BASIC DESIGN STUDY REPORT
ON
FISH MARKETING DEVELOPMET PROJECT
IN
THE KINGDOM OF TONGA

JANUARY, 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Kingdom of Tonga, the Government of Japan decided to conduct a Basic Design Study on the Fish Marketing Development Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Tonga a study team headed by Mr. Kenichi Sakurai, Deputy Director, International Division, Oceanic Fisheries Department, Fisheries Agency, from September 19 to October 9, 1985.

The team held discussions on the Project with the officials concerned of the Government of Tonga and conducted a field survey in the Tongatapu, the 'Eua, the Lifuka, the Uiha, the Nomuka and the Ha'afeva area in Tonga. After the team returned to Japan, further studies were made and the present report has been prepared.

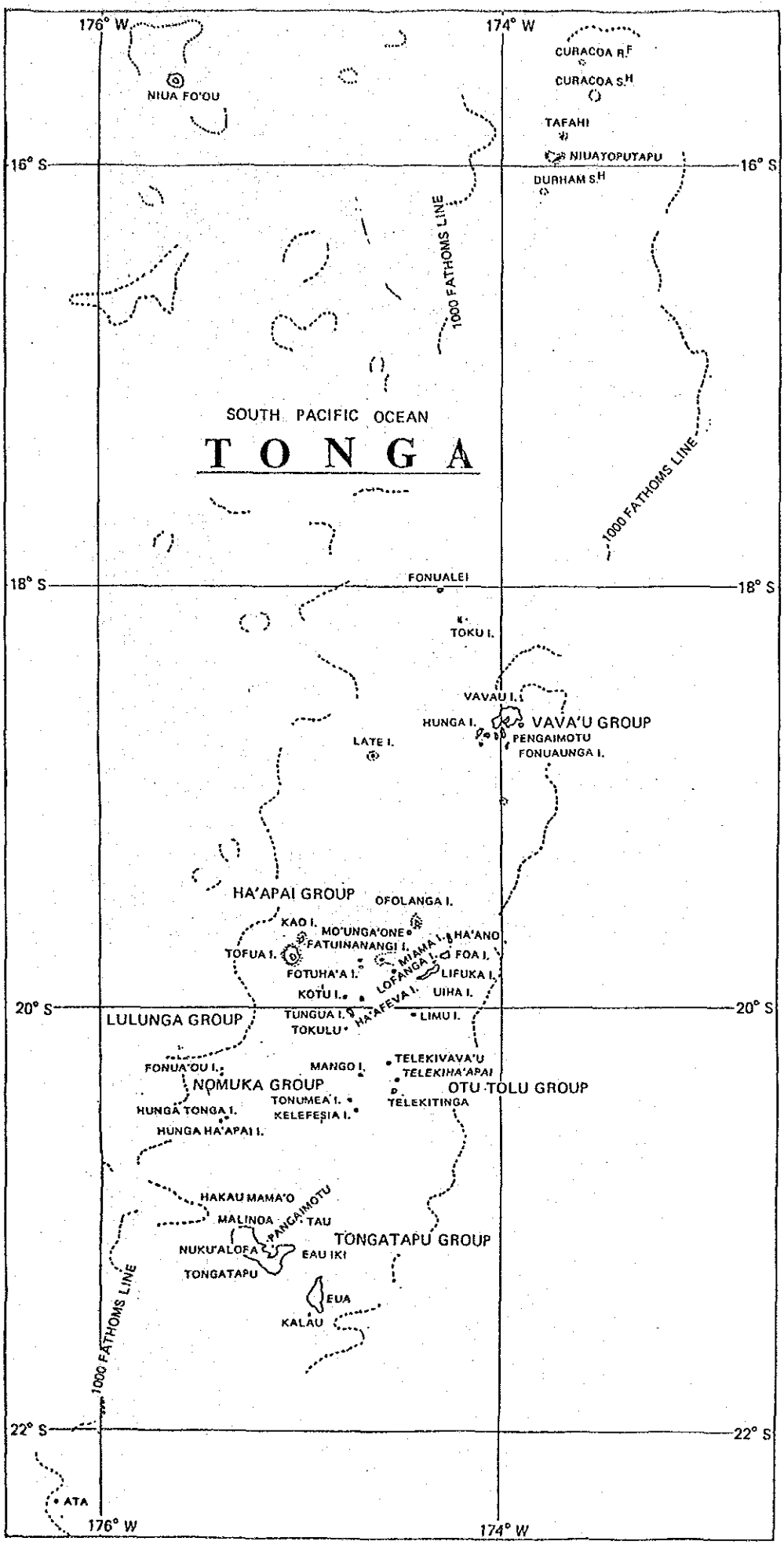
I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between the two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Tonga for their close cooperation extended to the team.

January 1986

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency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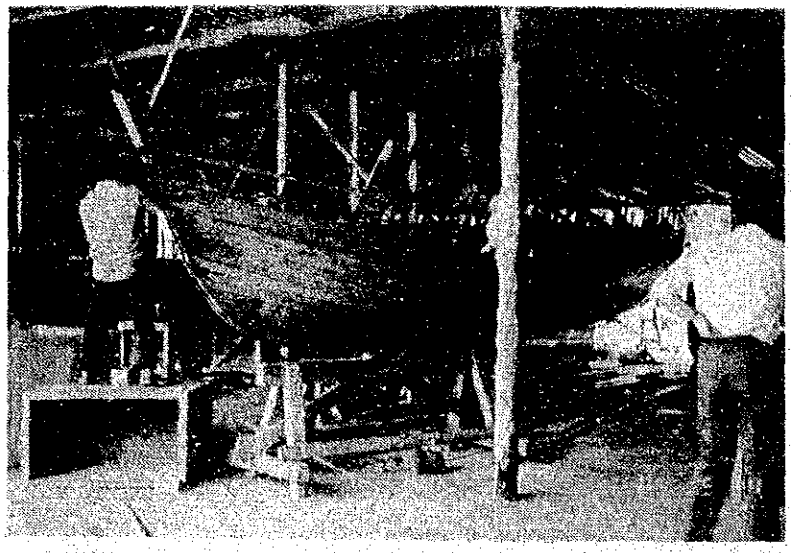
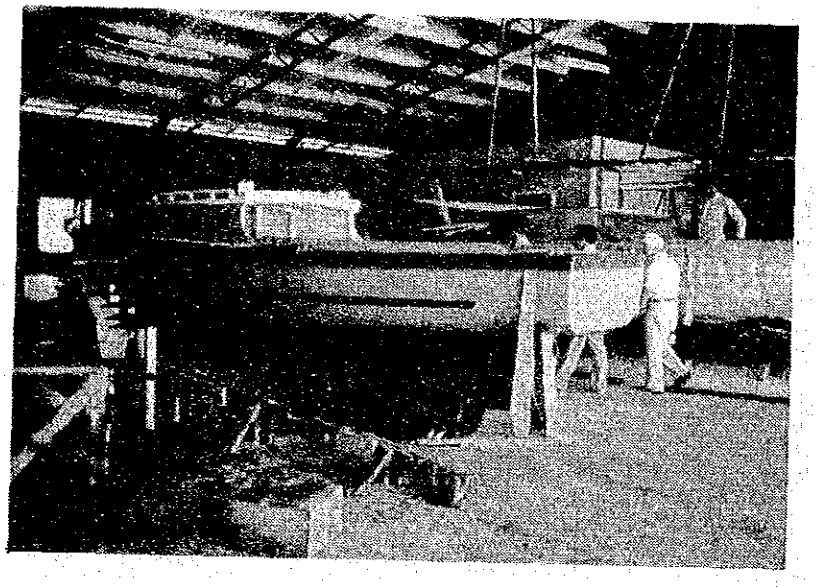
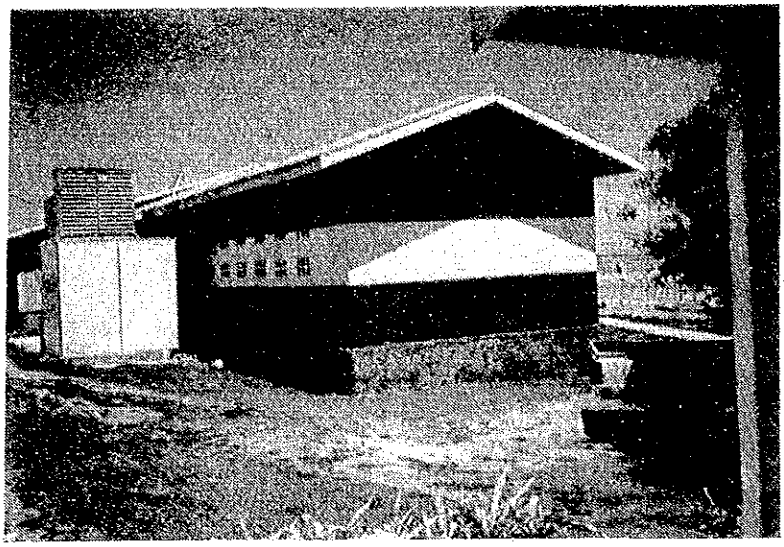


Construction of Fishing Boat at the SOPU Yard

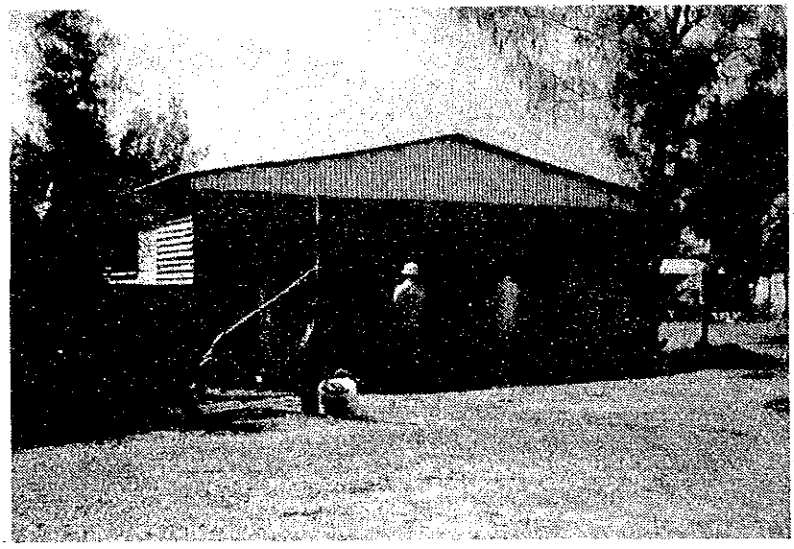


Construction of Fishing Boat at the HA'APAI Yard

Private Market (NUKUALOFA)

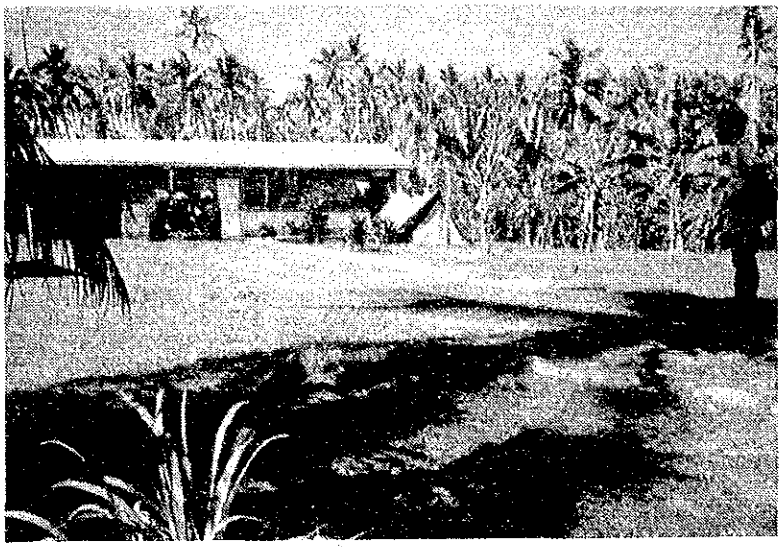


LIFUKA Island Plant Site

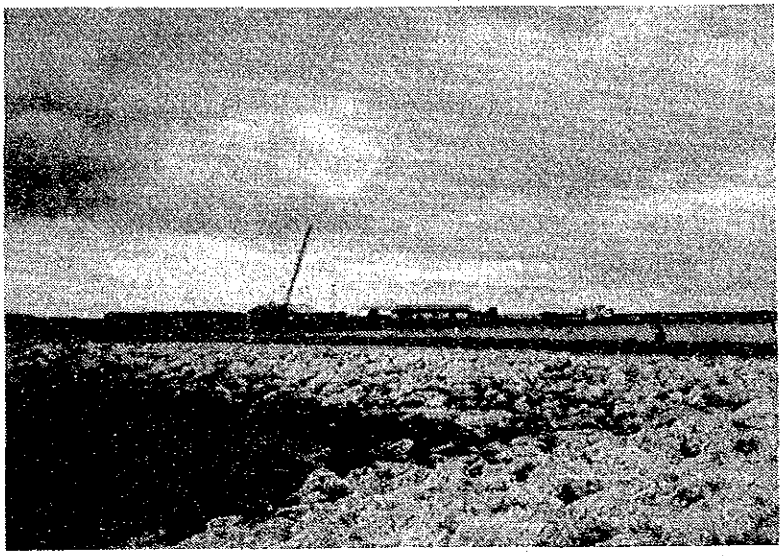


'UIHA Island Plant Site

HA'AFEVA Island Plant Site



NOMUKA Island Plant Site



TONGATAPU Island Plant Site

'EUA Island Plant Site

SUMMARY

SUMMARY

Since 1965, the Kingdom of Tonga has been actively engaged in the development of fishery in its four archipelagoes (Tongatapu, 'Eua, Lifuka and Vava'u) through four consecutive Five-Year Development Plans.

Against this background, the Government of Tonga has requested grant-aid cooperation for the promotion of fishery from the Government of Japan in the past. In response to these requests, the Government of Japan has offered a long line fishing boat, fishing gear and engines on three separate occasions in 1977, 1981 and 1982.

The Government of Tonga then requested the Government of Japan to provide further grant-aid for facilities, equipment, machinery and materials indispensable for the proper maintenance of freshness, preservation and transportation of fresh fish as well as for the strengthening of the processing industry directly related to the promotion of export industries. The Government of Tonga considers these facilities, etc. indispensable for strengthening fishing cooperatives of the above-mentioned archipelagoes and, therefore, for further promotion of fishery in the Kingdom of Tonga.

The Kingdom of Tonga gives the following four points as the major development strategies for its Fourth Five-Year Development Plan.

1) The preferential direction of a significantly larger share of national resources to the productive sectors, particularly agriculture, fishery and manufacturing.

2) The optimal utilization of the total resources in all sectors of the national economy.

3) The effective utilization of foreign aid.

4) The direction of increased distribution of national resources to less developed areas.

Based on these strategies, the Fisheries Division of the Ministry of Agriculture, Fisheries and Forests has designed the following implementation plans in regard to the development of fishery.

1) Boat Building Project
2) Fishing Gear and Method Development Programme
3) Fishing Gear and Engine Spare Parts Servicing Programme
4) Ice Supply, Fish Handling, Cold Storage Facilities and Marketing Facilities Scheme
5) Fish Transport Project
6) Fish Pricing Scheme
7) Off Shore Tuna Fisheries Development Project

4) and 5) above, together with the Boat Building Project which is currently in progress with the technical cooperation of FAO and is using equipment, etc. granted by the Government of Japan in 1982, are intended to stimulate people concerned with fishery, by strengthening the fishery production capability, as well as meeting the demand for marine products in consumption areas.

To achieve these objectives, the Government of Tonga established a comprehensive fish marketing project and requested the Government of Japan to provide grant-aid for such shore facilities as cold storages and ice making plants, etc. and fish carrier vessels to constitute foundation for the marketing of marine products.

As a result, the Study Team, sent by JICA in September, 1985, carried out basic surveys and collected information indispensable for the basic design study and assessed the pertinence of the Project based on the analysis of the survey results and collected material.

As result of the thorough consideration of the background of the request and the coordination with higher plans and the estimates of the supply and demand in the near future it has been concluded that shore facilities and fish carrier vessels of the following sizes and contents would be suitable.

1)	9 m^3 Cold Storages	6
2)	1 ton/day Ice Making Plants	8
3)	Service Centres (9 m x 9 m)	4
4)	Fish Carrier Vessels (5 and 7 tons)	2
5)	Ice Boxes	
6)	Others	

The cold storages will be used for fresh fish, excepting the one on the isolated island of Niuatoputapu and the plate ice making plants have been selected because they are appropriate for using sea-water. the fish carrier vessels have been designed for ice packed fish.

The construction cost is roughly estimated to be approximately 3,670 T$ for the Government of Tonga. The construction period in Tonga is expected to be some 4 months.

The Project is intended to enhance and promote a series of marketing functions, from the unloading of the fish from the coastal fishing boats on all Tonga islands to its efficient marketing and consumption in the Kingdom of Tonga.

As the smooth introduction of the Project and the proper performance of its intended functions are expected to, greatly contribute to the development of Tongan fishery, the implementation of the Project with grant-aid from Japan will have a significant meaning for both the Kingdom of Tonga and Japan.

ABBREVIATIONS

T$: Tongan Dollar = 170 Yen (at the time of the Study)
= US$1/1.35 (at the time of the Study)

GL : Gallon = 4.5459ℓ

M.S.Y.: Maximum Sustainable Yield

Mile : Nautical Mile = 1,852 m (e.g. 10' means 10 nautical miles)

kt : Knots (shows the boat speed in terms of nautical mileage per hour)

hrs : Hours

Loa : Length Over All

HP : Horse Power

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CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

The Kingdom of Tonga is an archipelago in the South Pacific which is scattered along the date line and which has a subtropical climate. The economy is self-sufficient with the major industries being agriculture for copra, banana and potato production and the coastal fishery of sea bream, grouper, skipjack and tuna. Nevertheless, due to the increase of the population and the westernization of the diet, food imports now hold the second place next to primary processed products, accounting for more than 20% of the country's total import value.

It is, therefore, considered that the improvement of the fishery production level will greatly contribute to the economic development of the Kingdom of Tonga, along with the promotion of agriculture.

Against this background, the Government of Tonga established the Fish Marketing Project parallel to the promotion of the Boat Building Project described in 2-2-1 (3) "Fishing Boats" and subsequently requested grant-aid cooperation for the implementation of the Project from the Government of Japan.

This request consisted of the following major shore facilities and fish carrier vessels.

1. Cold Storages
2. Ice Making Plants
3. Generators
4. Service Centres
5. Carrier Vessels: Inter-Islands and Inter-Ha'apai

In response to the request, the Government of Japan sent a Study Team to Tonga headed by Mr. Kenichi Sakurai, Deputy Director, International Division, Oceanic Fisheries Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries via the Japan International Cooperation Agency (see Appendix 1). Discussions on the Project

were satisfactorily carried out between the Study Team and officials of the Government of Tonga (see Appendix 2) from September 19 to october 9, 1985 and the Study Team conducted the necessary studies and collected materials in order to provide a basic project design (see Appendix 3).

The study items are given below. Those items confirmed by the Study Team and officials of the Government of Tonga are compiled as Minutes (see Appendix 4).

1. Confirmation of the background of the Request
2. Confirmation of the Requested Items
3. Field Study on Fishery
4. Survey on Fishery Administration
5. Study Relating to the Fish Marketing Project
6. General Study on Local Situation

This Report provides the optimal basic design after examination of the pertinence and feasibility of the Project, based on the analysis of the results of the above-mentioned studies.

CHAPTER 2

BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 General Condition of the Country

2-1-1 Natural Environment

(1) Geography

It was declared by King Tupou I, the founding father of the Kingdom of Tonga, in 1887 that the Kingdom's territory lay between latitude 15°S and 23°30'S and longitude 173°W and 177°W. a total of 171 islands are located within this area in the north-south direction, comprising a total land area of some 670 km^2, which is slightly smaller than Amami Oshima in Japan. This land area represents some 0.1% of the 700,000 km^2 which is the area within the 200 nautical mile economic waters.

The country is divided into 4 administrative areas, i.e. North, Central, South and the 2 isolated islands near Samoa, far north of the other islands. Most of the islands are made of flat elevated coral reefs with each area having some specific characteristics.

In the Vava'u area in the north, three layered geological formations can be seen in many places due to the 3 separate elevations. while the altitude in the area is high, the coastal lines of the islands show sharp gradients. As a result of these geological conditions, Port Refuge, a natural good harbour, is located in the south of Vava'u, the main island.

The Ha'apai island area in the centre consists of a number of islands made of flat coral reefs. These islands are, in fact, scattered in the shallow waters inside the huge reef.

Nukualofa, the capital, is located on Tongatapu Island in the south and is the political, economic and commercial centre of the Kingdom of Tonga.

The formation of the Tongan Archipelago can be explained by the Plate Techtonics theory in the following manner. On one hand, the Tongan Archipelago and the area to the west are on the Asian-Australian plate, which is moving eastwards while on the other hand, the area to the east of the Archipelago is on the Pacific plate, which is widely spreading to the east and moving westwards. At the boundary of these 2 plates, the Pacific plate to the east sinks under the Asian-Australian plate to maintain the balance. Whenever this balance is broken, a heavy crustal movement occurs around the boundary of the plates, causing the elevation of the coral reef along the edge of the Asian-Australian plate and forming coral islands. To the west of the Archipelago, lava was ejected to form volcanic islands.

Because of the geology of the area, there have been many earthquakes, as in the case of Japan. A big earthquake of 7-8 on the Richter scale hit the area in 1977.

(2) Climate

In general, the area has a subtropical marine climate with strong SE trade winds all year round.

1) Average Temperature

Table 2-1-1 Average Temperature

(Unit: °C)

Area	Vava'u		Ha'apai		Tongatapu	
Year / Month	1982	1983	1982	1983	1982	1983
January	27.1	27.2	26.6	26.1	26.3	25.5
February	27.1	28.1	n.a.	27.4	26.9	26.3
March	27.6	27.7	n.a.	26.8	26.3	26.6
April	26.4	26.6	26.5	25.8	25.3	24.9
May	25.3	25.5	25.0	24.6	23.9	23.3
June	25.0	24.9	24.2	24.0	22.5	22.8
July	24.7	23.7	23.1	22.9	21.0	21.5
August	23.5	23.4	22.2	22.4	20.7	21.1
September	23.6	24.4	22.4	23.5	21.0	21.9
October	24.7	24.8	23.7	23.8	22.1	22.6
November	25.5	26.8	24.9	25.3	23.9	24.1
December	n.a.	26.9	25.1	26.1	24.5	25.5

Source: Meteorological Observation for 1982 Pacific Island Stations
Meteorological Observation for 1983 Pacific Island Stations

2) Rainfall

Table 2-1-2 Rainfall

(Unit: mm)

Area	Vava'u		Ha'apai		Tongatapu	
Year / Month	1982	1983	1982	1983	1982	1983
January	611	173	261	15	386	37
February	420	218	n.a.	68	238	102
March	368	480	n.a.	177	253	73
April	473	42	436	21	136	9
May	177	78	217	48	241	26
June	56	20	54	8	58	69
July	73	34	59	59	87	118
August	199	21	74	21	149	66
September	151	51	156	95	75	41
October	17	42	14	157	34	108
November	115	86	24	61	19	24
December	n.a.	520	80	96	57	165
Annual Total		1,765		826	1,733	838

Source: Meteorological Observation for 1982 Pacific Island Stations
Meteorological Observation for 1983 Pacific Island Stations

3) Wind Force, Wind Direction (Tongatapu)

Winter in Tonga falls in July and August when it is chilly in the mornings and evenings. Towards the end of the year, strong sunshine returns to provide a more tropical climate. In January through March, both the temperature and the humidity are high and this is a cyclone season when the small tropical hurricanes formed in the sea to the north of Tonga may storm Tonga. Tonga was hit by large hurricanes in 1961, 1967, 1975 and 1982 with an exceptionally large one in March, 1982. In 1983, Tonga also suffered from a continuous water shortage.

In terms of the north-south geographical conditions, both the temperature and the humidity tend to become higher towards the northern islands.

Table 2-1-3 Wind Force, Wind Direction

Month	Average Wind Force (knots)	Wind Direction (%)								
		N	NE	E	SE	S	SW	W	NW	No Wind
January	9.3	3	13	29	35	9	8	0	2	1
February	8.9	6	18	29	29	3	3	0	11	1
March	8.9	5	12	21	39	14	4	2	3	0
April	8.4	3	7	16	57	7	0	3	4	3
May	6.5	2	5	9	44	17	16	1	2	4
June	6.8	13	7	7	19	15	18	6	12	3
July	7.2	4	8	9	35	15	17	3	7	2
August	8.4	2	13	14	38	13	14	4	1	1
September	9.3	3	10	21	45	9	9	0	2	1
October	9.3	6	12	31	30	10	8	0	3	0
November	8.9	2	8	13	42	18	11	1	9	1
December	10.2	2	11	35	37	10	2	0	2	1
Average		4	10	20	38	12	9	2	4	1

Source: Sailing Directions for the Pacific Islands

The southern wind, with the predominant SW wind, constitutes some 60% of all winds in the year. The wind direction is most stabilized for October through April. This period is the Tongan summer with high temperatures and high humidity when large migratory fish, such as skipjack and tuna, move into the Tongan sea area.

(3) Marine Climate

The south sub-equatorial current runs from east to west in the Tongan sea area. In comparison with the south equatorial current, this current is slower and seldom exceeds 0.75 nautical miles/hour. Refer to Current Charts 1-4 for currents around the Tongan Archipelago.

The tide is very regular and is seen twice a day. The tide levels are as follows.

Table 2-1-4 Tide Level Table (Unit: m)

Item / Place	Spring Rise	Neap Rise	Mean Sea Level
Lifuka (Ha'apai	1.2	1.1	0.72
Nomuka (Ha'apai)	1.5	1.4	0.96
Nukualofa	1.3	1.2	0.75

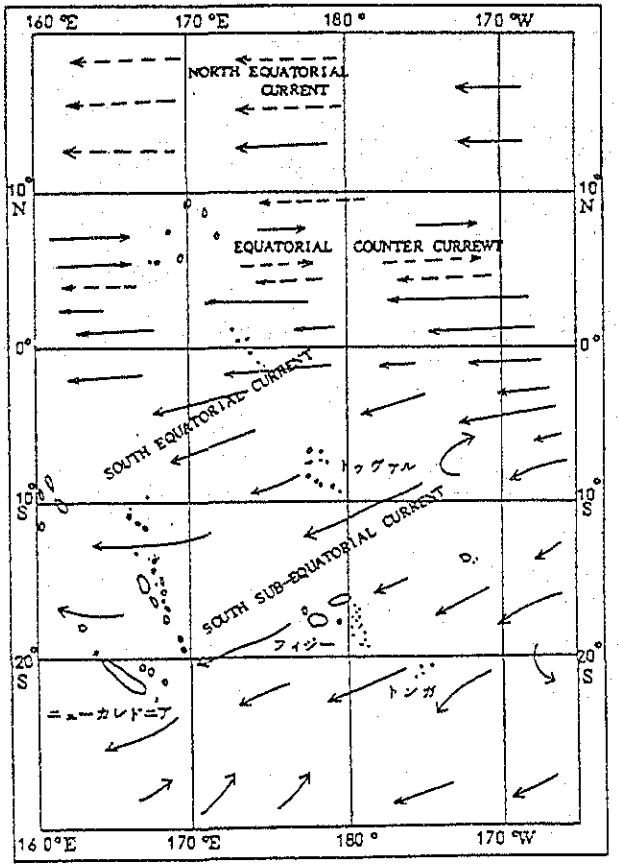
Source: Tide Table Vil. II, 1985

Notes: 1) Spring Rise ..... Mean height of high water above datum level at spring tide

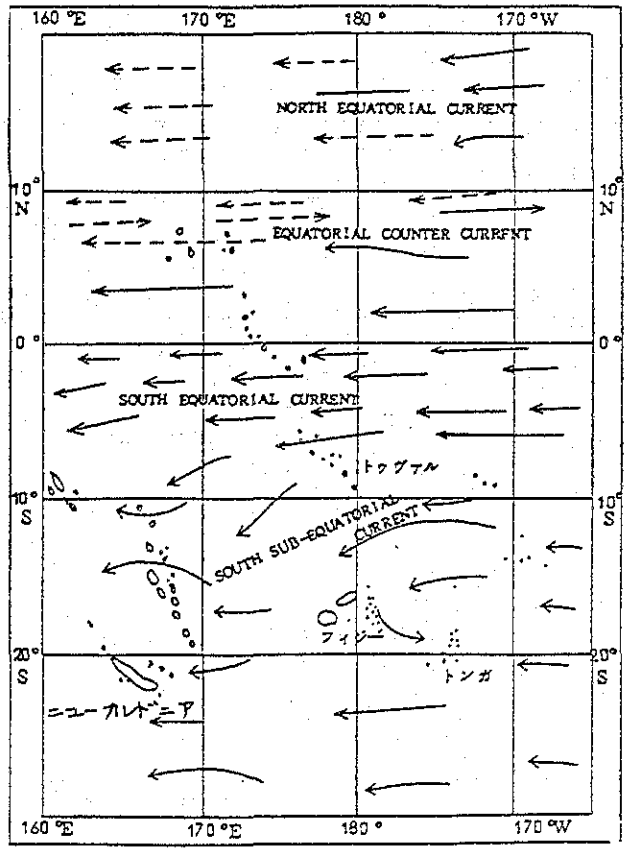
2) Neap Rise ..... Mean height of high water above datum level at neeap tide

3) Mean Sea Level ... Height of mean sea level above datum level

Current Chart-1 (December - February)



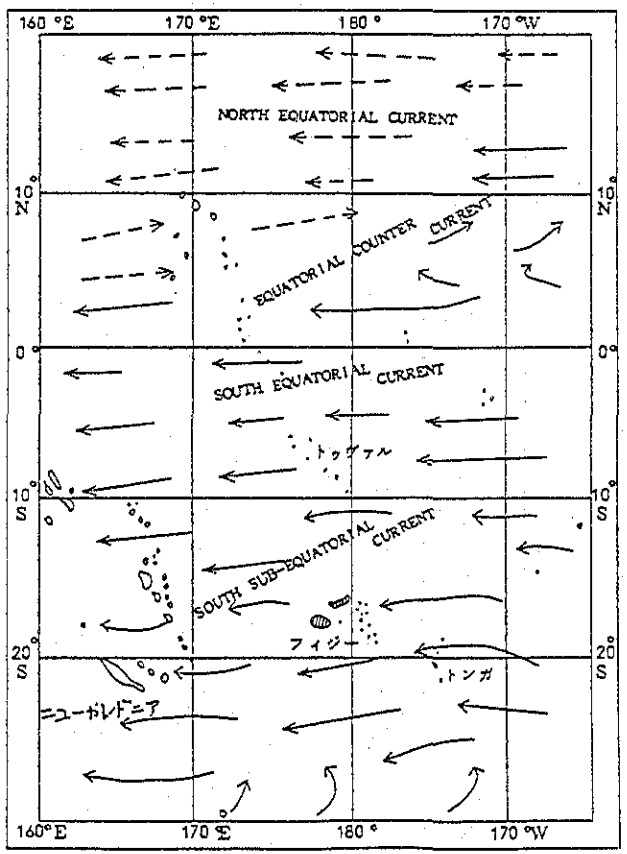
Current Chart-2 (March - May)



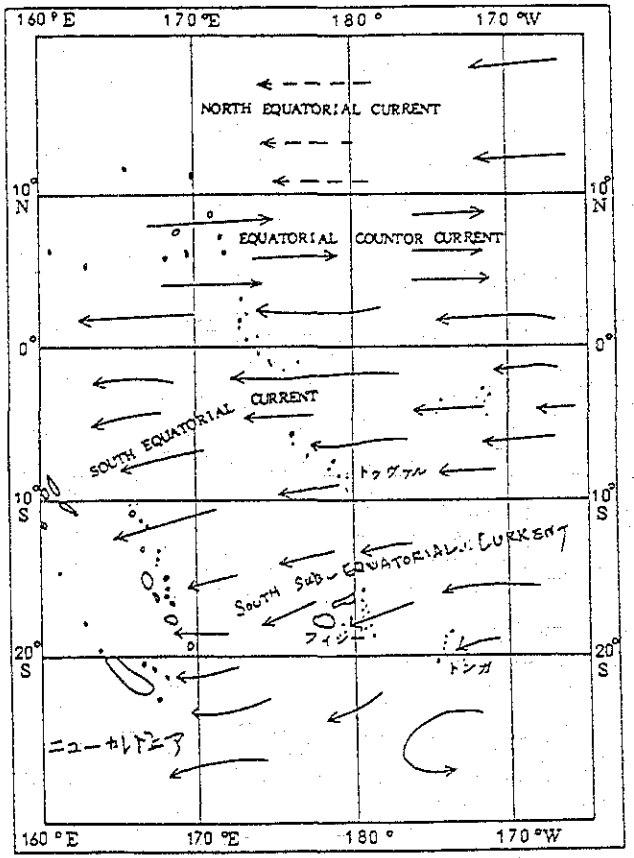
Source: Pilot Book (British Edition)

Note: Broken lines reflect a small number of observations.

Current Chart-3 (June - August)



Current Chart-4 (September - November)



Source: Pilot Book (British Edition)

Note: Broken lines reflect a small number of observations.

2-1-2 Social and Economic Condition

(1) Population

1) Population

Tables 2-1-5 and 2-1-6 show the results of the national census taken in November, 1976.

Table 2-1-5 Population (Unit: person)

Area	Population	%
Tongatapu	57,411	63.7
Vava'u	15,068	16.7
Ha'apai	10,792	12.0
'Eua	4,486	5.0
Niuas	2,328	2.6
Total	90,085	100.0

Source: Fourth Five-Year Development Plan

Table 2-1-6 Population Density in Major Areas

Area	km^2	Population Density (Person/km^2)
Tongatapu & 'Eua	349	177
Vava'u	143	105
Ha'apai	119	90
Niuas	38	61
Total	649	138

Source: Fourth Five-Year Development plan

For reference, the population density in Japan is 503 persons/km^2(estimate).

National censuses have been carried out 3 times in Tonga in the past, revealing the following composition by sex and the annual ratio of the population growth.

Table 2-1-7 Composition by Sex and Annual Ratio of Population Growth

	Population at time of Census			Estimated Population in 1980 (person)
	1956 (person)	1966 (person)	1976 (person)	
Male	28,938	39,837	46,036	48,290
Female	27,900	37,592	44,049	46,470
Total	56,838	77,429	90,085	94,760
Annual Average Growth Ratio	3.05 %	3.14 %	1.52 %	1.41 %

Source: Fourth Five-Year Development Plan

From 1939 to 1966, the annual ratio of the population growth exceeded 3%, causing a rapid increase in the population. During the next decade, from late 1966 to 1976, however, the growth rate showed a conspicuous decline, presumably due to the fall of the birth rate and the increase in emigration.

The Family Plan, centred on the Mother and Children Health Scheme promoted by the Government, has also been accounted as the administrative measure causing the decline in the population growth.

According to the Fourth Five-Year Development Plan, the estimated population in July 1985 was given as follows at 3 different levels from the factors of death rate and birth rate, and estimated number of emigrants.

Table 2-1-8 Estimated Population (July, 1985)

(Unit: person)

Estimate	Total	Male	Female
Maximum	102,780	52,160	50,620
Medium	102,190	51,850	50,340
Minimum	101,630	51,550	50,080

Source: Fourth Five-Year Development Plan

The biggest population problem in Tonga has been the above-described increase in the population, followed by the problem of population concentration in urban areas.

Table 2-1-9 shows the population trends by areas.

Table 2-1-9 Population by Areas

Year	1956		1966		1976	
Area	Population	%	Population	%	Population	%
Tongatapu	31,264	55.0	47,920	61.8	57,411	63.7
Vava'u	12,477	22.0	13,533	17.5	15,068	16.7
Ha'apai	9,918	17.4	10,591	13.7	10,792	12.0
'Eua	1,295	3.4	3,391	4.4	4,486	5.0
Niuas	1,254	2.2	1,994	2.6	2,328	2.6
Total	56,838	100.0	77,429	100.0	90,085	100.0
Nukualofa	9,202	16.2	14,816	19.1	18,312	20.3

Source: Fourth Five-Year Development Plan

In relation to the above-mentioned 2 population problems, the Government has been making every effort to prevent social problems caused by the possible increase of unemployment. The actual policies that have been implemented are the Family Plan, with a view to reducing the birth rate, and development plans aimed at those areas other than Tongatapu to stop the population concentration into urban areas.

2) Labour Force

According to 1976 statistics, the labour force consisting of those between 15 and 64 years of age accounted for 52% of the entire population. Of these, 21.4% were listed as employed. However, as certain information says that the average working days of a week of these employed are only 1 or 2, the current situation appears to lack the volume of work to guarantee a full working week to the potential labour force in Tonga.

Table 2-1-10 shows the working population by Industries.

Table 2-1-10 Working Population by Industries

	1956 Census		1966 Census		1976 Estimate	
	Number of Workers	%	Number of Workers	%	Number of Workers	%
Agriculture, Forestry & Fisheries	10,303	72.2	14,064	74.0	15,100	70.6
Mining & Manufacturing	401	2.8	502	2.6	600	2.8
Electricity & Water Works	26	0.2	40	0.2	150	0.7
Construction	173	1.2	89	0.5	360	1.7
Commerce	727	5.1	410	2.2	940	4.4
Transport & Communications	331	2.3	372	2.0	400	1.9
Government Service	160	1.1	340	1.8	1,180	5.5
Social Service	1,176	8.2	1,752	9.2	1,620	7.6
Others	973	6.9	1,429	7.5	1,050	4.9
Total	14,270	100.0	18,998	100.0	21,400	100,0

Source: General and Fisheries Situation in Tonga

The increase of the demand of the domestic labour market has not kept pace with the increase of the potential working population. In addition, due to the introduction of the restrictive regulation on immigration by New Zealand, it has become difficult to secure a sufficient number of emigrants (mostly to Australia or New Zealand) which was formerly considered to total 0.7% of the total population. As the unemployment ratio is said to be 13% (1976 estimate), it has increasingly become a political, as well as social, problem.

(2) Social Condition

Tonga's stable social foundation is said to have been brought about by the monarchy and the land system.

Tongan society is largely divided into 3 classes, i.e. the Royal Family, the aristocracy and the commoners. The power of the Royal Family is guaranteed by the Constitution, promulgated in 1875. The difference between the aristocracy and the commoners is that the former have hereditary privileges.

Apart from the monarchy, the stability of Tongan society is supported by its inherent land system called the API System. This System started when Tupou I, the founding father of the Kingdom of Tonga, abolished the traditional semi-serfdom and distributed certain land to the populace. The Constitution stipulates that on reaching the age of 16, every male shall be given 3.34 ha of unutilized land and tiny 0.16 ha of land in town. As all land is owned by the King, the land use by his subjects is under strict the government control.

Tongans in general form large families which are self-supporting with agriculture, economy which is mainly based on agriculture, and fishermen are members of such families.

As people with higher educational careers are not given land and as the available land has been becoming increasingly scarce due to the increase of the population, the API System has been gradually changing for the last 100 years.

(3) Economic Condition

As Tonga has a self-sufficient economy which is based on agriculture, some 87% of the total families were thought to be engaged in agriculture in 1980. While producing grains for their own consumption, they also produce cash crops of copra, bananas, vanilla,

fruit and vegetables. Agricultural products, inclusive of animal husbandry and fishery, still occupy some 40% of the GNP and agriculture is by far the leading industry.

Table 2-1-11 Gross National Product

Industry	Annual Average Growth Rate: 1975-1980 (%)	Proportion of GNP (%)	
		1979/80 Result	1984/85 Estimate
Agriculture & Forestry	1.3	35.8	34.7
Fishery	2.8	3.9	4.6
Mining	14.4	0.7	0.9
Manufacturing	8.1	7.8	9.6
Electricity & Water Power	10.6	1.1	1.3
Construction	12.3	5.7	7.3
Commerce & Service	4.9	15.1	11.1
Transport	18.8	6.5	7.2
Real Property	4.8	7.3	7.0
Social Government	4.6	16.1	16.4
Public Service			

Source: Fourth Five-Year Development Plan

Tonga's international balance has been constantly in a large deficit. The balance of invisible trade, the surplus from the transfer balance and the inflow of foreign capital have supplemented the deficit and, as a result, while the trend of the international balance is largely affected by the international price fluctuation of coconut products, accounting for 50% of the total export value, it is more affected by the income from tourism and private remittance, as well as the capital inflow from overseas.

The import/export statistics by categories of major merchandise are shown in Table 2-1-12 below.

Table 2-1-12 Import/Export Statistics (1982)

(Unit: T$)

	Imports	Exports
Food	8,936,148	1,598,231
Drinking Water & Tobacco	2,316,709	
Non-Food Raw Materials	3,128,660	272,482
Fuel	5,714,938	
Oils & Fats	38,575	1,291,086
Chemical Products	2,646,068	4,179
Primary Processed Products	9,417,568	27,004
Machinery & Transport Equipment	6,028,881	
Other Industrial Products	2,821,337	436,049
Others	155,821	16,567
Total	41,204,705	3,645,598

Source: Foreign Trade Report for 1982

Table 2-1-13 shows the import/export statistics by countries.

Table 2-1-13 Import/Export Statistics by Countries (1982) (Unit: T$)

COUNTRY	IMPORTS	EXPORTS	RE-EXPORTS	BALANCE OF TRADE
1	2	3	4	5 = 3 + 4 - 2
Australia	9,675,775	1,653,846	160,540	- 7,861,389
Belgium	22,934	-	-	- 22,934
Brazil	9,789	-	-	- 9,789
Canada	23,030	-	-	- 23,030
Ceylon	2,475	-	-	- 2,475
China (Mainland)	679,135	-	-	- 679,135
China (Republic)	740,680	15,000	15,000	- 710,680
Cook Is.	-	50	-	+ 50
Czechoslovakia	10,556	-	-	- 10,556
Denmark	43,593	44,849	-	+ 1,256
Fiji	2,938,174	91,880	82,560	- 2,763,734
France	486,654	19,090	-	- 467,564
Germany, West	111,722	10,648	-	- 101,074
Guam	-	1,545	-	+ 1,545
Hong Kong	523,215	3,521	-	- 519,694
India	85,644	897	6,277	- 78,670
Indonesia	264	-	-	- 264
Iran	-	4,941	-	+ 4,941
Italy	28,833	296	-	- 28,537
Israel	-	1,956	17,612	+ 19,568
Jamaica	2,681			- 2,681
Japan	2,509,902	322	2,360	- 2,507,220
Korea, Republic	63,651	-	-	- 63,651
Malaysia	12,457	-	-	- 12,457
Mexico	2,479	-	-	- 2,479
Nauru	15	-	-	- 15
Netherlands/Holland	38,997	-	-	- 38,997
New Caledonia	1,498	-	-	- 1,498
New Zealand	15,358,975	1,341,457	301,817	-13,715,701
Niue	514	80	60	- 374
Norway	1,747	-	-	- 1,747
Noumea	-	1,593	-	+ 1,593
Pakistan	29,400	-	-	- 29,400
Papua New Guinea	104		-	- 104
Peru	129,697	-	-	- 129,697
Philippines	17,245	1,000	9,000	- 7,245
Portugal	3,460	-	-	- 3,460
Romania	1,816	-	-	- 1,816
Samoa, East	49,787	41,340	19,643	+ 11,196
Samoa, West	295,261	5.006	12.255	- 278,000
Singapore	2,700,893	150	-	- 2,700,743
Sweden	5,237	-	-	- 5,237
Switzerland	19,340	-	-	- 19,340
South Africa	739	-	-	- 739
Spain	7,739	-	-	- 7,739
Thailand	47,975	-	-	- 47,975
Tuvalu	-	911	8,100	+ 9,011
United Kingdom	594,797	955	4,557	- 589,285
U.S.A.	3,914,705	351,920	2,527	- 3,560,258
Hawaii	2,010	52,345	-	+ 50,335
Tahiti	9,111	200	-	- 8,911
T O T A L	41,204,705	3,645,598	642,308	-36,916,799

Source: Foreign Trade Report for 1982

The import/export statistics of the major food items are given in Table 2-1-14.

Table 2-1-14 Import/Export Statistics of Major Food Items (1982)

Item	Imports	Item	Exports
Live Chickens	40,182	Giant Clams	2,202 kg
Beef	85,087 kg	Lobsters, etc.	2,952 kg
Mutton	576,626 kg	Salted or Dried Fish	50 kg
Chicken Meat	48,886 kg	Bananas	585,094 kg
Other Meat	1,110 kg	Dried Coconuts	229,422 kg
Corned Beef	415,670 kg	Pineapples	11,328 kg
Frozen Fish	281 kg	Taro	1,072,138 kg
Canned of Mackerel, Tuna, etc.	572,634 kg	Vanilla	11,604 kg
Rice	310,026 kg	Kavatonga	23,071 kg

Source: Foreign Trade Report for 1982

2-2 Summary of Fishery

2-2-1 Summary

(1) Structure of Fisheries Division

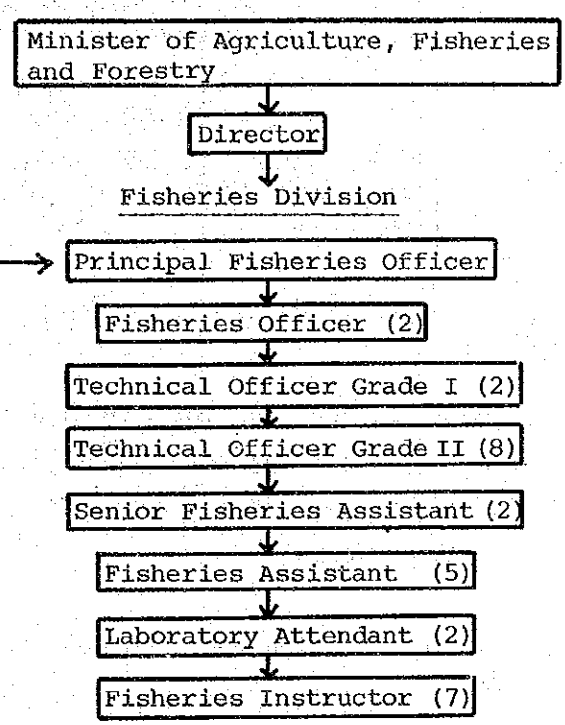
With regard to fishery in Tonga, the catch is expected to rationally increase based on the development of unutilized resources and the increased catch ability, which in turn have been brought about by a number of efforts carried out up till 1984.

The Fisheries Division takes the initiative in the development of Tongan fishery and is the main body for all processes, from planning to operation.

The structure of the Fisheries Division in shown below.

Fig. 2-2-1 Structure of Fisheries Division

A. Established Posts



Technical Assistance ⟶

Expert (3)
Adviser (2)
Volunteer (5)

Sea-Going Staff

Master .... Takuo
" .... Albacore

Chief Engineer
.... Takuo
" Albacore

Chief Officer
.... Takuo
" .... Albacore

B. Non-Established Posts

Fisheries Instructor	(7)	2nd Engineer ... Lofa	(1)
Master ... Lofa	(1)	Wireless Operation ... Lofa	(1)
Chief Engineer	(1)	Bpsun ... Lofa	(1)
Chief Officer	(1)	Other Crew	(16)

Note: Figures in parentheses show the number of officers.

(2) Fishery, Culturing and Processing

1) Public Sector (Fisheries Division)

As shown below, the Fiseries Division has promoted the development of fishery by operating 3 grant-aid fishing boats from Japan.

Table 2-2-1 Fishing Boats Owned by Fisheries Division

Name	Remarks
Lofa	Steel Boat, 188GT, 500HP, Tuna Long-Line Fishing, Delivered in 1983
Albacore	FRP, Loa: 12.6m, 90HP, Round Haul Net and Trolling Fishing, Delivered in 1981
Takuo	FRP, 23GT, 200HP, Pole and Line or Hand and Line Fishing of Skipjack, Delivered in 1978

Source: Fisheries Division

"Lofa" is operated for deep-sea long-line fishing of tuna in view of acquiring foreign currency. The crew consists entirely of Tongans and has achieved fair results under the guidance of JICA specialists.

The depreciation cost, however is not accounted in the table of the actual performance given below. Although the depreciation cost should be accounted based on the expected life in an ordinary commercial operation, it has not been considered here because of the fact that the boat was built with grant-aid.

The Albacore is mainly used for the survey and development of coastal small-scale round haul net, hand-and-line and trolling fishing. 140 days were spent for surveying in 1984 with a catch of 12.6 tons.

The Takuo, whose main assignment is to develop hand-and-line fishing of demarsal fish living on the outer slopes of the reefs, ended up spending 70% of 1984 in port due to the deterioration of the freezer and high fuel expenses. Takuo spent 92 days for surveying with a catch of 8.8 tons.

Table 2-2-2 Operation Performance of Lofa

Item \ Year	1982/1983	1983/1984	Mar.1-Dec.31, 1984
Operation Days	201	192	177
Sailing Days	32	26	10
Sundays	35	32	30
Days on Sea	268	250	217
No Work due to Unloading, Repairs in Dockyard, etc.	120	115	90
Total Days	388	365	307
Catch (ton)			
a) Fiji & Pago Pago	176.89	198.54	215.60
b) Tonga	134.26	122.38	72.86
Total	311.15	320.92	288.46
Sales Amount (T$)			
a) Fiji & Pago Pago	300,083	345,721	393,699
b) Tonga	139,111	120,684	58,154
Total	439,194	466,405	451,853
Operation Expenses (T$)			
a) Fiji & Pago Pago	168,907	190,276	179,976
b) Tonga	46,393	40,452	11,071
Total	215,300	230,728	191,047
Other Expenses (T$)			
a) Dividends to Crew	78,363	82,487	91,283
b) Ship Insurance	29,580	43,354	41,304
c) Dockyard Cost	9,343	18,164	23,811
d) Basic Wage for Crew	24,135	23,659	21,127
e) Miscellaneous	19,808	4,695	0
Total	161,292	172,359	177,525
Profit (T$)	62,665	63,318	83,281

Source: Fisheries Division

Table 2-2-3 Activities of Albacore and Takuo

Item \ Name	Albacore	Takuo
Agricultural Festival	(Ha'apai) 13 Days	(Vava'u) 5 Days
Dockyard	5 Days	10 Days
Engine Overhaul	51 Days	-
Operation	140 Days	92 Days
Anchored in Port	156 Days	254 Days
Chartered	-	4 Days
Total	365 Days	365 Days

Source: Fisheries Division

The Fisheries Division has been implementing the Boat Building Project in order to promote small-scale fishery. The Project anticipates the building of 20-32 feet long new fishing boats using 30 engines (20HP), as well as an additional 30 engines (30 HP) granted by Japan. The building of 40 boats is currently in progress.

The Fisheries Division has also been engaged in various culturing attempts, as described below.

o 1973 - Seed oysters were thrown in but died of their failure to adapt to the environment.

o 1974 - From 1974 to 1983, attempts were made to culture pearls using akoya shells, mabe shells, black pearl shells and white pearl shells but attempts have since been suspended.

o 1975 - Mexican molie were imported from Pago Pago in Samoa as a supply of live bait for the pole-and-line fishing of skipjack. They were later raised in the breeding ground which was constructed with grant-aid from Japan on a site belonging to the Fisheries Division.

The experiment was suspended, however, due to the low breeding rate which resulted from their viviparity and the unfavourable results of using them as live baits for skipjack.

The culturing of mullet and milk fish was also tried at the same time but later suspended due to unfavourable results.

- o 1976 - Seed blue mussels were imported from the Philippines, Singapore and other countries for culturing experiments. As in the case of the above-described oysters, the experiments failed.

- o 1985 - The culturing of sea plant (Euchuma) which is the raw material for Carrageenan is about to begin in the Vava'u area. The original plant was imported from Fiji.

2) Private Sector

Although the number of fishermen that are registered in the Fishermen Registration Scheme, which was started in 1984, is 477 in the Vava'u area and 589 in the Ha'apai area, the total number of fishermen in Tonga is unknown as there is a great number of unregistered fishermen. In comparison with other island countries, however, it can be said to be certain that many fishermen have a strong enthusiastic for fishing in Tonga, judging from the good preparation of fishing boats and gear and other aspects.

According to the survey by the Fisheries Division conducted in 1980, the number of people exclusively engaged in fishing is as follows:

Tongatapu Area	497
Ha'apai Are	575
Vava'u Area	628
Total	1,700

Local fishery is mostly dominated by fishweir, throw-net and beach-seining at the coasts, spear fishing and octopus fishing not far out at sea, and hand-line as well as trolling fishing in adjoining seas.

The total catch is estimated to be as follows:

Table 2-2-4 Total Catch (Unit: ton)

	1981	1984
Shallow Waters inside Reefs	1,920	2,710
Outside Slopes of Reefs	260	(Details
Adjoining Seas	120	Unavailable)
Total	2,300	2,710

Source: Fisheries Division

The average fish price was T$0.85/kg.

The major types of fish are skipjack, yellowfin, big-eye and marlin among surface fish and various demarsal fish, such as grouper, parrot fish and bream, etc. Refer to Appendix 5 for the detailed description of fish types.

No attempts at culturing have been made in the private sector. With regard to fish processing, only a small amount of salted or dried octopus and dried blue parrot fish, etc. are seen.

(3) Fishing Boats

Fishing boats can be largely divided into 6 categories, from the most traditional canoe to the new dual-type boats using sails and/or engines, offered as grant-aid from Japan as part of the Boat Building Project currently in progress under the supervision of the Fisheries Division.

The 1984 fishing boat building statistics compiled by the Fisheries Division are given below.

Table 2-2-5

Type	Number of Boats
Canoe	221
Small Boat without Motor	41
Small Boat with Outboard Motor	435
Sail Boat	42
Small Boat with Inboard Engine	18
New Dual-Type Boat (Sail/Inboard Engine)	17
Total	774

Source: Fisheries Division

The new dual-type boats are those built under the Boat Building Project, which started in 1982 and will continue up till 1987. 30 engines (30 HP) and additional 10 engines (20 HP) out of the total 60 engines have been given as grant-aid from Japan are used as main engines. The hulls are continuously being built by the Ha'apai Boat Yard and the Vava'u Boat Yard at the local Bureaus of the Fisheries Division and the Sopu Boat Yard at the Fisheries Division Headquarters with technical assistance provided by FAO/UNDP.

The situation of the progress at these 3 yards is shown below.

Table 2-2-6 Progress Situation of Boat Building Project

Location	No.	Standards			Building Period Commencement-Completion
		20 feet 20 HP	28 feet 20 or 30 HP	32 feet 30 HP	
Sopu Yard (Fisheries Division Headquarters)	1	1			25/ 6 /82 - 8 / 5 /83
	2	1			11/ 2 /83 - 10/11/83
	3	1			18/ 5 /83 - 22/ 8 /84
	4		1		5 / 7 /83 - 28/ 9 /84
	5		1		5 / 8 /83 - 5 /10/84
	6		1		24/10/83 - 3 /11/84
	7		1		24/10/83 - 3 /11/84
	8	1			30/ 3 /84 - 28/ 9 /85
	9			1	30/ 3 /84 - 30/ 8 /85
	10		1		17/ 8 /84 - 21/ 5 /85
	11	1			17/ 8 /84 - 28/ 2 /85
	12	1			8 / 2 /85 - 2 / 7 /85
Total		6	5	1	
Ha'apai Yard	1	1			9 / 5 /84 - 24/ 8 /84
	2	1			14/ 7 /84 - 28/ 3 /85
	3	1			26/10/84 - 28/ 3 /85
	4		1		1 / 2 /85 - 11/ 7 /85
	5	1			15/ 3 /85 - 25/ 7 /85
Total		4	1		
Vava'u Yard	1		1		12/ 3 /84 - 11/11/84
	2		1		6 /12/84 - 26/ 3 /84
	3		1		17/12/84 - 16/ 7 /85
Total			3		
Grand Total	20	10	9	1	

(Unit: boat)

Source: Fisheries Division

Note: As of October, 1985, the building of 3, 2 and 1/2 boats are in progress at the Sopu, the Ha'apai and the Vava'u Yard respectively.

Of the 60 engines given as grant-aid from Japan, 40 are planned for the Boat Building Project currently in progress. The remaining 20 engines are planned for the New Boat Building Project to be implemented by the Fisheries Division following the present Project.

The current Project envisages the building of 20, 28 and 32 foot long fishing boats. Figures 2-2-3 and 2-2-4 give the general outlines of the 28 and 32 foot long boats respectively. The operation of these newly built boats will be commissioned to those fishermen selected by the Artisinal Fisheries Development Committee, consisting of 4 government officials and 1 official from the Tonga Development Bank, who have completed 6 months sea training and 2 weeks classroom study. The commissioned fishermen will have 10 year contracts with the Fisheries Division and will be prohibited from using the boats for purposes other than fishing. Those fishermen operating the new dual-type boats will receive half of the annual profits, i.e. the total annual income minus the running costs. The remaining half will go to the Deposit Revolving Account at the Tonga Development Bank.

Fig. 2-2-3 28 Foot-Long Type Boat

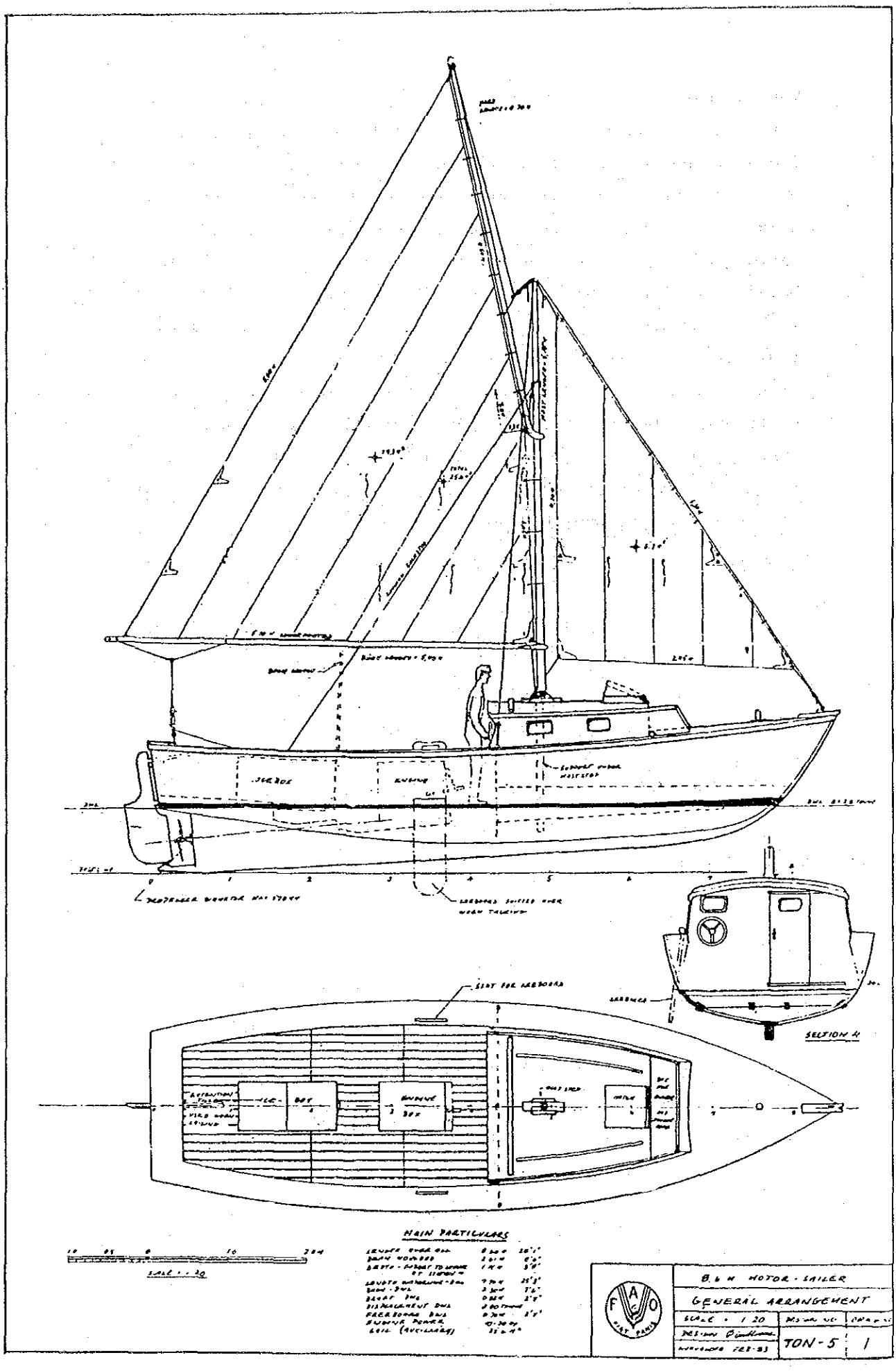
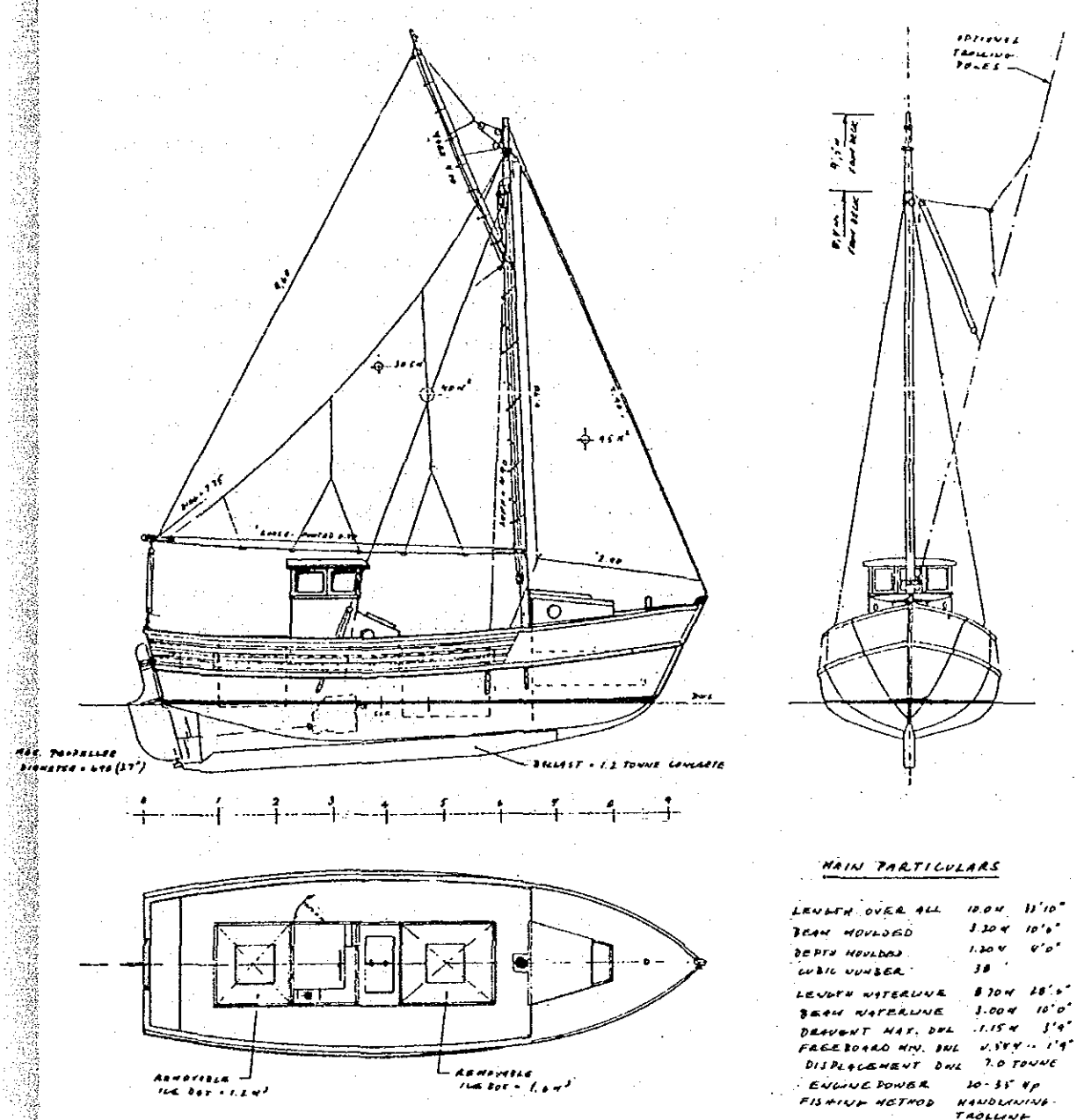


Fig. 2-2-4 32 Foot-Long Type Boat



FAO FIAT PANIS	10.04 MOTOR SAILER		
	GENERAL ARRANGEMENT		
	SCALE = 1:50	DESIGN NO	DRWG NO
	DESIGN Ø Gulbrandsen Grimstad, Aug - 83	TON-6	1 A

2-2-2 Distribution and Demand for Marine Products

A marine resource assessment, as well as a fish consumption survey, was carried out by FAO for the period between 1975 and 1977. The survey was carried out with questionnaires for 1,565 people of 395 families, selected by area and social class. The consumption figures ranged between 16 kg/person/year in urban areas and 50 kg/person/year in fishing villages. Since the consumption volume is affected by the potential supply volume, 30 kg/person/year was given as a reasonable figure.

As the total catch in 1979 was estimated by the Fisheries Division to be 2,010 tons with an estimated population of 94,491, the supply volume was given as some 21 kg/person/year. This figure is low in view of the fact that Tongans have a strong preference for fish, preffering fresh fish and eating it often, from the fish head to the bones and from small fish to shark and octopus, etc. Their most representative dishes are 'Umu', a sort of stone baked dish unique to Polynesia, and 'Ota', a sort of tropical style chopped fish soaked in coconut milk with lemon and various spices.

Based on the people's strong fish preference, the Government of Tonga has increased the supply of domestically produced fish and decreased imports of mutton flap* and other goods in order to economise the foreign currency, while trying to reduce the occurrence of geriatric diseases through the prevention of the excessive westernization of the diet.

The FAO survey in 1980 reported that the consumption of domestically produced fish in Tonga was 21.2 kg/person/year, in addition to 5.1 kg/person/year of such imported fish products as tins of mackerel, etc.

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* Mutton flap are spare ribs with a bone content sometimes reaching to almost 50%.

The Fourth-Year Development Plan estimates that the fish consumption/person/year in 1985 will be 40 kg and the annual total demand will be some 4,000 tons.

Fish prices at the time of the Study Team's survey (September, 1985) were as follows.

Table 2-2-7

(Unit: T$/kg as of September, 1985)

Area / Fish Type	Vava'u	Ha'apai
Bream, Tuna, Spearfish	1.35 (≒230)	1.00 (170)
Reef Fish	1.25 (≒230)	0.90 (153)
Small Fish	1.05 (≒179)	0.75 (≒128)
Skipjack	1.20 (204)	0.75 (≒128)
Octopus	1.80 (306)	1.30 (221)
Lobster	13.00 (2,210)	10.00 (1,700)

Source: Fisheries Division

Exchange Rate: 1 T$ = ¥170

Figures in parentheses are fish prices expressed in Japanese Yen

The transport of fish from the production areas to the consumption area of Tongatapu is mainly carried out by the large ferry, 'Olovaha' (owned by Shipping Corporation in Polinesia) and the ex-tuna fishing boat 'Nanasipau' (owned by Warner Pacific Lines). Since neither of them are specially designed for fish transportation, they do not frequently stop at ports. Moreover, as they cannot navigate in the Ha'apai area due to the shallow waters, the means of fish distribution are quite limited.

There are 2 fish markets in Tonga. One is located in the capital, Nukualofa, and is owned by the Government and the private market is located next to it. Frozen tuna and frozen saury unloaded by the Government-owned boats and ice, etc. are sold in the government market while fresh fish unloaded by the local fishermen is the main item in the private market.

Fish prices at the government market as of September 1985 were as follows:

Table 2-2-8

Product Name	Price (T$/kg)
Frozen Saury	2.85
Fillet	4.00
Ice	0.08

In the private market, the midrib of a banana leaf is pierced through various numbers of fish to make a basic sales bunch.

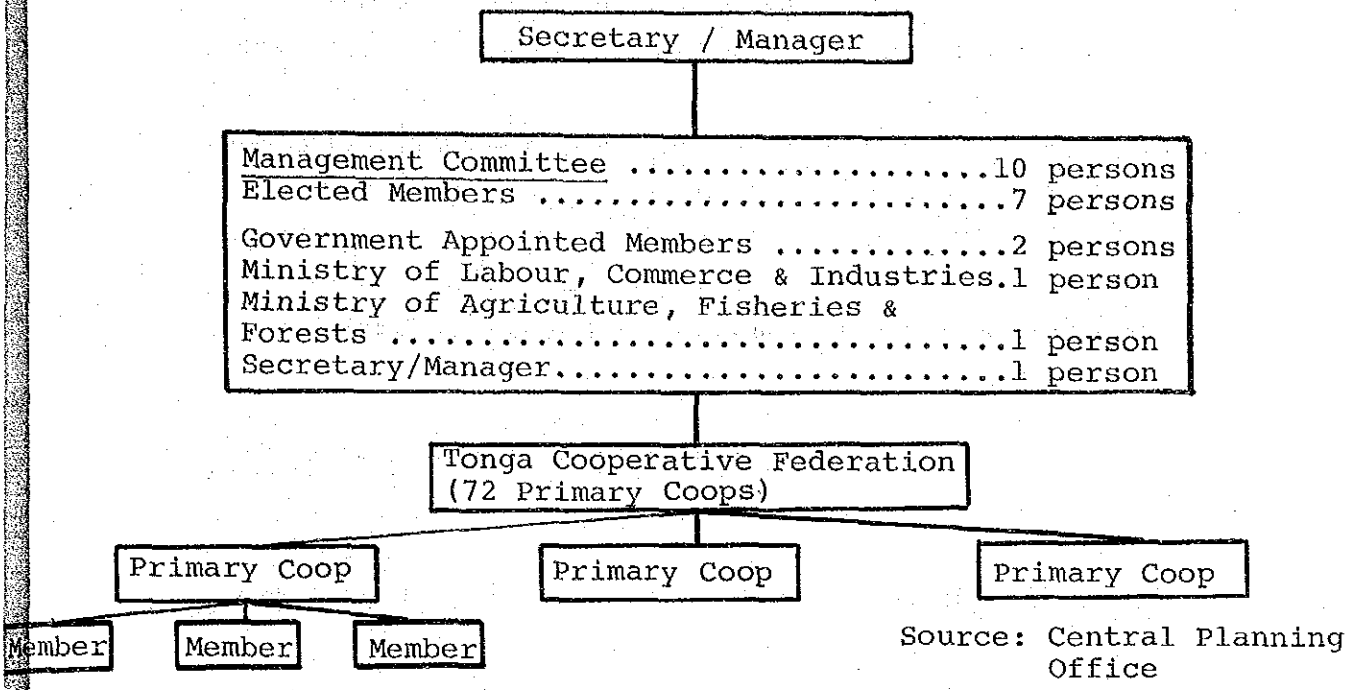
Their prices are as follows.

Fish	T$ 2.00 - 6.00/bunch
Lobster	T$ 12.00/kg
Giant Clam	T$ 3.00/kg
Ark Shell	T$ 2.00/bag

While the other Fish Market/Storage Complex in Vava'u, constructed by the ADB Fund, is subject to the management of the Fisheries Division, its actual operation has been commissioned to the Tonga Cooperative Federation.

The Tonga Cooperative Federation is under the jurisdiction of the Ministry of Labour, Commerce and Industry. The organization of the Federation is shown below.

Fig. 2-2-2 Organization of the Tonga Cooperative Federation



Source: Central Planning Office

The Tonga Cooperative Federation is the only federation of cooperatives in Tonga, consisting of primary cooperatives (also called cooperative societies). The main businesses of the Federation are as follows.

1. Wholesale
2. Fish Market (Sale of Fishing Gear Included)
3. Vanilla Marketing
4. Handicrafts

Although the 1983 annual balance was in the red, earnings and expenses in 1984 are balanced due to the improved business performance. With regard to the fish market business, the 1983 annual balance was in the red but went into the black in 1984.

The following is an example of the distribution costs in the case of Lifuka in the Ha'apai area. The fare to Tongatapu by the ferry 'Olovaha' is T$ 0.04/kg and the storage fee at the cold storage owned by

the Lifuka Branch of the Fisheries Division is T$ 0.15/11 kg * T$ 0.014/kg for the first 24 hours. The storage fee at Vava'u's Market/Storage Complex, operated by the Tonga Cooperative Federation, is the same.

The Fishermen's Cooperative is also a member of the Federation in view of doing business in the Fish Market.

2-2-3 Contents and Current Status of Japanese Grant-Aid Cooperation for Fisheries

The major contents of Japanese grant-aid cooperation for fisheries are as follows:

A 1978 Fisheries Research Centre and Skipjack Fishing Boat 'Takuo', etc.

B 1981 Small-Size Round Haul Netter 'Albacore', etc.

C 1982 Tuna Fishing Training Boat 'Lofa'

D 1983 60 Sets of Engines and Fishfinders for Small-Size Fishing Boats

(1) Fisheries Research Centre and 'Takuo'

The Fisheries Research Centre has been effectively used except for 6 20-ton breeder tanks and the Indoor Breeding Research Room. 3 tanks and the Indoor Breeding Research Room are now used as storage for fishing gear with the 3 remaining tanks being used as original drawing tables for the construction of new fishing boats.

The details of 'Takuo' and its activities in 1984 are as previously described. This vessel was originally built as a pole-and-line fishing survey boat. Due to the difficulty in obtaining live baits and the deterioration of freezer-related parts, especially the cooling pipes inside the fish hold, however, it is often used as a hand-line fishing boat for such demarsal fish as bream and grouper in the outer slopes of reefs. In addition, the fuel cost of 'Takou's' 200 HP engine, which is more than double that of the

'Albacore's' 90 HP engine, is obviously very high. While its maneuverability is excellent due to its nature as a skipjack pole-and-line fishing boat, it is not really suited to the hand-and-line fishing of demarsal fish due to its vulnerability to currents. As a result, it spent many days anchored in port rather than operating out at sea, as shown in Table 2-2-3.

The efficient use of 'Takuo' in the future should be considered to contemplate an effective utilization of payao (floating artificial fish gathering device) so as to enable skipjack pole-and-line fishing as well as hand-line fishing in the outer slopes of reefs, using a spanker sail (Note 1) or a para anchor (Note 2) to allow the boat to resist currents or wind.

Note 1) Sail put up at the quarter to keep the boat in line, mainly against the wind, in order to maintain the boat's stability.

Note 2) Parachute-type mid-water floating anchor thrown from the bow to keep the boat in line with the current in order to maintain the boat's stability.

(2) Small-Size Round Haul Netter, 'Albacore'

'Albacore' is a small-size round haul netting survey boat for the fishing of horse mackerel, mackerel and sardine, etc. in coastal waters. In addition, it is also engaged in the trolling fishing of skipjack yellowfin tuna, etc. The details of the boat and its activities in 1984 are as previously described.

In 1984, the Fisheries Division made a new attempt of the round haul net fishing by setting 3 payaos into the sea near Tongatapu for small surface water fish, such as sardine, etc., which gather around. Although fair results were obtained, only 1 payao is currently functioning as the other 2 have sunk into the sea. In view of the 'Albacore's' good maintenance and the crew's satisfactory technical level, the full utilization of the 'Albacore' will be achieved if such attempts as the use of fishing lamps for round haul netting at night at the payao, etc. are made.

(3) 'Lofa'

As described earlier, 'Lofa' has been engaged in an experimental fishing operation aimed at the establishment of the stable deep-sea long-lining of tuna, one of the Fisheries Division's most important objectives.

Table 2-2-9 gives the annual balance of the operation, achieved by deducting the interest and the depreciation cost from the operating income for each year.

Table 2-2-9

Item \ Year	1982/83	1983/84	1984 (Mar.1 - Dec.31)
Catch	311.15 tons	310 tons	288 tons
Operating Profit	62,665 T$	63,318 T$	83,281 T$
Interest (Note)	158,820 T$	148,200 T$	114,700 T$ (137,640 for the year)
Depreciation Cost (Note)	176,470 T$	176,470 T$	147,058 T$ (176,470 for the year)
Annual Loss	272,625 T$	261,352 T$	178,477 T$

(Note)

Item \ Year	First Year	Second Year	Third Year
Book Value	(¥450 million) T$ 2,647,000	(¥420 million) T$ 2,470,000	(¥390 million) T$ 2,294,000

Original Purchase Cost: Approximately ¥ 450 million

Depreciation Period: 15-year equal depreciation with an annual depreciation cost of ¥ 30 million

Interest Rate: A 6% interest rate, the same as for the Revolving Account opened by the Tonga Development Bank for the Boat Building Project, is employed.

As far as can be judged from Table 2-2-9, the operation will be continuously in the red for the entire 15 years of depreciation if the catch rate of 1.63 tons per operation day and some 58% operation ratio against the total operable days continue. While Tongan waters are the fishing grounds for albacore and yellowfin tuna, it is impossible to catch the highly-valued tuna for 'sashimi'. Accordingly, steady attempts to increase the catch by the provision of more operable days and fishing gears, are necessary to establish the long-lining of tuna in the Kingdom of Tonga.

(4) Engines for Small Fishing Boats

As described earlier, these engines for small fishing boats have been systematically used. Those which have not been used as yet are properly stored in the warehouse belonging to the Fisheries Division.

2-3 Background of the Request

2-3-1 Long-Term Development Objectives and the Fourth Five-Year Development Plan

The five long-term development objectives at a national level in the Kingdom of Tonga are as follows.

(1) The continuous growth of various products, services and the national income.

(2) The efficient management of the national economy.

(3) The fair distribution of products, services and the national income to all sectors of the economy.

(4) The improvement of the living and safety standards of the people, the preservation of the national heritage and the maintenance, as well as the improvement, of the life environment.

(5) The development of harmonious relationships, as well as mutual cooperation, in social, economic and other fields with all countries in the world and international organization.

The Fourth Five-Year Development Plan (1980-1985) is based on the above objectives. However, as it also incorporates the experiences of the Third Plan, emphasis is placed on the importance of the private sector in the economic development, the promotion of the local development activities and the improvements in the vigorous production activities. As stated in the 'Strategy' at the beginning of this Report, the direction of a larger share of the national resources to agriculture, fishery and manufacturing, and also to less developed areas, is listed as a preferential development strategy. Based on this strategy, the Government has set up a policy consisting of 16 points. Those points which are considered to relate to the Fish Marketing Project are as follows.

(1) The export expansion of marine products

(2) The promotion of production activities on islands other than the main Tongatapu Island.

(3) The further development of a long-lasting fishery based on small-scale fishery.

(4) The expansion and diversification of production activities in the private sector.

(5) The improvement, as well as the promotion, of the distribution system.

2-3-2 Objectives of Fishery Development in the Fourth Five-Year Development Plan

The Ministry of Agriculture, Fisheries and Forestry in Tonga has set the objectives of fishery development in the Fourth Five-Year Development Plan as follows.

(1) The improvement of the production of low price fish in order to meet the people's demand for fresh fish.

(2) The promotion of small-scale fishery by introducing new fishing boats, improving fishing gear and methods and establishing a fish marketing system whereby low price fresh fish can be adequately supplied.

(3) The expansion of the fishing grounds, from the conventional shallow water fishing to off shore fishing, utilizing unused resources and mitigating the concentration of fishing in shallow waters.

(4) The increased employment and income by the promotion of local fishery.

(5) The technical assistance to fishermen by the Fisheries Division.

(6) The fostering of export-oriented tuna fishery, which can be operated on a commercial basis, by utilizing resources inside the territorial waters to the maximum extent.

The Government plans to invest approximately T$10 million to implement these objectives. This figure comes fourth in the national budget items, following transport and communication (first), health and sports (second) and agriculture (third). The real annual growth rates during the 5 years of the Plan are expected to be as follows.

Annual Growth Rate of Tongan Economy	: 5.7%
Growth Rate of GDP	: 8.0%
Growth Rate of Agriculture and Forestry	: 4.0%
Growth Rate of Domestic Production Per Capita	: 4.1%
Population Growth Rate	: 1.5%

2-3-3 Interim Report and Concrete Programme for Fishery Development

It was announced by the Government of Tonga in its Interim Report on the Fourth Five-Year Plan, issued at the end of FY 1983 (July-June), that the growth rate of the GDP exceeded the target figure despite of the cyclone which hit Tonga in March, 1982. The average annual growth rates in real terms reached 15.0% in the agricultural sector and 20.9% in the fishery sector.

Although the share of agriculture, forestry and fishery in the GDP in FY 1982/83 was 46.7%, the expected share in FY 1984/85 was set at 39.3%, as shown in Table 2-1-11 of Chapter 2-1-2 (3).

The Fisheries Division has been carrying out the following implementation programmes in accordance with the objectives described in 2-3-2 above.

(1) Boat Building Project

This Project anticipates the use of 40 out of the 60 engines offered as grant-aid from Japan for 6-10 m-long motor-powered sailing boats whose hulls are built with the technical assistance of FAO/UNDP. The remaining 20 engines will also be integrated in a new boat building project to be implemented in the future.

(2) Fishing Gear and Method Development Programme

This Programme was implemented with the financial, as well as the technical, assistance of the South Pacific Fund but is currently suspended.

(3) Fishing Gear and Engine Spare Parts Servicing Programme

Fishermen at both Vava'u and Ha'apai will be subject to this Programme. It is currently in the planning stages and the details are under examination.

(4) Ice Supply, Fish Handling, Cold Storage Facilities and Marketing Facilities Scheme

Marketing facilities have been constructed at Vava'u and Ha'apai with the ADB fund and are currently in use.

(5) Fish Transport Project

This Project consists of 2 vessels, one operating in the Ha'apai area and the other connecting the capital, Nukualofa, with such production areas as Ha'apai, Vava'u and Niuatoputapu. The preparation of the request to Japan to provide these vessels was in progress at the time of the Interim Report.

(6) Fish Pricing Scheme

The introduction of tariffs on imported marine products and the establishment of a pricing system for domestically produced marine products are considered to be future tasks.

(7) Deep-Sea Fishery Development Project

The Japanese grant-aid boat 'Lofa' has been conducting experimental operations to exploit the plentiful resources with the introduction of deep-sea tuna fishing with a view to earning the foreign currency.

The Tongan Government's request this time (refers to items confirmed at the first meeting of the Study Team visiting Tonga) will supplement item (4) above and achieve the objective described in item (5) above. Furthermore, the implementation of various marking-related project, together with the consolidation of the fishing fleet now in progress, is expected to stimulate fishermen into increasing their productive capacities and to meet the demand for marine products on the main island, Tongatapu.

With regard to the demand for marine products, as the consumption per person in 1985 is estimated to be 40 kg (Fourth Five-Year Development Plan issued by the Tonga Central Planning Department), this figure is used as the basis for various projects and schemes (refer to 4-2-3 (2)).

CHAPTER 3

CONTENTS OF THE PROJECT

CHAPTER 3 CONTENTS OF THE PROJECT

3-1 Objectives

As described in Chapter 2-3 previously, the Fisheries Division states the objectives of the Project as follows.

(1) The establishment of a long-lasting marketing system.

(2) The development of opportunities for the well-ordered marketing of marine products for fishermen.

(3) The increased employment opportunities and income at production areas.

(4) The increased production of fresh fish at reasonable prices to meet the demand.

3-2 Examination of Requested Items

3-2-1 Requested Items

The contents of the final request made by the Government of Tonga to the Study Team visiting Tonga are shown in Tables 3-1-1 and 3-1-2.

Table 3-1-1 Land Facilities

Location	Items and Standards	QTY.
NIUA TOPUTAPU	Deep Freezer $10m^3$ -20°C	1
	Ice Making 1 ton/day	1
	Generator 3kW 220V 50Hz	2
	Generator 6kW 220V 50Hz	1
	Building $30m^2$ Steel Frame	1
	Ice Storage 5 tons	1
	Water Tank 3 tons	1
	Ice Box $0.5m^3$	3
	Ice Box $0.03m^3$	30
VAVAU	Deep Freezer $10m^3$ -20°C	1
	Display Freezer $1m^3$ -20°C	11
	Ice Making 1 ton/day	1
	Ice Storage 5 tons	1
	Water Tank 3 tons	1
	Ice Box $1m^3$	2
	Ice Box $0.03m^3$	100
	Ice Box $0.5m^3$	13
HAANO & OTHER ISLANDS	Ice Box $1m^3$	6
	Ice Box $0.03m^3$	6
	Ice Box $0.5m^3$	6

Table 3-1-1 Ctd.

Location	Items and Standards	QTY.
LIFUKA	Display Freezer $1m^3$ -20°C	4
	Ice Making 1 ton/day	1
	Generator 6kW 220V 50Hz	1
	Ice Storage 5 tons	1
	Water Tank 3 tons	1
	Ice Box $0.03m^3$	60
UIHA	Deep Freezer $1m^3$ -20°C	1
	Generator 3kW 220V 50Hz	2
	Ice Box $0.03m^3$	50
	Ice Box $1m^3$	1
NOMUKA	Deep Freezer $10m^3$ -20°C	1
	Ice Making 1 ton/day	1
	Generator 3kW 220V 50Hz	2
	Generator 6kW 220V 50Hz	1
	Building $30m^2$ Steel Frame	1
	Ice Storage 5 tons	1
	Water Tank 4 tons	1
	Ice Box $0.03m^3$	50
HA'AFEVA	Deep Freezer $10m^3$ -20°C	1
	Ice Making 1 ton/day	1
	Generator 3kW 220V 50Hz	2
	Generator 6kW 220V 50Hz	1
	Building $30m^2$ Steel Frame	1
	Ice Storage 5 tons	1
	Water Tank 3 tons	1
	Ice Box $0.03m^3$	50
TONGATAPU	Deep Freezer $10m^3$ -20°C	2
	Ice Making 1 ton/day	3
	Building $30m^2$ Steel Frame	1
	Ice Storage 5 tons	3
	Water Tank 3 tons	3
	Display Freezer $1m^3$ -20°C	50
	Ice Box $1m^3$	60
	Ice Box $0.03m^3$	50

Table 3-1-1 Ctd.

Location	Items and Standards	QTY.
'EUA	Deep Freezer 10m^3 -20°C	1
	Ice Making 1 ton/day	1
	Generator 3kW 220V 50Hz	2
	Generator 6kW 220V 50Hz	1
	Building 30m^2 Steel Frame	1
	Ice Storage 5 tons	1
	Water Tank 3 tons	1
	Ice Box 0.5m^3	3
	Ice Box 0.03m^3	30
MISCELLAN-EOUS	Water Pump 0.4kW	8
	Water Pump 0.4kW with Tank	8
	Fuel Oil Tank 300 lit.	5
	Control Box for Pump	8
	Scale Weight 0-100kgs	7
	Radio VHF 25W	5
	Radio VHF 100W	1
	Shelves 1220 x 610	14
	Installation	7
	Spare Parts	1
	Van 2 tons	2

Table 3-1-2 Fish Carrier Vessels

	FRP Carrier Vessel for Tongan Islands Area	FRP Carrier Vessel for Ha'apai Area
Gross Tonnage	Approx. 18GT	Approx. 7GT
Fish Hold	Approx. $20m^3$	Approx. $10m^3$
Fuel Tank	Approx. $4.5m^3$	Approx. $1m^3$
Water Tank	Approx. $1.0m^3$	Approx. $0.20m^3$
Number of Crew	6	3
Main Engine	Approx. 100HP	Approx. 60HP
Auxiliary Engine	Approx. 30HP	-
Refrigerating Capacity	-20°C	-
Speed	Approx. 8kt	Approx. 7kt
Cruising Distance	Approx. 800 Nautical Miles	
Equipment	NNSS, Radar, SSB, Echo Sounder, Magnetic Compass, etc., Derrick, Life Saving Appliances, Tender Boat	Radar, Echo Sounder, Magnetic Compass, etc., Derrick, Life Saving Appliances, Tender Boat

3-2-2 *Examination of Requested Items*

The requested items relate to equipment, as well as facilities, in the Fish Marketing Project which is indispensable for the promotion of Tongan fishery, together with the Boat Building Project which has been being implemented with a view to strengthening the productive capability.

The major items among these equipment and facilities are such shore facilities as cold storages and ice making plants, etc. in areas of both production and consumption, fish carrier vessels for the transportation of fish from major production areas to consumption areas and small fish carrier vessels in the Ha'apai area where many stock points are scattered. The major production areas under consideration are Niuatoputapu, the Vava'u area, the Ha'apai area and 'Eua from north to south while the consumption area under consideration is Tongatapu where the capital, Nukualofa, is situated.

3-3 Summary of the Project

3-3-1 Agency in Charge of the Implementation and Management System

All aspects of fishery development in Tonga, i.e. planning, procurement, construction/building, management and operation, are carried out by the Fisheries Division. In the case of the present Project, the Fisheries Division is responsible and, therefore, the management and operation should, in principle, be carried out by the Fisheries Division. However, if the commissioning to cooperatives, etc. is judged to be financially feasible, the operation of certain functions may be commissioned to some organizations (such as cooperatives) which will be selected on the basis of certain standards in regard to both their capability and reliability.

3-3-2 Basic Plan

The catch has increased due to various fishery projects, especially the Boat Building Project, carried out by the Fisheries Division, causing an imbalance between the production volume and the marketing capability. Accordingly, shore facilities such as cold storages and ice making plants, etc. at both production and consumption areas and fish carrier vessels connecting stock points and consumption areas have become necessary to solve this imbalance. The Project was designed based on these necessities.

The main stock points are Niuatoputapu, Vava'u, Lifuka, Ha'afeva, Nomuka, Uiha and 'Eua while the consumption area is Tongatapu where the capital is located.

Large ice boxes will be located at sub-stock points to supplement the marketing function within their respective areas as temporary cold storages.

In the Ha'apai area, where sub-stock points are scattered over a wide area, a small fish carrier vessel will operate between the major stock points and these sub-stock points.

3-3-3 *Location and Situation of Project Sites*

(1) Niuatoputapu Island (see Appendix 7)

This is a small island located at latitude 16°N, 340 miles from Tongatapu Island. It has a population of some 2,000 and is the northern most island in the Kingdom of Tonga.

Since the regular ship service from Tongatapu to Niuatoputapu only operates once a month, the Island is presumed to be a very remote area in Tonga. Under this geographical situation, although a public well exists to provide drinking water, the water quality is not very good, being hard and containing salt. There is no public supply of electricity and, therefore, the Island's own generator must be relied upon.

(2) Vava'u Island (see Appendix 7)

Vava'u Island is located at the central part of the Kingdom of Tonga, 170 miles away from Tongatapu Island. It has the second largest urban area in the country. As it has construction machinery, unloading facilities and piers and as a regular ship service connects the Island with Tongatapu Island, no problems are anticipated in regard to the transportation of construction equipment/materials and the construction of new facilities. With regard to utilities, public water and power services exist. The water quality, however, cannot be said to be good due to its hardness and its salt content. Frequent voltage fluctuations occur due to the small capacity of the generator in use.

(3) Lifuka Island (see Appendix 7)

This is the main island in the Ha'apai area and is 90 miles away from Tongatapu Island. As it has construction machinery, unloading facilities and piers with a regular cargo service between the Island and Tongatapu Island, there will be no problems in view of the transportation of construction equipment/materials and the construction of new facilities. With regard to utilities, although there is water supply serviced by public wells, the water is very hard and has a high salt content. There is a public power plant on the Island and electricity is sold. However, it only supplies electricity between the hours of 6:00-12:00 and 17:00-24:00 when voltage fluctuations frequently occur.

(4) Uiha Island (see Appendix 7)

Uiha Island is also located in the Ha'apai area and is some 10 miles to the south of Lifuka Island. There is no construction machinery or unloading facilities on the Island and there is also no regularship service between the Island and Tongatapu Island for transporting construction equipment and materials. With regard to utilities, although public wells provide water supply, the quality of the water is as bad as that of the other islands. No electricity service exists.

(5) Ha'afeva Island and Nomuka Island (see Appendix 7)

Both Islands belong to the Ha'apai area. Ha'afeva Island is 20 miles west of Lifuka Island and Nomuka Island is 30 miles southwest of Lifuka Island. Both these Islands do not have construction machinery, unloading facilities or piers and there are no regular ship services between the Islands and Tongatapu Island for the transportation of construction equipment and materials. With regard to utilities, neither public water supplies nor electricity services exist.

(6) Tongatapu Island (see Appendix 7)

Nukualofa, the capital of the Kingdom of Tonga, is located on Tongatapu Island. Accordingly, it has construction machinery, as well as unloading facilities. A fishing port is currently under construction at the planned construction site of the stock point and is expected to be completed in July, 1986. With regard to utilities, although the Island has both public water and electricity services, the quality of the water cannot be said to be good, as in the case of the other islands. Voltage fluctuations are also frequent.

(7) 'Eua Island (see Appendix 7)

'Eua Island is located 10 miles to the south of Tongatapu Island. While there is no construction machinery on the Island, simple piers and unloading facilities are provided. With regard to utilities, while the quality of the drinking water is good, there is only a limited supply of electricity with frequent voltage fluctuations.

3-3-4 Summary of Existing Facilities and Equipment

Location	Item	Number of Facilities/ Equipment
Tongatapu	Cold Storage approx. 15m^3, -20°C	7
	Ice Making Plant 750kg/16 hr.	2
Lifuka	Cold Storage approx. 20m^3, -20°C	2
	Ice Making Plant 1 ton/day	1
Uiha	Cold Storage approx. 10m^3, -20°C	1
Vava'u	Cold Storage approx. 10m^3, -20°C	4
	Block Ice Plant	1
	Blast Freezer	2

Note: Those listed are in operation as of September 30, 1985

3-3-5 Construction

The representative construction company in the Kingdom of Tonga is the Construction Division, Commodities Board Tonga, which is a joint-company with New Zealand capital. As well as being engaged in the collection and export of copra, Tonga's most representative product, it is also engaged in the construction business. As the Construction Division has carried out the construction of a number of churches which are scattered all over Tonga, its construction technology can be favourably evaluated.

CHAPTER 4

BASIC DESIGN

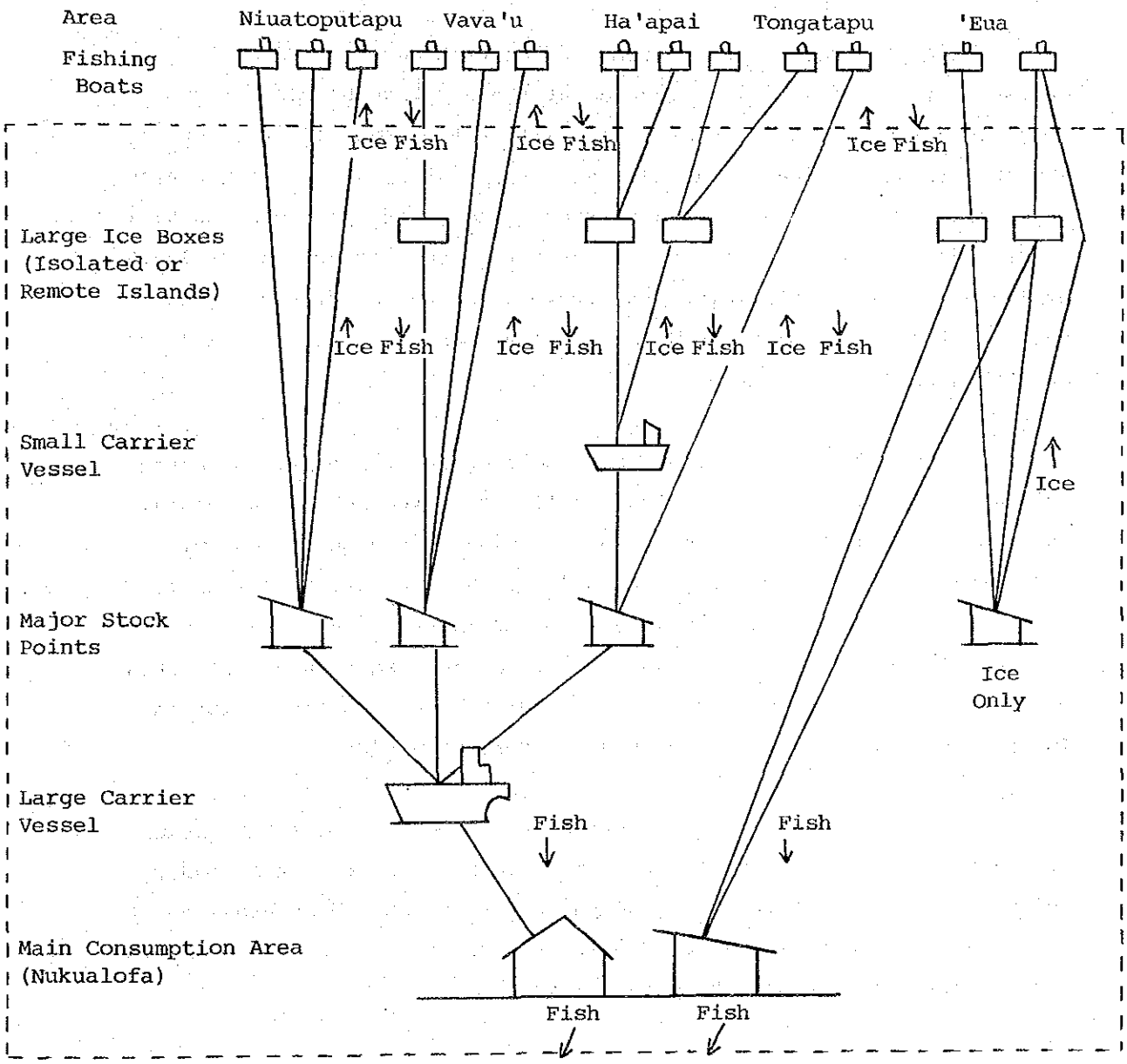
CHAPTER 4 BASIC DESIGN

4-1 Design Policy

4-1-1 General Concept

The general concept of the basic design is shown in Figure 4-1-1 below.

Fig. 4-1-1 General Concept



As shown in the Figure of the general concept, the Fish Marketing Project is an attempt to establish a marketing channel connecting production fronts in remote areas with Tongatapu, the large consumption area. Accordingly, 6 major stock points have been selected as described in Chapter 4-3 "Basic Plan", i.e. 1 each for the Niuatopatu and Vava'u areas, 1 in 'Eua and 1 each for the 3 groups in the Ha'apai area (Lifuka in the north with a sub-stock point in 'Uiha, Ha'afeva in the centre and Nomuka in the south) where a large number of islands are scattered over a wide sea area. The necessary facilities for each point will be considered independently.

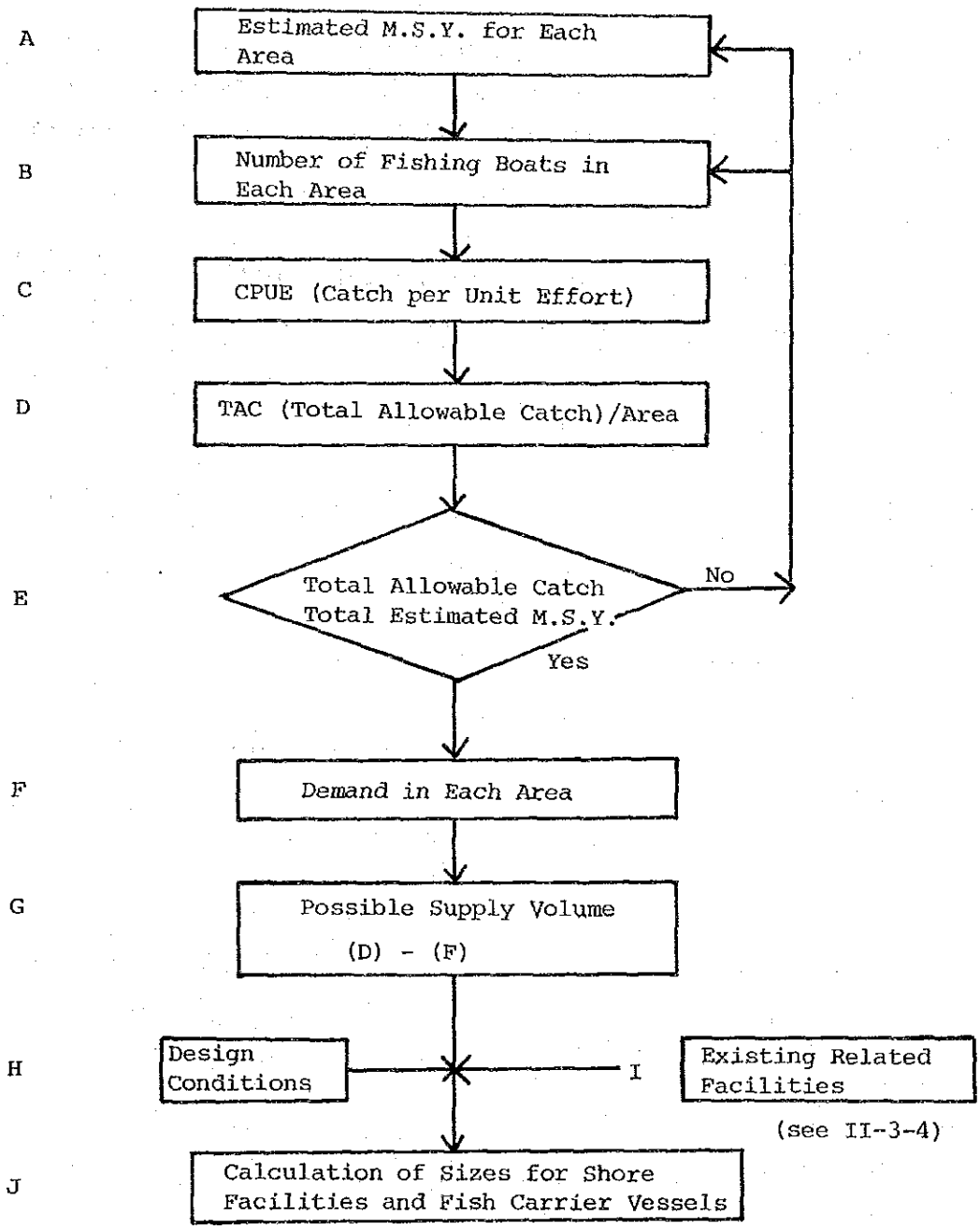
At Nukualofa, the capital and central consumption area, the necessary facilities will be located at the new fishing port at Fuau which is currently under construction with the EC fund (completion is expected in July, 1986). In addition, stock points and the consumption point will be connected by fish carrier vessels. Large ice boxes will be provided at sub-stock points, which are in fact islands or villages having no access to the major stock points due to the distances involves, despite of their being located in the same area or on the same islands as the major stock points.

As all the major stock points belong to the 3 groups in the Ha'apai area and are far away from their respective sub-stock points, and as these sub-stock points (fishing villages) are scattered over a wide area, a small fish carrier vessel will be required to transport both ice and fish between the major stock points and the sub-stock points. The handling of fish in the form of ice packs should be given priority in view of the Tongan people's preference for fresh fish and the possible length of the freshness preservation time.

Furthermore, service centres, with the main objective being the maintenance of the marketing facilities on land and the secondary objective being the processing and sale of fish, should be provided at the required locations (refer to 3.1) in order to provide a back-up to the operation of the marketing facilities.

4-1-2 Process of Basic Design

The process of the basic design is shown in Figure 4-1-2 below.



Note: M.S.Y. ... Maximum Sustainable Yield

4-2 Examination of Design Conditions

4-2-1 Estimated M.S.Y. by Subject Areas

(1) Subject Areas for Resource Estimation

The following areas were found by entering fish grounds on the marine charts at the Fisheries Division based on information concerning fish grounds where fishing boats are currently in operation.

Table 4-2-1

(Unit: km^2)

	Tongatapu	'Eua	Ha'apai	Vava'u	Niuatoputapu
Shallow waters inside reefs	300	100	2,700	700	0
Outer slopes of reefs	200	100	900	300	60
Offshore area	2,500	2,500	1,000	10,000	1,000

Source: Fisheries Division

(2) Yield per Unit Area

The Fisheries Division obtained the following figures by modifying the values of the Resource Assessment Survey in 1978 by FAO, in order to adequately reflect the present situation.

Table 4-2-2

(Unit: ton/km^2)

	Yield per Unit Area
Shallow waters inside reefs	0.55
Outer slopes of reefs	0.70
Offshore area	0.048

Source: Fisheries Division

(3) Estimated M.S.Y. by Subject Areas

The following estimated M.S.Y.s were achieved by multiplying the size of each subject area with the yield per unit area based on Table 4-2-2.

Table 4-2-3

(Unit: ton)

		Tongatapu	'Eua	Ha'apai	Vava'u	Niuatopu-tapu	Total
Mainly Demarsal Fish	Shallow waters inside reefs	165	55	1,495	385	0	2,100
	Outer slopes of reefs	140	70	630	210	40	1,090
Mainly Surface Fish	Offshore area	120	120	50	480	50	820
Total		425	245	2,175	1,075	90	4,010

4-2-2 *Total Allowable Catch by Subject Areas*

(1) Estimated Number of Fishing Boats in 1987

Here, the number of fishing boats in 1987 is estimated. 1987 is the year when the present Fish Marketing Project will be completed and when the Boat Building Project currently in progress to produce 40 new fishing boats will also be completed.

The estimated number is achieved based on the 1984 fishing boat statistics with the following estimates on increases or decreases of each type of fishing boat.

Table 4-2-4 Estimates on increases or Decreases of Fishing Boats (1987)

Type \ Area	Tongatapu	'Eua	Ha'apai	Vava'u	Niuatoputapu
Canoe	n.c.	n.c.	n.c.	n.c.	n.c.
Small Boat without Motor	n.c.	n.c.	n.c.	n.c.	n.c.
Small Boat with Outboard Motor	10% Increase	10% Increase	15% Increase	15% Increase	10% Increase
Sail Boat	n.c.	n.c.	Decrease by 10	Decrease by 1	n.c.
Small Boat with Inboard Engine	10% Increase	n.c.	10% Increase	Increase by 6	n.c.
New Dual-Type Boat (Sail/Inboard Engine)	More than 100% Increase	n.c.	More than 100% Increase	More than 100% Increase	Increase by 2

Source: Fisheries Division
n.c. : No Change

The estimated number of fishing boats in 1987 are as follows.

Table 4-2-5 Esimated Number of Fishing Boats in 1987 (Unit: boat)

	Tongatapu	'Eua	Ha'apai	Vava'u	Niuatoputapu	Total
Canoe	8 (8)	0 (0)	161 (161)	52 (52)	0 (0)	221 (221)
Small Boat without Motor	0 (0)	0 (0)	41 (41)	0 (0)	0 (0)	41 (41)
Small Boat with Outboard Motor	146 (133)	9 (8)	156 (136)	152 (138)	20 (20)	483 (435)
Sail Boat	1 (1)	0 (0)	10 (19)	21 (22)	0 (0)	32 (42)
Small Boat with Inboard Engine	6 (5)	1 (1)	9 (8)	10 (4)	0 (0)	26 (18)
New Dual-Type Boat (Sail/ Inboard Engine)	10 (4)	3 (3)	13 (5)	12 (5)	2 (0)	40 (17)

Source: Fisheries Division
Figures in parentheses are actual numbers in 1984

If the average catch per fisherman is estimated based on the statistics of the number of fishermen, the total potential catch can accordingly be determined. In Tonga, however, these statistics are unavailable as the Fishermen Registration Scheme only commenced in 1984. Therefore, the estimation method based on the available information on the current number of fishing boats was used for the present purpose.

(2) Catch per Unit Effort by Types of Fishing Boats

Table 4-2-6 Catch per Unit Effort by Types of Fishing Boats

(Unit: ton)

Type	Average Monthly Catch
Canoe	0.09
Small Boat without Motor	0.15
Small Boat with Outboard Motor	0.50
Sail Boat	0.50
Small Boat with Inboard Engine	0.70
New Dual-Type Boat (Sail/ Inboard Engine)	1.00

Source: Fisheries Division

(3) Potential Catch (Estimate for 1987)

To find the potential catch, the annual total catchable amount by types of fishing boats is firstly calculated based on the number of boats by types and the catch per unit effort by types of boats. The figures are then added to sum up the catchable amount in each area. The potential catch is lastly found by multiplying the sum of each area with the operation efficiency ratio of fishing boats, i.e. 90%.

The operation efficiency ratio of fishing boats is calculated on the basis of Table 4-2-7 below.

$$\text{Operating Efficiency Ratio} = \frac{243 \text{ days}}{243 \text{ days} + 27 \text{ days}} = 0.9 \ (90\%)$$

Table 4-2-7 Annual Operation Schedule

National Holidays	New Year's Day	January 1
	Easter	
	Anzac Day	April 25
	Birthday of Crown Prince Tubou Toa	May 4
	Independence Day	June 4
	King's Birthday	July 4
	Tubou I Commemoration Day	November 4
	Christmas Day	December 25
	Boxing Day	December 26
	Total:	10 days
Saturdays, Sundays and Other Holidays		85 days
Repairs, etc.		27 days
Operation Days		243 days
TOTAL		365 days

The potential catch in 1987 is estimated to be as follows.

Table 4-2-8 (Unit: ton)

	Tongatapu	'Eua	Ha'apai	Vava'u	Niuatoputapu	Total
Potential Catch	955	90	1,320	1,180	130	3,675

This may appear contradictory as the potential catches in Tongatapu and Vava'u exceed their respective M.S.Y.s. This can be explained by the absence of fishing rights or a fishing license system in Tonga. Therefore, in effect, the fishing boats of Tongatapu also

operate in the nearby 'Eua area, as well as in the Ha'apai area to the north. Vava'u fishing boats also similarly operate in the Ha'apai area to the south. As a result, if a comparison is made between the M.S.Y. and the potential catch, these 4 areas should be considered together.

4-2-3 Demand by Subject Areas

(1) Estimated Population by Subject Areas in 1987

According to the 1976 National Census, the population in each area is as follows.

Table 4-2-9

(Unit: person)

Tongatapu (where the capital is located)	57,411
'Eua	4,486
Ha'apai	10,792
Vava'u	15,068
Other Areas	2,328
Total	90,085

Source: Fourth Five-Year Development Plan

While the next census is expected to take place in 1986, 10 years after the previous one, the Government of Tonga estimates the population as of July, 1985 as follows.

Table 4-2-10

(Unit: person)

Maximum	102,780
Medium	102,190
Minimum	101,630

Source: Fourth Five-Year Development Plan

Based on an estimated population in 1987 of 102,000, the population in each area can be roughly estimated (see the following table) using information gathered by the Study Team, i.e. the population of the Niuatoputapu area is 1,787, there is a rapid population growth in Nukualofa, the capital and a depopulation of remote islands, etc.

Table 4-2-11 (Unit: person)

Tongatapu	71,700
'Eua	4,000
Ha'apai	8,600
Vava'u	15,000
Niuatoputapu	1,800
Other Islands	900
Total	102,000

(2) Annual Fish Consumption per Person

According to a survey carried out by a consultant of FAO, the annual fish consumption per person is as follows.

Table 4-2-12 Annual Animal Protein Intake per Person

(Unit: kg)

	Tongatapu		Islands other than Tongatapu	Average in Tonga
	Urban	Suburban		
Domestically Produced Fish	10.8	22.0	28.1	21.2
Imported Canned Fish				5.1
Domestically Produced Pork	1.8	6.3	5.9	4.9
Domestically Produced Beef	2.1	2.7	1.1	2.0
Imported Beef, etc.				9.3
Imported Corned Beef, Canned				3.5
Imported Mutton Wraps				29.8
Domestically Produced Chicken	0.5	0.4	1.0	
Imported Chicken, etc.				

Source: FAO Survey in 1980

The Government of Tonga estimates the annual fish consumption in 1985 to be 40 kg/person.

Taking the above-described information into consideration, the annual demand for fish per person in Tongatapu is set at 32 kg/year in view of the variety and abundance of other food products available and 40 kg/year for islands other than Tongatapu.

The question of fish marketing is examined in terms of people's preferences and prices and not in terms of the available resources. As described in 2-2-2 concerning the marketing and demand for marine products, the people's preference for fish is rather strong. The price of fish compared with these of other sources of animal protein is as follows.

Fish (unloaded at Tongatapu)	T$ 0.60/kg
Mutton (mostly mutton flap)	T$ 0.65/kg
Canned Mackerel, etc.	T$ 0.87/kg

Source: Fisheries Division, 1980

In view of the people's strong willingness to purchase fish, fish marketing should not have any difficulty provided that the fish is fresh.

With regard to the catch, there is adequate possibility for further development in terms of the available resources. In addition, the high level of fishing technique of fishermen, the large demand for fish and the favourable effects of the development efforts by the Fisheries Division all point to the strong possibility of an increased catch.

(3) Demand for Fish by Subject Areas

Based on the estimated population by areas given in 2-3-1 and the estimated annual fish demand per person given in 2-3-2, the rough demand for fish by subject areas is given as follows.

Table 4-2-13 Demand for Fish by Subject Areas

	Estimated Population	Annual Demand per Person	Total Demand (1987)
	(person)	(kg)	(ton)
Tongatapu	71,700	32	2,290
Vava'u	15,000	40	600
Ha'apai	8,600	40	340
'Eua	4,000	40	160
Niuatoputapu	1,800	40	70

4-2-4 Possible Supply Quantities for Consumption Areas

The possible supply quantities for consumption areas are found by deducting the demand by subject areas in 2-3 from the potential catch by subject areas.

Table 4-2-14 Possible Supply Quantities

Area	Total Potential Catch (A)	Demand (B)	Possible Supply Qty. for Consumption Areas (C) = (A) - (B)
Tongatapu	955 (ton)	2,290 (ton)	-1,355 (ton)
'Eua	90	160	-70
Ha'apai	1,320	340	980
Vava'u	1,180	600	580
Niuatoputapu	130	70	60

4-2-5 Design Conditions

(1) Shore Facilities

1) Annual Rainfall (used for the calculation of the running cost of the ice making operation)

Tongatapu, 'Eua	1,733 mm
Ha'apai	826 mm
Vava'u	1,765 mm
Niuatoputapu	2,160 mm

2) Temperature and Humidity (Tongatapu; used for the calculation of the required freezing capacity)

Temperature	31.9°C (maximum)
	10.6°C (minimum)
Humidity	70%
Sea Water Temperature	28.0°C

3) Wind Velocity and Earthquakes (used for the structural calculation for buildings)

Wind Velocity: The cyclone which hit Tonga in 1982 recorded a maximum instantaneous wind velocity of 58 m/sec.

Earthquakes: The large earthquake which hit Tonga in 1975 recorded 7.1 on the Richter Scale.

4) Water Consumption Standard

(Unit: ton per 1 ton of fish)

Area	Fishing Boat	Fish Carrier Vessel	Shore Facilities	Total
Vava'u, Ha'apai, 'Eua	0.5	0.5		1.0
Tongatapu	0.5		0.2	0.7

5) Standard Storage Capacities of Cold Storages

(Unit: ton)

Standard Capacities (Low Temperature Chilled Storage)	Species of Fish	Storage Quantity
$20m^3$	Skipjack, Tuna, etc.	6
	Bream, Grouper, etc.	5
$10m^3$	Skipjack, Tuna, etc.	4-5
	Bream, Grouper, etc.	3

(2) Fish Carrier Vessels

The following are considered to be the necessary design conditions for fish carrier vessels.

A Light weight, low frictional resistance and low running costs.

B Anti-corrosive and high durability.

C Simple and easy maintenance.

D Strong resistance to shocks.

E Light and fuel-efficient engine.

In view of the slipway provided at the new Fuau fishing port which will be completed in 1987 and in view of the Fisheries Division repair technology concerning FRP, FRP fish carrier vessels are the choice.

Small fish carrier vessels to operate in the Ha'apai area should have shallow drafts with flat bottoms due to the shallow water in the operation area.