per year	220,000
	231,343		1,619,402
(1 rupee is 4.2 yen as of Aug. 1992)		¥	6,801,488

The IFP returns all proceeds derived from sales of catch and processed marine products to the National Treasury. Thus, no catch sales are included in the estimation of operation cost. But, for reference, a balance of operation cost, allowing for the sales of the catch, is given below.

Table 3-18 Proceeds and Expenditions

	One voyage (Rs)	One year (Rs)
Expenditure (required fishing operation cost)	231,343	1,619,402
Income	139,536	976,752
Difference	-91,807	-642,650
Operation time	12.16 Hr.	
Trawling time	9.0 Hr.	
Catch per hour	228 Kgs.	
Catch per day	2,052 Kgs.	
Operation days per voyage	17 Days	
Catch per voyage	34,884 Kgs.	
	34,884 Kgs.	
Price of fish	4 (Rs)	
Landing per voyage	139,536 (Rs)	
Landing per year	976,752 (Rs)	
	¥ 4,102,358	

Chapter 4 Basic Design

Chapter 4 Basic Design

4-1 Design Policy

The preparation of the basic design of a Project fishing boat should be based upon sufficient consideration of the Five-Year National Plan, the objectives of the implementing organization (IFP), off-shore fisheries development plan, the IFP's past performance, the background of the Project, navigation schedules, the level of IFP navigators and navigation engineers, repair shop capability, maintenance capability, existing mooring facilities, and Indian lifestyle and customs. The design of the Project ship should also satisfy the conditions of Japan's grant aid cooperation.

1) To design the Project ship which will serve the purpose of research fishing as part of the off-shore fishing promotion program of the Five-Year National Plan.

2) To design the ship in such a way that it can be handled by IFP's slipway facility.

3) To determine the size of the ship and the capacity of equipment aboard the ship based on the navigation schedule executable within the technical level of navigators, after considering the conditions of vessels which the IFP has used as well as their equipment capacities.

4) To design the ship with high safety, stability, and seaworthiness as well as being an efficient fishing vessel.

5) To select equipment and machines which have structures, materials, and systems to enable saving of ship maintenance and repair costs.

6) To allow for energy and power saving features as far as such efforts would not complicate the equipment and machines.

7) To include in the engine design not only a feature to improve velocity in light conditions in calm water, but also to take sufficient consideration of India's sea conditions and trawling conditions.

8) To select fishing gear size suitable for the purpose of the operation and to adopt systems of fishing equipment which even trainees can safely handle.

9) To optimize a catch refrigerator design suitable for the conditions of the operating waters and the type of fish to be caught.

10) To equip the ship with navigation and fishing instruments suitable for the purpose of the operation.

11) To design accommodations allowing for Indian lifestyle.

4-2 Examination of Design Conditions

4-2-1 Dimensions and performance of equipment

Based on the contents of the plan described in this Chapter, capacities and equipment installation spaces required for the navigation schedule, dimensions of the Project ship and its required equipment capacity, will be determined.

4-2-2 Rules, Regulations, and Classification Society

After discussions with IFP staff, it has been decided that the Project ship will be designed in accordance with the following rules and regulations.

1) Items which are fundamental to the design of the hull, including the hull strength, structure, amount of equipment, equipment, and outfitting, will be designed based on the regulations of the Nippon Kaiji Kyokai (NK; Classification society in Japan).

2) NS* and MNS* (marks given to hulls and engines which pass inspection during construction and inscribed on the certificate) will be obtained by passing inspection during construction by the NK.

3) For life saving and fire fighting, due rules of the Japanese Government will be applied, while those of India's Vessel Laws related to life saving and fire fighting (1989) will be used as a reference.

4) The International Convention for Tonnage Measurement of Ships, 1969

5) The International Convention for Prevention of Collision at Sea, 1972

6) For stability criteria, Section 28, Annex 2 Stability Criteria, the International Conference on Safety of Fishing Vessel, 1977 will be applied.

7) The International Telecommunication Union and Radio Regulation 1990.

8) Export inspection of ships by the Government of Japan

9) For others, not covered by the above regulations and rules, standards of Japan Industrial Standard, Japan Electric Machine Industry Association, or Japanese Electric Committee will be applied.

4-2-3 Outside Air Conditions for Designing

Operation conditions of equipment and machines aboard the Project ship will require a standard performance level under the environmental conditions described below. No low-temperature conditioning will be considered since the operation areas of the Project ship will be limited to the tropical zone.

Ambient:	40°C
Sea water temperature:	32°C
Relative humidity:	85%
Atmospheric pressure:	1013 millibar

4-2-4 Requirements for Navigation Schedule

The Project ship will be designed to have the following capacities and performance in order to follow the navigation schedule. A fresh water tank of the Project ship which is larger than that of an ordinary Japanese fishing vessels of the same size. (Japanese fishing vessels of the same size usually have a fresh water tank of about $10m^3$ as they are equipped with a fresh water generator.) The Project ship may not have a fresh water generator because IFP feels that this equipment may not work efficiently in tropics. Instead, larger fresh water tanks will be installed.

1) Fishing method: Bottom trawling and pelagic trawling

2) Operation area: Mainly between water depths of 50m and 150m

3) Fish hold capacity: Total $87m^3$ (bale capacity)

(Fish hold capacity of about $79m^3$ and air blast freezer capacity of about $8m^3$)

4) Fuel tank capacity: About $60m^3$

5) Fresh water tank capacity: About $30m^3$

6) Complement: 16

7) Operation days: 21

4-2-5 Displacement in Dry Docking

IFP's slipway has a maximum load of 250 tons. Allowing for the cradle (about 28 tons), the displacement in dry docking will be designed to be below 220 ± 10 tons.

4-2-6 Trial

The Project ships are supposed to take inspections by NK and export inspections, and after completion, on shoretrial will be carried out, test-operated by the shipyard engineers, and will undergo experimental fishing trial so that necessary data can be obtained to determine the performance of the ships.

4-3 Basic Design

There are a few types of trawling methods used by trawlers. One is stern trawling, in which fishing gear is used, and the net is towed, at the stern. Conventional methods include side trawling, in which fishing gear is operated at the shipside, and semi-stern trawling, a medium between the former two. The Project ship will employ a stern trawling method (which has become an important fishing method in recent days) as requested by the Application Letter.

4-3-1 Type of Vessel

1) Type of vessel

Operation-wise a stern trawler needs a vast hauling deck, and the wider the deck, the more efficient the fishing vessel. As for the size of the vessel, a balanced arrangement of necessary spaces throughout the deck and the securing of necessary stern deck spaces are the requirements to minimize the size of the Project ship.

Vessels the size of the Project ship are apt to lack space on the deck, and this is also the case with the Project ship. Therefore, a long forecastle type, which allows

maximum use of space on the deck, will be adopted for the Project ship. The wheel house will be positioned atop the long forecastle to ensure an unobstructed view.

The use of a long forecastle type allows the hull's center of air pressure (center point of the side area above the water line) to move forward, slightly reducing the course and maintaining the performance of the ship during trawling in the headwind (with wind). However, reserve buoyancy (buoyancy which occurs only when big waters on deck, but does not work under normal conditions) of the bow increases to improve seaworthiness. Merits and demerits of the two element (course stability and seaworthiness) mentioned above were examined and the conclusion was reached that the latter element should be adopted, as the ships safety is considered to be prominent.

2) Arrangement

According to the above, the arrangement and classification of the hull is as follows:

Under the main deck:

Forepeak tank (Sea water ballast cum fresh water tank)

Fore deep tank (fresh water)

Fish hold (under hold is double-bottom fuel tanks)

Engine room (a part of which room bottom are double-bottom fuel tanks)

Steering engine room, net store, fuel tank, etc.

On the deck:

Boatswain's store

Accommodation space and Quick freezing room

Fishing deck space

4-3-2 Dimensions of the Hull

1) Dimensions of the hull

Dimensions of the Project ship (length, breadth, and depth of the hull) to satisfy the requirements of stability, required fish hold capacity, and fuel and fresh water capacity as earlier described are determined.

For determination of major dimensions, we had to determine major items during the field survey and immediately prepare general arrangement plans. These dimensions

were determined, using required capacity, baced on a simplified caluculation using parameters, such as L/B (ratio of length between perpendiculars to breadth), B/D (ratio of breadth to depth), Cb (cubic block coefficient which is given by dividing the volume of a ship under load water line by length and breadth of the ship and depth up to the load line), and speed length ratio (also called Froude number, a function of speed and length).

To facilitate this process, first we collected data of similar vessels in advance and carefully studied them. Then, we prepared lines (which describe the curves of the hull in planes and profiles), hydro static curves (also called hydrostatic curve showing weight, draft, center of buoyancy, metacentric height, etc. which enables estimation of stability), and Bonjean's curves (calculation sheets and drawings showing the area of each section of the hull) and calculated the exact capacities and stability required.

The principal particulars of similar vessels used in those calculations are as follows:

Table 4-1 Principal Particulary of the Similar Type Ships

		Application	A	B	C
Length overall	m	26.8	30.55	28.7	28.0
Breadth molded	m	6.7	6.9	6.5	7.2
Depth moulded	m	3.6	2.95	3.1	3.0
Complement	persons	17	16	12	-
Fish hold capacity	m^3	200	108	105	-
Fuel tank capacity	m^3	60	108	79	-
Fresh water tank capacity	m^3	30	9	21	-
Main engine	horse power	600	575	500	450
Generator capacity	KVA	100 x 2	94 x 2	100 + 40	140 x 2

The principal particulars of the Project ship are to be determined by the following process. (Its flow chart is shown on the following page.)

Preparation of the draft (Preliminary preparation before research)

(1) Examination of the Application Letter (Review of points in question)

(2) Examination of the Project

(3) Examination of necessary fish hold capacity, fuel tank capacity, and fresh water tank capacity according to the navigation schedule of the Application Letter

(4) Examination of fishing methods, fishing gear, and fishing equipment according to the navigation schedule of the Application Letter

(5) Examination of the complement and accommodation arrangement

(6) Examination of the horse power of necessary propulsion engines

(7) Examination of generator capacity and refrigerator and its performance

(8) Determination of the engine room length according to the engine room arrangement plan

(9) Examination and selection of the type of vessel

(10) Selection of similar vessels and study of their capacity, principal particulars and performance specifications

(11) Examination and coordination of dimensions of the Project ship based on the similar vessels chosen for reference

(12) Determination of dimensions of the Project ship, and preparation and coordination of general arrangement plans

(13) Coordination of the Project ship's dimensions based on the general arrangement plans

(14) Estimation and confirmation of stability of the Project ship

(15) Coordination of general arrangement plans and major dimensions of the Project ship

(16) Completion of the draft

Discussions and Basic Design

(1) Determination of the Project

(2) Determination of necessary fish hold capacity, fuel tank capacity, and fresh water tank capacity according to the navigation schedule

(3) Determination of fishing methods, fishing gear, and research areas and water depths, and fishing equipment according to the navigation schedule

(4) Determination of necessary trawling force, engine type, and main engine horse power

(5) Determination of generator capacity, refrigerator and its performance, and necessary equipment and its performance

(6) Coordination of engine room arrangement plans, and engine room dimensions

(7) Examination of the arrangement of fish hold, fuel tank and fresh water tank

(8) Examination of the size of complement and accommodation arrangement according to the navigation schedule

(9) Examination of fishing equipment arrangement plans and cargo handling equipment and examination of the arrangement of stores

(10) Preparation of hull drawings, hydrostatic curves, and Bonjean's curves

(11) Review of dimensions and examination of stability of the Project ship

(12) Confirmation of the proper type of vessel

(13) Preparation of general arrangement plans

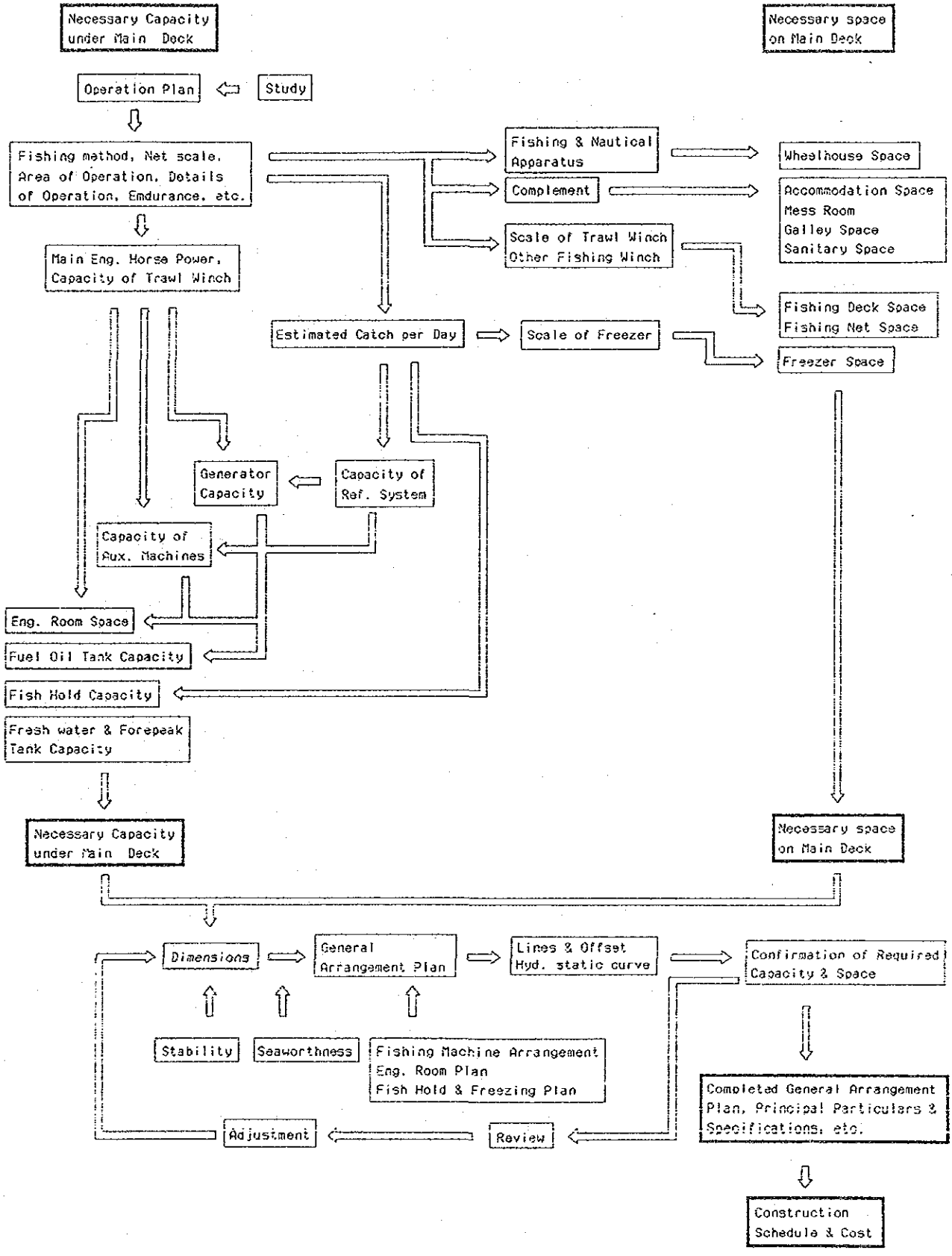
(14) Coordination of major dimensions

(15) Coordination of general arrangement plans

(16) Determination of major dimensions

Major dimensions of the Project ship were determined based on Cb (cubic block coefficient which is given by dividing the volume of a ship under load water line by length and breadth of the ship and depth up to load line) and considerations of the empirically derived ratio between major hull dimensions. Each factor has the following performance-wise relationships:

DESIGN PROCEDURE



Given the same dimensions, a vessel of a smaller Cb is, faster with reduced propulsive resistance, but smaller in capacity. Trawlers are mostly designed, on an empirical basis, to have Cb ranging from 0.63 to 0.68. There are empirically determined optimum ratios of main hull dimensions which differ from vessel to vessel, whether it's Japanese or European, a fishing boat or a cargo ship, or depending on it's length. The following range of the coefficient is considered appropriate for vessels the size of the Project ship.

L/B = 3.3 to 5.0 (for a vessel of around 25m in length between perpendiculars)

B/D = 2.0 to 2.4

L: Vessel's length of perpendiculars (a dimension for designing, which is the length from the center of the rudder stock to the intersection of the designed load water line and the stem)

B: Vessel's breadth molded (a dimension for designing, which is the maximum breadth of the vessel excluding the thickness of the shell plating)

D: Vessel's depth molded (a dimension for designing, which is the depth, at the center of the L, almost from the main deck to the bottom of the hull)

As L increases, hull resistance reduces to allow the vessel to easily speed up. As B increases, stability is enhanced. The construction cost of a vessel decreases with a shorter length (L), and a greater breadth (B) or depth (D), if the capacity is unchanged. The following dimensions were determined for the Project ship based on the navigation schedule, so that the ship can satisfy the designed capacity and performance with excellent stability and seaworthiness.

Length between perpendiculars	:	24.8m
Length overall	:	28.8m
Breadth molded	:	7.2m
Depth molded	:	3.3m

The following coefficients were used:

L/B = 3.44

B/D = 2.18

Cb = 0.64 (when length between perpendiculars is 24.8m and draft is 2.80m)

When the transverse framing system (a structure of the frame placed transversally, widely used for medium- and small-size vessels) is used for the Project ship with a frame space of 500mm (a space between frames, which is generally 450mm to 650mm for a small vessel), capacities determined by Bonjean's curves are as follows:

Table 4-2 Loading Capacities

Frame number	Use	Capacity	Remarks
46 ~ FP	ballast tank	about 6.5 m^3	Fore peak tank
44 ~ 46	chain locker	about 4.0 m^3	part of Deep tank
40 ~ 46	F.W.T	about 29.3 m^3	Deep tank Total 30.8 m^3
			(include cofferdum)
39 ~ 40	Cofferdum	about 1.5 m^3	Void and/or ballast
21 ~ 40	Fish hold	about 87.0 m^3	Bale capacity
21 ~ 27	Air blast freezer	about 8.0 m^3	Inside fish hold
19 ~ 39	F.O.T.	about 48.3 m^3	Double bottom, tank (0.95 m/h)
AFT ~ AP	F.O.T.	about 13.0 m^3	P & S
			Total 61.3 m^3
0 ~ 4	net store	about 17.0 m^3	P & S
6 ~ 21	Engine room		See engine room arrangement

Metacentric height GM (Vertical distance between the center of gravity and the metacenter. It is a measure of stability and the draft is then as shown in Table 4-3. No corrections of trim and GGo (free water effect) are made.

Table 4-3 Metacentric Height and Mean Draft

Condition	Metacentric height (GM)	Mean draft
Leave port full load	about 86 cm	2.69 m
Arrive port full load	about 70 cm	2.53 m
Fishing condition	about 74 cm	2.58 m
Standard condition (light weight plus Fishing gear, crew and effect	about 47 cm	2.17 m

The principal particulars of the Application Letter and those of a proposal and the Basic Design are compared as follows:

Table 4-4 Comparison Table of the Principal Particulars

Principal particulars		Application	Proposal	Basic Design
Type of vessel		Stern trawl	Stern trawl	Stern trawl
Length overall	m	26.8	31.8	about 28.8
Breadth molded	m	6.7	7.4	7.2
Depth molded	m	3.6	3.15	3.3
CN (length x breadth x depth)	m	646	741	684
Complement	person	17	17	16
Fish hold capacity	m^3	120	120	87
Fuel tank	m^3	60	60	60
Fresh water tank	m^3	30	30	30
Main engine output		600 HP	600 PS	600 PS
Generator capacity	KVA	100 x2	130 x 2	80 x 2

Note: An air blast freezer will be installed in the fish hold of $87m^3$.

4-3-3 Propulsion Engine (Main Engine) and Other Equipment

1) Type of the propulsion engine (main engine) and its selection

When selecting a propulsion engine for the Project ship, its durability and engine capacity must both be satisfactory. Thus, a medium-speed diesel engine with reduction gear will be selected. Greater emphasis is placed on durability. So, among engines of the same cylinder diameter, piston stroke (distance a piston covers when it shuttles), and revolution, one that has a lower supercharge pressure (delivery ratio of the turbocharger) and a small heat load will be selected.

A propulsion engine for a vessel the size of the Project ship is usually a marine diesel engine. Marine diesel engines come under three types according to the in revolutions: low speed, medium speed, and high speed. As a diesel engine has a lower and lower cylinder maximum combustion pressure (pressure generated when fuel

explodes inside the cylinder), its durability is greater. If the engine's piston stroke is greater and its speed is lower, its fuel efficiency is greater with better fuel consumption, but its horse power/weight ratio decreases, which means it is a large and heavy engine. Though the conditions are quite the opposite for a high speed engine, they are suitable for small vessels with a smaller engine room as horse power/weight ratio and volume ratio increase. Ideal engine conditions for a small vessel are quite the opposite to those for a large vessel, and they both have their merits and demerits. It remained to be decided as to what would make the most advantageous use at them both.

IFP is experienced in operation and maintenance of vessel diesel engines of slow, medium, and high speeds. They now hope to have an engine of excellent durability, especially a medium-speed one which has the lowest possible revolution, if conditions permit.

2) Selection of the horse power of the propulsion engine (main engine)

The discussion concerning the navigation schedule concluded that bottom trawling would be the main fishing method with midwater trawling as a secondary option. It enabled the design of a engine under the condition that total resistance of fishing gear is 4 tons. As a result, supposing a bollard pull of 7 tons, thrust of speed at 3.5 knots (one knot travels 1 nautical mile, or 1852m per hour) will be 5 to 6 tons, and will reduce to around 4 tons due to the resistance of waves in the ocean. To satisfy these conditions, a variable pitch propeller will be adopted (to be explained later) and the main engine will have 600 PS.

The largest factor in determining the horse power of the Project ship is net scale. The bottom trawl net has no limit of net scale as it touches the sea bottom and is expected to obtain a catch proportional to almost the length of the head rope (rope length at the upper part of the net mouth). On the contrary, for a midwater trawl net, schools of fish swim away in all directions. Therefore, on a commercial basis, a net mouth needs to be about 20m Vertically, transversely and in all directions. Net towing speed has recently reached 4 to 4.5 knots. The minimum horse power necessary in this case would be about 1000 HP. For the Project ship, towing of a midwater trawl net at 3.5 knots is planned using a net of a mesh size of 8m (maximum mesh size of a bottom trawl net is 20cm) to ensure the net mouth of 20m.

3) Type of the propulsion engine

Existing vessels owned by IFP are all supplied by Norway. They are all equipped with variable pitch propellers probably because Scandinavian countries have the longest history of variable pitch propeller use for fishing boats. Captains (fishing

masters) of IFP therefore have a lot of experience in the navigation of fishing boats with variable pitch propellers, but none with those with fixed pitch propellers. Thus, it is determined that the Project ships will be equipped with variable pitch propellers, based on which the propulsion engines will be designed.

As midwater trawling is required to facilitate high trawling power due to the nature of its fishing gear, use of Kort nozzles as a thrust booster was requested in the Application Letter. However, the choice of a variable pitch propeller leads to the improvement of thrust during trawling. So the Kort nozzle was deleted from items of negotiation. The Kort nozzle engine has a propeller in the cylindrical duct, and the propeller used for it is usually a Chaplain type (fan-shaped blade) to maximize the effect of the engine. But this propeller often gathers foreign matter by suction, which damage its propelling blades.

4) Design and designed speed of the propeller

The standard pitch of a variable pitch propeller will be designed to be 6 knots. The revolution of the propeller, though somehow related to the propeller aperture (a clearance between the propeller blade edge and the hull, which causes hull vibration if it is too small), should be 300 per minute with the diameter of a propeller being about 1.9m to enhance propeller efficiency. Propeller development area ratio (ratio of the actual area of the propeller to the area of a circle drawn by the diameter of a propeller) should be such that no cavitation should occur.

(A cavity occurs where an area of high vacuum is generated at the back of the propeller blade. When this cavity is crushed by water, its impulse damages the metal surface. This phenomenon is called "cavitation." Use of a blade of larger surface area can usually prevent it.)

The Project ship is a fishing boat, so in determining the propeller, emphasis was put on trawling thrust. The Project ship, when completed, will have a smaller displacement (the weight of the hull is lighter) and therefore is inclined to have its speed considerably reduced by wave. However, this may turn out to be beneficial in the long run when the entire voyage is taken into account since pitch distribution of the blade will be designed at a speed close to the trawling conditions by reducing the standard pitch.

5) Selection of the propeller shaft bearing equipment

Water at Cochin Port and its off-shore vicinity is silty. Ordinary fishing boats' propeller bearings using sea water lubrication soon take silt in sea water into the

bearings, or are subject to accelerated abrasion of the bearings because of silt. Therefore, the oil bath system is selected and will be designed for the Project ship.

6) Control

For control of the propulsion engine and the clutch, the self-compensating oil control system is employed for its firmness and security. The starting of the engine will be (by and large) manual and will have a remote control facility only to activate the emergency stop function.

There are several methods of remote control. The wire or rod method is excellent in rigidity and requires no special maintenance skills, but whether it is adaptable or not depends on the distance between the steering room and the engine room and their relative locations. On the other hand, the electric or pneumatic method is not governed by those conditions mentioned above and can facilitate subtle and precise control, but requires special maintenance skills. The method proposed for the Project ship has the advantages and disadvantages of both methods mentioned above, but was selected as the emphasis was put on easy maintenance.

4-3-4 Design of Power Supply

1) Power plan

The power plan needs to meet the requirements of power supply conditions in India. So the Project ship will be designed to have a 400V, 50 Herz three-phase A.C. power supply for a major power source and a 230V single-phase A.C. supply for a minor power source or power for lighting. For the major power source, three-phase A.C. for one horse power and over and single-phase A.C. for less than one horse power will be used, and a transformer will be used for a voltage drop from 400V to 230V. Power will be supplied by the three-wire three-phase system.

The three-phase four-wire power supply system is used in India. 230V are drawn out directly from 400V through neutral lines ($400V/\sqrt{3} = 231V$). The advantage of this system is that it can easily draw single-phase low voltage without using a transformer, and its disadvantage is that it tends to lose its phase palance. Thus, it is suitable for a power supply facility with a big generator. Whereas aboard the Project ship, generators of a limited capacity will only be available, and loss of correlation balance by the three-phase four-wire system will directly lead to actual reduction of generator capacity.

Therefore, the use of the three-phase four-wire system requested in the Application Letter was deleted from discussion items by mutual agreement.

However, as on-shore city power uses a three-phase four-wire power supply system, the three-phase four-wire system will be used for city power reception and on-shore generators. Then neutral lines will be stopped at the terminals in the power reception panel and generator panel. Power supply in the ship will use the three-phase and four-wire system.

2) Generator

In accordance with the calculation sheets of power consumption, the proposed power plan is that parallel operation of two 80KVA generators will supply power to meet maximum power needs during fishing operation and that one generator can be used to manage low power needs during navigation or fishing operation.

We explained that using one generator to handle maximum power needs, as stated in the Application Letter, wouldn't be very beneficial for a small-size ship. Because, with that plan, a greater generator capacity and a wider engine room space are required, causing an increase of ship building cost, and when the ship is under light electric loads, the combustion condition of the generator will deteriorate, causing an increase of fuel consumption per H.P., or dirtying fuel injection valves and combustion chamber due to imperfect combustion, eventually reducing quality of the lubricant.

4-3-5 Fishing Equipment

1) Fishing equipment and other winches

The design of fishing equipment intends to use bottom trawling as a primary research method and midwater trawling as a secondary method.

Since midwater trawling is considered to be a secondary fishing method and since the fishing deck space is limited, the two net drums requested, in the Application Letter, have been reduced to one. The gallows and fishing equipment will be designed under the conditions that the otter board, for midwater trawling, will be housed on the deck and that when it is used the otter board for bottom trawling will be used instead.

The prime motor for fishing equipment on a fishing boat the size of the Project ship is usually powered by electricity or by a hydraulic system. Hydraulic systems are categorized into a lower pressure hydraulic systems and a high pressure hydraulic

systems. The Project ship will use a high pressure hydraulic system since it is easy to repair and will reduce the space required for piping. The proposed use of a variable pitch propeller for the Project ship will allow the hydraulic pump to be driven easily by the main engine since it can reduce propeller thrust when keeping the main engine revolution constant. As a result, the proposed system, in comparison with the generator driving system, can reduce the ship building cost and maintenance requirements. It will also realize fine system structure port and energy efficiency improvements.

It will be arranged so that when at author, when the main engine cannot be used, electric motors will drive a small hydraulic pump to supply power to the other equipment, including a mooring winch (windlass and the like) and a cargo winch. Since many of the IFP's vessels were granted by Scandinavia a region of advanced hydraulic technology, they are equipped with fishing equipment that use both high and low pressure hydraulic systems. Therefore, the IFP's staff should have no problem handling such equipment.

A large power source is generally required to drive a hydraulic pump for fishing equipment. (About 90 H.P. is estimated necessary for a vessel the size of the Project ship.) To drive a winch, the hydraulic pump may be driven directly by the main engine, or a diesel engine for power generation, or by a motor powered by an inboard power supply. The features of these three methods are outlined as follows:

(1) Hydraulic pump-Direct drive from the main engine

Of the three, this is the most energy efficiency (with fuel consumption of 165gram per hour per H.P.). However, if a fixed pitch propeller is used, its revolution varies, changing delivery of fluid. This problem does not arise in the case of project ship since it uses a variable pitch propeller. The main engine generates the greatest horse power than any other engines aboard the ship and can afford to supply sufficient energy to the hydraulic pump. No additional prime mover is necessary to drive the hydraulic pump.

(2) Hydraulic pump-Direct drive from power generating diesel engine

This is the second most energy efficient method (with fuel consumption of 185gram per hour per H.P.), but additional power is required to drive the hydraulic pump. This type of diesel engines designed for power generation, ensures constant revolution, and is a superior power supply for the hydraulic pump. (With a fixed pitch propeller, it is impossible to get large power from the main engine when its speed is reduced. Then, the only power supply for the hydraulic pump is a diesel engine.)

(3) Drive by motor

Since energy is converted from the diesel engine - generator - motor - hydraulic pump, energy efficiency is the worst of the three driving methods. In addition, a large space is needed for installation. However, this system provides high utility since the hydraulic equipment can be driven by more than one generator or, even at anchor, by a city power supply.

2) Shape of the trawl winch

The trawl winch will be designed as a combination type net winch because of width restrictions on the fishing deck. In this case, the warp will be a type that winds in the main drums on both sides and has a net drum at the center. The net drum capacity must be at least 4.5m^3 to sufficiently wind in a bottom trawl net whose volume is large.

3) Performance of the trawl winch

When the stationary thrust of the Project ship is 7 tons and at 3.5 knots, net towing power is 4 to 5 tons. Given this condition, the winding pull of the trawl winch is set at 6 tons. Winding pull, which is estimated as 85% of the stationary thrust, is then sufficiently powerful. The winding speed will be set at 40m/min. as requested in the Application Letter.

The length of warp (wire rope to tow a trawl net) will be 1000m as stated in the Application Letter, since according to the navigation schedule, the research water depth is between 50 and 150m, but sometimes as deep as 300m. However, the winch must be designed to wind the warp as long as 2000m allowing for securing and marking of the warp during winding. The diameter of the warp will be 16mm to sufficiently bear resistance of the net.

In general it is considered that the stationary thrust of a large trawler is 1 ton per 100 H.P., and that the winch pull is 60 to 70% of the stationary thrust. However, greater values are usually adopted for a small trawlers than for a large ones.

A faster winding speed can shorten the net hauling/casting cycle. However, the research waters currently scheduled are not so deep and, even if the winding speed was increased it wouldn't be that effective since one net hauling/casting time is about 30 min. and the trawling time is 2 hours.) Therefore, to save driving power, the winding speed remains as it is in the Application Letter. The considerations used to reach this conclusion are shown below for reference.

Table 4-5 Reference Table of the Trawl Winch Capacity

Winding speed	Operation depth	Warp length	Winding time	Driving power
40m/min.	100m	300m	7.5 min.	90 H.P.
60m/min.	100m	300m	5 min.	135 H.P.

When winding in a new warp, the warp on both drums will be wound into one drum on one side (for a length of 2000m), and then it will be wound into another drum under tension. The warp must be firmly wound, or the outer laps of the warp may get tangled with the inner laps and the warp may be damaged. Therefore, as mentioned above, sufficient allowance must be secured on the each drum to firmly and properly wind in the warp.

4) Control of the trawl winch

When the net is being cast into the sea the warp is under high tension. A hydraulic brake will be used to control net casting. For stationary braking during towing and clutch control, a friction type brake band control system, using air cylinders, will be adopted to provide sufficient safety for CIFNET trainees.

5) Other fishing winches

Apart from the trawl winch, a total of two fishing winches, one on each side, will be installed behind the wheel house. These 1.5-ton capacity winches will be arranged so they can lift a cod end (a bag at the end of a trawl net where fish is caught) during a big catch and also serve as an cargo winch during loading and unloading catch.

4-3-6 Fishing Gear

1) Bottom trawl net

The bottom trawl net of the Project ship will be besigned by the total resistance of the fishing gear. It will be 4 tons at 3.5 knots. Although there are a lot of pelagic-prone species (such as squid, bream, ribbon fish, etc.) at the target research areas too. In this condition, the trawl net design has been employed as the six seam net to get more height of the Head rope than two seam net. The resistance calculations has been made 40m Head rope and other board area is 2.94m2 (2,100 x 1,400). In the trawl fishing, the net door (submarine blade) is called other board for open the net wings, this door makes lifting power when the ship is towing. The towing speed has been decided Max 3.5 knot

from Engine H. P. and the Oceanic conditions in Indian Ocean. The towing speed at fishing is seems to change from 3.5 knots to 2.8 knots of this vessel size, when the towing speed become down less than 2.8 knots, the other board can not be kept it stability and finally it goes flat down on the sea bed. This is experimental result at laboratory test. This. Above reasons, the project ships towing speed has been made determination.

The fishing gear resistance has mean total resistance of warps, other boards and net body. The resistances of warps and otherboards are in proportion to squar times and the net body will be in proportion to 1.7th power by the ships towing speed. Various expressions of the formulas has been proposed to those calculations for the gear resistances, but still those are prone to error as the results when comparing the actual conditions. It is very rare to meet the differences with in 10%. Owing to this situation, the safest approch for good design of the fishing gear is to find the similar models which has been given the measured values (Towing conditions, Engine power, etc.). Then such models measurment can be used as the alternations or the modifications to reach desirable values of the gear scale. This approach has been employed in our calculations.

2) Midwater trawl net

As previously explained, the Net mouth opening is 20m wide in all directions (vertical, horizontal, and transversal) with 3.5 knots towing speed. The total resistance will be 4 tons. The other board size is 2.0m x 1.3m (2.6m2). The tendency in recent years in Japan, the towing speed of midwater trawl has been used 4 to 4.5 knots towing speed with lighter other boards. This lighter board has been made purposely for two way as the bottom and midwater. But the project ship has only 600 H. P. main engine, the two way other board can not be employed for small engine.

4-3-7 Refrigerating Equipment

1) Outline

The research waters converted by the navigation schedule are vast and the voyage duration will exceed 20 days. In tropical climates, Ice storaged catches can, at best, remain fresh for only a week. The ice conservation system therefore fails to remain effective through out the original navigation schedule period or until the whole research areas are covered. Therefore, it is essential that the project ship have quick freezing equipment and a freezing fish hold.

Hairpin coils will be used for freezing the fish hold. The fish hold will be designed so that the ceiling and walls, on which hairpin coils are to be applied, can meet evaporation area requirements. No hairpin coils will be applied to the floor piping which is subject to a high risk of damage. The fish hold may also be cooled by using an air cooling unit, but since it is not a suitable system (in terms of operation and maintenance) for a small vessel like the Project ship it will not be used.

For the quick freezing equipment both the plate type (which freezes fish placed on a shelf of hollow plates through which the refrigerant passes), commonly used on trawlers, and the air blast type (which freezes fish placed on a shelf consisting of refrigerant pipes by circulating air with a large blower), widely used in factories on land, for by-catch large fish will be adopted. However, in the interests of conserving space the plate type will be the main system, with the air blast type as a secondary, to allow for a future possibility of freezing marine products aboard the ship for export.

In the selection of the freezing method, environmental considerations were taken into account. R-22 is the best choice as a refrigerant since it does not badly damage the ozone layer and since it is easy to obtain. For the quick freezing equipment, and for the freezer fish hold, a direct dry expansion system will be adopted because of its relative freedom from risks of liquid return and its ease of operation. The flood liquid system is an excellent quick freezing method as it enhances freezing performance. However, it is excluded because of its complex arrangement and difficult operation. Hot defrosting, using the discharge gas of the refrigerator, is also available for removing frost or ice but as this system needs a complex valve operation and causes greater load fluctuation to the refrigerator, it was not adopted.

A reciprocating type, which has already become familiar to IFP people, will be adopted as the compressor. It needs to be made to meet the requirements that two freezing machines will be able to handle a maximum load, taking into consideration the compressor load, generator capacity, starter currents of the compressor, and other factors.

2) Fish hold temperature and quick freezing equipment performance

The standard trawler fish freezing temperature of -25°C will be maintained in the Project ship's freezer fish hold. The evaporating temperature will be -40°C and condensing temperature will be 40°C (based on the predetermined sea water temperature of 32°C).

The plate type and air blast type will both be adopted for the quick refrigerating equipment and will operate at a freezing capacity of 2.2 tons in 12 hours, according to