

**BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR COASTAL FISHERIES PROMOTION
IN
REPUBLIC OF MALDIVES**

APRIL 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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国際協力事業団

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PREFACE

In response to a request from the Government of the Republic of Maldives, the Government of Japan decided to conduct a basic design study on the Project for Coastal Fisheries Promotion and entrusted the study to the Japan International Cooperation Agency (JICA).


JICA sent to Maldives a study team headed by Mr. Shinya Nakai, Director of Second Basic Design Study Division, Grant Aid Study and Design Department, JICA, from October 13 to November 21, 1990.

The team held discussions with the officials concerned of the Government of Maldives, 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 Maldives in order to discuss a draft report and the present report was prepared.

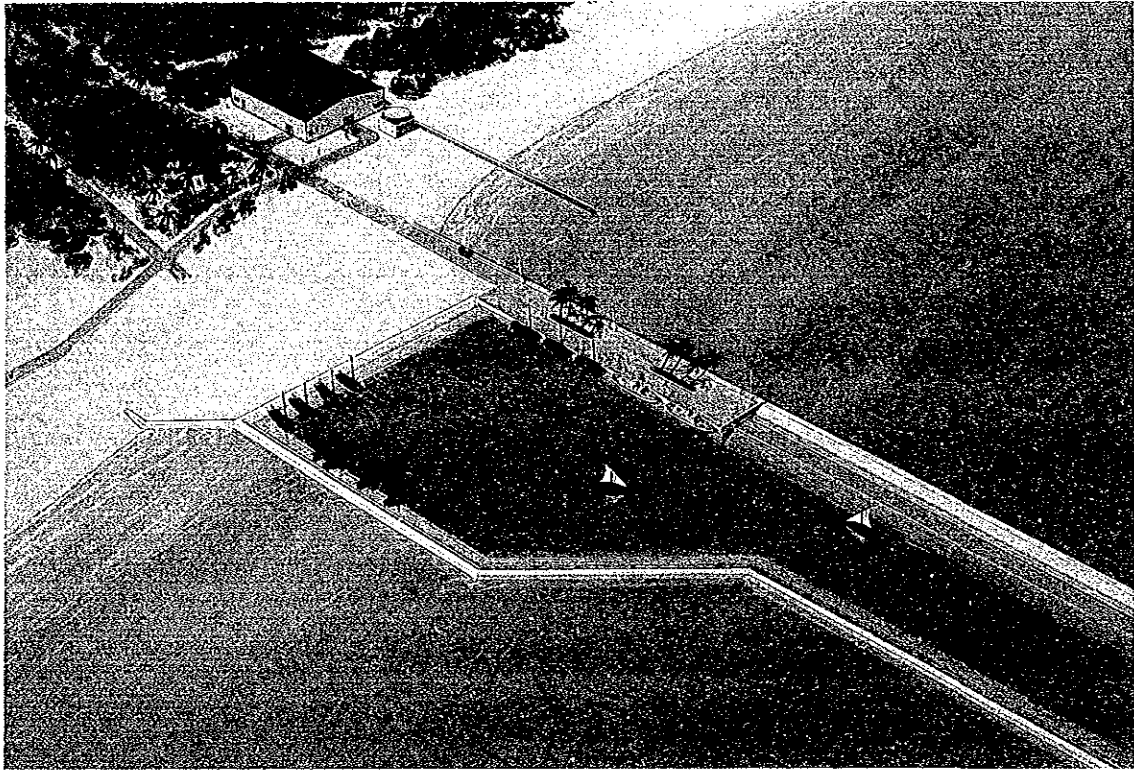
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

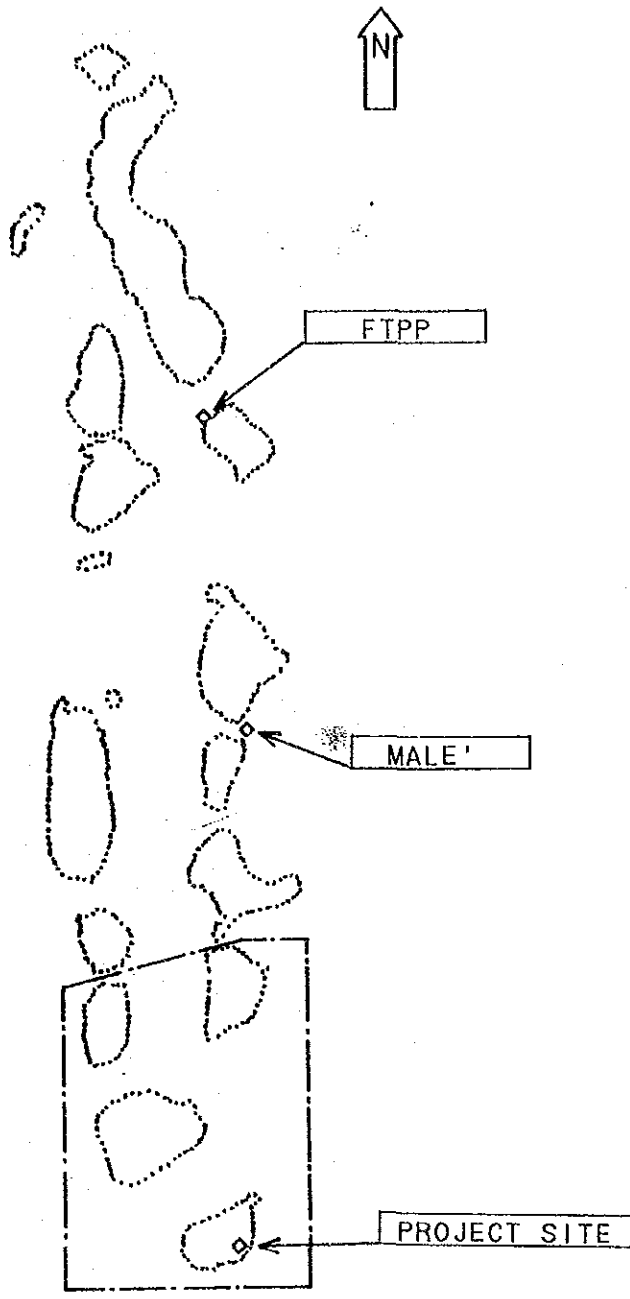
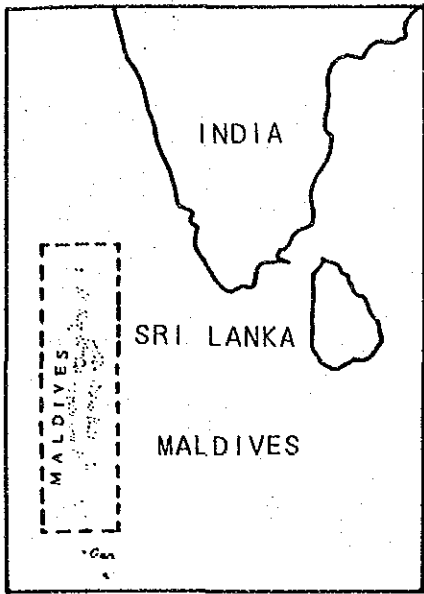
I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Maldives for their close cooperation extended to the teams.

April 1991



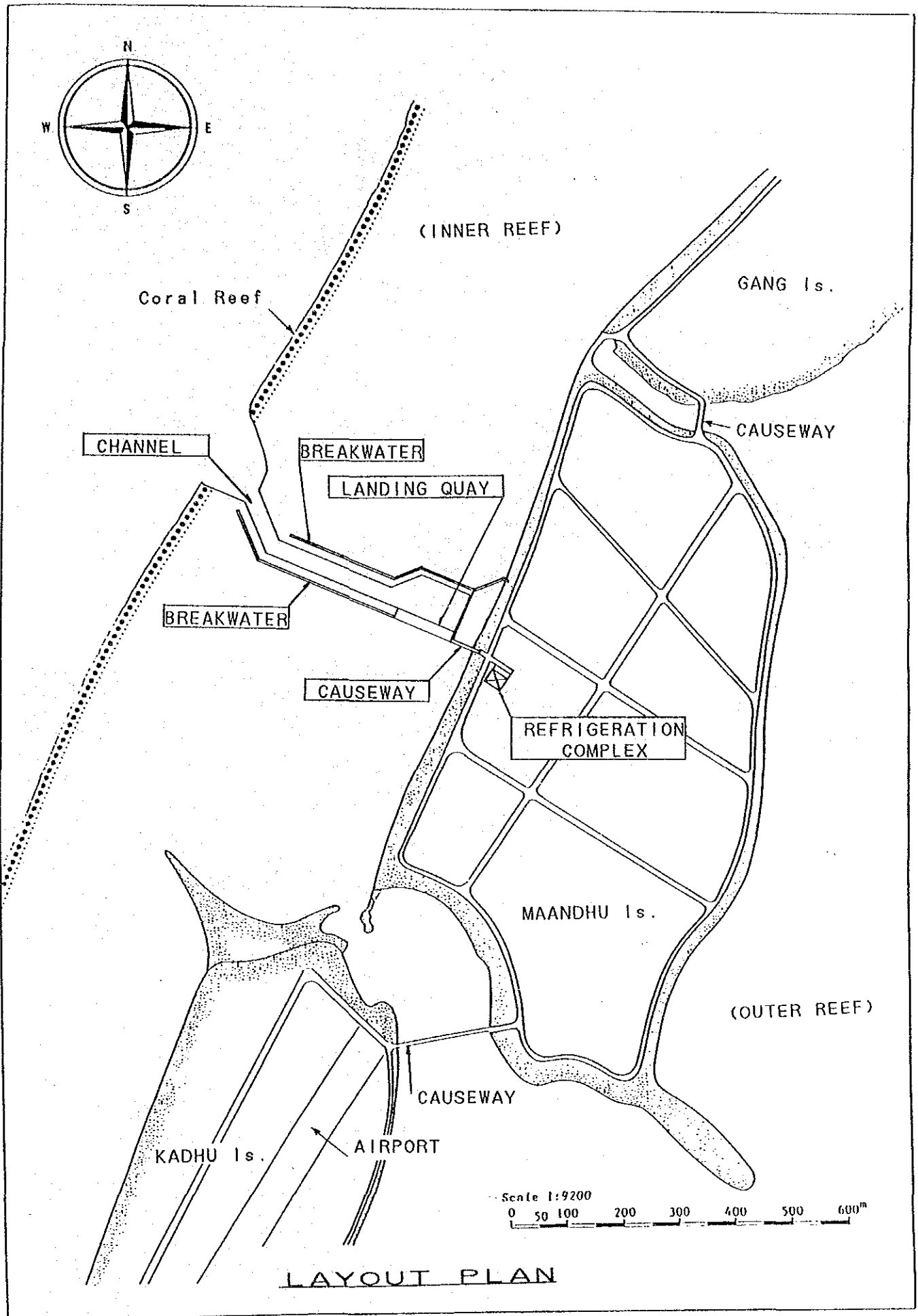
Kensuke YANAGIYA
President
Japan International Cooperation Agency





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LOCATION MAP

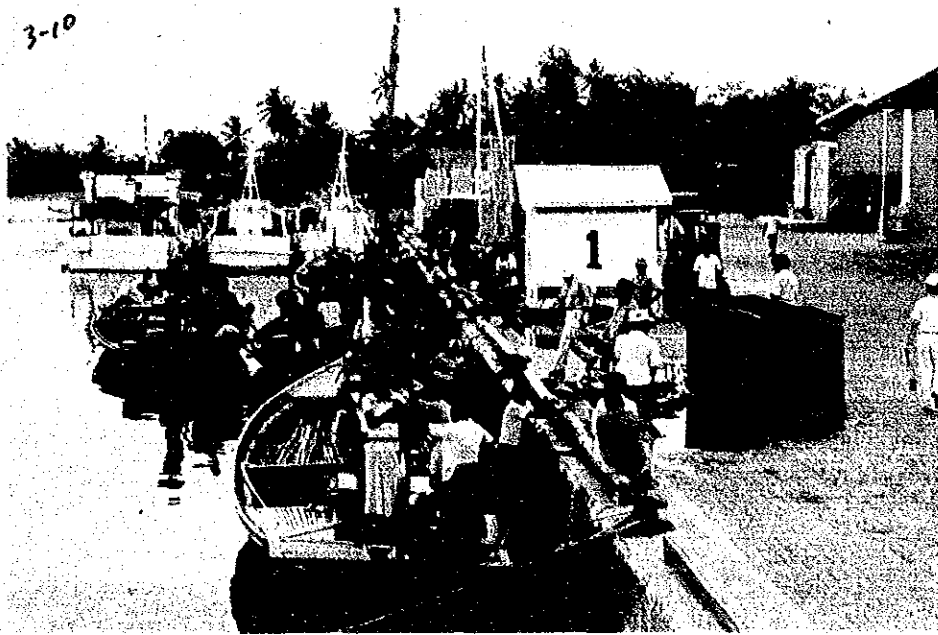




Project Site

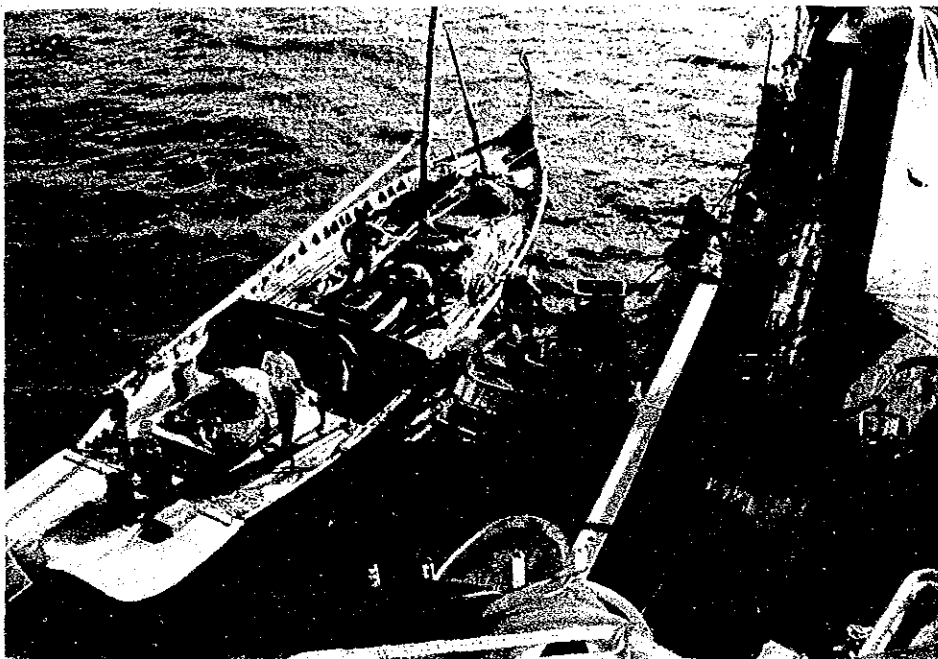
The coast line inside of the coral reef at the project site is quiet as a mirror when there is no wind. The reef (depth of 0.5m to 2.0m) extends out to the sea some 600m. The island is grown over with mangrove, and there is coconut plantation in some parts of the island. The main road is well maintained.

3-10



Felivaru Tuna Processing Plant
 Close to evening, the Dhonies begin to dock at the Felivaru Dock with their catch of skipjack tuna one by one. The catch is unloaded usually 0.5-1.0 ton, but can be big as 2-3 ton when they have a good catch.

The fishermen toss their catch of skipjack tuna on to the dock. The workers of the STO arrange the skipjack into the freezing pallets one by one while checking the quality and taking count, and separating them to the ones over 2 Kg and less than 2 Kg, and separating the tuna into separate pallets. This is to decide the purchasing price and for taking data for statistical purposes.



Mother Vessel

The Dhonie docks along the pontoon attached to the refrigerated mother boat and unload their catch into the fish containers (30-50 Kg) according to their size. The fish containers are loaded onto the deck of the mother boat by hand. There is a staircase between the pontoon and the deck, and it is used by the labores to hoist the catch onto the deck.



The container is weighed immediately on the deck, and the fishermen are paid immediately in cash for their fish.

Summary

SUMMARY

The Republic of Maldives is located mid point of Central Indian Ocean due southwest of the Indian Continent. It is a typical island country composing of 26 coral atolls about 70 nautical miles wide, spaced some 450 nautical miles running north to south. The seas in the islands are teemed with skipjack, tuna, and other fish species, have been known for its potentials. In 1990, the population was approximately 210,000. The growth rate in the past 3 years at 3.5%, has been very high.

The economy of the Maldives consists principally of tourism, transportation services, and fishing, representing more than one-half of the GDP. Fishing accounted the largest share of the export industry.

Skipjack fishing in the Maldives consists of the pole and line method dating back from ancient times, and is still being used todate. In the outlying island districts, fishing is the only means of livelihood, and comprises approximately 57% of the primary industry, or 16% of the GDP. Fishing which provides employment for a large segment of the labor force is also the principal source of food nutrients. Processed fish is exported and earns a lion's share of the foreign currency exchange earnings and is the basic industry of the country's socio-economic support. The fishing industry engaged more than 20,000 people accounting for more than 20% of the labour population. The fishing boats consist of the traditional Dhoni wood which in recent years more than 70% were equipped with mechanical engines. The annual fish production has been more than 70,000 tons, 80% of which has been skipjack.

Of the foregoing, approximately 20,000 tons or about 30% has been exported as frozen skipjack under the business operation of the State Trading Organization (STO). Procurement of fish catch is undertaken by refrigerated mother boats. Unfortunately, their refrigerating capacity is inadequate so that purchasing is often times suspended particularly when there is an oversupply. Compounding the problem is the high cost of operation of inefficient old timer mother boats. For the fishermen in the outlying areas, the sale of their produce to STO is the only method of disposing their catch which they would rather dispose for cash at a sacrifice than to process it.

Confronted with these problems, the Government of Maldives has embarked this project to develop the fishing industry in the Southern coastal region by

strengthening the collection of fish products, processing for refrigeration, and providing the required refrigerated storage facilities in Laamu Atoll nearby the largest fishing grounds. To realize the implementation of the project, the Government of Maldives approached the Government of Japan for assistance under a Grant-Aid Program.

On the basis of the above request, the Government of Japan mobilized a Project Study Team under its implementing arm Japan International (JICA) to Maldives from October 13, 1990 to November 21, 1990 to conduct basic investigation and studies. The study confirmed the rationale of the project and the associated socio-economic impacts and recommended the need for supporting facilities including a fishing port and on-land refrigeration plant to alleviate the plight of the fishing population.

The attached table lists the inventory of the facilities.

LIST OF THE FACILITIES

Name of Facility	Type	Dimensions, Specs.
<u>Fishing Port Civil Work</u>		
Breakwater	Concrete Block Mound Type	Concrete Block: 1ton/0.5ton type Length (Main B/W) : 110m (Sub B/W) : 40m
Submerged Groin	Rubble Mound Type	Length (Main B/W) : 245m (Sub B/W) : 185m
Revetment/Seawall	Rubble Mound Type	Length : 175m
Approach Channel	to be dredged	Length : 110m +140m
Basin/Anchorage	to be dredged	Depth : W.D.L. -3.0m/-2.5m
Landing Quay	Concrete Block Type	Width : 30m Depth : W.D.L. -2.5m
Causeway	Rubble Mound Type w/concrete pavement	Crown Height : W.D.L. +1.8m Apron Width : 10m Water Depth : -2.5m Quay Length : 95m
Building Facility		Width : 5.5m Length : 55m
Refrigeration Complex Bldg. (incl. Office)	Reinforced Conc., Partially Steel Structure	One-story Total Floor Area, 832m ²
<u>Utilities</u>		
Electric Power Supply System	Diesel Engine Generator, 3 units.	Output 250KVA, 400V AC, 50Hz, 3 Ph, 4 Wire
Fuel Oil Supply System	Storage & Dispensing System, Lump Sum	F.O. Tank Cap. : 250k/ x 1 unit
Water Supply System	Storage & Distr. System Lump Sum	150 ton Rainwater Reservoir
<u>Refrigeration Plant</u>		
Freezer	Brine Immersed System	Refr. Cap, 20t/day Ammonia Refrigerant
Cold Storage	Prefabricated Insulation Panel Type	Refrg. Strg. 300ton, Temp. -25°C
Ice Making Plant	Block Ice (using seawater, 22kg/block)	Ice Making Cap. 5ton/day Ice Storage Cap. 30ton

Construction of the Project will be divided into 3 phases and will take 32 months as listed hereunder :

First Phase	:	D/D	2 months
		Construction	12 months
Second Phase	:	D/D	3 months
		Construction	12 months
Third Phase	:	D/D	2 months
		Construction	8 months

The fishing port and freezer/refrigeration facilities will be operated by the STO who is presently operating the Ferivaru Tuna Processing Plant and who is collecting fish produce with 10 refrigerated mother boats. This organization has the expertise, personnel and training facilities, as well as management know-how required to perform the operations in addition to its financial capabilities to purchase fish products, even with rise in the cost of prices.

This project is expected to invigorate the fishing industry in the Southern Atolls Area through provision of the necessary processing facilities. With increasing income it would motivate fishermen to produce more through development of the fishing ground potentials. Construction of a fishing port will contribute to the flow of goods, and the development of the outlying region. The project site has been earmarked as a development area, and the project is expected to trigger development of other fish processing factories and other industries. This will increase opportunities for employment, increase the level of income of the local residents, and impede the migration of people to the capital city. It is envisioned that this will minimize if not diminish the difference in the cost of living between the urban and rural areas.

An early implementation of the project is therefore strongly recommended.

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Chapter 1. Introduction

Chapter 1. Introduction

(1) Objectives of the Study

The development of fishing industries in the Haddummati (Laamu) Atoll in the Republic of Maldives (hereinafter referred to as the "Project for Coastal Fisheries Promotion") was planned for the following three project components:

- ① the development of port facilities, including infrastructures of electric power, water supply and drainage systems,
- ② refrigeration facilities, and
- ③ fish processing plant facilities.

The necessary funding for the project is planned to be obtained from foreign financing institutions. The Government of Japan received a request on February 11, 1990 for the infrastructures and the refrigeration facilities, and amended by another letter dated August 16, 1990, modifying the request to furnish the construction of the refrigeration facilities as a Grant-Aid project.

This project realizes the practical import together with the background of the project, the socio-economic effects, the justification of the project as a Grant-Aid project, to provide the basic design with the most suitable facility and materials, and this project proposes to obtain the necessary data and information for this purpose.

(2) Dispatch of the Study Team

In response to the request for this study, JICA decided to send a preliminary study team headed by Mr. Shinya Nakai, Director of Second Basic Design Division, Grant-Aid Study & Design Department, to Maldives from September 30, 1989 to October 15, 1989.

Based on the results of the preliminary study, the site investigations were made by the basic design study team consisted of 2 Japanese government officials and 5 specialists from private consultants (see Appendix 1). The basic design study team conducted their study in the field from October 13,

1990 to November 21, 1990, and on October 24, held discussions with the Maldivian government officials. (see Appendix 4)

The basic study team of 5, excluding the Team Leader and one consultant specialist, arrived on October 13, 1990, made courtesy calls at the JICA office in the Japan Embassy, Sri Lanka, and arrived at the site on October 16, 1990. The Team Leader departed on October 17, 1990, paid his respects at the JICA Office in the Japan Embassy, Sri Lanka, and joined the study team on October 18, 1990. The government officials left Maldives on October 25, 1990, returned to Japan after paying their respects to the Japanese Embassy and the JICA Office. The 5 private consultant specialists departed Maldives in turn, and the last specialist returned to Japan on November 21, 1990. Details on the investigation and the schedule of dates are given in Data #2.

Details of the Investigation

(a) Advance Preparatory Studies in Japan

- 1) Analysis and Study of the 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 Maldivian officials.
- 2) Explanation of the Japanese Grant-Aid Projects system and discussions.
- 3) Investigation of the project background and investigations.
- 4) Investigation of other projects with higher priority.
- 5) Study of the project facilities and discussions.
- 6) Investigation of the project management and monitoring methods.
- 7) Investigation of the present Maldivian fishing industry and related problems.

- 8) Investigation of the natural conditions of the project site.
- 9) Investigation of the present condition of the project site.
- 10) Investigation of construction related problems.
- 11) Collection of related data.

A list of the people questioned during the course of the investigations conducted, and a list of the data collected are given in Data #3 and #5.

(c) Analysis of the Project in Japan

- 1) Preparation of the investigation report and submission thereof.
- 2) Clarification of the background of the project, the purpose and its position.
- 3) Determination of Conditions to fix the facility size.
- 4) Analysis of the field investigation, and recommendations.
- 5) Determination of scope of the facility and equipment capacity, and preparation of basic design.
- 6) Study of schedules.
- 7) Project cost studies.
- 8) Description of projects financed by the Maldives government, the construction costs, and the progress of the works.
- 9) A study of the maintenance and operation of the facilities.
- 10) The effects of this project, and the justification for the studies.
- 11) The conclusions of the evaluation of the project, and recommendations.
- 12) 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.

Chapter 2. Background of the Project

Chapter 2. Background of the Project

2.1 Description of Maldives

(1) The Country

The Republic of Maldives when it is observed from the Indian Continent lies due Southwest in the middle of Central Indian Ocean. It consists of 26 coral reefs of various sizes, and is a typical island country, ranging from north latitude 7°9' to near the equator of north latitude 0°45', for a distance of some 750km running north to south. Coral reefs which count some 1,190 atolls of which 990 are not inhabited. It covers a total of approximately 298 sq km. The largest is about 6km, and they are all very narrow. The elevation is low with the highest point 1 to 2 meters above sea level.

The weather of the Maldives is affected by the tropical monsoon winds from November to April, the Northeast monsoon prevails with little rain and winds, and dry. On the other hand, from May to October, the Southwest monsoon prevails, with occasional thunderstorms with rain and strong winds, and is the wet season. The average temperature is 20°C, and the relative humidity is 80%, and the amount of rainfall is 1,800mm. Since it is near the equator, there are no cyclones.

(2) The population

The population of the Maldives according to the census taken in 1990 was 214,139 persons, and the average rate of growth was 3.5%.

In March 1990, the population of the capital city of Male was 56,060 persons, 26.2% of the country, and the density was 31,600 person/sq km which is high, and the rate of growth is also high.

(3) The Economy

The GDP in 1989 was, at 1985 prices Rf147.3 million (9.3% growth of previous year) and growing, gave a per capita income of Rf4,083.

The breakdown of the GDP, gave Rf147.3 million for tourism at 17.5%, and next in line was transportation services (Rf144.1 million, 17.1%), and fishing industry (Rf million, 15.7%) which takes up a large percentage, and the 3 services comprise more than one-half of the GDP.

2.2 The Fishing Industry of the Maldives

(1) The Fishing Industry, Fish Resources

The Maldives Islands consists of coral reefs which rise from the Indian Ocean and is 70 nautical mile wide and 450 nautical mile long from North to South. There is no continental shelf in this area, and the edge of the coral reef drops abruptly down to the sea bottom. The climate is affected by the tropical monsoon, and is ocean oriented, and the neighboring islands are also affected to a large degree by the monsoons. From November to April, when the Northeast monsoon prevails, the ocean current is affected by the northeast monsoon current which flows westward, and from May to October during the Southwest monsoon season, the southwest monsoon current which flows to the east prevails. The surface temperature is 27°C to 28°C and varies very little.

The ocean currents and coral reefs create an upwelling in the sea, and there are many small fish living in this area and is suitable for their breeding with the result that it is a good ground for skipjacks and tuna to roam and provide a good marine resource.

The fishing industry in the Maldives is developed around the skipjack (*Katsuwonus pelamis*). Next in the order of catch, ranks the tuna (*Thunnus albacares*), small amounts of bonito (*Auxis thazard*), and Taiwan yaito (*Euthynnus affinis*). The skipjack consists of a school that roam the Indian Ocean, and another school that live permanently in the shoals around the Maldives, with the result that fishing can be performed all around the year.

The skipjack fishing in the Indian Ocean is as follows:

Table 2-1 Skipjack Catch in Indian Ocean

Year	1984	1985	1986	1987
West Indian Ocean	113,774	10,359	10,194	8,909
East Indian Ocean	89,947	111,769	118,333	137,599
Totals	103,721	122,164	128,527	146,508
Inner Maldives Catch	32,049	(32,000)	(32,000)	(32,000)

From early 1980s, there have been many maki ami fishing boats from France and Spain fishing in the West Indian Ocean off the Seychelles catching tuna and skipjack. Their catch is increasing by the year, and in 1987 their catch of tuna was 56,000tons, skipjack 83,000tons (FAO 1989 Fishing Statistics). The catch by the maki ami fishing fleet affecting the catch in the Maldives can be expected to have their effects.

There has not been any useful statistics of skipjack resource catch in the Indian Ocean. Also, it has not been possible to obtain the potential catch of skipjack in the Maldives, but according to reports released by the Ministry of Fisheries and Agriculture, they have indicated that, i) there has been no appreciable change in the size of fish, ii) there has been no big change in the effort to catch fish during the 1980s. The interpretation of this tendency is that there is no cause for any big change in the fishing industry, and strengthens the present policy to secure the fishing within the distance of 75 nautical miles of the Maldives.

The total catch of skipjack in the world was 997,000tons (FAO 1989 Statistics), with a breakdown of Pacific Ocean 741,000tons, Indian Ocean 147,000tons, Atlantic Ocean 109,000tons (FAO 1989 Statistics). If this is computed into catch per ocean area, it is 4,400 ton/million sq km, Indian Ocean 2,400 ton/million sq km, Atlantic Ocean 1,300 ton/million sq km. If it is assumed that there will be little change in the abundance of catch of skipjack, it can be assumed that there is still room to develop the catch of skipjack in the Indian Ocean.

The fishing of skipjack in the Maldives is by the pole-and-line method, and this will be further described in another chapter. This method is dependent on the live bait, and skipjack fishing relies solely on the availability of live bait for their catch. The live bait used in the Maldives given by their scientific classification are the Takasago-ka (Caesionidae), Urume-iwashi-ka (Dussumieridae), Tenjikudai-ka (Apogonidae), including some other 20 species. The small live bait resource is still plentiful, and this has supported the skipjack fishing industry using the pole-and-line method.

(2) General Description of the Fishing Industry

The fishing industry in the Maldives has been performed by the fishermen who live in the coral reef islands and put out to sea for their living which has been the age-old method. This has not changed even today, and the industry has been supported by the multitude of petty fishermen.

In the outlying islands, fishing is the principal means of living, and makes up 57% of the primary industry, and 15.7% of the national industries. It also provides food for the nation, and the produce provides the main export which brings in the foreign exchange, and is the basic industry which supports the socio-economic fabric of the country.

2.3 The Fishing Activity at the Project Site

2.3.1 General Description of the Fishing Activity

The fishing activity at the project site is similar to that anywhere in the country of Maldives, and the fishing is performed by the local fishermen, and the fishing of skipjack is with the pole-and-line. Other methods of seine fishing, hook and gaff fishing, and other methods are rarely used, of other methods. The fishing boats engaged in skipjack fishing with pole and line are now motorized, and all boats have in-board diesel engines with 30-50 HP, are called the motorized Mas Dhonies.

The fishing statistics for the Laamu, Thaa, Dhaalu, and Meemu Atolls are given as follows. From this data, it can be seen that the fishing activities are very high at the project site when compared with its population.

Table 2-2 Fishing Activity at the Project Area

Atoll	Population	Fishermen	Registered Nos. Mas Dhories	(Fishing Boats)	No. of Trips	Fish Catch ^a	Purchased Amount ^b	b/a
Meemu	4,172	915	69	(56)	7,589	2,312	1,182	51%
Dhaalu	4,116	688	56	(51)	5,979	1,369	166	12%
Thaa	8,299	1,372	99	(63)	9,863	4,565	1,812	40%
Laamu	9,109	1,601	133	(85)	15,650	5,701	4,774	84%
Total for Area	25,696	4,576	337	(255)	39,081	13,947	7,934	57%
National Total	214,139	22,025	1,647	(1,114)	183,944	71,247	31,544	
Ratio	12%	21%	20%	21%	21%	20%	25%	

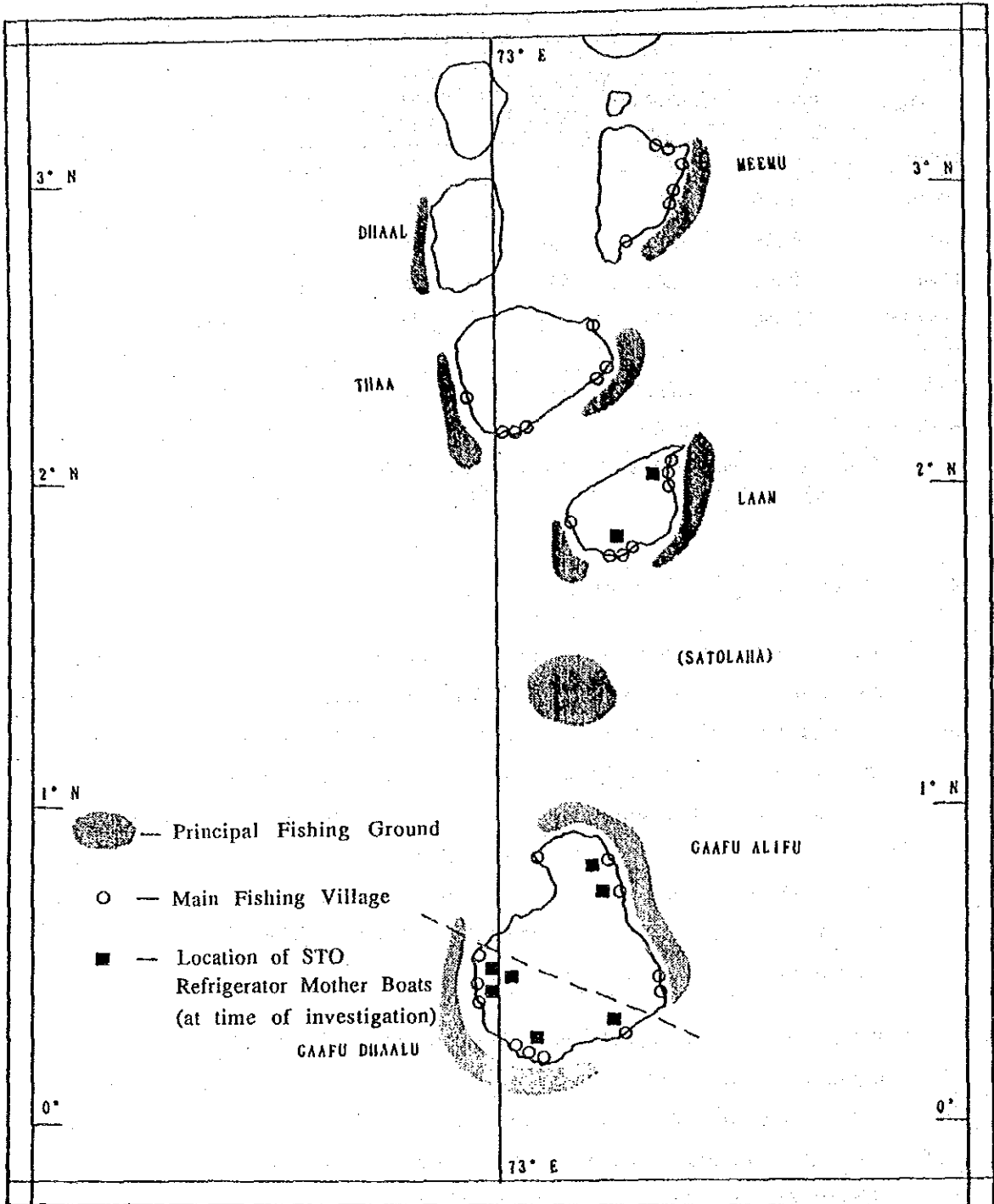
(population obtained from Statistical Year Book, 1990, other figures obtained from Ministry of Agriculture & Fisheries, 1989, and STO purchase data.)

2.3.2 Description of the Fishing Grounds

The fishing at the skipjack fishing grounds is to the windward side of the monsoon winds approximately 10 nautical miles from the edge of the atolls. From December to April during the Northeast monsoon, the grounds are in the Northeast to Easterly area of the atoll, and from May to October during the Southwest monsoon, the grounds are from the Southwest to Westerly side of the atoll. In the vicinity of the Maldives, the ocean currents from the monsoon winds prevail. There are ocean upwells and ripcurrents which bring driftwood and schools of fish. The fish is caught on the windward side by detecting these signs.

In the area approximately 30 miles due south of the Laamu Atoll, there is a mountain range (called Satolaha locally) that rises from a depth of 2,000 miles from the sea bottom, and this provides an excellent fishing ground with the mountain range at its center. There is good fishing throughout the year, and many fishing boats come here from the Laamu Atoll and the Gaafu Alifu Atolls. The following is a map of the fishing grounds in the Southern Atolls.

Fig.2-1 Fishing Grounds



2.3.3 The Fish Catch

Fish catch in the area of the four atolls was as follows:

Table 2-3 Recent Fish Catch

	Unit: ton				
	1986	1987	1988	1989	1990(to June)
Meemu Atoll	2,000	2,200	2,700	2,312	1,496
Dhaalu Atoll	1,400	1,100	1,400	1,369	622
Thaa Atoll	4,000	3,800	5,200	4,565	2,464
Laamu Atoll	4,300	4,800	3,400	6,400	3,358

Source: Fisheries Statistics, Ministry of Agriculture & Fisheries

2.3.4 Fish Distribution and Processing

The use and distribution of the fish catch are generally as follows:

- a) local consumption as fresh fish and processed fish, such as smoked and dried fish.
- b) sale to the STO and/or sale to private vendors.
- c) sale to the STO as fresh skipjack.

Similar to the other atolls, there is a limit to the local demand of fish. It is not possible to make sale of fish to the largest consumer market, Male, due to the distance to the area. In the project area of Laamu Atoll, the purchase by the STO mother boat assigned to the area, becomes the easiest access, however, to the fishermen in the other atolls, it is difficult to make sale of the fresh fish.

The excess of fish caught is preserved as smoked or dried fish in the time-proven method, and when the opportunity presents itself, the processed fish is shipped to the Processed Fish Center of the STO in the Mafusi Atoll, south of Male Atoll. Also, the fish is sold to private merchants who come around once in a while.

It is difficult to process large amounts of fish as smoked or dried fish. For the following reasons, the incentive to process the fish is low as compared to the fresh fish which can be exchanged for cash on the day of the catch.

- a) large amounts of firewood and salt is needed to process the fish, and the purchase of the materials is difficult.
- b) the work is labor intensive.
- c) the STO is active in making purchases, and purchase by private merchants is irregular.

At Muli Island in the Meemu Atoll, there is a fish processing plant operated by the STO where the fish brought by the fishermen is purchased for processing into dried fish. However, the plant is of small scale operation as the market for dried fish is limited, and the collection and processing of fish is not being conducted actively.

There are no statistics available for the fish processed and sold in all the atolls, however, there are data available for the fish industry, purchase records of the fish collected, and the fish consumed per capita, and from these data, the usage of the fish catch can be assumed as follows. At the Laamu Atoll, the shipment of fresh fish can be easily processed and so it has been assumed that there is no shipment of processed fish from the Laamu Atoll.

Table 2-4 STO Activity

	Population	Fish catch ^a	Purchase Amounts ^b	b/a	Shipment for Processing ^c	Local Consumption	Consumption per/yr
Meemu Atoll	4,172	2,312t	1,182t	51%	192t(53%)	501t	120kg
Dhaalu Atoll	4,116	1,369t	166t	12%	709t(52%)	494t	120kg
Thaa Atoll	8,299	4,565t	1,812t	40%	1,757t(38%)	996t	120kg
Laamu Atoll	9,109	5,701t	4,774t	84%	0t(0%)	927t	102kg

2.3.5 The Collection and Purchase of Fish

In the four atolls of the project area, skipjack is being purchased by the STO (DMP Dept.) with the Laamu Atoll at its center. The Laamu Atoll is considered the leading collection point, and there are 1 to 2 main refrigerated mother boats assigned to this area to purchase fish regularly. The refrigerated boats assigned at the time of this investigation were as follows:

Table 2-5 Mother Boats in Laamu Atoll

Assigned to Laamu Atoll	Refrigerated Mother Boat	Gross Tonnage	Age (Yr)	Fish Stg. Capacity	Refrigeration Cap. (t/shift)
Maamendho Is.	Remoara 1	956t	27	730t	18
Maabaidho Is.	Kalaminja 401	932	6	575t	14

A collector boat is dispatched from the refrigerated mother boat to the Thaa Atoll and Meemu Atoll to purchase fish, but the boat is sent infrequently and not regularly scheduled.

The purchase of fish at the four atolls recently is given in the following table. The purchase of fish is the largest by the refrigerated mother boat which is stationed at the Laamu Atoll. The amount of skipjack purchased by the DMP of the STO is about 30% of the total purchased. The collection of fish at the other 3 atolls and the one-time purchase is made by the refrigerated mother boat, but the amount is small and not on a regular basis.

Table 2-6 The Quantities Purchased at the 4 Atolls

	1989	1990 (to Sept.)
Meemu Atoll	1,182t (5.1%)	1,019t (6.4%)
Dhaalu Atoll	166t (0.8%)	2t (5.0%)
Thaa Atoll	1,812t (8.7%)	762t (4.8%)
Laamu Atoll	4,774t (23.0%)	4,886t (30.5%)
Total Purchase by DMP	20,756t (100%)	15,995t (100%)

(* Small quantities have been purchased by the private firm IEL on a small scale at Meemu and Thaa up to June 1989. The quantities purchased by IEL in 1989 was Meemu 386t, and Thaa 1,023t.)

Recent purchases made at Thaa and Laamu Atolls are as follows:

Table 2-7 Monthly Purchase of Fish by STO

Date	Laamu Atoll		Thaa Atoll		Total Purchased
	Purchased Amounts	Avg. Daily Amounts	Purchased Amounts	Avg. Daily Amounts	
1989, Jul.	507	20.3	152	6.1	659
Aug.	393	15.7	58	2.3	451
Sep.	36	13.5	141	5.6	477
Oct.	207	8.9	37	1.5	244
Nov.	745	29.8	142	5.7	887
Dec.	572	22.8	86	3.4	658
1990, Jan.	519	20.7	110	4.4	629
Feb.	494	19.8	150	6.0	644
Mar.	647	25.9	34	1.4	681
Apr.	752	30.1	113	4.5	865
May	409	16.3	127	5.1	536
Jun	684	27.4	110	4.4	794
Jul.	683	27.3	58	2.3	741
Aug.	322	12.9	36	1.4	358
Sep.	377	15.1	23	0.9	400

Recent annual purchased amounts : Laamu Atoll : 6,411ton
 (Oct. 1989 to Sep. 1990) Thaa Atoll : 1,026ton

How Fish is Purchased

When the fishing boat returns from the fishing grounds, they dock along side the refrigerated mother boat and unload their catch. On the mother ship, the catch is classified by type (skipjack and yellofin), by weight (more than 2kg, and less than 2kg), and after weighed, they send the fish to be refrigerated. The fish is paid at the announced price, and paid in cash in accordance with the weighed amount.

The hours that fishing vessels dock at the refrigerated mother boat to unload their catch is between 2:00PM and 6:00PM due to the hours of operation of the fishing boats, and there is a heavy concentration of

The refrigerated mother boat has its limit in capacity, and when there is a large catch, all the fish brought to it cannot be accepted. This has made it necessary to limit the quantities, and this has created a problem for the fishermen.

2.3.6 The Causes that Restrict Fisheries Development

The problem that limits the development of fisheries development is that in the project area there is no large market that is commensurate with the fish caught, and also that there is no facility that can readily accept the fish.

The local demand for the fish is limited as previously stated. Due to the distance to Male, it is not possible to ship the fresh fish there, and the opportunity to send the fish is limited.

The purchase of the fish by the STO is the only means that the fishermen have to ship the fresh fish, but the refrigerated mother boat and the collector boats do not have the capacity to purchase the fish caught throughout the country of Maldives. There are areas where the fish can not be purchased, and it is not possible to ship out the fish even if they were caught. Even in the areas where STO makes purchase of the fish, due to the limited capacity of the mother boat to refrigerate the fish and store in their holds, when there is a large catch, all the fish cannot be purchased.

This problem prevails for the entire country, and does not apply only to the project area, except for the Ferivaru Fish Processing Plant in the North.

2.4 Outline of the Request

The Request for Japanese Grant-Aid portion of the project was made for the construction of the refrigerated facilities and the materials and equipment for the facilities. The description of the various facilities and materials of the requested items will be as follows in their order of priority:

1. Refrigerated Storage Facilities and the refrigeration equipment therefore. (incl. buildings)

2. Fish Hoisting Equipment.
3. Transportation vehicles and Work Vessels.
4. Repair Workshop Facilities (incl. buildings)
5. Ice Making Equipment.
6. General-Purpose Equipment.

The projects contemplated by the Government of Maldives is, ① the infrastructures, ② freeze/refrigeration items, and ③ fish processing complex consisting of fish processing items. They requested financial aid for the items to foreign countries, and it became clear during the field survey that except for Item ② which was requested to Japan, that there was no financial measures made for Items ① and ③. So for the basic design of this project, in addition to Item ②, Item ① was added as a part of the infrastructures of the port facilities, and that the facility could function as a fishing base without the fish processing facilities (cannery), and so the project was planned on this basis for its smooth operation.

The description of the port related infrastructures for Item ① are as follows:

1. Quays
2. Trestles
3. Breakwaters
4. Navigation Channels
5. Fuel-oil facilities for fishing boats

Chapter 3. Outline of the Project

Chapter 3. Outline of the Project

3.1 Objective

The fishing industry of the Maldives, together with Tourism, forms one of the two principal national industries. It is also the one area where export industry is performed by the Maldivians. However, in spite of there being room for development of this resource, the desire to increase the catch in being obstructed due to the following matters:

- The free market for fresh fish is only in the capital city of Male, and the purchase (at official price) of fresh fish is being performed by the collector boats and the refrigerated mother boats of the STO, and the local fisherman can only sell salted-dried fish to the STO. As long as the export market cannot be expanded to the local fisherman, the income of the local fishermen will not increase.
- As long as the fisherman depend on the traditional fish processing methods (smoking and salt-drying), it will not be possible to process large catch of fish. There are the following factors which keep the incentive of the fishermen to process the fish:
 - Firewood and salt, which are the basic materials to process the fish, are difficult to obtain.
 - Fish processing is labor intensive.
 - The international market for fish is limited, and the STO is not collecting fish actively.
 - The fisherman would much rather deal in fresh fish which brings in cash as compared to salt-dried fish processing.
- The collection of the fish by the STO is not being performed at all of the atolls, and so the fishermen at the outer atolls are forced to salt-dry the fish to preserve them. This makes it difficult to keep the young fishermen at the atolls, with the result that they tend to concentrate in the capital city, and this is causing the big difference with the local atolls.

- The atolls where fish is not being purchased by the STO are all requesting that the fish be purchased at their atoll. Even where the fish is being purchased, the fishermen are not satisfied with the amounts being prepared, and they are all requesting that the amounts being purchased to be increased.
- The purchase of fish is being performed by the refrigerated mother boats, but due to the limitation in capacity of refrigerator and storage, even when there is a good catch, the purchase of fish is suspended. The present fleet of refrigerated mother boats have the following problems:
 - Lack in capacity to freeze and refrigerate.
 - Superannuation of the refrigerated mother boats.
 - Increase in the expenses to manage the purchasing fleet.

In order to solve these problems, the Government of Maldives has decided to strengthen the collection of fresh fish, refrigerated processing of the fish, and increase the cold storage facilities. It is planned to increase the fish catch, increase the export of fish, and increase the income of the fishermen. In order to start such a project, it is planned to construct a fishing port in the Laamu Atoll which is closer to a major fishing ground with a frozen/cold storage facility.

3.2 Study and Examination on the Request

The request from the Government of Maldives for this project is as described in paragraph 2.4 of this report. An analysis of the results of our investigation has revealed the following.

(1) The Justification and Necessity for the Project

The present system of collecting the fish by refrigerated mother boats is not only expensive, and due to the shortage in capacity, it becomes necessary to suspend the purchase of fish when there is a large catch. This has been the obstruction to the fishermen to catch the fish, and is also a waste of the fish caught. By providing the fishing port facilities, and the freezer/refrigeration facilities where the fish catch can be accepted, the fishermen can engage in their fishing without

any worries and contribute to increasing their income. This will also add to their incentive to build a cannery plant, add value to the fish caught, and be an efficient method to the use of resources on a National Level and bring additional revenue to the Nation.

(2) Implementation and Management of the Project

The fishing port and the refrigerated/freezer facility will be operated by the State Trading Organization (STO). The STO in managing the Cannery Plant and the Fish Collection and Refrigerated Fish Export at Felivaru, and has the organization to manage and operate the project upon its completion. Financially, this will consist of purchase of the fresh fish, managing the facilities and the workers through the proceeds of the export of the frozen fish. It will be capable of managing the project even if the operating costs increase.

(3) The Relation with Other Similar Projects

As previously described in paragraph 2-3, there is a similar project being planned to construct a refrigerated fish plant for export in the Aleef Atolls of the Laamu Atolls under a Joint Investigation of the FAO and the World Bank. The project will be financed by IDA, but it has not been fully developed for full funding. The fishing vents and the fishing grounds for the project are different from those of this project, and so the two projects will not compete with each other. However, there may be a problem in the assigning of the technicians to operate the facility, and it may be necessary to plan the manpower ahead of time.

(4) The Study of the Facilities Requested

The facilities requested will be capable of accepting the fresh fish, freezing, refrigerating and exporting the processed fish.

1) The Infrastructure

- Quays and Jetties
- Breakwaters
- Ships Channels

- 2) Refrigerating Facilities
 - Refrigerators
 - Refrigerated Storage
 - Ice Making Equipment/Ice Storage
 - Electric Generating Plant
 - Water Supply System
 - Administration Office

- 3) Other Related Facilities
 - Fish Handling Equipment
 - Freezing Facilities for Fishing Boats
 - Work Boats for Export Handling

(5) Necessity for Technical Assistance

Technical assistance will not be required.

(6) Basic Policy for Cooperation

In the implementation of this project, it was confirmed of the Maldives Government that they have the capability to follow through on its justification and realization, that the project conforms to the requirements of Grant-Aid Projects and will realize the desired effects, and justifies the implementation of the Japan Grant-Aids Cooperation. Therefore, the project will be investigated and the basic design will be planned under the Japan Grant-Aid Project.

3.3 General Description of the Project

3.3.1 Executing Agency and Operational Structure

1) The State Trading Organization (STO)

The executing agency of this project is the State Trading Organization (STO) of the Fisheries Projects Implementation Department (FPID).

The State Trading Organization (STO) was reorganized in 1984 after disbanding the original organization. The capital was provided by the Government of Maldives, and is managed by the Ministry of Trade and

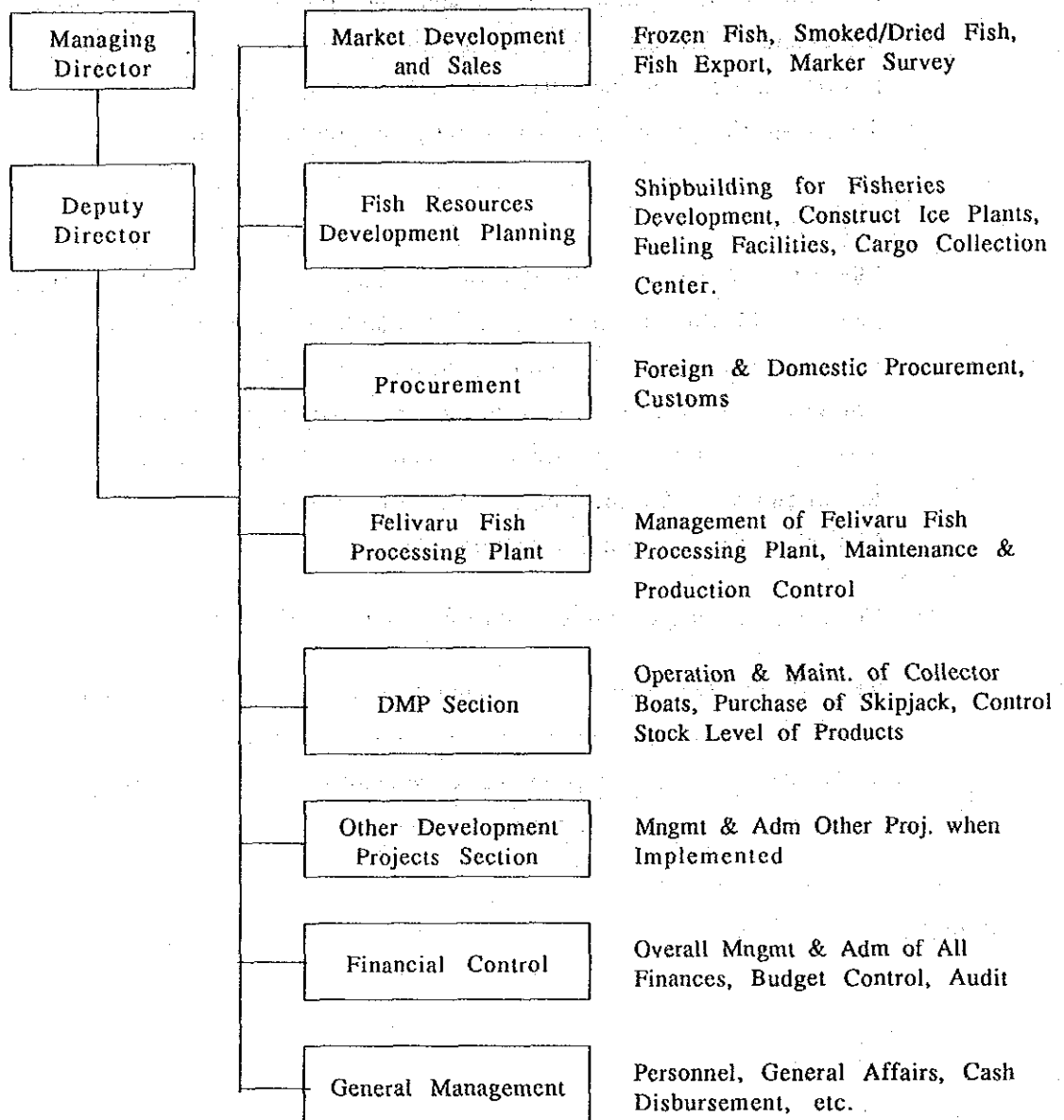
Industry. The position of the president of the STO is held by the Minister of the Ministry of Trade and Industry, and the members of the Board of Directors are appointed by the President of Maldives. All profits realized by the STO are deposited into the annual revenue after deducting the legal reserves, if any surplus is realized.

The STO is composed of the Import Section, Food Supply Section, Sales Section, Fishing Planning Section, Facilities and Maintenance Section, and conducts the transactions of Export/Import Services, Foodstuffs/Petroleum Products/ Construction Supplies Services, Textiles/Electric Supplies Services, Import/Sales of General Merchandise, Collection/Export of Processed Marine Products, Fisheries Project Implementation Services.

2) Fisheries Projects Implementation Department (FPID)

The Fisheries Projects Implementation Department (FPID) Manages the fisheries related matters of the STO. The number of staff is about 1,750 persons, and consists of 6 divisions and 2 executive departments as indicated in the following diagram:

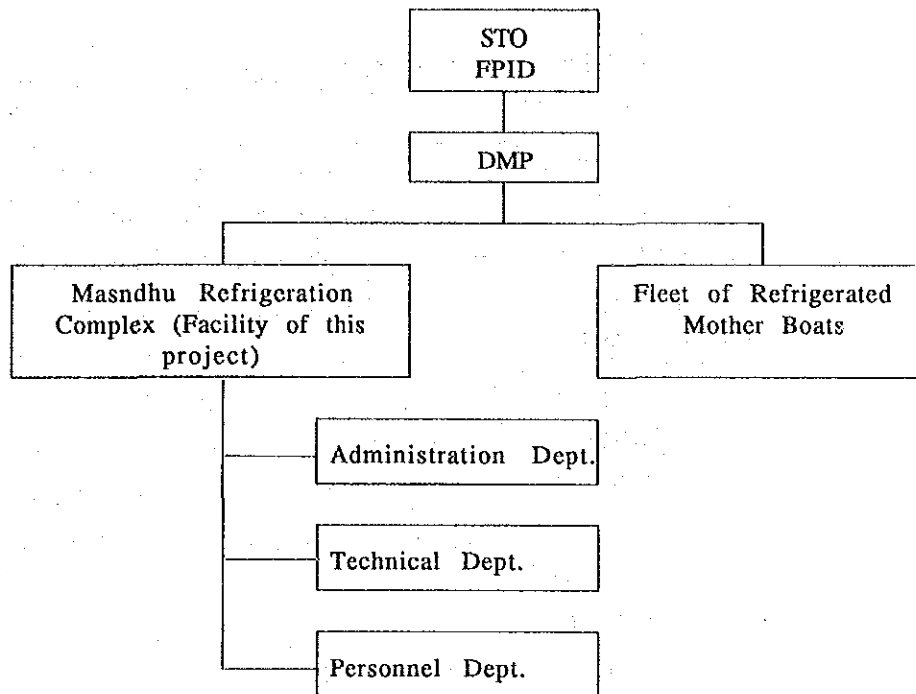
Fig.3-1 Organization Chart of FPID



3) Operations

This project will be managed and operated directly by the FPID of the STO as a part of the skipjack procurement program (DMP). The operations of this project include the assignment of facilities personnel, the arrangement of the cold storage collector boats, to include the production control of frozen skipjack, export, making arrangements for the loading of ocean-going vessels, the frozen storage boats, and the overall coordination of operations.

Fig. 3-2 Proposed Organization of the Project Operation



Field personnel for the facilities will include 4 management persons with 7 technicians, and 50 field personnel.

Management personnel will consist of the chief and 3 persons assigned from the FPID Headquarters in Male, who will manage the general affairs, finances and perform overall coordination.

The technicians will consist of 7 refrigeration, electrical and ship-hold loading engineers who will operate and maintain the equipment in the facilities. For the refrigeration and electrical equipment, there will be 3 shifts for the operation of the equipment on a 24 hour basis. These engineers will be selected from the cold storage mother boats and they shall all be backed with years of experience.

49 workers who will handle the freezing, refrigerating, loading and unloading. There will be 33 workers assigned at the dockside to unload, and all work of transporting to the freezer and refrigeration plant, and they perform work in 2 shifts. All of the field workers will be selected from those personnel who have experience on the mother boats.

Table 3-1 Staffing of Project

Personnel Assigned to Facilities

		Number
Management staff		
A.	Chief	1
B.	Office Manager	3
Technical Staff		
<u>Refrigeration</u>		
A.	Chief Engineer	1
B.	Engineer	3
C.	Mechanic	3
Field Worker		
A.	Supervisor	1
<u>Refrigeration</u>		
B.	Foreman	2
C.	Driver	2
C.	Common Worker	12
<u>Dockside</u>		
B.	Foreman	2
B.	Cashier	2
B.	Inspector	2
C.	Driver	3
C.	Common Worker	24
Total		61 Workers
	A:	3
	B:	14
	C:	44

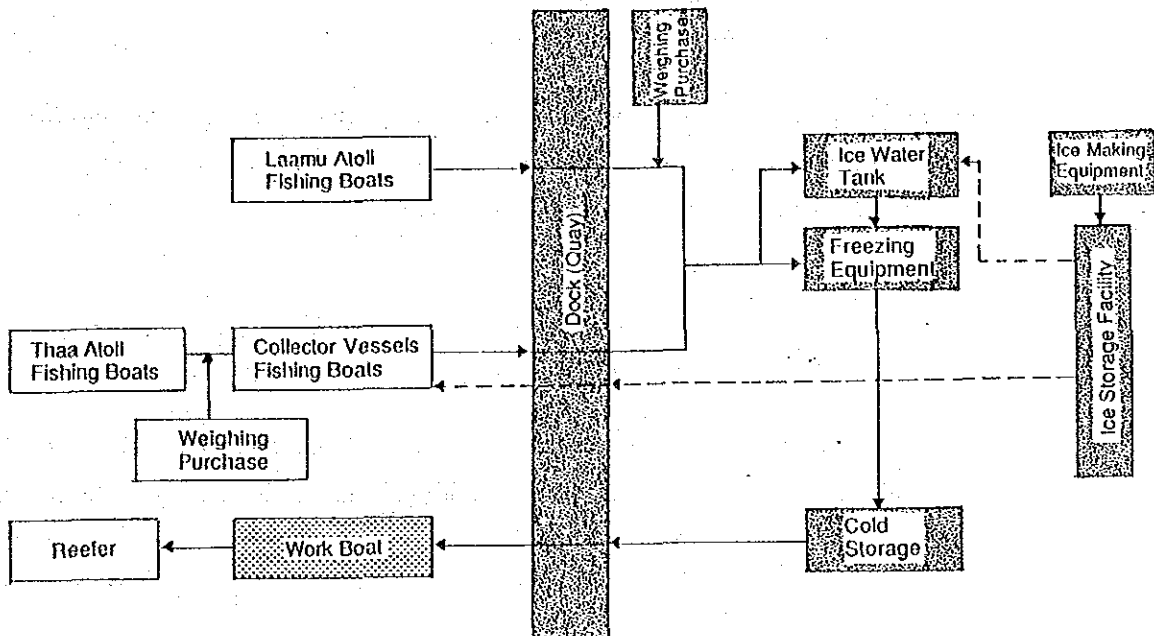
In addition to the above, there will be some 40 additional temporary workers hired to assist with the work on the dock, transporting of the frozen/refrigerated fish, and work with the mother boats.

3.3.2 Plan of Operation

1) Basic Planning Conditions

This project will be managed directly by STO/FPID, and will be a part of the skipjack purchasing project in its implementation and management. With the implementation of the project, there will be a refrigerated storage facility constructed on land in Maanadhu Island, Laamu Atoll, which will replace the refrigerated storage boat used in the past. With the operation of this facility, the fish catch (skipjack) caught by the local fishermen will be accepted for their total quantities, and the frozen skipjack will be exported on a fixed schedule. The flow of Fish/Activity is schemed in Fig. 3-3.

Fig. 3-3 Fish Flow



The collection and purchase of the fish will take place at Laamu Atoll and Thaa Atoll which is closest and has the next largest catch of fish.

There will be two methods of collection: i) direct unloading of fish from the fishing boat to facilities on land, and ii) collection of the fish by collector boats. The fishing boats of Laamu Atoll will unload directly to the proposed facility, and catch of the Thaa Atoll will be collected by the collector boats.

There will be a minimum of two collector boats which make the project site their home base, make scheduled trips to Thaa Atoll where they will make the collection, making payment at the time of collection. It will take 3 to 4 days to make one trip per week, and each boat will make a minimum of 50 trips in one year.

The existing collector boats will be used temporarily, and in the future there will be 2 new collector boats similar to the one used at the Felivaru Fish Processing Plant to replace the present boats.

2) The Assumed Quantities to be Purchased

The main boats that will be used for this project will be the motorized Mas Dhonie Boats (to be called fishing boats herein after). The number of fishing boats stationed at Laamu Atoll and Thaa Atoll area as follows:

Laamu Atoll	85 boats
Thaa Atoll	63 boats

The boats put to sea every day except on Fridays, and depending on the conditions of the sea they do not go fishing, and so it will be safe to say that they put to sea once every 2 days. In checking this against the records available, the number of days that the boats put to sea will be as follows:

Table 3-2 Dhonis Activity

	Number of Times Put to Sea (Yr)	Number of Times Trips per Boat
Laamu Atoll	15,000 - 16,000	Approx. 180/Yr
Thaa Atoll	9,500 - 10,000	Approx. 150/Yr

It is possible throughout the year, and there seems to be no good or lean times for fishing, but in general the overall trend of better fishing months are December thru February, with lean months being May is seems to prevail. From fishing data collected from the Atoll Office, and hearings conducted, the monthly fishing catch breakdown by the month at the Laamu and Thaa Atolls are assumed as follows:

Table 3-3 Assumption of Monthly Fish Catch

Mon.	Laamu Atoll				Thaa Atoll				Total (ton)
	Avg. Catch	No. trips	Catch Month	Catch Day	Avg. Catch	No. trips	Catch Month	Catch Day	
1	0.5t	1,400	700t	28t	0.5t	900	450t	18t	1,150
2	0.5t	1,400	700t	28t	0.5t	900	450t	18t	1,150
3	0.4t	1,400	560t	22t	0.5t	800	400t	16t	960
4	0.4t	1,200	480t	19t	0.4t	700	280t	11t	760
5	0.3t	1,200	360t	14t	0.3t	700	210t	8t	570
6	0.5t	1,300	650t	26t	0.5t	800	400t	16t	1,050
7	0.5t	1,300	650t	26t	0.5t	800	400t	16t	1,050
8	0.4t	1,300	520t	21t	0.4t	800	320t	13t	840
9	0.4t	1,200	480t	19t	0.4t	700	280t	11t	760
10	0.3t	1,200	360t	14t	0.3t	700	210t	8t	570
11	0.4t	1,400	560t	22t	0.5t	850	425t	17t	985
12	0.5t	1,400	700t	28t	0.5t	900	450t	18t	1,150
Totals		15,700	6,720t			9,550	4,275t		10,955

No. trips: 185/boat/year 125/boat/year
 Avg. Catch: 0.42 ton/trip/boat 0.44 ton/trip/boat

The ratio of purchase to the catch has been 84-90% or more in recent years at Laamu, and 30-45% at Thaa. Based on these results, the ratio of fish purchase to the catch was determined as 90% Laamu and 40% for Thaa.

Table 3-4 Assumption of Fish Purchase by STO

	Laamu Atoll	Thaa Atoll	Totals
Yearly Purchase	6,000 ton/yr	1,728 ton/yr	7,700 ton/yr
Avg. Monthly	500 ton/mo.	144 ton/mo.	640 ton/mo.
Avg. Daily	20 ton/dy	6 ton/dy	26 ton/dy
Good Season			
Avg. Monthly	625 ton/mo.	184 ton/mo.	800 ton/mo.
Avg. Daily	25 ton/dy	7 ton/dy	32 ton/dy
Lean Season			
Avg. Monthly	325 ton/mo.	88 ton/mo.	410 ton/mo.
Avg. Daily	13 ton/dy	4 ton/dy	17 ton/dy

These assumed values will be compared with recent catch records. At the Laamu Atoll the yearly amounts purchased were 6,411ton (October 1989 to September 1990). The monthly amounts purchased was 200 to 750ton. The daily amounts were 9 to 30 tons, and the assumed values compare favorably with the actual records.

The catch for last year was 1,026 tons which is a monthly catch of 20 to 150 tons, and the catch per boat is 0.45 ton, which gives a catch of 3-14 ton per fishing boat. This is based on none-scheduled catch. If the purchase-collection was made on a scheduled purchase, a much higher number of fishing boats would gather there.

The assumed amounts of fish purchase-collection by the collector boats will be analysed in the following:

- Number of trips by Collector : 100 trips
- Boats : (1 trip/week x 50trips/year/boat x 2boat)
- Number of days spent for purchase-collection : 4 days
- Average number of fishing boats put to sea : Approx. 32 boats (152 times/boat/year x 63boat 300 day/year)
- Of which, number of fishing boats purchased from : 12 (if changed to scheduled collection, it can be assumed that there will be a 40% increase of fishing boats landing fish)
- Average fish landing by fishing boat per trip : 0.4 ton (based on records)

With the above conditions, fish collection by the collector boasts per year will be approximately 1,900ton (0.4ton x 12 boat x 4 day/trip x 100 trips), which indicates that the fish collection from the Thaa Atoll is within the assumed values.

3) Loading of Export Vessels

The purchased-collected fish (skipjack) will be used as the raw material for canning and exported to Thailand from the land facilities of this project in a frozen or refrigerated condition.

It is planned to make the time kept in a frozen condition as short as possible, and keep the loading period of the ocean-going vessel as short as possible. The loading of the ocean-going vessel will be more than twice a month during good seasons, and more than once a month during lean seasons. The fixing of arrangements of the refrigerated vessels is a very important matter, together with the scheduling of the export refrigerated vessels by the DMP Department, and is firmed up by the FPID of the STO in the Male Headquarters.

Table 3-5 Record of Refrigerated Export Vessels (1989 and 1990)

1989	Loading Dates	Loaded Amounts (ton)	Destination
	January	1,812	Bangkok
		310	Japan
	February	1,327	Bangkok
		366	Bangkok
	March	2,485	Bangkok
	April	357	Bangkok
		1,756	Bangkok
	May	1,299	Bangkok
	June	1,202	Bangkok
		359	Bangkok
		258	Japan
	September	1,491	Bangkok
		1,345	Bangkok
	October	360	Bangkok
	November	589	Bangkok
		362	Bangkok
		1,303	Bangkok
	December	478	Japan
		984	Bangkok
		1,543	Bangkok
	Totals	19,987	

1990	Loading Dates	Loaded Amounts (ton)	Destination
	January	351 790	Bangkok Bangkok
	February	1,065 403	Bangkok Japan
	March	1,656	Bangkok
	April	802	Japan
	May	343 1,298 451	Bangkok Bangkok Japan
	June	580	Japan
	August	1,116	Bangkok
	September	1,170	Bangkok
	October	367	Bangkok
	Totals	10,390	

(Data available up to the first vessel in October, 1990)

3.3.3 Location and Condition of Project Site

1) The site of the project is at north longitude 1°52', east longitude 73°32' on the island of Maandahu on the West North West side. The site is on the eastern part of Laamu Atoll on the inside.

2) The Terrain

The Maandahu Island has approximately 54ha, and on the north is the Gang Island, and Funadu Island on the south and connected there to with causeways. The four islands when connected comprise the largest piece of land in the Maldives. The terrain is flat with an elevation of 1 to 2 meters, and is covered with mangrove or coconut plantations.

The islands are encircled with corals, and the depth of water on the inside are 1 to 2 meters and there are effects of water on the shore. However, outside of the coral reefs, the shoreline slopes down to several hundred meters, and the waters of the Indian Ocean wash the outer edges of the coral, and from May to October when the Southwest Mammu prevail, water (1 to 2 meter)wash the atolls.

3) The Weather Conditions

The weather data presently available in the Maldives, are the records kept at Male Atoll and Gang Island by the Weather Observation Station. For the project site of Maandahu Island and Kadu Island which are connected by causeways, the Weather Station at the Kadu Airport, the temperature, humidity, rainfall, barometric reading, wind direction, and wind speeds are recorded twice a day at regular hours (08:00 and 17:00 hour). The yearly rainfall and wind speed from November 1989 to October 1990 are given in Fig. , which shows the rainfall to be heavy in October with 374mm, with variations of 100 to 200mm, and there does not seem to be water shortages during the dry season.

Since there seems to be almost no design data for this project, the results of observation made are given as follows. The exact location where the observation were made are shown on the map. Since it is expected that there will be much sand movement at the shore of the project site, the sea bed investigation, and shore line observation were made together with tidal movement checks to investigate littoral sand movements.

The results of the survey are given as follows:

- collection of weather data
- tide range observation (31 day and night, 1 each)
- depth investigation
- check of terrain
- soils investigation (boring on land 1 each, boring at sea, 3 each)

Monthly Rainfall at Kadu Island
1989.11-1990.10(1,716.7mm)

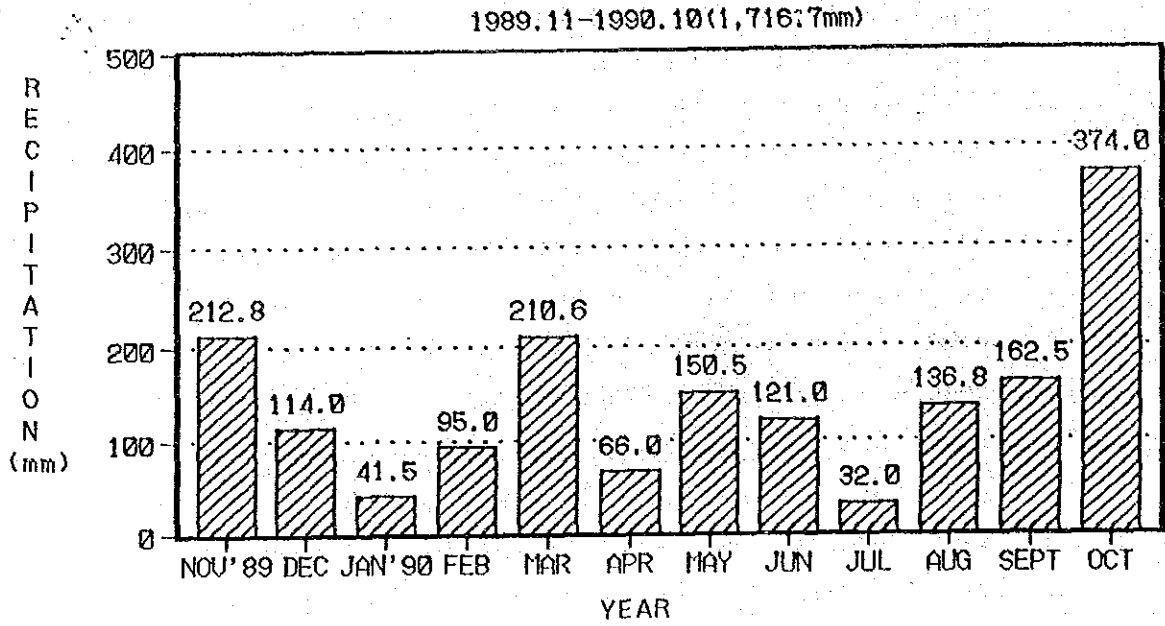


Fig. 3-4 Precipitation (Kadhu)

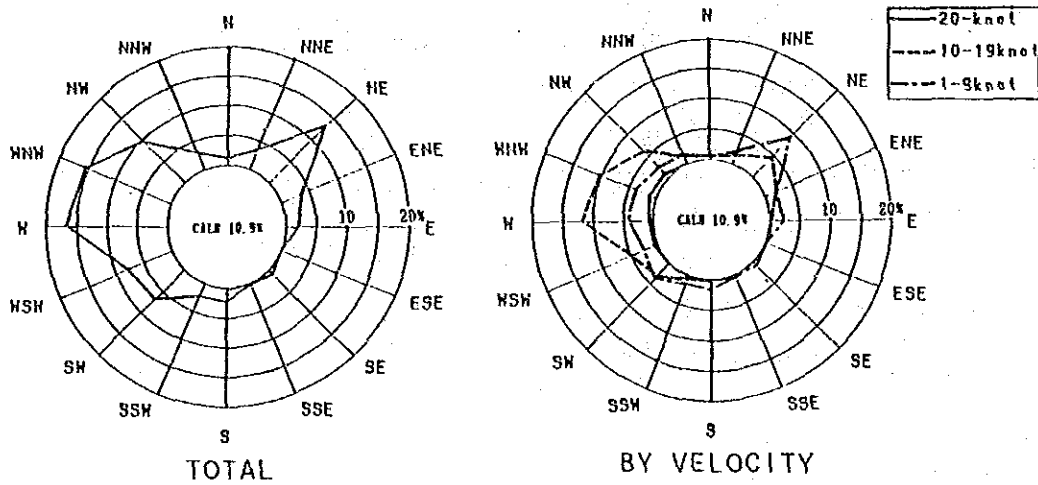


Fig. 3-5 Wind Rose

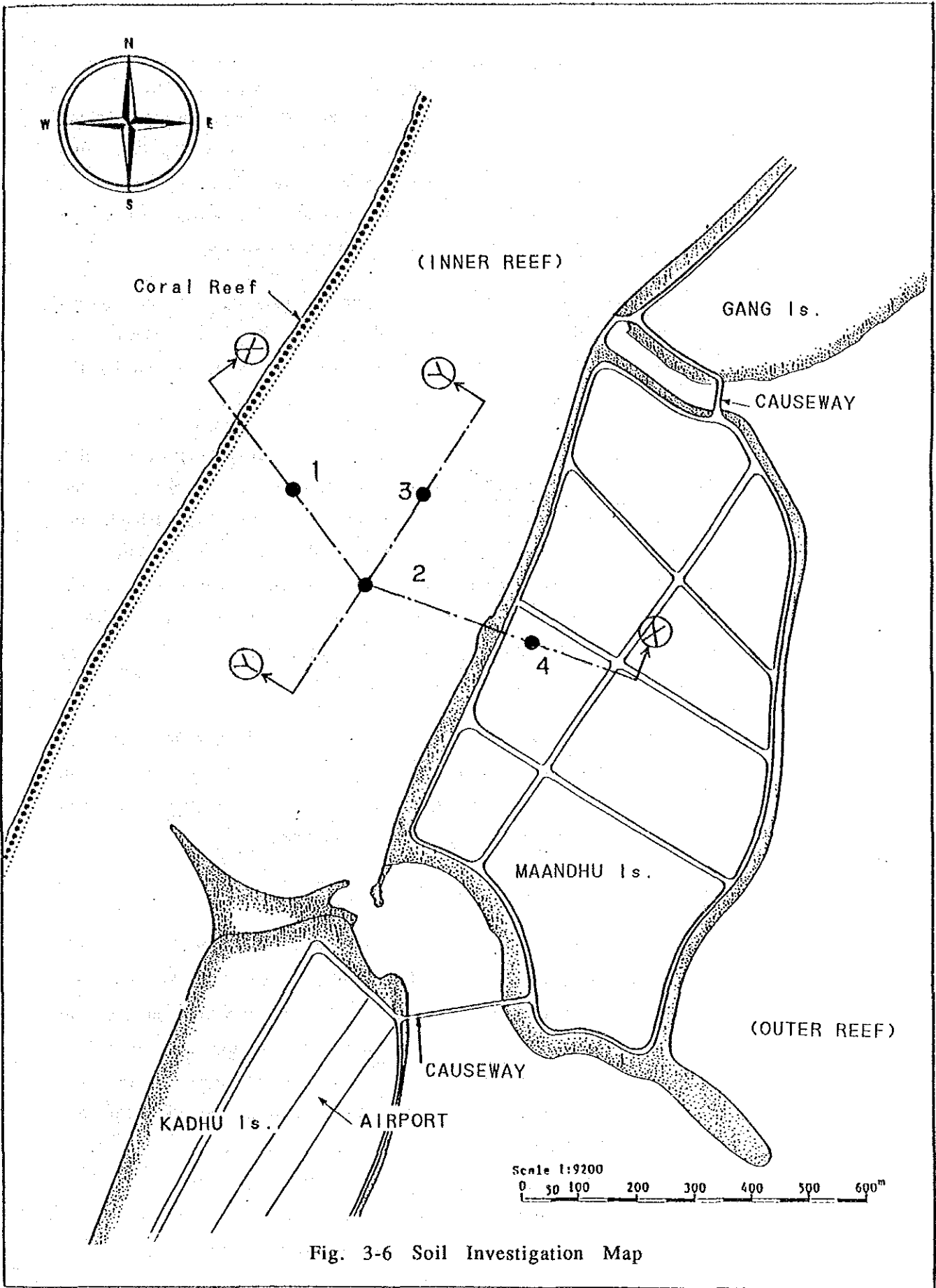


Fig. 3-6 Soil Investigation Map

4) Description of the Project Site

The project site on Maandahu Island and the adjacent four islands have been selected as suited for local development and development of the coral atolls. As a starter, there has been a T-Shirt Factory opened up on Gang Island with Indian financing, and is collecting foreign exchange with its exports.

The project site seashore has mangrove growing, coconut plants growing on the island side, and it will not be necessary to procure new land since the land on Maandahu is all owned by the STO.

The infrastructure is not the best, but there are causeways which connect the four islands (one-way traffic), with a width of 10m. Of the four domestic airfields, one is located on Kadu Island, and the airfield is currently being expanded. At the present time there are 3 scheduled flights a week (Dornier Aircraft). Access from the sea is not developed, and there is no mooring facilities for boats, and the shipment of daily necessities from Male is by Dhonies, and the cargo is beached.

Electric power is turned on at night for people's welfare (6:00PM), and there is no extra power available for construction purposes. There seems to be no dry season for potable water, and the needs seem to be well met with rainwater.

5) The Conditions of the Project Site

The site where the freezer-refrigerator facilities will be constructed is being used to plant coconut tree, and the trees are young trees which can be transplanted. The elevation at the site is 1 to 2 meters, and it will be necessary to provide an earth fill to raise the site for the buildings. It is recommended to preserve the mangrove trees to protect the facilities from the effects of sea air from corroding the equipment.

3.3.4 Outline of Facilities and Equipment

The facilities and equipment discussed with the Government of Maldives (Refer to Appendix 4) are used as the base to which the items necessary for this project have been added in the following list:

Table. 3-6 Description of Facilities and Equipment

Description of Work	Facilities and equipment
Civil Works for Fishing Port	Breakwaters Landing Quay, Preparations Quay, Channels, Anchorages
Building Construction	Freezer/Refrigerator Building
Utility Facilities	Water Supply Facilities, Fueling Facilities, Electrical Facilities, Drainage Facilities
Plants	Refrigerated Storage, Freezer Storage, Ice Making Equipment, Ice Storage Facilities, Electric Generating Plant

3.3.5 Operation and Maintenance Plans

1) Maintenance Organization

The maintenance and operation of the facilities and equipment will be performed by the field personnel for preventive maintenance and repair work, and the STO, FPID has budgeted for this work.

A full understanding of the freezer/refrigerator facilities and their function will lead to the proper use and their operations. The operating personnel will be thoroughly trained in the operation of the equipment so that the equipment will be utilized properly.

The Mechanical equipment of the Freezer/refrigerator Systems

The operation and maintenance of the electric power generator, freezer/refrigeration equipment should be performed by specially trained personnel in this field. The technical personnel experienced in these fields will be selected from technicians who have works on the refrigerated mother boats and the Felivaru Fish Processing Plant.

Also, it will be the responsibility of the personnel to understand the new equipment and become acquainted with the operation methods and their maintenance. Therefore, it will be necessary to come to the construction site and observe the installations and start-up of the equipment of the systems, and become acquainted with the system operation.

The electric generating equipment and refrigeration equipment will be set up for a 24-hour operation, and the attendant personnel will be assigned to this work schedule. The equipment will be set up for scheduled inspection and replacement of consumable parts. The life of the equipment are generally as follows, and replacement schedule shall be set up to conform with this time table:

Generating Equipment	12 years
Electric Panelboard	20 years
Refrigeration Compressor	12 years
Condenser	15 years
Refrigerated Storage	30 years
Brine Freezer	20 years
Ice Making Equipment	20 years

Procurement of Replacement Parts and Equipments

The stock level of replacement parts and consumables shall be firmly established, and based on requests from the field and the stock on-hand, the FPID Office in the Male Office shall procure the necessary parts without fail.

Technical Backup by the FPID Main Office

The FPID Office in the Male Main Office will take the necessary procurement action, and also provide the following technical backup service:

- 1) Provide the leadership and supervision by higher grade engineers.

- 2) Technical research by field personnel domestically and by foreign training trips.
- 3) Invite technical representatives of manufacturers to train field personnel as necessary.

2) Maintenance and Operation Expenses

The direct expenses required for maintenance and operation are as follows:

a) Personnel	Rf	1,243,200 /yr
b) Fuel	Rf	3,587,000 /yr
c) Loading Expenses	Rf	349,000 /yr
d) Maintenance	Rf	924,000 /yr
e) Overhead	Rf	120,000 /yr
Total Yearly Expenses		Rf 6,223,200 /yr

The breakdown of the expenses are as follows:

(A) Personnel

Job Description	Number	Monthly Wages, Incl. Meals	Rf/mo.
Chief	1	5,000	5,000
Office Worker	3	2,000	6,000
Engineers:			
Chief Engr.	1	4,000	4,000
Engr.	3	2,700	8,100
Mechanic	3	1,700	5,100
Supervisor	1	3,500	3,500
<u>Freezer/Refrig.</u>			
Foreman	2	2,300	4,600
Driver	2	1,700	3,400
Manual Worker	12	1,300	15,600
<u>Landing Opns.</u>			
Foreman	2	2,300	4,600
Cashier	2	2,000	4,000

Weigh Checker	2	1,700	3,400
Driver	3	1,700	5,100
Manual Worker	24	1,300	31,200
Total	61		Rf 103,600/mo.
			= Rf 1,243,200/Yr
			(@Rf9.5/US\$ = US\$ 103,863/Yr)

(B) Cost of Fuel

a) Electric Generating Plant

Fuel : 2,700l/dy x 30dy x Rf3.5/l = Rf 283,500/mo.
 Oil/Grease : 360l/mo x Rf21/l = Rf 7,560/mo.

b) Forklift, Crane, etc.

9l/h x 5h/dy x 2 each x 25dy x Rf3.5 = Rf 7,875/mo.

Total Rf 298,935/mo.

= Rf 3,587,000/yr

(@Rf9.5/US\$ = US\$ 377,602/yr)

* Fuel for Fishing Boat by Fishermen.

* Fuel for Barge included in Cost of Barges.

(C) Cost to Load Ocean-Going Vessels

a) Extra Help to Load Vessels

40 person x Rf100/dy x 2dy/Shipment = Rf 8,000/Shipment

b) Cost of Barge, 2 Barges

Fuel Oil: 40l/hr x (1hr x 7Trip/dy x 2dy) x Rf 3.5/l
 = Rf 1,960/Shipment

Direct Costs to Load Ship: (a)+(b) = Rf 9,960/yr/boat

Annually for 15 Trips: Rf149,000/yr

c) Maintenance & Repair of Barge

Rf100,000/boat/yr x 2 = Rf 200,000/Shipment

Total Rf 349,000/yr

(@Rf9.5/US\$ = US\$ 36,779/yr.)

(D) Maintenance Costs:

a) Refrigeration Oil, Ammonia, Salt Rf 280,000/yr

b) Refrigeration Equipment, Electric
Generator Equipment, Repair costs 530,000/yr

c) Maintenance Dredging
1,000 m³/yr x 114 Rf/m³ = 114,000/yr

Total Rf 924,000/yr.

(@Rf9.5/US\$ = US\$ 97,263/yr.)

(E) Overhead

Rf 10,000/Month x 12 = Rf 120,000/yr (US\$ 12,631/yr)

From the above, the maintenance and operation costs for this project are estimated annually at Rf6,223,200. According to the project plan, the costs for purchasing, collecting, refrigerating, and exporting 3,600tons of frozen skipjack, the cost (processing cost) is Rf1,729. (US\$182) per ton. This cost is lower than the existing cost to process the skipjack by the refrigerated mother boat, and when compared to the cost to process 1ton, it is approximately same cost.

Chapter 4 Basic Design

Chapter 4 Basic Design

4.1 Design Policy

The basic design for this project will be based on the following basis in connection with the items described in Chapter 2, Background of the Project, and Chapter 3, Description of the Project, in consideration of the fishing industry in the project area.

(1) The Overall Project Scope

- 1) The facilities planning will be based on a suitable demand forecast, with the scope established to match the production at the project site and meet with the local distribution system, so that the operation and maintenance can be performed easily and with the least cost.
- 2) The facilities and materials are within the standards for Grant-Aids, and are within the scope of work requested by the Government of the Republic of Maldives.
- 3) The facilities, materials and equipment conform to Japanese Industrial Standards and the scope of construction is within the funding provided by the Government of the Republic of Maldives.
- 4) The mode of operation of existing and similar facilities are considered as the standards for Maldives, and the project scope will be considered as reasonable and just.

(2) Natural conditions at the project site will be carefully considered.

- 1) The terrain, geology, and consideration of weather and marine phenomena will be reflected in the design.
- 2) The littoral drift from currents occurring within the coral reef will be considered.
- 3) The effects of high tides, abnormal weather and high waves will be considered, and the ground levels will be considered on this basis.