BASIC DESIGN STUDY REPORT
ON
FISHING MOTHERSHIP BUILDING PROJECT
IN
THE REPUBLIC OF KIRIBATI

JUNE 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Kiribati, the Government of Japan decided to conduct a Basic Design Study on the Fishing Mothership Building Project and entrusted the survey to the Japan International Cooperation Agency (JICA). JICA sent to Kiribati a survey team headed by Mr. Akira KUROIWA, Fishing Boat Inspector, Fishing Boat Division, Oceanic Fisheries Department, Fisheries Agency, from March 22 to April 14, 1984. The team had discussions with the officials concerned of the Government of Kiribati and conducted a field survey in Tarawa and Betio area. 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 our two countries.

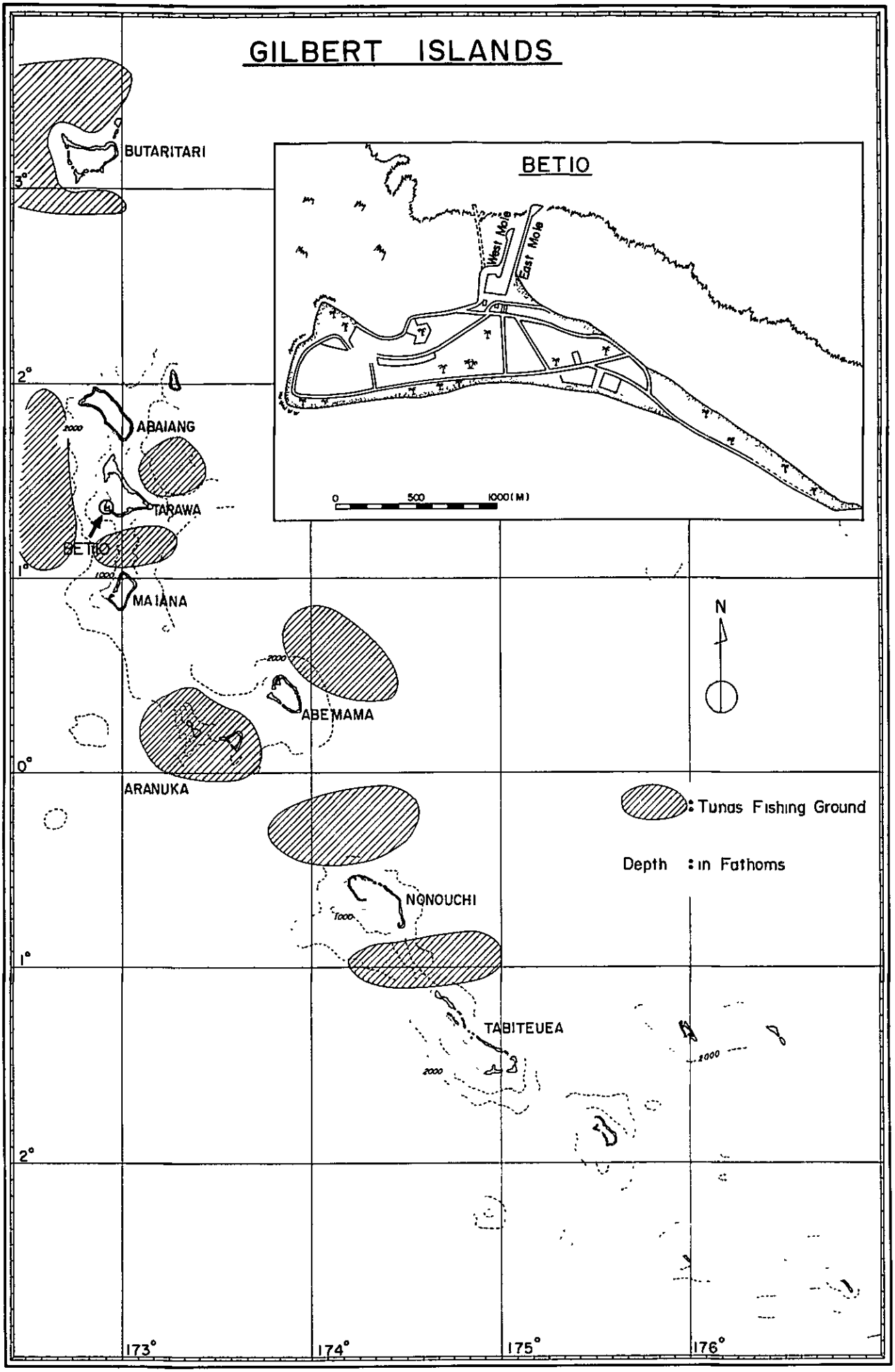
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Kiribati for their close cooperation extended to the team.

June, 1984

Keisuke ARITA
President
Japan International Cooperation Agency

CONTENTS

Appendices


GILBERT ISLANDS
BUTARITARI
3°
BETIO
West Mole
East Mole
0
500
1000(M)
2°
ABAIANG
TARAWA
BETIO
1°
MAIANA
N
ABEMAMA
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ARANUKA
: Tunas Fishing Ground
Depth : in Fathoms
NONOUCHI
1°
TABITEUEA
2°
173°
174°
175°
176°

SUMMARY

The Republic of Kiribati is an island nation located in the Central Pacific (at latitude 10°N - 10°S; longitude 167°E - 146°W). Since the exhaustion of its phosphate resources in 1979, the major problem facing this country, which has no industry, has been that of developing its natural resources.

Through the Fourth National Development Plan (1979-1982) and the Fifth National Development Plan (1983-1986), major emphasis has been placed on the development of fisheries and agriculture along with an industrial development program.

With specific regard to fisheries, various developmental projects have been formulated, but particularly high expectations are held for the development of the tuna and skipjack fishery. The development of this fishery dates back to the start of the 1970's. Since that time, on the basis of assistance from such sources as the U.K., Japan, and UNDP/FAO, steady progress has been recorded. Along with this development, the Government of Kiribati, in 1981, established a National Fisheries Company (Te Mautari, Ltd.) to provide effective direction for this key sector.

Te Mautari, Ltd. is responsible for the operation of four pole and line skipjack fishing vessels as well as all of the shore-based facilities that have been granted from the U.K. and Japan. In addition to tuna and skipjack catches by these vessels, the Company also purchases catches from local fishermen. The bulk of its tuna and skipjack is exported in frozen form.

To transport these exports, the Company has chartered a former tuna long-line vessel converted to carrier use. However, since this vessel has become superannuated and has only a small fish hold, it can no longer cope with recent levels of landings.

For this reason, the Government of Kiribati has developed a plan for the building of a fishing mothership, which would have sufficient carrying capacity and could also operate as a mothership for its skipjack vessels. The Government has requested cooperation from the Government of Japan in the form of a grant-in-aid so as to be able to implement this program.

Pursuant to this request, the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team to Kiribati to carry out the survey on the fishing mothership building project. The Team stayed in the country from March 22 to April 14, 1984.

The Survey Team evaluated the subject project by studying the current status of the local tuna and skipjack fishery along with related facilities and holding a series of discussions with the officials of the Ministry of Natural Resource Development and Te Mautari, Ltd.

Based on the results of the field survey, the discussions with concerned parties in Kiribati, and a subsequent analysis of the findings after returning to Japan, the Survey Team has concluded that it would be appropriate to design a fishing mothership with the following specifications:

General Specifications of the Fishing Mothership

	(all figures approximate)
Gross Tonnage	
(International Tonnage)	600 tons
(Japan Domestic Tonnage)	400 tons
Total Length	57.40 m
Class Width	9.0 m
Class Depth	4.0 m
Draft (planned)	3.6 m
Volume of hold (cubic measurements)	640 m^3
Horsepower of Main Engine	600 p.s.
Speed	9.2 knots
Size of Crew	25 persons

The period required to carry out the project is projected at a total of 12.5 months, broken down as follows:

... Exchange of Notes to the start of vessel construction ..... 4 months

... Start to completion of construction ..... 8 months

... Delivery of vessel in Japan to its arrival in Kiribati ..... 0.5 months

If this project reaches the stage of implementation, the agency within the Government of Kiribati that would be responsible for the project would be the Ministry of Natural Resource Development. However, after delivery of the fishing mothership, its operation and management would be delegated to Te Mautari, Ltd., which is under the aegis of the above Ministry.

Te Mautari, Ltd. has shown continual deficits since its establishment. However, since May, 1983, when all four of its skipjack vessels became operative, and assisted by an improvement in fishing condition, its financial situation has improved to the point that it has been able to show its first profit, even after depreciation.

Based on our financial analysis of Te Mautari, Ltd., applying the operating results for 1983, if the fishing mothership is purchased on a cash basis as an initial capital investment, the Financial Internal Rate of Return (FIRR) over a 15 year project life is shown at 2.17%. While this degree of profitability is hardly outstanding, we can at least conclude that, if a lower discount factor than 2.17% is applied, the subject project can become financially self-supporting.

Given the fact that operating costs are not likely to prove burdensome and the seeming absence of problems with respect to crew recruitment and management services, we deem that the subject project is fully appropriate in relation to the implementation structure available in Kiribati.

The principal benefits that can be expected to result from the subject project, if implemented, would include:

1) A decline in the cost of exporting fish and importing fuel oil.

2) A decrease in cargo congestion as a result of the increased carrying capacity, along with an improvement in capital turnover.

3) A saving in fuel costs for the skipjack fishing vessels as a result of the mothership operations by the new vessel, along with a stabilization of catch levels.

4) Increased fish production, based on the more effective collection of catches from small-scale fishermen in the outer islands and greater opportunities for these fishermen to earn cash income from their catches.

5) Increased training opportunities for trainees from Marine Training School (M.T.S.) in Kiribati.

Our rigorous analysis demonstrates that the benefits from implementation of the subject project should be quite substantial. Accordingly, we believe that there would be considerable significance in the Government of Japan extending the requested grant-in-aid.

However, in order to further improve the operational effectiveness of the fishing mothership and facilitate developmental operations, we would like to make the following recommendations:

1) To enable the fishing mothership to operate efficiently over a long period, it is, in our opinion, necessary that a regular program of dry-dock maintenance be established, with a frequency of no less than once a year.

2) It would be desirable to develop, at an early opportunity, a pool of Kiribati nationals fully qualified and licensed to serve on international routes and to also train a cadre of technicians with freezing and engine skills.

3) We suggest that there be an increase in catch purchases from local fishermen and that the target area for such purchases be expanded.

4) It is recommended to establish an appropriate support program for bringing back essential goods required by the Kiribati economy by the fishing mothership on the return voyage.

5) It is desirable that the expansion project for the quay facilities at the port of Betio be undertaken as soon as possible.

SECTION 1 INTRODUCTION

Since the termination of phosphate production, owing to depletion of this resource, the Republic of Kiribati has focused its sights on the area of natural resource development as the main prop for the national economy, with priority being placed on agriculture and fisheries.

Through the Fourth and Fifth National Development Plans, the country has been attempting to implement an industrial development plan centered on these two areas.

With regard to fisheries, various developmental projects have been conceived, from an expansion of fishery-related facilities to the cultivation of seaweed, but particularly high hopes are held for the development of the tuna and skipjack fishery in view of its role as an export producer.

In order to develop the tuna and skipjack fishery, the Government of Kiribati, at the beginning of the 1970's, started experimental operation on a small scale. In 1977/78, based on assistance from Japan, a resource development survey was carried out for the pole and line skipjack fishery in waters around the Gilbert Islands. Subsequently, in 1978, a 100-ton class skipjack pole and line fishing vessel was obtained through a grant from the United Kingdom, and, in 1980/81, Japan granted a 100-ton class training vessel for this fishery together with 2 fish distribution centers in Betio and Kiritimati. In 1982/83, Japan provided additional assistance in the form of 2 skipjack research and training vessels of 59 tons and 20 tons respectively, along with an ice-making/freezer facility and a refrigerated store at Betio.

Along with the introduction of these facilities and vessels, Kiribati has also received technical assistance from the above 2 countries and the UNDP/FAO, and this program of technical transfer has built up a steady record of achievements.

In tandem with the preparation and expansion of these production facilities, the Government of Kiribati, as a means of effectively developing the tuna and skipjack fishery in this country into the commercial levels of pro-

duction, established in 1981 a National Fishery Company, Te Mautari, Ltd. This Company presently operates, on an integrated basis, the above 4 skipjack vessels and related facilities, with its activities geared mainly to fish production.

In addition to catches by these skipjack vessels, Te Mautari, Ltd. has been purchasing the catches of local fishermen as well. While a portion of the landings from these sources is sold on the domestic market, the bulk is shipped in frozen form to the export market.

As the carrier for transporting this cargo, the Company has been chartering a former tuna longline vessel but, since this vessel has aged and the capacity of its reefer compartment is quite limited, it cannot handle the present volume of landings. As a consequence, in months of heavy landings, a large volume of fish cannot be loaded and so has to be left behind.

For the above reasons, the Government of Kiribati has developed a plan to build a fishing mothership that would have sufficient capacity as a reefer carrier and would also be able to operate as a mothership for the existing skipjack vessels without the constraints of the charter contract covering the old vessel. To carry out this project, Kiribati has requested a grant-in-aid from the Government of Japan.

For purposes of assessing the appropriateness and feasibility of the proposed project, the Government of Japan, through the Japan International Cooperation Agency (JICA), dispatched a Basic Design Study Team to Kiribati, led by Mr. Akira Kuroiwa, Fishing Boat Inspector, Fishing Boat Division, Oceanic Fisheries Department, Fisheries Agency, Ministry of Agriculture, Forestry, and Fisheries. The team stayed in Kiribati from March 22 to April 14, 1984.

The primary objectives of this Basic Design Study were as follows:

1) Validate the plan for the construction of the fishing mothership and examine the present state of the tuna and skipjack fishery in Kiribati.

2) Determine the appropriate size, from both an operational and technical standpoint, of the contemplated fishing mothership and design a vessel along these lines.

3) Examine the scope and appropriateness of cooperation from the Government of Japan.

The Survey Team conducted a survey of related facilities in and around Betio, which is expected to be the port of registry for the subject vessel, and of the skipjack fishing vessels and various production facilities being operated by Te Mautari, Ltd. In addition, with respect to the details of the project and the scope of cooperation being sought from Japan, the Team held a series of discussions with the Ministry of Natural Resource Development of the Government of Kiribati as well as with related agencies, particularly Te Mautari, Ltd.

The results of the field survey were confirmed by the Minutes of Discussions exchanged with the above Ministry.

After returning to Japan, the Survey Team conducted a supplementary technical evaluation of present conditions in the tuna and skipjack fishery, fluctuations in catch levels, and the management plan for the subject vessel.

Having thus confirmed the appropriateness of the project, the Team then prepared a Basic Design and Implementation Plan, which is the subject of the present report.

A copy of the Minute of Discussions, a list of the members of the Survey Team, the itinerary for the field survey and names of discussants, and reference photos have been included as Appendices (I)-(V), respectively, following the body of the report.

SECTION 2 BACKGROUND OF THE PROJECT

2-1 Present Conditions in the Tuna and Skipjack Fishery

The tuna and skipjack fishery in Kiribati is operated by Te Mautari, Ltd. and local fishermen based in Tarawa.

The skipjack and tuna catches of Te Mautari, Ltd. totaled 551 tons in 1981, 504 tons in 1982, and 1,699 tons in 1983, with a sharp increase in the latter year. This improvement may be attributed to a doubling in the number of fishing vessels (from 2 to 4) in May, 1983 as well as an overall improvement in fishing conditions, including the supply of bait fish.

The Company's purchases of skipjack and tuna from local fishermen have also been on an increasing trend, from 193 tons in 1981 to 156 tons in 1982 and 424 tons in 1983.

As a result, during 1983, when shipments were delayed during periods of good fishing, owing to the fact that the present 100 ton freezer had not yet been completed, the shore-based refrigerated capacity became inadequate. This caused a prolonged suspension in purchases from local fishermen on two occasions, while the Te Mautari, Ltd. fishing vessels were also forced to suspend fishing activity for an average of 5 days per vessel. Thus, during the period from May, 1983 to March, 1984, when all 4 skipjack vessels were operative, these suspensions in fishing and purchase activity caused a cutback in fish production volume. If we estimate this lost volume from average daily landings at those times and add these values to the actual landings, the total potential monthly landings during the period are shown to average 248 tons.*)

When we compare this value with the 60 ton average landings recorded during 1981 and 1982, we can see how much the current level of landings has grown.

2-2 Future Expansion Plans

In accordance with the 5th National Development Plan, Te Mautari, Ltd. has

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*) Detailed data on monthly landings of skipjack and tuna are shown in Appendix (VI).

developed plans for future expansion, centering on fishing vessels and refrigeration facilities. These plans call for an expansion of the fleet from 4 to 6 or 8 vessels with the possibility of increasing the 59 ton skipjack pole and line vessel, while checking the abundance of live bait resources. And, when it becomes technologically feasible, the Company also plans to introduce purse seine fishing vessels. It is clear from these plans that the productive capacity of Te Mautari, Ltd. will be steadily increasing in the years to come.

As to the future volume of production, while there may be small increases based on improved levels of fishing technology, unless there is an actual increase in the number of vessels engaged in this fishery, there is no likelihood that the spectacular gains in production from 1981/82 to 1983 will be repeated.

Accordingly, whether from the standpoint of the basic concepts behind the 5 Year Plan or from that of efficient utilization of the resource, we feel that a persuasive case can be made for seeking a continuing increase in the productive capability of the tuna and skipjack fishery.

At present, there are no quay facilities in the port of Betio with adequate water depth. As a consequence, none of the three skipjack vessels of 59 tons or over is able to berth at the existing quays. A considerable amount of time is, therefore, required to tranship catches from fishing vessels to shore freezers and from the latter to the reefer carrier vessel. This poses a major problem in terms of both freshness retention and operating efficiency.

For a number of years, there has been discussion of the possibility of extending the quay from the Eastern Mole of the port, but as yet there has been no evidence of actual implementation of this plan. During 1984, however, a preliminary survey on a quay with piled structure is expected to be carried out under an aid program from the United Kingdom, and the results of this study are being awaited with interest.

Given the limits in catch transshipment efficiency and the danger of a shortage developing in the storage capacity of the shore-based facilities, it will be difficult at present for Te Mautari, Ltd. to contemplate any

increase in the number of operating vessels, at least until the above quay construction work actually gets underway.

2-3 Operating Conditions for the Carrier Vessel

Te Mautari, Ltd. ships its catches, as obtained from its own fishing vessels and its purchases from local fishermen, in frozen form to the export market.

During its first year of operations, the fishing vessels were used to carry loads to Majuro in the Marshall Islands but, in April, 1982, a 2-year carrier charter was arranged with a private firm overseas for a former tuna longline vessel, and this vessel has been carrying cargo to Pago Pago in American Samoa for sale to the canneries located there. This charter contract expired in March, 1984, but was renewed for 3 months. The intention, for the time being, is to continue renewing this charter at 3-month intervals.

The subject charter vessel has made a contribution to the export operations of Te Mautari, Ltd. over the past two years*), but it has been aging rapidly, particularly in the freezer compartment, while the maximum load of frozen fish that it can carry is only 250 tons, which is not sufficient to meet present landing requirements.

Thus, since May, 1983, when all skipjack vessels were placed in operation, large amounts of catch have had to be left behind, and the Company is now faced with the necessity of urgently locating a substitute carrier vessel.

As alternative carrier methods, one possibility would be to charter another reefer vessel and another would be to ship the cargo with freezing containers aboard merchant vessels presently calling at the port of Betio. However, if a relatively new reefer vessel with adequate carrying capacity is chartered on a regular basis, the charter fee is likely to be much higher than that for the present vessel, thereby putting considerable financial pressure on the Company.

As to the option of shipments by merchant vessels, it should be noted that

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*) Monthly loads and operating patterns of the chartered vessel for the period since May, 1983 are shown in Appendix (VII).

arrivals of such vessels at the port of Betio are very irregular, perhaps only once in 6～8 weeks, which is far too long an interval. In addition, loading would be limited to only 24 hours, meaning that only a miniscule 70～90 tons could be carried per vessel. From the foregoing, neither alternative would appear to be workable as a substitute for the present charter veseel.

In addition to the above conditions, the functions that can be performed by a reefer carrier vessel under charter are limited to the transport of catches and possibly an expansion of storage space while waiting at the port of Betio. It would not be possible for such a vessel to operate freely as a mothership in tandem with the skipjack fleet.

The skipjack vessels operated by Te Mautari, Ltd. are, under present conditions, usually limited to one-day trips. This is due to the fact that these vessels are shore-based as well as the fact that their live bait supplies are liable to decay and thus cannot be stockpiled on the vessels for more than a few days.

As a result, the selection of fishing grounds is highly restricted.

Accordingly, in order to increase production capacity of the tuna and skipjack fishery, the Company deems it absolutely vital that a reefer carrier vessel be procured that will incorporate the functions of a mothership, accompanying the skipjack fleet to the fishing grounds, transshipping catches, and supplying these vessels on the grounds with both fuel and fresh water.

SECTION 3 BASIC PLAN FOR THE FISHING MOTHERSHIP

3-1 Objectives and Substances of the Project

3-1-1 Objectives of the Project

Pursuant to the "Background of the Project", as outlined in Section 2, the main purposes of the Fishing Mothership Building Project are as shown below:

1) to increase export carrying capacity, which has become inadequate as a result of a major increase in landings since 1983,

2) to raise the future levels of production efficiency by shortening the time that is presently required for landing and supply operations and by permitting supply operations and the transshipment of catches on the fishing grounds,

3) to develop an effective system for purchasing fish from local fishermen, thereby contributing to the development of small-scale fisheries.

3-1-2 Substance of the Project

On the basis of the above points, we have summarized the principal and auxiliary functions to be performed by the projected fishing mothership as follows:

1) The loading capacity of the vessel would be larger than that of the existing chartered vessel and would be appropriate to the present level of landings so as to minimize left-over catches.

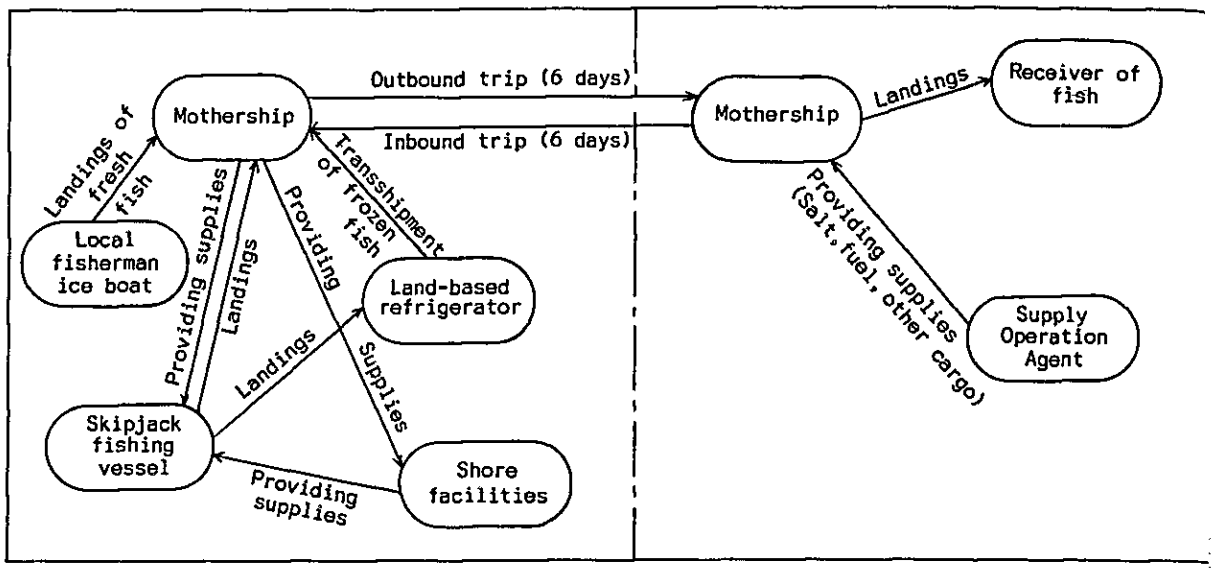
2) By preserving the mothership function as well, the vessel will be able to supplement the supplies of the skipjack vessels in Betio and so improve the efficiency of catch transshipment operations. And, when necessary, it will permit supply operations and transshipment of catches on the fishing grounds.

3) By providing on-vessel freezing equipment, it will be possible to collect and assemble catches from local fishermen located in islands other than Tarawa.

4) In order to provide on-the-job training for students of the M.T.S., the vessel will be equipped with extra facilities to permit the boarding of about 5 such trainees on each trip.

Accordingly, we have planned a fishing mothership that will be fully equipped to effectively carry out the above functions. We have also studied the crew requirements for this vessel along with its expected costs of operation. These various functions, relating to the transportation and supply of catches, are shown in the following chart.

Chart 3-1 Functions of the Fishing Mothership



NOTE TO CHART 3-1:

"Supply operations" refer to the provision of fuel oil, fresh water, brine salts, and other supplies. The items to be furnished by the fishing mothership to the shore facilities will be fuel oil and brine salts purchased in Pago Pago.

3-2 Basic Guidelines

We have formulated a plan for the fishing mothership in accordance with the following guidelines:

1) This project will not be confined just to the provision of an independent fishing mothership but will rather be integrated into the overall complex of shore facilities and skipjack fishing vessels presently operated by Te Mautari, Ltd.

2) Since the fishing mothership is not intended to be a profit producer in its own right, we have held its size down to the minimum possible level, while keeping operating costs as well at an appropriately low level.

3) In designating the fittings for this vessel, we have deliberately specified, wherever possible, items of a level comparable to those found on the existing skipjack vessels, avoiding sophisticated equipment unless there is a particular reason for its use.

4) The home port of the subject vessel will, for the time being, be Betio, with round-trips to be made between Betio and Pago Pago. However, since consideration is being given to inaugurating mothership operations, in the future, such mothership functions have also been incorporated in the design and fittings of the vessel.

3-3 Basic Design

3-3-1 Basic Conditions

The basic conditions for the design of the fishing mothership have been determined on the basis of the operations of the Azuma-maru No.35, present chartered vessel, along with fish landing activities of Te Mautari, Ltd.

(1) Operational Patterns, Trip Time

In considering the operational patterns of the subject vessel, we have noted that, although eventually it is to function as a mothership, for the present, the vessel will be used solely as an independent freezing carrier, replacing the existing chartered vessel.

The operational patterns for the present chartered vessel, in terms of the average number of days per round-trip and the average number of days spent in port, are shown below: (Cf. Appendix VII)

Outbound:	Betio - Pago Pago	6 days
	At Pago Pago	15 "
Inbound:	Pago Pago - Betio	6.2 "
	At Tarawa (Betio Port)	8 "
	Total Time	35.2 "

The only seeming possibility for shortening the above time would be to reduce the time spent at Pago Pago. This time is now broken down as follows:

... 6 days waiting for a berth,
... 6 days loading,
... 2 days taking on fuel oil, and
... 1 day for customs clearance and other matters

Te Mautari, Ltd. plans to dispatch a supervisor to this port in hopes of shortening by half the 6 days spent waiting for berthing (i.e., to only 3 days). If this becomes possible, the elapsed time per trip for the subject vessel would be reduced to:

Outbound:	Betio - Pago Pago	6 days
	At Pago Pago	12 "
Inbound:	Pago Pago - Betio	6 "
	At Tarawa (Betio)	8 "
	Total Time	32 "

Since a total of 45 days a year have been allocated to dry-docking operations, the effective number of operating days per year for the vessel works out to 320 days (365 days - 45 days), meaning that 10 trips per year will be feasible.

(2) Volume of Landings and Shipments

In Appendix (VI), we have estimated the landing volume that would result from combining:

... catches by the skipjack fishing vessels now operated by Te Mautari, Ltd.,
... purchases from local fishermen, and
... the potential increase in landings that would result if the shore-based storage facilities were no longer at full capacity.

Data prior to April, 1983 relate to a period when the four skipjack fishing vessels were not yet fully operational, while Te Mautari, Ltd. itself was still operating under the old form of organization. Thus, data before this date were not suitable for making projections.

Between April, 1983 and March, 1984, average monthly landings were 248.2 tons,*) with an average of 310.2 tons during peak periods (the top six months in the series). The largest monthly landings recorded during this period were 354.6 tons in November, 1983.

If we were to base the fish-hold specifications (i.e., the size of the freezer compartment) of the subject vessel on the above average monthly landings of 248.2 tons, then, in five of the 11 months between May, 1983 and March, 1984, there would have been left over catches. These surpluses not only cause the delay of cashing of the catches but also place a serious constraint on the production of the skipjack fishing vessels themselves, owing to cargo congestion resulting from the unloaded catches. In order to entirely eliminate these catch residues, the minimum carrying capacity of the new vessel should be 350 tons.

Te Mautari, Ltd. has, for its part, established the following targets for annual landings, based on the activity levels of the present skipjack fishing vessels, and it would be desirable, in our view, for the carrying capacity of the new vessel to respond to these targets.

Target Landings Set by Te Mautari, Ltd.

	Landings per Year
3 skipjack fishing vessels (59 tons & up)	2,700 tons
1 skipjack vessel of 20 tons	350 "
Volume of skipjack purchases from local fishermen	480 "
Groundfish species	80 "
Total Target Landings	3,610 tons

*) Shown in metric tons.

Some 150 tons per year of the targeted volume is expected to be consumed on the domestic market. If we substract this amount from the total amount and set the carrying capability of the new vessel at 10 trips per year, we arrive at a carrying capacity of 346 tons per trip. [(3,610 tons/year - 150 tons/year) ÷ 10 trips]

These figures also confirm the desirability of a carrying capacity of about 350 tons/trip. We have, accordingly, set this capacity of the new vessel at about 350 metric tons.

(3) Steaming Radius, Service Speed, Navigation Area, Class of Voyage

The ports of destination presently being considered for the subject vessel are Pago Pago (in U.S. Samoa) and Suva (in Fiji).

Pago Pago is 1,270 nautical miles from Tarawa (Betio), while Fiji is about the same distance. Thus, a steaming radius of over 1,270 nautical miles would be adequate.

In order to cover this distance of 1,270 nautical miles in six days (24 x 6 = 144 hours), a speed of at least 8.81 knots would be required. We have stipulated a speed of about 9 knots.

The navigation area is designated as "long range" and the class of voyage as "international voyage".

(4) Crew

The composition of vessel crew would be as follows:

	No. of Persons
Captain	1
Chief Engineer	1
First Mate	1
First Engineer	1
Boatswain	1
Ordinary Crew	20 (including 5 trainees)
Total	25

This size crew is larger than for the ordinary class of carrier vessel. However, we have set the number on the high side in view of the need, during loading periods, to rotate personnel in freezing hold operations and with a view toward increasing employment opportunities, based on the principle that foreign workers are to be minimized. We have also made provision for the boarding of M.T.S. trainees at regular crew members to offer them the benefit of on-the-job training.

(5) Regulations and Vessel Class

The vessel will be subject to and will abide by the Ship's Safety rules and regulations of the J.G. and other applicable regulations and will acquire the NK, NS*, NMS*, and RMC* of the Nippon Kaiji Kyokai.

(6) Basic Vessel Plan

The subjected vessel will be a freezing carrier, with forecastle, long poop, single deck, and a single propeller driven by a diesel engine. Accommodations and engine room will be located at the stern.

(7) Functions

As discussed in the section on "Operational Patterns and Trip Times", we may summarize as follows the main functions of the subject vessel from the standpoint of the role it will eventually play as a fishing mothership.

a) The vessel must be capable of freezing catches landed by ice boats and local fishermen (freezing equipment)

b) It must be capable of storing the frozen fish. (refrigeration equipment)

c) It must be capable of supplying fuel and other oils to the skip-jack vessels (including shore facilities) and should be more effective in these functions than the present supply arrangements. (supply facilities for fuel, water, etc.)

d) It must be able to receive transshipments, easily and quickly, from shore-based refrigerated warehouses and from the skipjack vessels. Transshipment operations should be feasible from both sides of the vessel.

(appropriate loading and handling equipment)

3-3-2 Determination of the Principal Specifications

(1) Principal Dimensions

We have determined the principal dimensions of the subject vessel by first estimating these from data on comparable vessels and then making appropriate adjustments.

1) Sampling Data

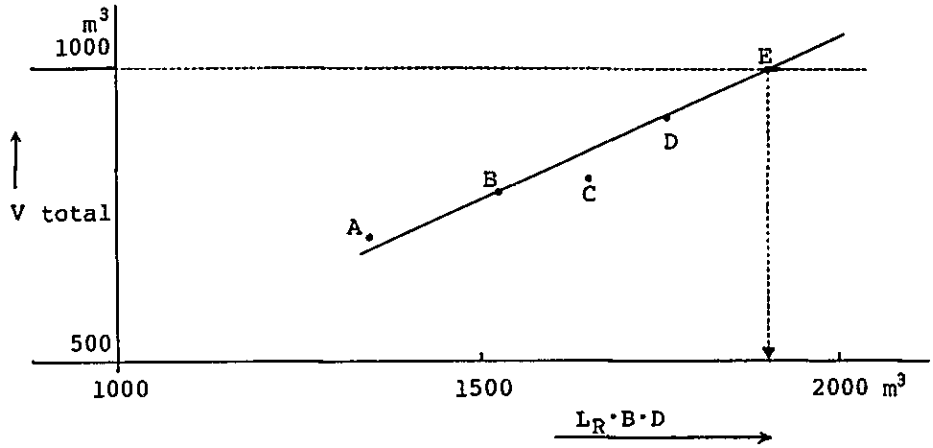
Table 3-1 Principal dimensions for similar vessels

Sample Vessel	L_R	B	D	L_R.B.D	FH	FO	FW	LO	V total
A	44.95	8.60	3.60	1392	392	257	23	7	679
B	46.15	8.80	3.75	1523	404	300	28	12	744
C	47.70	9.00	3.85	1653	458	309	29	11	807
D	49.20	9.00	3.95	1749	543	332	27	7	909
E	50.15	9.40	4.00	1586	527	438	27	10	1002

KEY: L_R: Registered length (m)
B : Width (class) (m)
D : Depth (class) (m)
FH: Capacity of fish hold (m^3)
FO: Capacity of fuel tank (m^3)
FW: Capacity of freshwater tank (m^3)
L : Capacity of lubricating oil tank (m^3)
V total: Total combined capacity (m^3)

Based on the data in Table 3-1 above for similar vessels chosen at random, we can demonstrate, as shown below, the general relationship between the product of [Registered Length (L_R) x Width (B) x Depth (D)] and the Total Capacity V (of fish-hold, fuel tank, freshwater and lubricating oil tanks) by means of the expression.

Chart 3-2 Relationship between V total and $L_R \cdot B \cdot D$



From the above, we can see that there is generally an inverse relationship between the values for combined capacity and the expression (L_R x B x D).

Based on this relationship, in estimating the total required capacity of the subject vessel, we can obtain the value for (L_R x B x D) from the above chart, make certain adjustments based on differences in specifications, and then estimate the final value of (L_R x B x D).

2) Capacity plan

The total capacity of the subject vessel is estimated as follows. (The next section will examine the required capacity of the various tanks.)

Fish Hold		Fuel Tank		Freshwater Tank
640 m³	+	290 m³	+	50 m³

	Lubricating Oil Tank		Total Capacity
+	6 m³	=	986 m³

From the above aggregate capacity, we can derive $L_R \times B \times D$ on the basis of the preceding chart. Since the resulting figure seems somewhat small, based on certain partial modifications in specifications vis-a-vis similar vessels, we have chosen to increase the above combined total of 986 m^3 by a factor of +1%. On this basis, the final value for total capacity may be estimated at:

$$986\ m^3 \times 1.01 \fallingdotseq 996\ m^3 \Rightarrow 1{,}000\ m^3$$

From this value and from the above chart, LD x B x D works out to about 1885.

The partial differences in specifications relate to four areas:

a. An increase in the fish hold, due to the positioning of the cooling coils.

b. An increase in the size of the engine room, based on a change in its length.

c. An increase in the size of the No.1 fish hold, based on the absence of a dividing partition.

d. A modification in the block coefficient.

3) Main Dimensions

Based on vessel stability, $B/D \fallingdotseq 2.25$.
(Since there will be no fish hold on deck and the KG will be relatively low, this value should be adequate.)

From the standpoint of speed, $L_R/B \fallingdotseq 5.8$.
(It is said the maximum $\fallingdotseq 6$, but we have allowed an extra 10% in length over comparable vessels.)

Accordingly, $L_R \cdot B \cdot D = (5.8B) \cdot B \cdot (B/2.25) = 2.578\ B^3 = 1885$

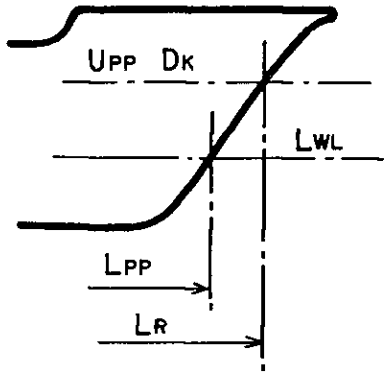
$\therefore B = \sqrt[3]{1885/2.578} = 9.00$ m

$D = B/2.25 = 4.00$ m

$L_R = 5.8\ B = 52.20$

$Lpp \fallingdotseq L_R \fallingdotseq 52.0$ m

Thus, Lpp x B x D = 52.0 x 9 x 4.0



NOTE: The registered length L_R is the L based on various regulations and so is somewhat higher than the length between perpendiculars (Lpp).

(2) Freezing Equipment

1) Freezing hold

The total carrying capacity of the subject vessel has been set at 350 MT. Ordinarily, we apply a value of 0.55 t/m^3 as the proportion of reefer bulk cargo in the stowage factor to derive the desired capacity of the freezing hold:

350 tons / 0.55 t/m^3 = 640 m^3

The cooling method that has been specified is direct expansion grid coil, which is simple to maintain. The refrigerant will be R-22, the same as that on the skipjack fishing vessels.

The holding temperature on the skipjack vessels is -25 to -30°C and, in the shore freezer, -25 to -35°C. But, since the frozen products are destined for use in canned products, we have set this temperature at -25°C.

Capacity of the Freezing Hold : 640 m^3

We have specified two freezer units of 37 KW each.
(Cf. Appendix VIII)

2) Freezer facilities

There are a number of freezing method but, since the quality of end products on the subject vessel does not have to be as good as "sashimi" grade we have specified brine freezing, which permits batch processing and is relatively simple to handle. We estimate that the brine compartment will be sufficient to process 10 tons of catch per day, and so we have provided for twin compartments, each with a capacity of 9 m^3. The brine temperature is assumed to be -17°C, the initial temperature of the catch +28°C, and the final temperature of the catch at about -10°C.

When soaking the catch in the brine tank, surplus brine tends to overflow. We have, therefore, provided for an extra compartment of some 7 m^3 as a reserve tank to accommodate this overflow. (Cf. Appendix VIII)

Brine tank capacity	about 9 m^3 x 2 compartments
Reserve tank	about 7 m^3

3) Bulk provisions storage

We have provided a bulk provisions storage area with separate sections for meat and fish and for vegetable storage. The temperature within this storage area has been stipulated at -10°C for meat use and +5°C for vegetable use. In both compartments, cooling and cold retention are to be done via cooling coils.

From the relationships with comparable equipment, we plan to use R-22 as refrigerant. The capacity within the compartments and the storage volumes are shown as follows:

Table 3-2 Capacity and Storage Volume of Provisions Stores

	Cubic Capacity (m^3)	Storage Capacity (kg)	Remarks
Meat	about 1.0	about 185 *	*Sufficient to feed 25 persons for 32 days (in each category)
Vegetables	" 3.0	" 660 *	

Calculating the capacity of the freezer under these conditions, we arrive at a value of about 1.5 kw. (Cf. Appendix VIII)

Freezer Capacity : about 1.5 KW

4) Air conditioning equipment

While the subject vessel is to be used mainly in tropical waters, it will be difficult to arrange the living areas in such way as to achieve good natural ventilation. Even with the use of powered ventilating fans, the temperature in the various cabins will be quite high. Thus, there is a likelihood that very uncomfortable conditions will develop in these areas.

We have, accordingly, provided for air conditioning on the subject vessel. However, the air conditioned temperature is to be set at only about 5°C below outside temperatures, so that extreme cooling action will not be required.

(3) Main and Auxiliary Engines

1) Main engine

We have estimated, as follows, the output of the main engine in the subject vessel:

① Hull specifications:

Lpp x B x d : 52.0 m x 9.0 m x 3.6 m

Cb : 0.625

Displacement (with full load)	: about	1,079 tons
Displacement (with light load)	: about	540 tons
Dead weight	: about	539 tons

② We have allowed an average margin 15% to compensate for the effect of gradual deterioration of the hull, engine, and propellers, and for corrosion/dirt at the bottom of the hull.

—— Rate of margin ①

③ We have allowed a 15% sea margine.

—— Rate of margin ②

From the relationship between EHP(effective horsepower) and speed, as calculated with the above adjustments, the EHP, at a speed of 9.0 knots, has been set at about 210 P.S. We may then estimate BHP(brake horsepower), with a propulsion efficiency of 0.5 and a load factor of 75% MCR. (Cf. Appendix IX)

$$\text{Propulsion efficiency} = \text{EHP/BHP} \div 0.5$$
$$\text{Load factor} \quad 75\%$$

From the above,

$$\text{BHP} \times 0.75 = \text{EHP} \div 0.5$$
$$\text{BHP} = \text{EHP} \div 0.5 \div 0.75 = 560 \text{ P.S.}$$

But, we have rounded this up to 600 P.S.

Horsepower of main engine : about 600 P.S.

And the EHP, based on a 600 P.S. for the main engine horsepower and a load factor of 75%, becomes:

$$\text{EHP} = \text{BHP} \times 0.75 \times 0.5 = 225 \text{ P.S.}$$

From the relationship of EHP to speed, the speed is calculated at about 9.2 knots. However, with a clean underside (comparable to that of a new vessel) and while cruising in calm waters, we can expect a speed of about 10 knots.

2) Auxiliary engines

We shall next calculate the power requirements for the various items of equipment that are to be installed on the subject vessel. From these requirements, we can calculate the capacity, number, and load factor of the generators. The results of these calculations are shown below:

Table 3-3 Capacity of Generator and Load Factor

Category		At Tarawa		Underway (at sea)	At Pago Pago	
		During Loading	Awaiting Berth		During Loading	Awaiting Berth
Required power	KW	149.85	120.05	83.43	102.63	73.83
	KVA	186.0	150.06	104.28	128.28	92.28
Generator in use	KVA x No.	160 x 2	160 x 1	160 x 1	160 x 1	160 x 1
Load factor	%	58.13	93.79	65.18	80.18	57.68

From the above, we can anticipate a requirement for 2 auxiliary engines of about 200 P.S. each to meet the generating needs of the vessel.

Auxiliary engine	about 200 P.S. x 2
Generator	about 160 KVA x 2

Power sources on the vessel will be as follows:

Motive power	AC 220 V/ 60 HZ/ 3 ϕ
Lighting	AC 110 V/ 60 HZ/ 1 ϕ
For emergency and wireless use	DC 24 V

(4) Tank Capacities

1) Fuel tank

The heavy oil that is used as fuel in Kiribati is quite expensive and, at times, cannot be obtained, owing to cancellation of calls by overseas vessels. For this reason, it would be advantageous economically if the new vessel could buy a cargo of low-cost heavy oil available in Pago Pago, which would also contribute to the stability of vessel operations.

The heavy oil requirements may be estimated as follows:

Table 3-4 Heavy oil requirement of Te Mautari, Ltd.

Intended Application	Amount (kℓ)	Remarks
Subject Vessel	50	Appendix (X)
Skipjack Fishing Vessel	130	Appendix (XI)
Shore Generator	25	
Reserve Unit	55	
Total	260	

The reason for the reserve of 55 kℓ is that there is a distinct variation in the consumption of skipjack fishing vessel, and we thought it wise to make a provision in this amount for emergencies.

The capacity of the tank, based on a 0.9 stowage factor, may be calculated as follows:

$$260\ k\ell / 0.9 = 289\ m^3$$

Fuel Tank Capacity : approximately 290 m^3

2) Fresh water tank

The amount of fresh water required by the vessel per trip, based on a daily consumption of 40 liters/man·day for the 25-man crew, may be calculated as follows:

40 ℓ/man·day x 25 men x 32 days = 1,000 ℓ = 32 m^3

If we were to allow for a sufficient additional supply of fresh water to meet the entire deficiency of the skipjack fishing vessels, a huge tank would obviously be required. But, owing to the severe space limitations, we have held the total capacity down to only about 50 m^3.

Since the supply of fresh water from shore is erratic, there is a definite need for both a water-distilling unit and a rain collecting system as well as for a piping system to route water from both sources to the freshwater tank.

Fresh water tank capacity : about 50 m^3

3) Lubricating oil tank (Cf. Appendices (X) and (XI))

The per-trip requirements for the subject vessel will be 389 liters. In addition, the four skipjack fishing vessels consume a total of 630 ℓ per month. From these requirements, we may calculate the amount of lubricating oil to be carried per trip as:

630 ℓ/month x 12 months ÷ 10 trips = 756 ℓ/trip

Thus, including the subject vessel's own requirements, the total requirements for lubricating oil per voyage come to 1,145 ℓ. After, giving due consideration to the structural relationships on the vessel, we have set the tank capacity for lubricating oil at about 6 m^3.

Total capacity of the lubricating oil tank : about 6 m^3

(5) Deck Equipment

As deck equipment, we have specified an windlass, mooring equipment, gangway ladder, and steering gear. These equipments will be either electrically or electro-hydraulically powered in the interest of simplicity and ease of maintenance. We have selected these items with reference to applicable regulations as well as examples of such equipment on vessels of a comparable class.

(6) Loading Facilities and Materials Handling Equipment

Since the loading equipment aboard the present chartered vessel, Azuma-maru No.35, is quite inadequate, a great deal of time is consumed in transshipping catches from shore freezers and the skipjack fishing vessels.

In order to improve the efficiency of loading operations while the new vessel is moored outside Betio harbor, we have stipulated the following:

1) Loading facilities that will permit simultaneous loading operations from both sides of the vessel (with an extra-long derrick boom).

2) Use of cargo nets in making transshipments from the small FRP carrier boat.

3) To permit the transshipped catch to be moved to the fish hold from any location, we have also provided materials handling equipment, such as belt conveyors and chutes.

4) So that the fish that has entered the hold can flow smoothly to locations deep within the hold, we have provided for funnel-type chutes of variable direction, in the lower part of the entrance area.

5) With a view to further improving the carrying efficiency between shore freezers and the subject vessel, the latter will also be provided with a FRP carrier boat.

Summarizing the above requirements, we have:

Loading equipment	Derrick boom (2 ton capacity)	2 units & 2 sets
Cargo nets	2.5 m^2 (approx)	8
Belt conveyor	about 6 m in length, 0.5 m in width	3
Chutes		5
Funnel-type chutes		at 2 locations
FRP carrier boat		1

In addition, the derrick booms are to be installed both to the rear and in front of the king posts on the upper deck to permit loading by the Burton system, using the winch on the winch table (with a capacity of 2 tons x 30 m/minute).

(7) Fuel and Water Supply Equipment

As equipment to supply oil and water from the subject vessel to the skipjack vessels and the shore-based tanks, we have provided for pumps, flexible hoses (ϕ 2 1/2, 200 m with buoyancy unit), and meters.

(8) Water Distilling Equipment

In our earlier discussion of the capacity of the freshwater tank, we noted that, in view of spatial constraints, this cannot be more than about 50 m^3. If replenishment of water supplies for the skipjack fishing vessels is attempted from this tank, there will be a tendency for shortages to develop which would hamper operations. In addition, while water supply facilities exist at the home port of Betio, this supply, relying as it does mainly on rain water, tends to be inadequate.

In view of the above factors, we have elected to provide water-making equipment aboard the subject vessel with a view to producing as much water as possible both to meet the needs of the vessel itself and to permit the replenishment of the skipjack fishing vessels from any available surplus.

The productive capacity of this water distilling equipment is determined by the amount of hot water that can be generated by the main or auxiliary engines. Whether hot water is to be taken from the main or auxiliary engines depend on their carolic output.

On the subject vessel, it is clear that the main engine will have a higher caloric output than the auxiliaries, but this main engine will actually operate on only 12 days of the 32 day round-trip cycle. On the other hand, in the case of the auxiliary engines, though each unit will have a lower caloric output than the main engine, one of the two auxiliary engines will be continuously operating throughout the entire 32 days; thus, the total caloric output of the auxiliary engines will actually be larger than that of the main engine. (The estimated caloric output of the main engine works out to about 15.4×10^9 K cal; that of the auxiliary engine about 17.8×10^9 K cal.)

The larger the caloric output per hour, the larger the capacity that will be required for the water distilling unit, which implies a large initial investment and high operating expenses. On the subject vessel, therefore, we will produce water by using only the caloric output of the auxiliary engine.

The circulating volume and the temperature of the circulating water in the auxiliary engines are estimated, respectively, at 10 m^3/hr and 75°C (average). Under these conditions, the volume of water to be produced may be estimated on the following basis.

As shown below, there is a tendency for the water distilling capacity to fall as the temperature of the seawater rises.

Table 3-5 Water Distilling Capacity

Water Volume (m^3/hour)	Temperature (°C)	Seawater Temperature (°C)	Volume of Water Produced (tons/day)
10	75°	35	1.98
		34	2.05
		33	2.08
		32	2.13
		31	2.18

The design seawater temperature in the areas in which the subject vessel will operate is about 30°C, but, on many days, the vessel will be moored in shallow lagoons with considerably higher seawater temperatures, which will reduce the water producing capacity of the equipment. We have, accordingly, set the design value of the seawater temperature at between 32-33°C.

On this basis, 2.08 - 2.13 tons of water per day can be produced. After further allowing for a 15% loss in efficiency as a result of changes over the course of the year, this productive capacity becomes about 1.8 tons.

Water distilling capacity : 1.8 ton/day

Using the water distilling unit, the supply of fresh water can be augmented by 1.8 tons a day. Since the vessel itself will consume some 3.2 tons/day, we estimate that a total of about 25.6 tons of fresh water can be provided once every 32 days to the skipjack fishing vessels. (Cf. Appendix XII)

(9) Navigational and Radio Equipment

We have specified as navigational and radio equipment for the subject vessel, the items already being used on the skipjack fishing vessels provided from Japan. The only items to be added on the new vessel will be an echo sounder, VHF international marine channel radio telephone, and VHF portable radio telephone.

The echo sounder will be used for installing Payao and will need a sounding range of about 3,000 m.

The VHF radio telephones will be used to communicate with shore stations when entering port and during loading operations. Other fittings will be provided, as required by relevant rules and regulations.

3-3-3 General Description of the Fishing Mothership

Following is a summary description of the fishing mothership, as determined from the findings of the preceding analysis.

(1) General Arrangement of the Vessel

The vessel is designated as a well-decker, with forecastle and long poop.

Below the upper deck, there will be positioned, from the bow, the fore peak tank (empty), the fuel tank, the freezing hold, the engine room, and the fresh-water tank. Directly below the freezing hold and the engine room, there will be a double bottom, which will be used as a fuel tank and, partially, as a tank for lubricating oil.

The freezing hold will be heat-insulated on all sides with urethane foam, maintaining a temperature of about -25°C by means of hair pin coil cooling pipes. In the hold, there will be two longitudinal rows of removable wooden shifting boards.

In the forecastle on the upper deck will be a chain locker, bosun store, and a paint store. Also, in almost the dead center of the weather part of the upper deck will be a samson type derrick post and winch platform, with 2 cargo winches positioned at the front and rear of this platform. The interior of the mast house directly below will house the hydraulic pump unit used to drive the winch, with a portion of this house serving also as a deck storage area. In addition, in the weather foreward part of the upper deck will be stored a skiff to ferry the crew and this will be raised and lowered by the loading derricks.

In the forward part of the poop will be 2 brine tanks for freezing, a brine reserve tank, and a brine pumping room. Inside the poop, starting from the front, will be, in turn, a refrigerating machine room, storage area for engine, living quarters, provision stores, deck storage, and steering room.

In the deck house in the upper section of the poop will be living quarters, mess and galley, and sanitary facilities, with the wheel house situated on the deck directly above. On the compass bridge deck, there will be a steering stand and a remote-control stand for the main engine, duplicating the facilities on the wheel house, with a canvas awning installed above.

All living quarters will be air conditioned, and the functions in these areas have been designed with due allowance for the tropical climate in which the vessel will be operating.

(2) Applicable Laws and Regulations

The subject vessel will be governed and will conform to the following laws and regulations:

1) The Ship's Safety Rules and Regulations of the Japanese Government

2) International Conference on Load Line (1966) and its regulations

3) International Conference for Tonnage Measurement of Ship, 1969, and its regulations

4) Rules and Regulations for Tonnage Measurement in Japan

5) International Convention for the Prevention of Pollution from Ships, 1973, and its Regulations

6) Regulations for Prevention of Pollution of the United States Coast Guard for foreign flag vessels

7) IMO Recommendations on Intact Stability for Passenger and Cargo Ships under 100 meters in Length (A.167)

8) Rules and Regulations for Steel Ships of Nippon Kaiji Kyokai

(3) Principal Specifications

Vessel type	Freezing carrier
Vessel material	Steel
Vessel grade	No.4 class steam vessel (in accordance with the Rules of the Japanese Government)
Navigation area	Long range, international voyage
Vessel class	NK, NS*, NMS*, RMC*

Principal Dimensions:

Overall length	about	57.40 m
Length between perpendiculars	"	52.0 m
Width (mold)	"	9.0 m
Depth (mold)	"	4.0 m
Draft (designed)	"	3.6 m
Gross tonnage (by International)	"	600 tons
Gross tonnage (based on regulations of the Government of Japan)	"	400 tons
Main engine horse-power	"	600 P.S.
Freezing hold capacity	"	640 m^3
Fuel tank capacity	"	290 m^3
Fresh water tank capacity	"	50 m^3
Lubricating oil tank capacity	"	6 m^3
Speed	"	9.2 knots
Size of crew	25 men	

Engine Part:

Main engine (about 600 P.S.)	1 unit
Auxiliary engines (about 200 P.S.)	2 units
Water distilling unit	1 unit
Mechanical ventilation equipment (engine room, galley, etc.)	1 set
Other auxiliary equipment	1 set

Electrical Equipment:

Generator	about 160 KVA/200 P.S.	2 units
Other Electrical Equipment	(main switchboard, transformers, batteries, chargers, other)	1 set

Freezing and Refrigerating Equipment:

Freezer compartment	Holding temperature	-25°C	1 set
	Cooling method	Grid coil direct expansion type	
	Cooling medium	R-22	
Freezing equipment	Freezing method	Brine soaking type	1 set
	Final brine temperature	-17°C	
	Freezing capacity	10 ton/24 hr	
	Cooling medium	R-22	
Provision stores	Storage temperature	-10°C and +5°C	1 set
Air-conditioning equipment			1 set

Deck Machinery:

Windlass	(4 ton x 9 m/min, electric motor-driven)	1 unit
Loading Equipment (cargo winch)	(2 ton x 30 m/min. electro-hydraulic)	4 units
Mooring equipment (Capstan)	(1.5 ton x 13 m/min. power-driven)	1 unit
Gangway ladder	(with power winch)	1 unit
Steering rudder unit		1 unit

Navigational and Radio Equipment:

Steering stand	1 unit
Auxiliary steering stand (on compass deck)	1 unit
Gyro-compass (with automatic pilot)	1 unit
Magnetic compass	2 units
Radar	1 unit

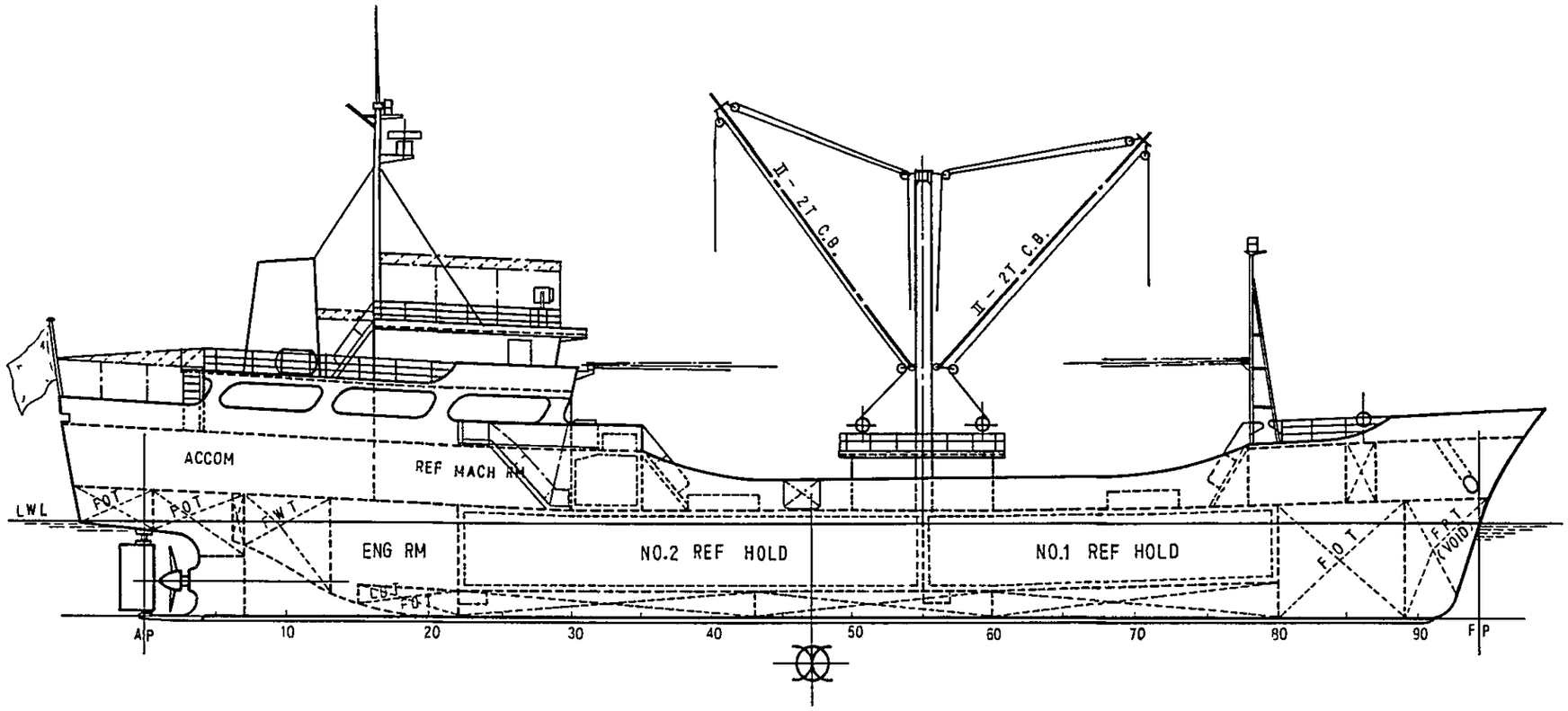
Echo sounder (capable of dection up to a range of 3,000 m)	1 unit
Navy Navigation Satellite System	1 unit
Direction finder	1 unit
Doppler speed log	1 unit
Wind direction and wind velocity gauge	1 unit
Surface water thermometer	1 unit
Seachlight (3 KW)	1 unit
SSB radio (150 w)	1 unit
VHF international marine channel radio-telephone	1 unit
VHF portable radio-telephone	2 units

Other Items:

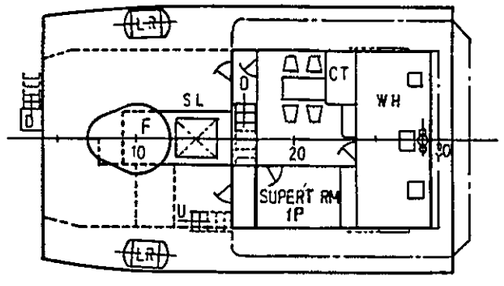
Sewage tank	(for a crew of 25)	1 set
Handling equipment		1 set
Skiff		1 set

3-4 Drawings

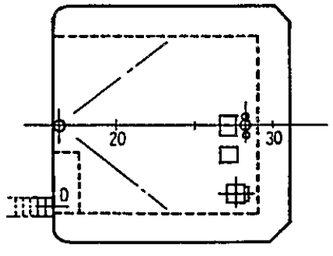
General Arrangement (1)



NAV. BRIDGE DK



COMPASS BRIDGE DK



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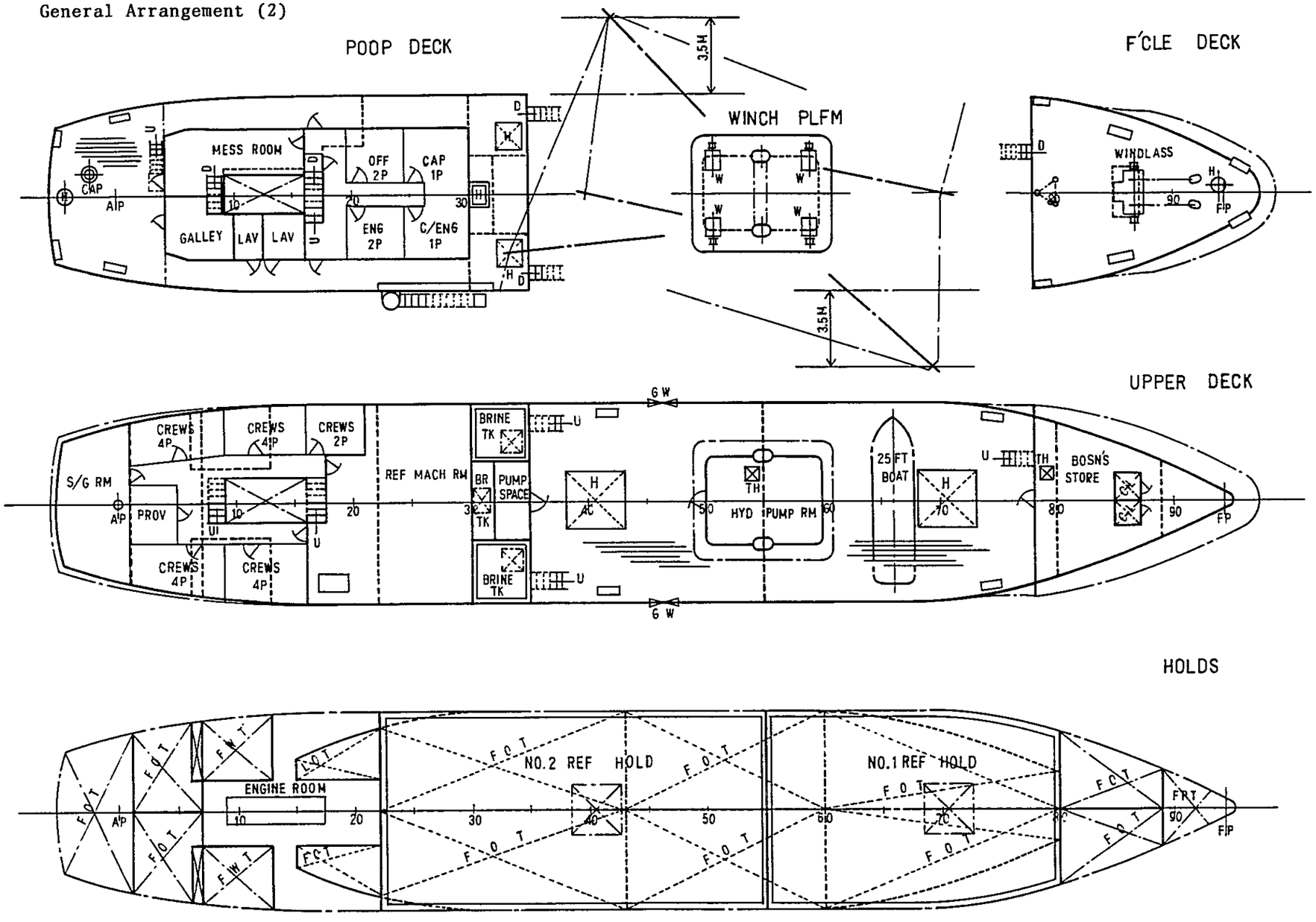
General Arrangement (2)



SECTION 4 MANAGEMENT AND OPERATIONAL PLAN

4-1 Management Structure

The subject project falls under the jurisdiction of the Ministry of Natural Resource Development. However, after completion and delivery of the fishing mothership, its operation is to be entrusted to Te Mautari, Ltd., which comes under the aegis of the above Ministry.

Te Mautari, Ltd., as shown in Appendix IX, is composed of Administration, Operating, Marketing, and Freezing Technology Divisions. Its personnel total 148 with 135 in direct operations and 13 in administrative services. Out of 135 employees in direct operations, 108 work in the Operating Division, which includes the operations of the four skipjack fishing vessels.

In a corner of one of the Company's shore-based freezer facilities, a work-shop (repair shop) has been established with equipment donated under a 1983 grant-in-aid from Japan.

From an organizational standpoint, then, the necessary divisions generally exist for both vessel and shore operations, with the staff of these divisions already actively performing these functions. Of course, experts from the U.K. and Japan are reinforcing these operations, but qualified personnel are being developed among local Kiribati nationals, and we should not underestimate the progress that is being made in this area.

4-2 Maintenance

With respect to the skipjack fishing vessels and the shore-based facilities currently owned by the Company, maintenance is presently being provided by Japanese technicians and Kiribati engineers. The Kiribati complement is independently executing maintenance operations as well a minor repairs but, owing to a lack of training opportunities and experience, they find it difficult to perform major repairs.

Excluding a very few technicians, therefore, it is by no means easy for Kiribati personnel to maintain and repair freezers and main engines, owing

to the fact that they have not had the benefit of suitable training. However, through on-the-job training using presently owned vessels and facilities as well as technological transfer from Japanese experts, there is every reason to expect an improvement of skill levels in these maintenance and repair functions.

Given these conditions, it is necessary that the machinery and equipment to be installed aboard the planned fishing mothership be easy to maintain, relatively trouble-free, and simple to dissassemble for maintenance purposes. With regard to the operation and handling of equipment comparable to that presently being used, there should be no problems in entrusting these functions to local Kiribati staff. However, if breakdowns occur, repairs are likely to be quite time-consuming. This situation too can be said to reflect a problem of inadequate training opportunities in maintenance techniques.

With respect to equipment and machinery in shore-based facilities and the engines aboard the vessels, present condition of those is kept quite well, considering the inadequate maintenance facilities. However, in the case of cleaning and repairing hulls, there are various operations which local personnel are not able to perform in view of the absence of landing facilities. We feel, therefore, that it will be necessary to establish a dry-dock servicing abroad once a year.

Needless to say, even the plans prepared by Te Mautari, Ltd. for the fishing mothership call for a maintenance period of some 40-50 days per year after it has been placed in service, and a budget has been provided in the plans for this purpose. However, it is absolutely vital that the budgetary and operating plans provide for an annual dry-dock program to assure economical operations and extend the useful life of the vessel.

4-3 Personnel Plan

As already discussed in (4) Crew, Section 2-3-1 of the Basic Plan, the regular complement for the subject vessel has been set at 25 persons, to include: a captain, chief engineer, first mate, first engineer, boatswain, and 15 general crew members.

Since it will be difficult at present to recruit a captain and chief engineer from among local nationals, owing to a lack of suitably qualified persons, these posts will have to be initially filled by foreigners, such as those presently serving on the chartered vessel (i.e., from Japan or Korea). However, in the near future, we anticipate that qualified personnel capable of operating the fishing mothership can be recruited from among Kiribati candidates for the positions of captain and chief engineer.

Candidates for officer positions other than those of captain and chief engineer can be recruited from the personnel serving on the present skipjack fishing vessels. The resulting vacancies aboard the existing vessels should cause no particular problem, since reserve personnel have already been trained to fill these vacancies.

There are numerous applicants for positions in Te Mautari, Ltd., and we understand that many candidates have registered with the Company in hopes of being called up to fill vacancies as they arise. Of course, even when candidates on the register are employed, they are not immediately sent to sea; they are first given a trial on land for a prescribed period. If a problem arises after this trial period, the offer of regular employment can be withdrawn or the employee can simply be discharged. In this way, only persons deemed fit and qualified are allowed to fill vacancies aboard the vessels.

If a problem develops after the candidate is taken on board, he can be relieved of vessel duty or, again, simply discharged. Given these strict regulations and screening procedure governing the employment of new personnel, the persons finally selected to serve aboard the skipjack fishing vessels can be said to be of superior caliber.

From the above conditions, we may conclude that the program in Te Mautari, Ltd. for training and developing regular staff has been quite successful. As the next step, a new personnel development program has been introduced to select and qualify candidates for senior crew positions by sending them to a training school in Fiji. We may, therefore, expect excellent results in terms of the future development of vessel personnel.

4-4 Technical Cooperation

As explained in Section 4-3 (Personnel Plan), the plan is to initially employ foreigners to man the fishing mothership, as is the case with the current chartered vessel, and later to switch over to local nationals in all positions. Thus, for purposes of operating the fishing mothership, we do not anticipate the need for any technical cooperation beyond existing programs in terms of dispatching either trainees or technicians.*) While there does appear to be a requirement for technical assistance in connection with the project to train small-scale fishermen, this would have no direct connection with the subject fishing mothership project. Accordingly, in so far as the fishing mothership building project is concerned, there does not appear to be any need for technical cooperation.

4-5 Operating Budget

4-5-1 Current Budget for the Chartered Vessel

The present chartered carrier vessel (Azuma-maru No.35) made six trips over the period May-December, 1983. The sum paid by Te Mautari, Ltd. to the owner of this vessel was as shown below. We have extrapolated these figures to develop an estimate of operating cost for the vessel based on a schedule of 10 trips per year.

(1) Charter fee, etc.		A$ 327,937
Cost of transporting fuel on the inbound voyage		44,000
Cost of transporting brine salts on the inbound voyage		3,300
		375,237
(2) Cost of transporting reefer containers		41,145
Total Cost		A$ 416,382

Using the charter fee, etc. from (1) above and converting the cost data per trip to a level of 10 trips per year, we have:

A$ 327,937 ÷ 6 trips x 10 trips/year = A$ 546,562

*) At the time of our survey, there were 4 Japanese technicians in Kiribati: 2 engaged in fishing operations and 2 machinists.

Thus, the first condition required for the new fishing mothership is that its operating costs be less than the A$ 546,562 presently being paid to operate the chartered vessel.

Let us now estimate the operating costs that would apply to the fishing mothership after it is placed into service.

4-5-2 Operating Budget for the Fishing Mothership

Following are the assumptions on which our estimates have been based:

(1) The Assumptions

a) Fuel Consumption

Main engine: 155 gr/hr p.s. x 450 p.s. (75% of rated output)

Generator: 160 gr/hr p.s. x 130 p.s. -- at sea
x 214 p.s. -- (average) -- while at Tarawa
x 129 p.s. -- (average) -- while at Pago Pago

Specific gravity of fuel oil 0.85

b) Consumption of Lubricating Oil

Main engine: 0.8 gr/hr p.s.

Generator: 2.0 gr/hr p.s.

Specific gravity of lubricating oil: 0.85

c) Distance from Tarawa to Pago Pago -- about 1,270 nautical miles

d) Cruising speed of vessel -- 9.2 knots

e) Depreciation -- based on an estimated initial cost of about ¥550,000,000

f) Insurance -- setting the average rate over 15 years at 0.018

g) Cost of repairs, provisions, and crew wages are as given in the data provided by the Kiribati authorities

h) Days per trip

Table 4-1 Planned Days per Trip

One-way	141 hrs (6 days)	
Round-trip	282 hrs (12 days)	
Berthed at Tarawa and Pago Pago:	8 days	
Loading	6 "	
Taking on fuel [refueling]	1 "	
Customs clearance	2 "	
Waiting for berth	3 "	
① Total Number of Days per Trip		32 days
② In Dry-dock		45 days
Number of trips (365 days - ②)/①		10 trips

(2) Operating Costs for the New Vessel

Calculations for fuel consumption data are shown in Appendix (X).

① Fuel Consumption and Cost

Consumption:

Underway	2.476 kℓ/day x 12 days	29.71 kℓ/day
At Tarawa:	0.966 kℓ/day x 8 days	7.73 kℓ/day
At Pago Pago:	0.58 kℓ/day x 12 days	6.96 kℓ/day
	Total consumption	44.40 kℓ per trip

Fuel cost:

(at A$280/kℓ x 10 trips) ..... A$ 124,320

② Consumption and Cost of Lubricating Oil

Consumption:

Underway; at Tarawa; at Pago Pago	.....	389 ℓ
Total consumption:	.....	389 ℓ/trip
Cost: (at A$288/180ℓ x 10 trips)	.....	A$ 6,224

③ Maintenance and Repairs (annual)		A$38,400
Provisions (annual)		A$14,400
④ Insurance (annual)		A$45,000

⑤ Crew wages (annual)

Captain	A$1,500/mo.	x	12 mos.	A$ 18,000
Chief engineer	1,100 "	x	"	13,200
First mate	450 "	x	"	5,400
First engineer	450 "	x	"	5,400
Boatswain	250 "	x	"	3,000
Ordinary crew (15)	2,250 "	x	"	27,000
Total crew wages	.....			A$ 72,000
Sum of 1, 2, 3, 4, and 5	.....			A$300,344

⑥ Depreciation (constant rate -- 15 years)		A$183,333
(A$1 = ¥200)		

⑨ Other costs

Sum of (1, 2, 3, 4, and 5) x 20%	.....	A$ 60,069
GRAND TOTAL	.....	A$ 543,746

In the above calculations, the following cost categories have been deleted:

⑦ Charter fee

⑧ Loading costs

Based on the above analysis, we see that, when the new vessel is

put into service, there will be a slight saving over the existing chartered vessel. From this, we can conclude that the size of the fishing mothership is not inappropriate from the standpoint of operating costs.

4-5-3 Operating Budget for a New Chartered Vessel

In as much as the present chartered vessel has become obsolete, it will clearly have to be retired within the next few years. In this context, if the proposed new fishing mothership is not made available, it will be necessary to make a new charter for a substitute vessel.

If a substitute vessel of the same class were to be chartered, it may be anticipated that charter rates, based on the current charter market in Japan, would run some A$458,000 - 490,000 per year.

We have estimated below the probable operating costs for a hypothetical new chartered vessel with the following specifications and operating conditions.

Specifications for a new chartered vessel:

Load capacity	about 315 tons
Cruising speed	10 knots
Main engine	1000 P.S. (1 unit)
Auxiliary engines	200 P.S. (2 units)

Charter conditions:

All costs other than the charter fee, stevedoring, (loading) and fuel costs would be for the account of the owner.

Estimating assumptions:

The number of trips per year and the operating rates for the main and auxiliary engines are assumed to be similar to those used in making the estimates for the fishing mothership.

Based on the above conditions and assumptions, we have developed the following estimate of the costs entailed in operating a new hypothetical charter.

① Fuel Costs

Underway:

Main engine:	1000 ps x 0.75 x 0.155 kg/hr.ps x 276 hrs ÷ 1,000 ÷ 0.85	37.8 kℓ
Auxiliary engine:	200 ps x 0.6518 x 0.160 kg/hr.ps x 288 hrs ÷ 1000 ÷ 0.85	7.1 kℓ

At Tarawa:

During loading operations:	200 ps x 2 units x 0.58/3 x 0.160 kg/hr.ps x 112 hrs ÷ 1000 ÷ 0.85	4.9 kℓ
Awaiting:	200 ps x 0.9379 x 0.160 kg/hr.ps x 80 hrs ÷ 1000 ÷ 0.85	2.83 kℓ

At Pago Pago:

During loading operations:	200 ps x 0.8018 x 0.160 kg/hr.ps x 84 hrs ÷ 1000 ÷ 0.85	2.54 kℓ
Awaiting berth:	200 ps x 0.5768 x 0.160 kg/hr x 204 hrs ÷ 1000 ÷ 0.85	4.43 kℓ

Total consumption ..... 59.6 kℓ/trip

Fuel Cost: (at A$280/kℓ x 10 trips) A$ 166,880

Costs for Items ②-⑥ would be nil. These cover, respectively, lubricating oil, maintenance and repairs, provisions, insurance, and crew wages, all of which would, under the above assumptions, be for the owner's account.

⑦ Charter fee

Based on the prevailing market in Japan, the going charter rate is in the order of U.S.$458,000 - 490,000. We have assumed parity between the U.S. and Australian dollars.

⑧ Loading (stevedoring) costs

¥2,000/ton ÷ ¥200/A$1.00 x 315 tons/trip x 10 trips = A$ 31,500

⑨ Other costs

A$166,880 x 0.2 = A$ 33,376

Accordingly, total costs for the hypothetical charter would amount to A$689,756 - 721,756 per annum.

Consolidating the above estimates, we can make the following comparison of operating costs between the present chartered vessel, the new fishing mothership, and a hypothetical new charter.

Table 4-2 Comparison of Annual Operating Costs

(In A$)

Category	Present Chartered Vessel	New Fishing Mothership	Hypothetical New Charter
No. of Trips/Year	10	10	10
① Fuel cost	-	A$ 124,320	A$ 166,880
② Cost of Lub. Oil	-	6,224	-
③ Repairs/Provisions	-	52,800	-
④ Insurance	-	45,000	-
⑤ Crew wages	-	72,000	-
Sum of Items ①-⑤	-	A$ 300,344	A$ 166,880
⑥ Depreciation (constant rate-15 years--A$1=¥200)	-	183,333	-
⑦ Charter fee (based on A$)	-	-	458,000 - 490,000
⑧ Loading charges	-	-	31,500
⑨ Other costs [①+②+③+④+⑤] x 20%	-	60,069	33,376
Total Cost	A$ 546,562	A$ 543,746	A$ 689,756 - 721,756

From the above findings, we see that, while the proposed new fishing mothership would result in only a slight saving in operating costs vis-a-vis the current chartered vessel, in terms of load capacity, the new vessel would be able to transport 350 tons, a full 100 tons more than the 250 tons possible with the current charter. Thus, the operating cost per ton of load would be considerably lower in the case of the new vessel than with the present charter. And, as opposed to the hypothetical new charter, the fishing mothership would clearly prove more economical.

SECTION 5 PROJECT IMPLEMENTATION PLAN

5-1 Implementation

If the subject project is carried out on the basis of a grant-in-aid from the Government of Japan, its implementation will follow procedures as set forth in Japan's system for such grant-in-aid. In this Section, we shall discuss certain key points that must be borne in mind in order to assure the smooth operation of the project.

(1) Method of Procurement

As is evident from a review of the project, its principal aspect will be the construction of the subject vessel. Various approaches are available for procuring the vessel, but we feel that it would be most suitable to order it directly from a shipyard.

To select the supplying shipyard, it would be desirable to conduct a pre-qualification examination, on the basis of which bids would be solicited from yards confirming to certain specified levels with regard to building records, creditworthiness, and financial stability.

The subject contract should not be confined only to the construction of the fishing mothership; the contracting shipyard should be expected to take full responsibility for the vessel, including transportation to and operational instructions at the final destination, so as to help assure smooth operations in the Kiribati area.

(2) Construction Supervision

No particularly sophistical technology seems to be required for the class of fishing mothership being considered but, in order to build a vessel that will satisfy the requirements set forth in the specifications within a limited construction period, it is essential that the various divisions of the contracting shipyard work effectively together, with close liaison among them. For this purpose, it would be desirable, in our view, to adopt a unified project approach, whereby a project team would be formed from among technicians chosen from the divisions concerned with one member being given primary responsibility for project coordination.

(3) Project Scope and Division of Responsibility

This project is to be implemented on the basis of a grant-in-aid from the Government of Japan for the provision of a fishing mothership within the overall program for the development of the tuna and skipjack fishery in Kiribati. The scope of the project may be outlined as follows:

1) Provision of the subject vessel.

2) Expenses entailed in sailing the vessel from Japan to Kiribati.

3) Operational instructions and vessel checks after arrival in Kiribati.

4) Provision of consulting services in connection with the implementation of the above.

The division of responsibility between Japan and Kiribati with respect to the various project services will be as follows:

Table 5-1 Division of Responsibility

Item	Kiribati	Japan	Reference
① Recruitment of vessel crew	*		Section 4-3
② Provision of operating funds for the vessel	*		Section 4-5
③ Registration and approvals in Kiribati, as required, for construction and operation of the subject fishing mothership	*		
④ Construction of the vessel		*	

(Continued)

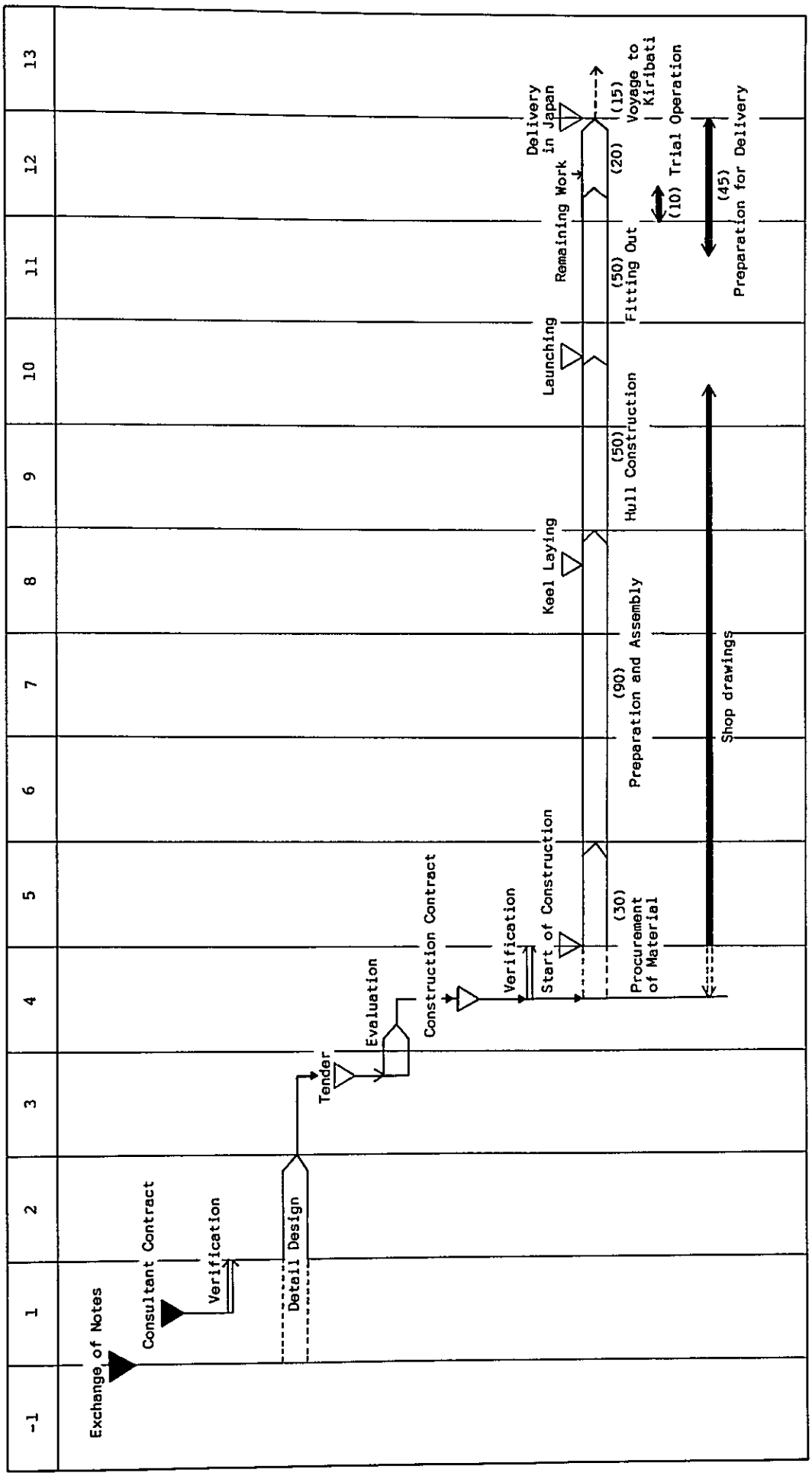
⑤ All costs in connection with moving the vessel from Japan to Tarawa (Betio)		*	
⑥ Immediate customs clearance upon arrival at a Kiribati port; obtaining of duty exemption for the subject vessel	*		
⑦ Obtaining exemptions from duties, local taxes, and other assessments in connection with the provision of equipment and servicing by Japanese technicians	*		
⑧ Operational instructions and final vessel checks in Kiribati		*	
⑨ Consulting services in connection with the above implementation plan		*	

5-2 Implementation Schedule

We contemplate that some 8 months will be required to construct a vessel of the class envisaged under the subject project while approximately another four months would be required between the Exchange of Notes and the start of construction.

On this basis, the total implementation time would be in the order of 12 months. Allowing another two weeks after delivery in Japan to sail the vessel to Kiribati, the total project time works out to about 12 1/2 months in all. Following is a project schedule based on this time frame.

Project Progress Schedule



SECTION 6 PROJECT EVALUATION

6-1 Financial Analysis

6-1-1 Purpose of the Financial Analysis

This financial analysis is intended to determine the appropriateness of the subject project as a target for a grant-in-aid. In other words, the purpose of the analysis is to establish whether, should the new vessel be granted, Te Mautari, Ltd. and the Government of Kiribati would be capable of operating it without financial strain. The question of profitability and profit planning will not be directly addressed in this examination.

Nevertheless, it must be remembered that Te Mautari, Ltd. is the central organization for implementing Kiribati's project for the commercial development of the skipjack and tuna fishery and was established on the premise that it would become a self-supporting entity geared to commercial production operations. Accordingly, we cannot overlook the financial viability of this Company as a factor directly impacting on the significance of the subject project.

Accordingly, we will first evaluate the revenue/expenditure structure of Te Mautari, Ltd. with respect to its fishing operations and then take up the subject of the cost burden involved in operating the fishing mothership.

6-1-1 Revenue/Expenditure of Te Mautari, Ltd.

In the following table, we have summarized the catch performance and earnings by year of Te Mautari, Ltd. from its foundation in 1981 through the end of 1983.

Table 6-1 Landings of and Income Earned from Skipjack and Tuna by Te Mautari, Ltd.

(in A$)

	1981*1)	1982	1983*2)
Skipjack and tuna landings (tons)	744	660	2,123
Revenues			
Sale of catches:			
1. Exports	491,525	473,780	1,712,200
Domestic Sales	175,888	171,894	193,200
2. Miscellaneous income	33,202	20,292	34,600
3. Total revenues	700,615	665,966	1,940,000
Expenses			
4. Purchase of catches	184,119	154,325	294,600
5. Transport costs	25,435	331,100	467,800
6. Wages	157,725	206,857	350,900
7. Provisions	38,036	51,190	78,900
8. Supplies and maintenance	17,432	48,636	57,900
9. Fuel oil	321,608	329,972	434,300*3)
10. Electric power	48,143	51,035	62,000*3)
11. Salts and fresh water	12,117	12,964	23,400
12. Bait	38,776	32,987	36,600
13. Insurance	34,700	38,000	40,100
14. Travel expense	11,652	5,509	12,700
15. Other costs	37,427	40,809	108,500
16. Total expenses	927,170	1,303,384	1,967,700
17. Earnings before depreciation	Δ 226,555	Δ 637,418	Δ 27,700
18. Depreciation	208,206	224,308	334,200*3)
19. Earnings after depreciation	Δ 434,761	Δ 861,726	Δ 361,900
Revenue/cost ratio (③ ÷ ⑯ x 100%)	76%	51%	99%

NOTES: *1) In 1981, the accounting period was 11 months (February-December).

*2) 1983 figures are preliminary.

*3) Estimated value.

The revenue/cost ratio, derived by dividing total revenues by total expenses (excluding depreciation) is shown as 76% in 1981, 51% in 1982, and 99% in 1983. As these figures show, while operations are still at a loss, with the rise in landings, there has been a major improvement in the 1983 profit picture. This is a reflection of the fact that, since May, 1983, all of the four skipjack vessels operated by the Company have for the first time been in full operation. For the 8-month period from May through December, 1983, as shown below, the revenue/cost ratio reached a healthy 124%, showing, for the first time, a value of 105% even after including depreciation in the costs of operation.

Table 6-2 Operation results of Te Mautari, Ltd. for the Period May-December, 1983

Category	Amount (A$)
Total Revenues	1,668,400
Total Costs (exclusive of Depreciation)	1,364,000
Depreciation for period (prorated)	222,800
Net Profits	101,600

Cumulative losses from 1981 to 1983 are shown at about A$1,660,000. Te Mautari, Ltd. received A$250,000 in aid from the U.K. in 1982, which partially offset the losses in its balance sheet. Similarly, in 1983/84, it is expected that the Company will have received aid in the amount of some A$1,170,000, and this should wipe out the bulk of the deficit incurred through the end of 1983.

Fuel oil, which is the largest single element in variable costs, is understood to reflect roughly the total cruising distance covered by the fishing vessels. The trend in landings versus fuel costs shown below on an index basis, with 1981 = 100:

Table 6-3 Trend in Landings vs. Fuel Costs

Category	1981	1982	1983
Landings	100	89	285
Fuel Costs	100	103	135

As shown above, since the start of 1983, even allowing for an increase in the number of operating vessels, such factors as a decline in the number of days spent catching bait and the ability to operate in waters close to the base have helped improve operational efficiency and may be presumed to explain the disproportionate increase in catch relative to fuel costs during 1983.

6-1-3 Financial Analysis

(1) World Markets for Skipjack

The frozen skipjack and tuna being exported by Te Mautari, Ltd. are presently consumed as raw material for canning.

The major consuming market for canned tuna and skipjack is the United States, which is said to account for some 50% of total world consumption of canned tuna.

As a result of the U.S. recession and a world-wide excess of supplies prices of skipjack and tuna on the international market have, for some time, been generally depressed and unstable.

The FOB prices of the Te Mautari, Ltd. for frozen skipjack and tuna follow those of the A.T.S.A.*) From May to December, 1983, they averaged about A$0.95/kg, including young yellow fin tuna. Fluctuations on the international market are indeed a source of considerable uncertainty in trying to anticipate the future performance of this Company but, so long as present selling price can be maintained, we do not foresee any problems in connection with pricing.

*) American Tuna Sales Association

(2) The Financial Analysis

We have conducted a cash-flow analysis, based on the introduction of the subject fishing mothership, predicated on the financial operating patterns during 1983 for all facilities of Te Mautari, Ltd., including those on shore.*)

The life of the subject project has been set at 15 years, corresponding to the useful life of the vessel. And, although the acquisition cost of the vessel under the subject project is not actually treated as an expenditure by the Company, this cost has been imputed as an initial capital investment. In order to evaluate operational capabilities under present conditions, we have assumed that, over the project period, there will be no other expansion of facilities and no further growth in landings based on an expansion of productive capacity. We have stipulated resale value of the subject vessel at the end of its operating life as 10% of original cost.

If, based on these estimates, we treat vessel procurement as a cash disbursement for initial investment, there will be a cumulative deficit through Year 13. And, for an estimated Financial Internal Rate of Return (FIRR) of 2.17%, we can hardly say that profitability is outstanding.

If, hypothetically, we were to apply a 2% discount factor to the initial investment, the Net Present Value (NPV) would become A$228,000 and the ratio of benefits to costs 1.0090. If the fishing mothership is introduced into Te Mautari, Ltd. under the assumption that landings and sales will remain at 1983 levels, the operation of the vessel should not adversely affect the Company's finances, while the initial capital cost can be recouped during, or at least by the end of, the project period.

However, when we consider that the project is not likely to be fully viable as a commercial investment and further take into account the background and objectives of the Project, we can certainly state that implementation of a grant-in-aid is highly desirable.

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*) The detailed cash-flow analysis is shown in Appendix (XIII).

6-2 Economic Evaluation

The introduction of the fishing mothership was originally considered from the standpoint of replacing the functions performed by the present chartered vessel. From its very nature, this type of carrier vessel does not inherently contribute to production operations, being limited to the provision of direct transport services and activities associated with the replenishment of supplies.

As a result, if this project is implemented, it would be quite separate and distinct from a plan to expand the fishing fleet itself, from which an increase in actual fish production might be expected. It is our feeling, therefore, that this assessment of benefits should focus primarily on indirect, as opposed to direct, benefits to be derived from the introduction of the subject vessel.

The principal benefits that can be anticipated, comparing with existing conditions, from the implementation of the subject project would include the following:

1) Savings in the cost of exporting fish and importing fuel oil.

2) A reduction in cargo congestion as a result of an increase in carrying capacity, along with an improvement in the rate of capital turnover.

3) A saving in fuel costs for the skipjack fishing vessels, based on mothership operations by the new vessel; stabilization of catch levels.

4) An increase in fish production on the basis of improved collection of catches for artisinal fishermen in the outer islands, which will lead to an improvement in their opportunities for cash earnings.

5) Expansion of training opportunities for trainees from the Marine Training School (M.T.S.).

6) Retention within Kiribati of depreciation reserves.

Let us now analyze those benefits which are susceptible of quantitative measurement: namely, the reduction in exporting and fuel oil costs.

Reduction in fish exporting costs:

① Saving in the cost of shipping frozen containers (based on two shipments)	A$ 41,145
② Saving in charter fees for 10 trips by the existing charter vessel	546,562
③ Less operating costs over 10 trips for the fishing mothership	(360,413)
Total Net Savings	A$ 227,294

The cost of exporting fish will be reduced only by the use of reefer containers with the new fishing mothership and the net saving in operating costs from replacing the present charter vessel with the new vessel. These savings can be categorized as benefits from the project.

For convenience sake, the elimination of costs totaling A$587,707 [① + ② above] as a result of terminating the present transport system may be calculated as a social benefit, while the new expenditures of A$360,413 [③ above] to replace the charter vessel may be calculated as a social cost.

Savings in the transport for importing of fuel and salts:

Based on data for the period May-August, 1983 inclusive, a total of A$47,300 was paid for transport charges in connection with imports of fuel and salts for brine tank. Extrapolating these figures to a 10-trip level, the following annual savings can be realized from the new vessel in this area:

$$A\$\ 47{,}300 \div 6 \times 10 = A\$\ 78{,}833$$

As a result of the cost/benefit analysis*), the EIRR works out to 8.21%, while

*) Appendix (XIV) shows the calculation of benefit/cost ratios.

the NPV, based on a 7% discount factor, comes to A$182,000, with a benefit/cost ratio of 1.0288.

Assuming Te Mautari, Ltd. can maintain the same landing and sales performance as during the May-December, 1983 period, then, even if we limit our analysis only to benefits of a quantitative nature, clear benefits can be expected from implementation of the subject project while, at an 8.21% discount rate, capital investment and returns would be in balance.

Accordingly, from the above, we can certainly conclude that the benefits from carrying out the project to build a fishing mothership have stood up against a most rigorous analysis and that there would appear to be ample significance for the Kiribati economy in extending this grant-in-aid from the Government of Japan.

SECTION 7 CONCLUSIONS AND RECOMMENDATIONS

7-1 Conclusions

As one of the various economic programs for building self sufficiency which have been developed by the Government of Kiribati, the present fishing mothership project is geared toward the development of the tuna and skipjack fishery, which is acknowledged to have a high level of commercial viability. This project is positioned as one of those that have been developed within the country's 5-Year National Development Plan.

As we have explained in the body of this report, Te Mautari, Ltd. which was established for the purpose of developing the tuna and skipjack fishery to the stage of commercial viability, is not only a fish producer but also has the role of shipping the fish to the export market as frozen products. At the present time, one of the most important goals of this Company is to improve its earnings from the sale of fish through these commercial activities.

The objective of the subject project is to procure and operate a new reefer cargo vessel as a replacement for the charter freezer vessel presently being operated by the Company for export transport, since the carrying capacity of the latter is quite low and the vessel is rapidly aging. A companion objective is to provide the new vessel with the capacity to function also as a mothership for skipjack fishing vessels.

We must confess that, as a general rule, it is somewhat exceptional for an entity with only four fishing vessels to operate a full-time freezer carrier, whether under charter or owned. However, Kiribati is a state composed of various islands located in the remote recesses of the Central Pacific and thus under a considerable transportation handicap. In addition, since production levels are still low, while port facilities are not well developed, it is not possible, at the present stage, to solicit calls by large reefer carriers on a regularly scheduled basis. Thus, the reality is that there is no other feasible way to accomplish the nation's objectives.

The Government of Kiribati has a plan for expanding the production facilities of Te Mautari, Ltd., centering on fishing vessels and land storage facilities. However, with time and funding for this program still indefinite, the program has not yet reached the stage of concrete implementation. In addition, the construction plan for extension of the quay at the port of Betio, which constitute a basic prerequisite for implementation of these expansion plans, remains in the study phase. It has therefore, perhaps been most realistic for us to project future export volume, at current levels and give the subject fishing mothership a carrying capacity in line with current levels of activity.

Accordingly, from the standpoint of present volume of landing by the Company we have concluded that it would be appropriate to consider a plan for introducing a fishing mothership with a capacity for carrying a maximum of 350 tons of frozen skipjack per trip.

We have prepared a basic design plan, based on a consideration of various other functions required for a fishing mothership and have, on the basis of an estimate of operating costs, come to the conclusion that the costs of operating the present charter vessel and those of operating the fishing mothership, including depreciation, would be about the same. We anticipate, moreover, that it would be far more costly than either of the above alternatives to charter a new reefer cargo vessel of the same size and capacity as the subject fishing mothership.

From the cash-flow calculations, it appears that the introduction of the new fishing mothership will not have an adverse impact on the financial condition of Te Mautari, Ltd. We do not therefore, anticipate that the operating costs for this vessel will cause an undue burden on the Company. Even if the costs of construction and delivery are treated as initial capital investments, so long as the discount factor is held at 2.17% or less, it will be possible to recoup the capital cost. Nevertheless, since the project would not be truly viable on a purely commercial basis, we have concluded that an investment of a public nature, in the form of a grant-in-aid, will be necessary.

Based on the field survey, we anticipate no problems in relation to crew recruitment or management capabilities. And, considering the fact that the

operating costs should not be burdensome, we feel that the structure for plan implementation on the Kiribati side is fully adequate.

If this project is implemented, we anticipate a major saving over current levels in the costs of exporting fish products and importing fuels along with a considerable reduction in cargo congestion as a result of the projected increase in carrying capacity.

Also, by initiating mothership fishing operations with this vessel, there will be major savings in fuel costs for the skipjack vessels, even when fishing in distant grounds. This may be expected to produce a broadening of fishing ground options, thereby ending greater stability to catches than under existing conditions.

The subject project has been shown to be of clear benefit to the Kiribati economy, and so there would seem to be ample justification for the Government of Japan extending a cooperative grant-in-aid for its implementation. In our view, it would be desirable for the project to be brought to the stage of implementation as quickly as possible.

7-2 Recommendations

With a view to permitting more effective and developmental operations in the future by the fishing mothership we recommend that the Government of Kiribati and the Te Mautari, Ltd. consider the following measures:

(1) Implementation of a Program for Regular Maintenance

We feel it is definitely necessary that a program of regular annual dry-dock maintenance be instituted for the fishing mothership over the entire project period (namely the useful life of the vessel) so as to prevent a loss in operating efficiency.

(2) Training of Personnel

It would be highly desirable to develop, at the earliest opportunity, a pool of nationals qualified for international operations, particularly

with respect to the positions of captain and chief engineer.

A training program should also be implemented to develop an adequate cadre of technicians in the fields of freezing operations and engines.

(3) Development of Small-scale Fishermen

The development of small-scale fishermen is seen as one of the major functions of the Te Mautari, Ltd. Through implementation of this project, it should be possible to further increase the planned purchases of fish from these local fishermen. It would, therefore, be desirable to establish a program of direct transshipments to the fishing mothership during its stay in Tarawa and to schedule calls at the outer islands during its return voyage from Pago Pago, with a view to enlarging the target area for its fish purchases from local fishermen.

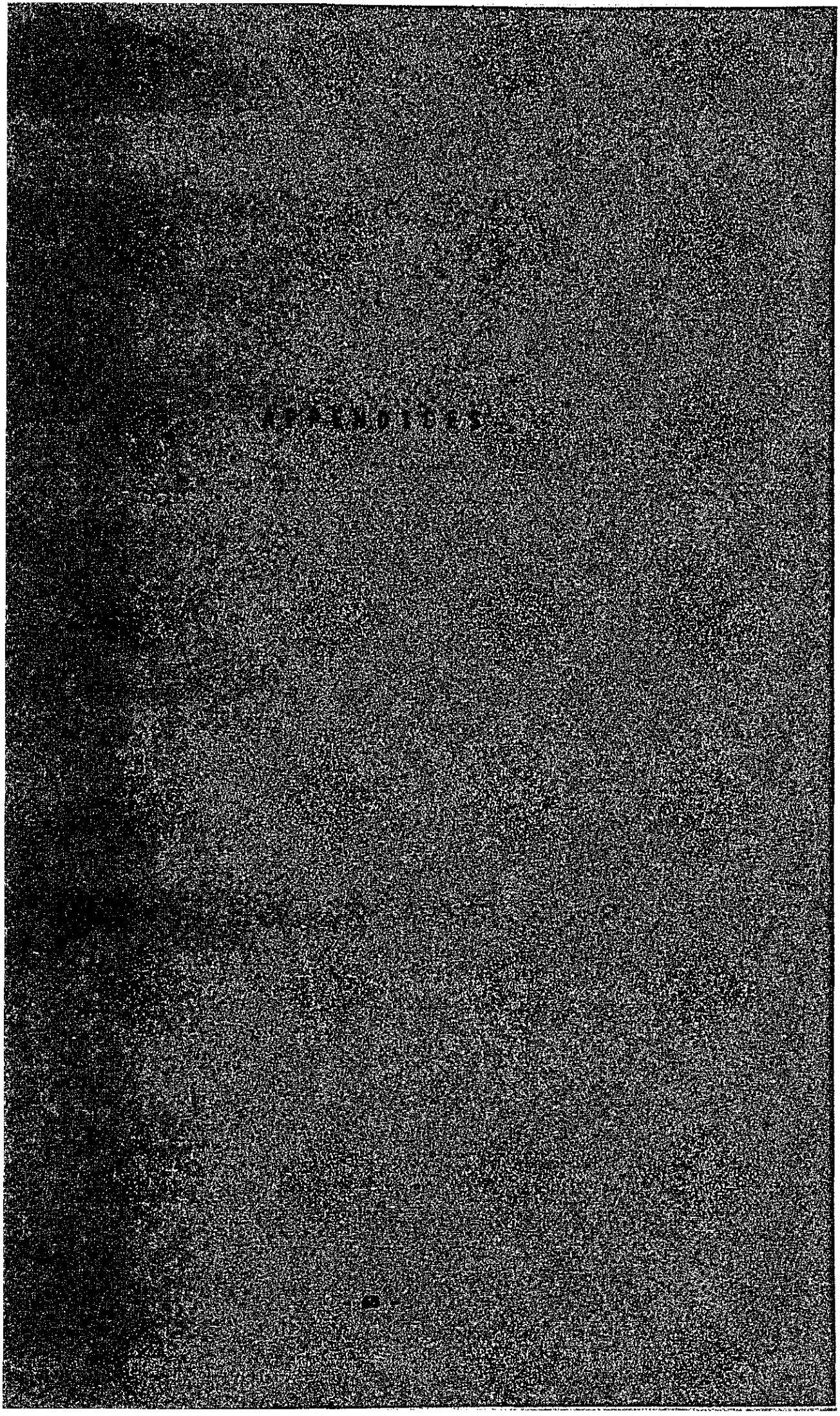
(4) Transport during the Return Voyage

Included in the subject project is a plan for Te Mautari, Ltd. to transport fuel and other materials on the return voyage of the fishing mothership. It should also be possible to expand opportunities to bring back other essential items, such as fresh foodstuffs, for which the economy must rely heavily on imports, thereby contributing to supply stably such products. It is therefore recommended to establish an appropriate support program for transporting daily necessaries by the fishing mothership on the return voyage.

(5) Construction to Expand the Quay at Betio

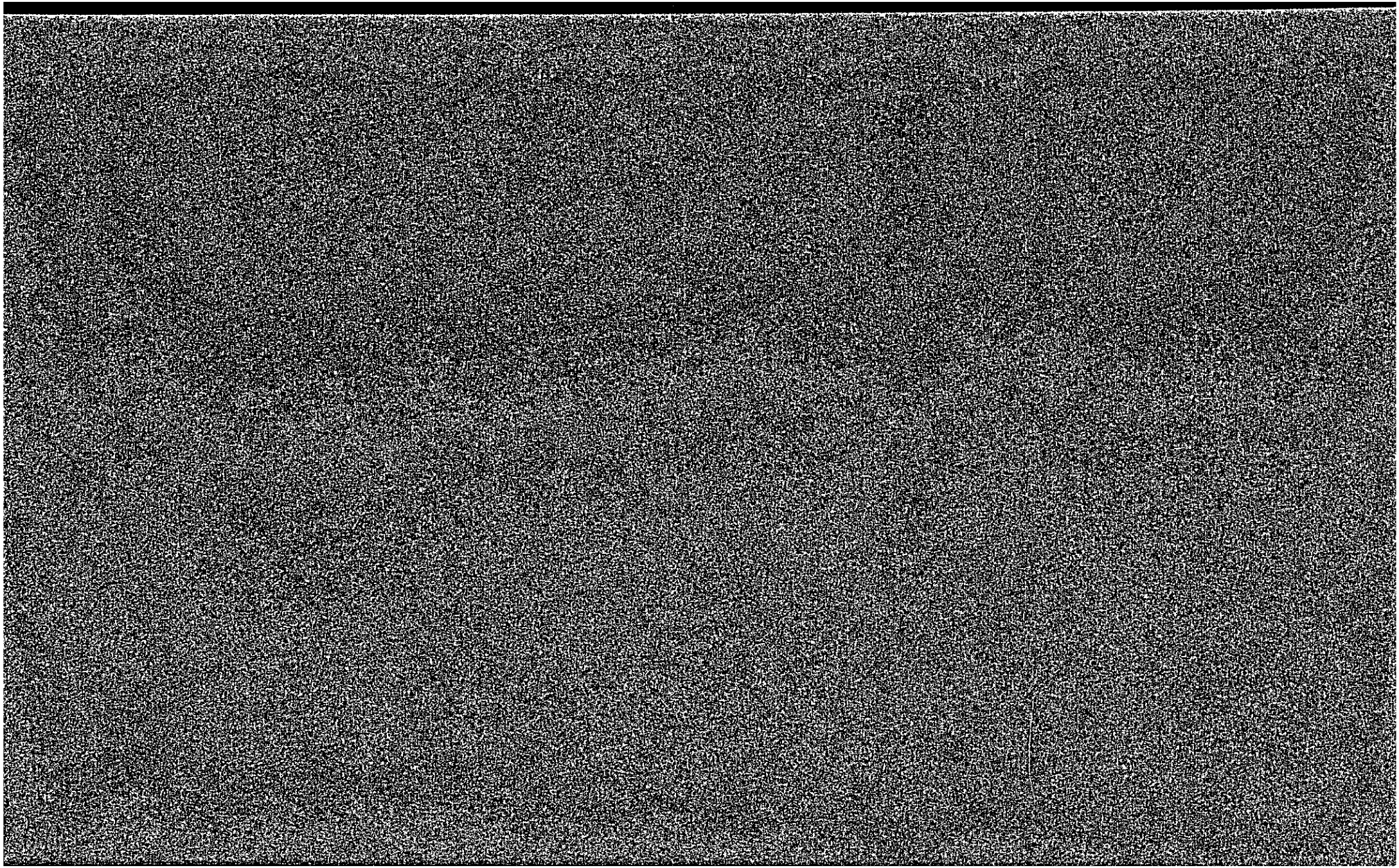
Implementation of the planned program for an expansion of the quay facilities at the port of Betio should greatly expedite loading operations for the fishing mothership, such as the landing of fuel and brine salts at shore-based facilities and the receipt of frozen fish products from these shore-based installations. In addition, we can expect direct and indirect benefits of major proportions in the form of a considerable reduction in the time required to land fish from and supply the skipjack fishing vessels.

This project is a basic prerequisite for the facility expansion program being planned by Te Mautari, Ltd. and, as such, should be implemented as soon as possible.



This project is a basic prerequisite for the facility expansion program being planned by Te Mahitahi, Ltd. and, as such, should be implemented as soon as possible.

A P P E N D I C E S



APPENDIX (I) Minutes of Discussions

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY FOR THE FISHING MOTHER SHIP BUILDING PROJECT
IN
THE REPUBLIC OF KIRIBATI

In response to the request by the Government of the Republic of Kiribati for the Fishing Mother Ship Building Project (the Project), the Government of Japan has sent, through the Japan International Cooperation Agency (JICA), a study team headed by Mr Akira Kuroiwa, Fishing Vessel Inspector, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, to carry out a basic design study on the Project from March 25th, 1984 through April 8th, 1984.

The team has carried out a field study, held a series of discussions and exchanged views with the authorities concerned of Kiribati.

As the result of the study and discussions, both parties have agreed to recommend to their respective governments and the authorities concerned to examine the result of the study attached herewith toward the realization of the Project.

Tarawa
The Republic of Kiribati
FRIDAY APRIL 6TH 1984

黒岩 秋

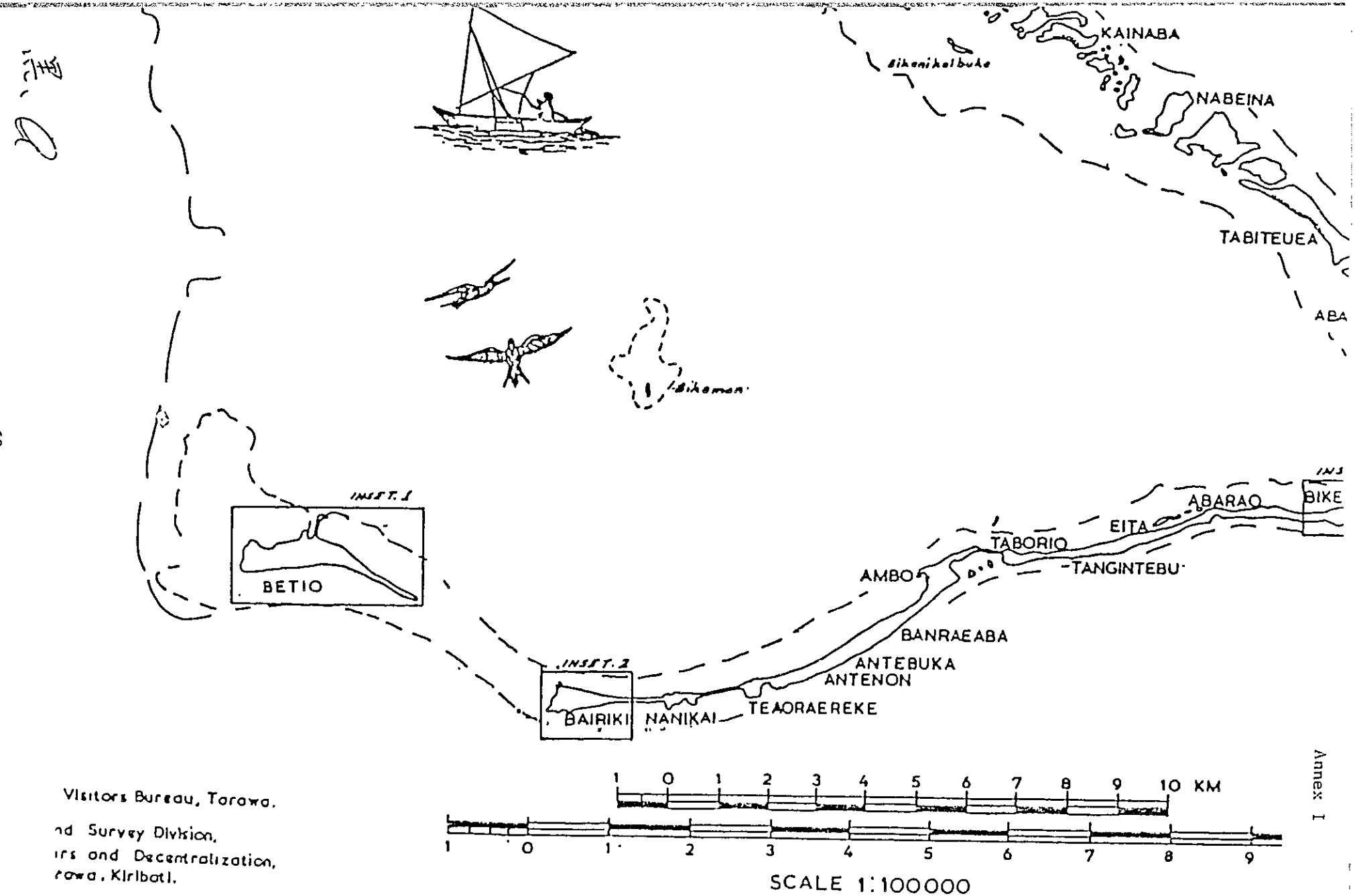
Akira Kuroiwa
Team Leader
Japanese Study Team

The Hon. Babera Kirata
Minister of Natural Resource Development

黒A

MINUTES

1. The objective of the Project is to provide a Fishing Mother Ship (The Ship) to promote the Tuna Fisheries Development Programme in Kiribati.
2. The proposed main home port of the Ship is Betio, Tarawa Atoll, Kiribati. (Annex I)
3. Ministry of Natural Resource Development will be responsible for administration of the Project and will be the executing agency of the operation of the Ship.
4. The Japanese study team will convey to the Government of Japan the desire of the Government of Kiribati that the former takes necessary measures to cooperate in implementing the Project and provides the Ship stated in Annex II, some particulars of which may be changed in accordance with the Grant Aid Scheme of Japanese Economic Cooperation.
5. For the implementation of the Project, the Government of Kiribati will carry out necessary measures as follows:
   a) to provide data and information necessary for the design during implementation of the Project
   b) to facilitate prompt customs clearance of the Ship at the port of Kiribati.
   c) to exempt the Japanese nationals concerned from customs duties, internal taxes and other fiscal levies which may be imposed in Kiribati on the occasion of the supply of materials and services for the Project
   d) to provide and accord necessary permits and licences and registrations as required by Kiribati laws and regulations for carrying out the Project.
   e) to bear all the miscellaneous expenses other than those to be borne by the Grant, necessary for the Project
   f) to promote the development of port facilities for more efficient operation of the Ship
6. Both parties confirmed that the Japanese study team explained the Japanese Grant Aid System and Kiribati side understood it.



Visitors Bureau, Tarawa.

nd Survey Division,
irs and Decentralization,
Tarawa, Kiribati.

Annex I

Annex II

THE FISHING MOTHER SHIP

No. of ship	one (1)
Loading capacity	about 350 tons

Note: Basing upon the results of the field study and data analysis in Japan, the study team will prepare a study report and submit the draft report to JICA at the middle of May, 1984.
The final report will be presented to the Government of the Republic of Kiribati through the diplomatic channel.
The details of the Ship, including the loading capacity stated above, will be finalized in the final report.

APPENDIX (II) Team Members

Mr. Akira Kuroiwa	Team Leader	Fishing Boat Inspector, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries
Mr. Takahide Naruko	Coordinator	Second Economic Cooperation Division, Ministry of Foreign Affairs
Mr. Kanji Yoshimi	Vessel Design	Fisheries Engineering Co., Ltd.
Mr. Kouichiro Nakamura	Machinery and Refrigeration	Fisheries Engineering Co., Ltd.
Mr. Toyomitsu Terao	Management Analysis	Fisheries Engineering Co., Ltd.

Appendix (III) Survey Itinerary

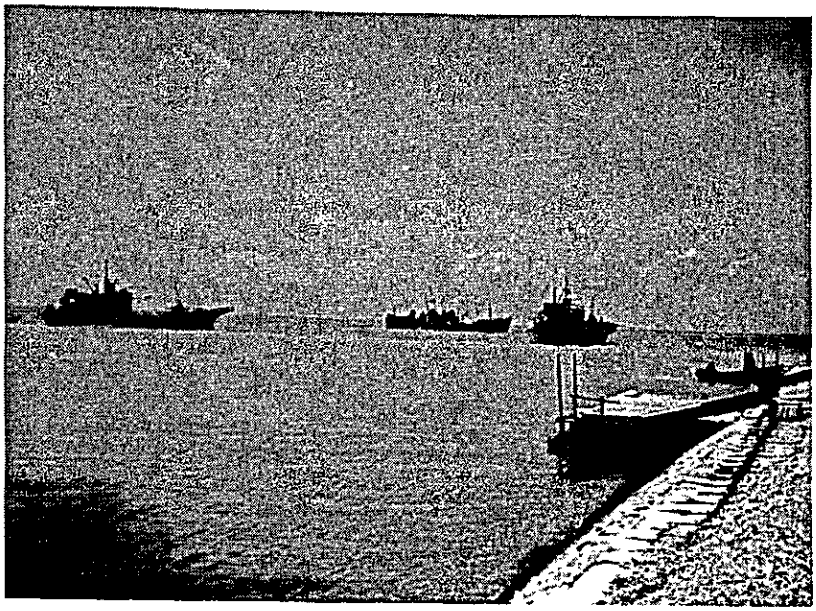
Day	Date	Itinerary	Description
1	Mar.22(Thu.)	Lv. Tokyo (11:00)	
2	Mar.23(Fri.)	Ar. Nauru (03:20)	
3	Mar.24(Sat.)	Nauru	
4	Mar.25(Sun.)	Lv. Nauru (09:30) Ar. Tarawa (10:40)	Discussion on the itinerary Presentation of the Inception Report and Questionnaire
5	Mar.26(Mon.)	Tarawa	Visit to Ministry of Natural Resource Development (NRD) and Te Mautari, Ltd. Discussion with Te Mautari, Ltd.
6	Mar.27(Tue.)	Tarawa	Discussion with Te Mautari, Ltd.
7	Mar.28(Wed.)	Tarawa	Discussion with Te Mautari, Ltd. Visit to Marine Superintendent Investigation of the pole and line fishing (Nei Kaneati)
8	Mar.29(Thu.)	Tarawa	Discussion with Te Mautari, Ltd.
9	Mar.30(Fri.)	Tarawa	Visit to NRD, Attorney General, Ministry of Finance, and Land Office Data collection
10	Mar.31(Sat.)	Tarawa	Discussion with Te Mautari, Ltd.
11	Apr. 1(Sun.)	Tarawa	Mr. Naruko leaving Tarawa Discussion within the Team Survey for the fishing vessels
12	Apr. 2(Mon.)	Tarawa	Investigation of the shore facilities Discussion with Te Mautari, Ltd.
13	Apr. 3(Tue.)	Tarawa	Visit to Marine Training School and Shipyard Discussion with Te Mautari, Ltd. Investigation of the pole and line fishing (Nei Arintetongo)
14	Apr. 4(Wed.)	Tarawa	Discussion with Te Mautari, Ltd.
15	Apr. 5(Thu.)	Tarawa	Discussion with Te Mautari, Ltd.

Day	Date	Itinerary	Description
16	Apr. 6(Fri.)	Tarawa	Signature of Minutes of Discussions Visit to Attorney General, Land Office, Ministry of Finance, Fisheries Division (NRD), and etc.
17	Apr. 7(Sat.)	Tarawa	Supplementary collection of data and information
18	Apr. 8(Sun.)	Tarawa	Preparation for data analysis (Delay of departure by the flight cancel)
19	Apr. 9(Mon.)	Lv. Tarawa (12:40) Ar. Nauru (14:20)	Mr. Kuroiwa and Mr. Nakamura leaving Tarawa
20	Apr.10(Tue.)	Tarawa/Nauru	
21	Apr.11(Wed.)	Lv. Nauru (07:00) Ar. Guam (11:40)	
22	Apr.12(Thu.)	Lv. Guam (06:00) Ar. Tokyo	Mr. Kuroiwa and Mr. Nakamura arriving Tokyo
23	Apr.13(Fri.)	Lv. Tarawa (09:00) Ar. Guam (17:36)	Mr. Yoshimi and Mr. Terao leaving Tarawa
24	Apr.14(Sat.)	Lv. Guam (03:55) Ar. Tokyo (07:35)	Mr. Yoshimi and Mr. Terao arriving Tokyo

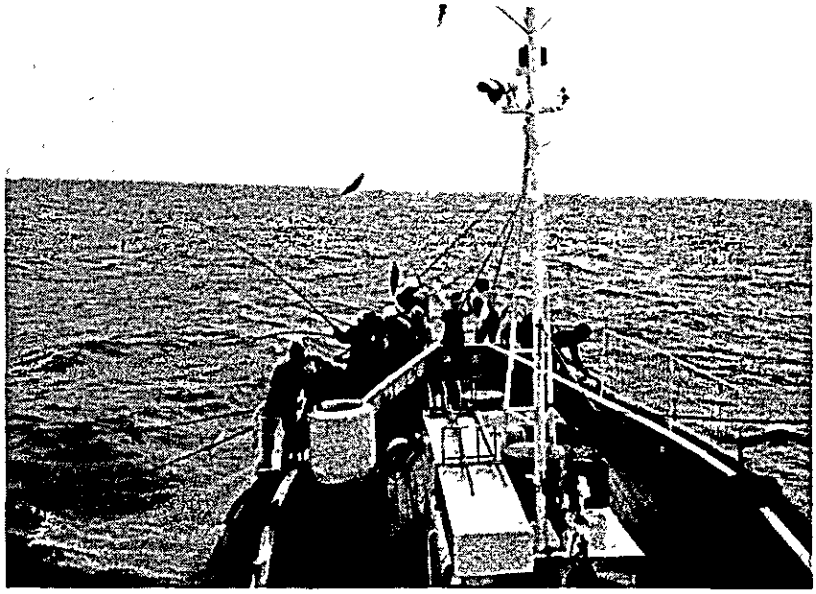
APPENDIX (IV) Discussants

NAME	TITLE AND ORGANIZATION
THE Hon. BABERA KIRATA	Minister of Natural Resource Development (NRD)
TEITEN TOKETAKE	Secretary, Ministry of NRD
BRENDAN DALLEY	General Manager, TE MAUTARI, Ltd.
BEWIANINA TINGA	Secretary, Ministry of Finance
MIKAERE BARAWIKO	Planning Officer, Ministry of Finance
CHARLES MACFADDEN	Republic Statistician, Ministry of Finance
BEIAITI HIGHLAND	Marine Superintendent, Ministry of Communications
J. M. BONIBATI	Chief Lands Officer, Ministry of Home Affairs and Decentralization
N. G. PAPPS	Land Surveyor, Ministry of Home Affairs and Decentralization
MICHAEL N. TAKABWE	Attorney General
MICHAEL HENATCHE	Chief Officer, Marine Training School
P. T. TIMEON	Assistant Secretary, Ministry of Foreign Affairs

Appendix (V) Photographs

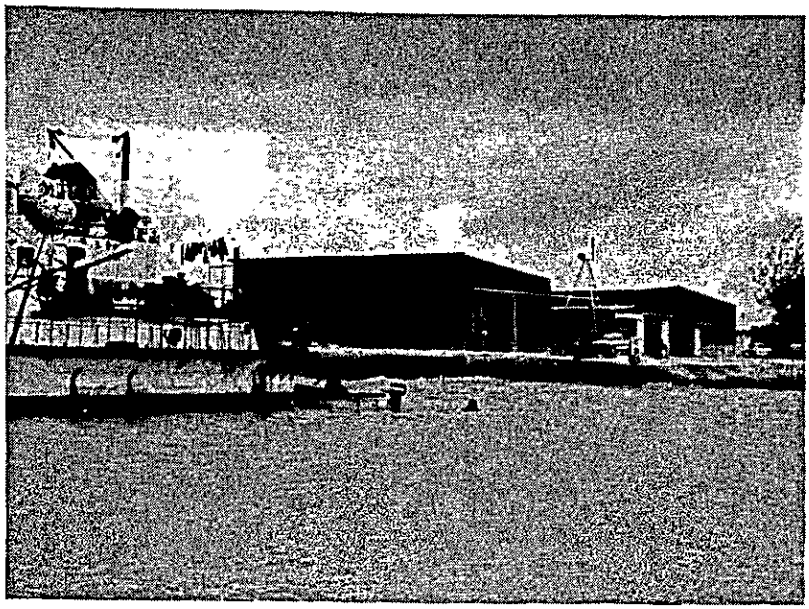


Eastern Mole in the port of Betio, Fishing vessels of Te Mautari, Ltd.

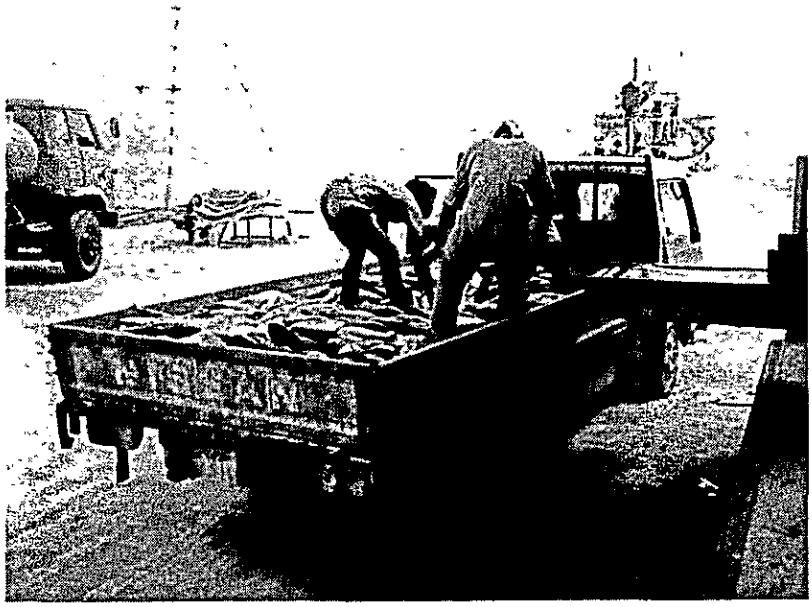


Fishing operation at the bow, the Maiana fishing ground

Fishing operation at the stern, the Maiana fishing ground

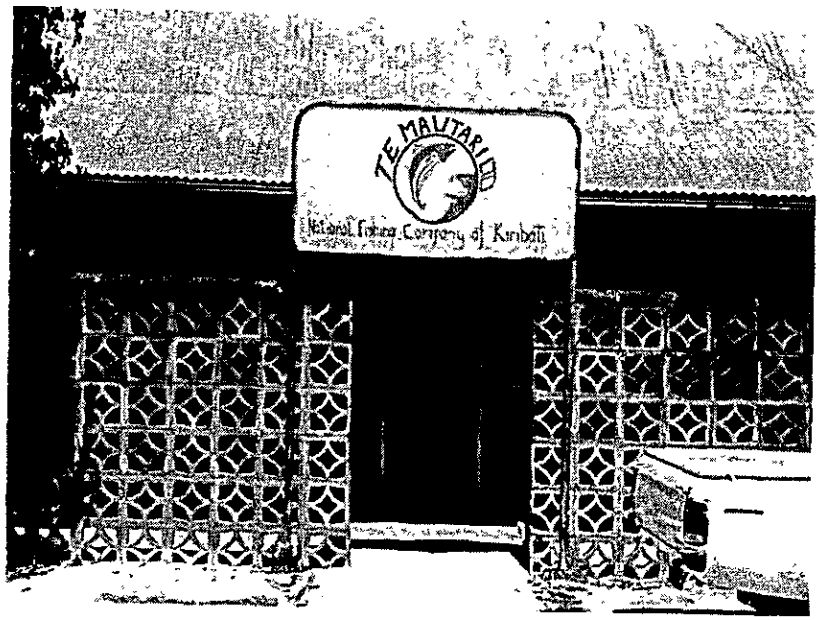


Te Mautari, Ltd.'s freezing facilities at Eastern Mole

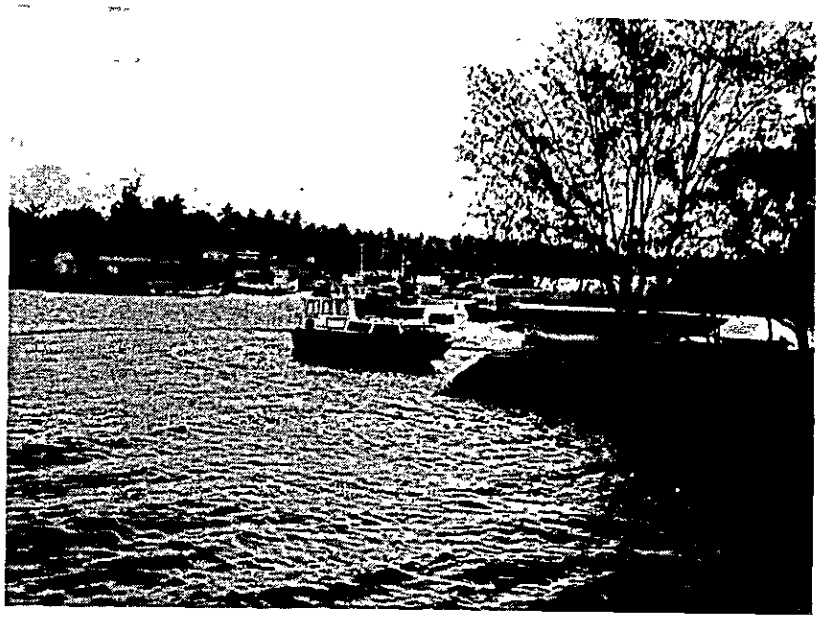


Landing of catches

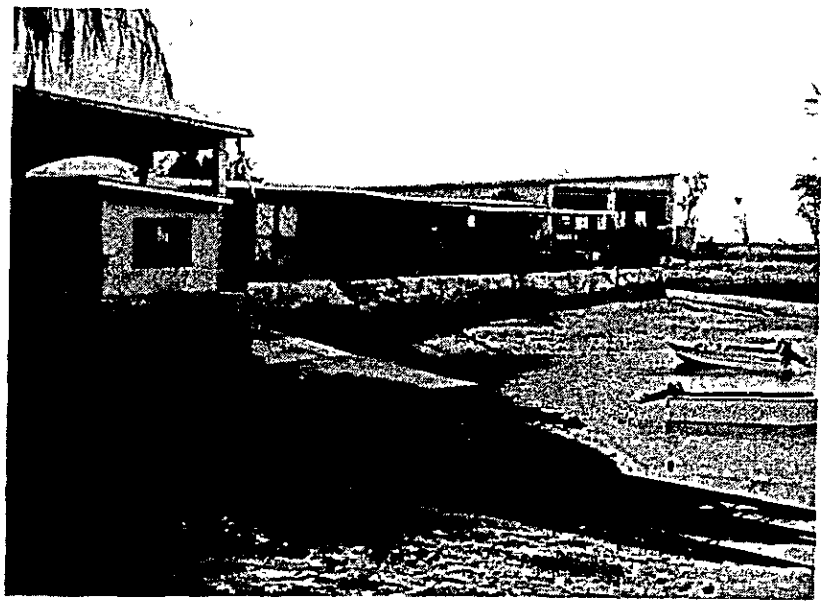
Discharge from the freezing store



Head Office of
Te Mautari, Ltd.



Moorage in the
port of Betio



Betio Shipyard

APPENDIX (VI) Monthly Landings of Skipjack and Tuna by Te Mautari, Ltd.

(in metric tons)

Month	Catch by Company Vessels	Purchases from Local Fishermen	(A)	(B)	Total	Remarks
1983 JAN	3.2	45.9			49.1	
FEB	46.6	25.9			72.5	59GT and 20GT vessels placed in service
MAR	80.6	34.4			115.0	
APR	37.1	41.5			78.6	120GT and 99GT vessels withdrawn from operation to undergo repairs
MAY*	203.0	36.4	51.0		(290.4)	
JUN	114.0	33.6			147.6	Start of full operations by all 4 vessels
JUL*	245.4	86.2			331.6	
AUG*	208.7	5.6	56.1	52.7	(323.1)	
SEP	158.9	19.4			178.3	
OCT*	192.0	40.3			232.3	
NOV*	305.5	49.1			354.6	
DEC	103.8	5.3	35.1	30.0	(174.2)	
1984 JAN	110.8	40			150.8	
FEB	158.6	60			218.6	
MAR*	308.9	20			328.9	New freezing store placed in service
May, 1983 - March, 1984 (Monthly average)	191.8	36.0	-	-	248.2	248.2 x 12 months ≒ 3,000/year
Monthly average of good catches during above period (Best 6 months)	-	-	-	-	310.2	310.2 x 12 months ≒ 3,700/year

Notes: 1) *) Best 6 months No mark: Poorest 5 months

2) (A): The total number of days during which fishing operations had to be suspended while awaiting the arrival of the carrier, owing to lack of space in the refrigerators (on shore and aboard vessel), were: 22 days in May, 22 days in August, and 14 days in December.

We estimated the loss of production from these interruptions on the basis of daily average catches.

3) (B): Estimated value of the drop in landings based on a suspension of purchases from local fishermen for the same reasons as in (A): 31 days in August-September; 20 days in December.

APPENDIX (VII) Operations of the Existing Chartered Vessel

(1) Loads Carried by the Chartered Vessel:

The amount of skipjack and tuna carried to Pago Pago (American Samoa) by the chartered vessel (Azuma-maru No.35) over the period May, 1983 to March, 1984 was as follows:

(in metric tons)

Date of Departure from Tarawa	Amount Carried	Remarks
1983: May 26	196.56	
June 29	152.78	
July 29	224.55	
(August 5)	(64.50)	Supplementary shipment by container (to the U.S. West Coast)
August 31	214.44	
(September 23)	(47.70)	Supplementary shipment by container (to the U.S. West Coast)
October 15	216.19	
November 15	245.60	
December 23	245.00	
1984: February 2	140.00	
March 12	248.84	
TOTAL	1,996.16	

(2) Record of Operations by the Chartered Vessel
(May 20, 1983 to December 29, 1983)

The following figures show the number of days spent at sea, at Tarawa (T), and at Pago Pago (P) by the present chartered vessel during the above period.

Schedule	Outbound Voyage	At Pago Pago	Inbound Voyage	At Tarawa
Lv. T May 26 Ar. P Jun. 1 Lv. P Jun. 11 Ar. T Jun. 18	6	10	7	11
Lv. T Jun. 29 Ar. P Jul. 4 Lv. P Jul. 14 Ar. T Jul. 20	5	10	6	9
Lv. T Jul. 29 Ar. P Aug. 5 Lv. P Aug. 20 Ar. T Aug. 26	7	15	6	5
Lv. T Aug. 31 Ar. P Sep. 6 Lv. P Oct. 1 Ar. T Oct. 7	6	25	6	8
Lv. T Oct. 15 Ar. P Oct. 21 Lv. P Nov. 3 Ar. T Nov. 9	6	13	6	6
Lv. T Nov. 15 Ar. P Nov. 21 Lv. P Dec. 8 Ar. T Dec. 14	6	17	6	9
Lv. T Dec. 23 Ar. P Dec. 29	6			
Total number of days: Number of trips/calls	42 days / 7 trips	90 days / 6 calls	37 days / 6 trips	48 days / 6 calls
Average number of days per trip/call	6	15	6.2	8

The following points may be made with regard to the average number of days shown above:

1) Setting the speed of the new vessel at 9 knots and the distance traveled at 1,270 nautical miles, we arrive at a total required time of 6 days, which is appropriate.

2) A number of the days at Pago Pago are spent waiting for a berth, and so the total number of days spent at this port average 15. However, there is a possibility that this time can be shortened through the efforts of a supervisor who is to be dispatched to Pago Pago.

3) The number of days spent at Tarawa averages 8, which is probably the minimum required under existing loading conditions.

Appendix (VIII) Capacity Plan for the Freezing Equipment

1. Refrigerating Unit for the Freezing hold

1) Calories entering from the surrounding walls (Q_1):

$$Q_1 = KA\ (t_1 - t_2)\ (K\ cal/h)$$

where K: coefficient of overall heat transmission (K cal/h) (0.25)

A: heat transmission area (m^2) (666.3)

t_1: outside temperature (°C) (40)

t_2: temperature inside compartment (°C) (-25)

$$Q_1 = 0.25 \times 666.3 \times [40 - (-25)]$$

$$\therefore Q_1 = 10,828\ k\ cal/hr$$

2) Calories of the air entering the compartment from the outside:

$$Q_2 = E \times V \times n \times 1/24$$

where: E = calories of the air entering from the outside (K cal/m^3) (36.1)

V = cubic capacity within compartment (m^3) (640)

n = number of air ventilation (times/day) (3)

$$Q_2 = 36.1 \times 640 \times 3 \times 1/24$$

$$\therefore Q_2 = 2,888\ k\ cal/hr$$

3) Calories needed to cool the catch:

$$Q_3 = [C_1 T\ (t_f - t_2)] \times 1/H$$

where: C_1 = specific heat below the freezing point (k cal/kg°C) (0.43)

T = amount of catch to be carried into the compartment (kg) (44,000)

t_f = temperature of catch upon entering freezer (°C) (-10°C)

t_2 = final temperature of catch (-25°C)

H = Time required to cool down (hours) (12)

$$Q_3 = [0.43 \times 44,000 \times [-10°C - (-28°C)]\ ] \times 1/12$$

$$\therefore Q_3 = 23,650\ k\ cal/hr$$

Accordingly, the total calories needed for cooling down becomes:

$$Q = Q_1 + Q_2 + Q_3 = 37,366\ k\ cal/hr\ (11.3\ RT)$$

With a 10% safety allowance, this becomes:

37,366 k cal/hr x 1.1 = 41,103 k cal/hr (12.4 RT)

Using R-22 with a 2-stage compression refrigerating unit of 1,450 rpm and a discharge volume of 281.2 m^3/h, when the condensing temperature is +40°C and the evaporating temperature -40°C, the number of kw per RT for this class of refrigerating unit becomes 2,597 kw/RT.

12.4 RT x 2,597 kw/RT = 32.2 kw

Accordingly, we have selected a unit with a standard motor capacity of 37 kw.

2. Refrigerating Unit for the Brine Freezing Equipment

10 tons of catch of 28°C are placed in the brine freezing unit and cooled to an average temperature of -10°C. At this point, the brine temperature is set at -17°C.

1) Calories needed for freezing (Q_4)

The calories needed for freezing (Q) =

0.82 x 10,000 kg x [28°C - (-1°C)]
+ 0.43 x 10,000 kg x [-1°C - (-10°C)]
+ 61.67 x 10,000 kg.
= 893,200 k cal

Based on a 24-hour freezing cycle, the number of calories become:

$Q_4 = Q/24$ = 37,217 k cal/hr

2) Calories entering from the surrounding walls (Q_5)

We use the same formula as in 1-1) above.

Here, A is 54 m^2.

$Q_5 = 0.25 \times 54 \times [40°C - (-17°C)]$

$\therefore Q_5 \fallingdotseq 770$ k cal/hr

Accordingly, the total capacity (Q) becomes:

$Q = Q_4 + Q_5$ = 37,987 k cal/hr

With a 10% safety allowance,

37,987 k cal/hr x 1.1 = 41,786 k cal/hr (12.6 RT)

One of the units for the freezing hold is to be used for the brine freezer. When this refrigerating unit is used with at a condensing temperature of 40°C and on evaporating temperature of -30°C or above, there will be a capacity of at least 21.0 RT (69,720 k cal/hr), and so no problems should develop.

3. Refrigerating Unit for the Provisions Store

After determining the estimated load for the provisions store, we may fix its electrical capacity.

Meat storage capacity:

0.21 kg/man·day x 25 men x (32 days x 1.1) = 185 kg

Capacity: 185 kg / 185 kg/m^3 ≒ 1.0 m^3

Vegetable storage capacity:

0.75 kg/man·day x 25 men x (32 days x 1.1) = 660 kg

Capacity: 660 kg / 210 kg/m^3 ≒ 30 m^3

Holding temperature: meat compartment -10°C

vegetable compartment +5°C

The number of hours of operation for the refrigerating unit has been set at 12 hours/day or less.

Load:

Heat transmission from the wall $Q_w = K \cdot A \cdot \Delta t$

① Meat compartment:

K: 0.34 k cal/m^2.h.°C

A: 7.2 m^2

Δt: 50°C

Q_{w1} = 123 k cal/hr

② Vegetable compartment:

K: 0.34 k cal/m^2.h.°C

A: 12.6 m^2

Δt: 35°C

$$Q_{w2} = 150 \text{ k cal/hr}$$

Latent heat of the goods $Q_p = \frac{W}{h_c} [\gamma_1(t_0-t_f) + \gamma_2(t_f - t_h) + q_f + q_g]$

① Meat compartment:

$W = 185$ kg

$h_c = 24$ hours

$\gamma_1 = 0.84$ k cal/kg°C

$\gamma_2 = 0.43$ k cal/kg°C

$t_0 = +5°C$

$t_f = -2.2°C$

$t_h = -10°C$

$q_f = 61$ k cal/kg

$q_g = 0$

$$Q_{p1} = \frac{185}{36} \times [0.84 \times (5+2.2) + 0.43 (-2.2+10) + 61]$$

$$\therefore Q_{p1} = 517 \text{ k cal/hr}$$

② Vegetable compartment:

$W = 660$ kg

$h_c = 24$ hours

$\gamma_1 = 0.9$ k cal/kg°C

$\gamma_2 =$ ——

$t_0 = 30°C$

$t_g = 5°C$

$t_h =$ ——

$q_f =$ ——

$q_g = 12$ k cal/kg

$$Q_{p2} = \frac{660}{36} \times [0.9 \times (30°-5°C) + 12]$$

$$\therefore Q_{p2} = 633 \text{ k cal/hr}$$

The other loads (Q_M) are set at 40% of Q_w.

$$Q_M = 0.4 \times (Q_{w1} + Q_{w2}) = 0.4 \times (123 + 150) \fallingdotseq 110 \text{ k cal/hr}$$

Total calories (Q_c)---

The capacity of cooling is set at the larger of the values obtained from the following equations:

$$Q_{c1} = C_{\ell 1} \times (Q_{w1} + Q_{w2} + Q_{p1} + Q_{p2} + Q_M)$$

$$Q_{c2} = \frac{24}{h_m} \times C_{\ell 2} (Q_{w1} + Q_{w2} + Q_M)$$

$C_{\ell 1}$ = safety margin (1.1)

$C_{\ell 2}$ = safety margin (1.3)

h_m : operating hours of the refrigertaing unit (12 hrs)

$$Q_{c1} = 1.1 \times (123+150+517+633+110) \fallingdotseq 1686 \text{ k cal/hr}$$

$$Q_{c2} = \frac{24}{12} \times 1.3 \times (123+150+110) \fallingdotseq 996 \text{ k cal/hr}$$

Accordingly, $Q_c = Q_{c1} = 1686$ k cal/hr

In order to determine simply the capacity of the refrigerating unit, we have set the condensing temperature of the refrigerant at +40°C and the evaporating temperature at -15° to -25°C.

The ratio between the number of kw and the kcal of the applicable refrigerating units under these conditions comes to almost 1,167 k cal/kw. Thus, the capacity corresponding to the above calories becomes 1,516 kw. From this, we can set the refrigerating unit at more than 1.5 kw.

Refrigerating unit more than 1.5 kw

Appendix (IX) Horsepower of Main Engine

We may derive, as follow, the relationship between EHP and speed for the main engine, based on the following hull specifications:

Hull Specifications:

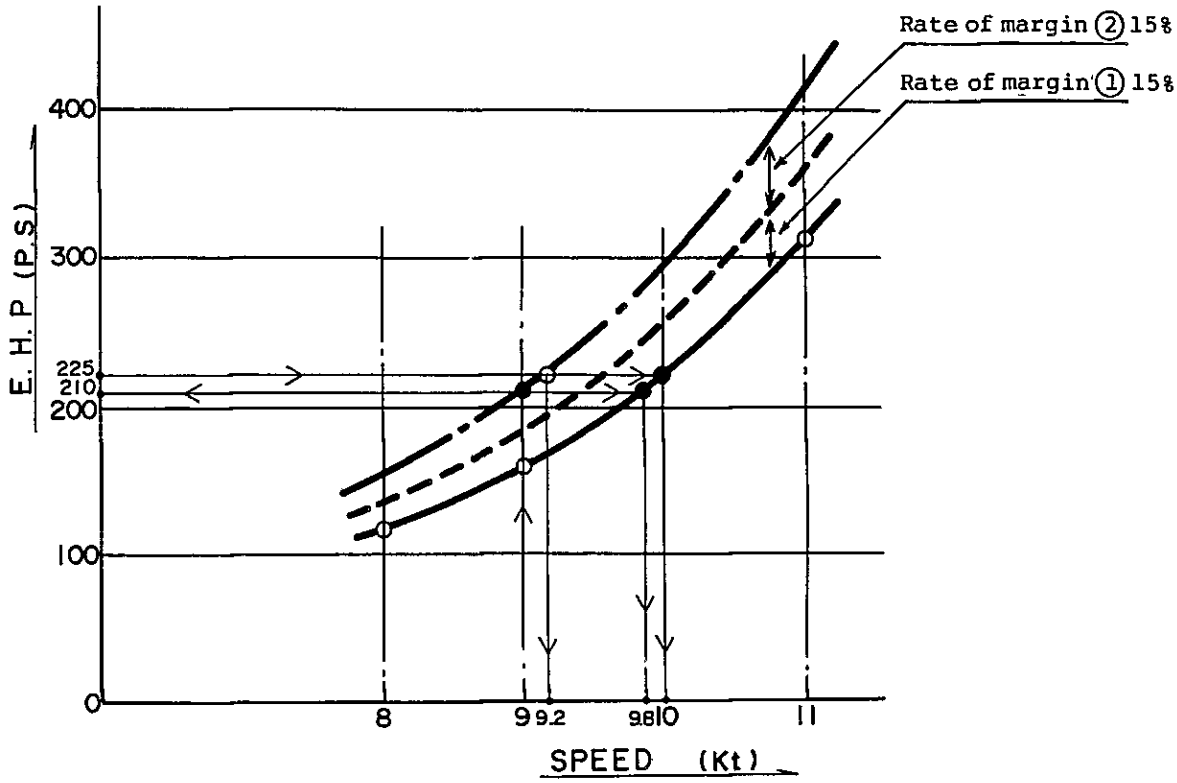
Lpp x B x d = 52.0 m x 9.0 m x 3.6 m

Cb = 0.625

Displacement

(full load)	about 1,079 tons
(light load)	" 540 tons
(Dead weight)	" 539 tons

The EHP and speed of the main engine are calculated as follows:



NOTES: We have allowed an average margin 15% to compensate for the effect of gradual deterioration of the hull, engine, and propellers, and for corrosion/dirt at the bottom of the hull.

—— Rate of margin ①

We have allowed a 15% sea margin.

—— Rate of margin ②

Appendix (X) Consumption of Fuel and Lubricating Oil by the Fishing Mothership

1) Fuel Oil Consumption (per trip)

Main engine --- 155 gr/hr ps

Generator --- 160 gr/hr ps

Distance to be traveled --- about 1270 nautical miles (one way)

Stage of voyage	Days	Hours	Main engine	Aux. engine
At sea	12	Main 276 Aux. 288	1,270N.M ÷ 9.2kt = 138Hrs 450ps x 155gr/hr.ps x 276Hrs = 19,251 kg	200ps x 65.18% x 160gr/hr.ps x 288Hrs = 6,007 kg
At Tarawa (Loading operation)	8	14Hrs x8 =112Hrs		200ps x 2 x 58.13% x 160gr/hr.ps x 112Hrs = 4,166 kg
At Tarawa (Awaiting)		10Hrs x8 =80Hrs		200ps x 93.79% x 160gr/hr.ps x 80Hrs = 2,401 kg
At Pago Pago (Loading operation)	6	14Hrs x6 =84Hrs		200ps x 80.18% x 160gr/hr.ps x 84Hrs = 2,155 kg
At Pago Pago (Awaiting berth)	6	60 + 144 =204Hrs		200ps x 57.68% x 160gr/hr.ps x 204Hrs = 3,766 kg
Total			19,251kg ÷ 0.85 = 22.648 kℓ	18,495kg ÷ 0.85 = 21.759 kℓ
			44.41 kℓ ≒ 45.0 kℓ (Note)	

NOTE: In estimating the tank capacity, we have added 5 kℓ for emergency use.

2) Consumption of Lubricating Oil (per trip)

Main engine --- 0.8 gr/hr/ps 0.8/155 x fuel consumption

Generator " --- 2.0 gr/hr/ps 2.0/160 x fuel consumption

For the main engine ..... 19,251 kg x 0.8/155 = 99.36 kg

For the generator engine ... 18,495 kg x 2.0/160 = 231.20 kg

Total 99.36 kg + 231.20 kg = 330.56 kg

Setting specific gravity at 0.85, we have: 330.56 kg ÷ 0.85 ≒ 389 liters

Appendix (XI) Actual Consumption by the Skipjack Vessels of Fuel, Gasoline, Lubricating Oil, and Water

1) Fuel Oil (4 skipjack vessels)

(in kℓ)

Vessel Name / Horse Power / Year Month	NEI MANGANIBUKA	NEI ARINTETONGO	NEI KANKATI	TE TIAROA	Total
	750 ps	600 ps	400 ps	240 ps	
1983 June	32.17	32.25	29.02	11.0	104.44
July	31.0	28.6	21.0	16.8	97.4
Aug.	32.0	26.4	15.5	10.0	83.9
Sept.	34.0	50.6	29.0	11.5	125.1
Oct.	39.0	40.05	37.0	10.1	126.15
Nov.	39.0	30.2	21.0	16.0	106.2
Dec.	—	—	—	—	—
1984 Jan.	—	—	—	—	—
Feb.	40.0	35.3	23.1	13.1	111.5
March	37.0	32.7	25.2	17.6	112.5
Total (kℓ over 8 months)	284.17kℓ	276.1kℓ	200.82kℓ	106.1kℓ	867.19kℓ

Annual consumption: (867.19 kℓ/8 months) x 12 months = 1,301 kℓ/year

Amount to be carried per trip: 1,301 kℓ/10 trips = 130.1 kℓ/trip

2) Gasoline

3 skipjack vessels of the 100 and 59 GT class:

1.5 drum/month·vessel x 3 vessels = 4.5 drums/month

1 skipjack vessel of 20 GT class:

0.5 drum/month·vessel x 1 vessel = 0.5 drums/month

Total: 5 drums/month
(900 ℓ/month)

3) Lubricating Oil

3 skipjack vessels of the 100 and 59 GT class--

1 drum/vessel x 3 vessels = 3 drums/month

1 skipjack vessel of the 20 GT class

0.5 drum/vessel x 1 vessel = 0.5 drum/month

Total: 3.5 drums/month

(630 ℓ/month)

4) Water

Skipjack vessels --- 1 ton/day x 4 vessels x 20 days/month

Total: 20 tons/month

Appendix (XII) Capacity for Supplying Fresh Water to Skipjack Vessels

We have set:

... water distilling capacity as X (2 tons/day)

... daily water consumption by the fishing mothership as A_0 (1 ton/day) and

... the amount of water to be supplied to the skipjack vessels as Y tons once every 32 days.

The volume of fresh water on the fishing mothership on the day the skipjack vessels are supplied is set as B_1 (50 m^3 x 0.9 = 45 tons) and the day on which these vessels are supplied is designated as "No.1 Day". Accordingly, on the day of 33rd, on the assumption that, based on replenishment from the water-distilling unit, the volume of fresh water on the new ship will recover the B_2 (45 ton) level of the initial period (i.e., No.1 Day), we can estimate the supply available for the skipjack vessels.

Based on the above assumptions, the following relations are established between the water distilling capacity (X), the new vessel's own requirements (A_0), the volume of water to be supplied to the skipjack vessels (Y), and the number of elapsed days "n" (Day # 33).

$$B_1 - Y + (n-1)(X-A_0) = B_2$$

With $B_1 = B_2 = 45$ tons,

$$-Y + (n-1)(X-A_0) = 0$$

With: $n = 33$ days and

$A_0 = 1$ ton/day,

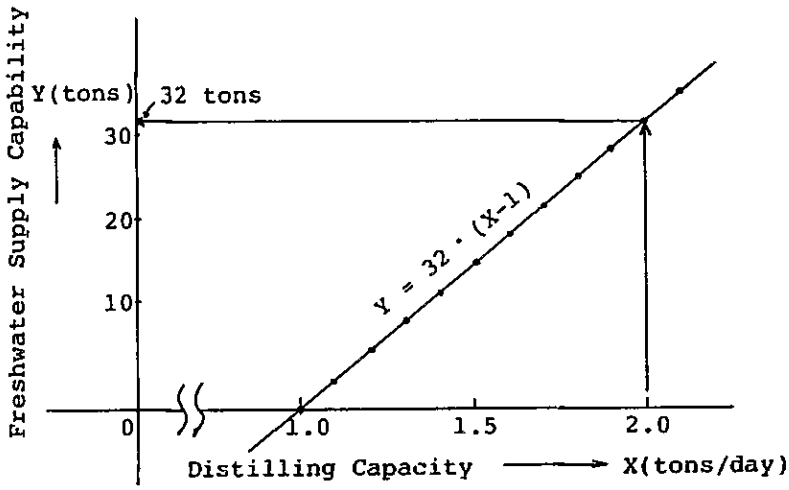
the amount of water (y) supplied becomes:

$$Y = 32 \times (X-1)$$

If we now vary the distilling capacity (X) (tons/day) in the above equation from 1.0 to 2.1 at 0.1 intervals, and then solve for Y (the amount to be supplied), we obtain the following data:

X	Y	X	Y
1.0	0	1.6	19.2
1.1	3.2	1.7	22.4
1.2	6.4	1.8	25.6
1.3	9.6	1.9	28.8
1.4	12.8	2.0	32.0
1.5	16.0	2.1	35.2

Expressing the above data now in chart form, we have:



CASH FLOW

(in A$ 000)

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sales Revenue	-	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940
Sale of Capital Asset	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	275
Cash Revenue	-	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	2,215
(A)	-	1,940	1,902	1,865	1,828	1,792	1,757	1,723	1,689	1,656	1,623	1,591	1,560	1,530	1,500	1,679
Operating Costs	-	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725
Purchase of Capital Asset	2,800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash Disbursements	2,800	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725
(B)	2,800	1,725	1,691	1,658	1,626	1,594	1,562	1,532	1,502	1,472	1,443	1,415	1,387	1,360	1,333	1,307
Net Cash Income	-2,800	215	215	215	215	215	215	215	215	215	215	215	215	215	215	490
Cumulative Totals	-2,800	-2,585	-2,370	-2,155	-1,940	-1,725	-1,510	-1,295	-1,080	-865	-650	-435	-220	-5	210	700

NOTES: 1) (A) --- present value of cash income at a 2% discount rate.

2) (B) --- present value of cash disbursements at a 2% discount rate.

3) Since depreciation does not represent an actual cash disbursement, it has been excluded from the above figures on operating costs.

ECONOMIC ANALYSIS

Year	Social Benefits			Social Costs			Net Difference	Present Value at 7% Discount Rate	Present Value at 9% Discount Rate
	Cost Reduction of Exporting Catches	Reduction in Import Costs	Total Benefits	Fixed Capital Investment	Operating Costs	Total Costs			
1	588	79	667	2,800	361	3,161	Δ2,494	Δ2,494	Δ2,494
2	588	79	667	-	361	361	306	286	281
3	588	79	667	-	361	361	306	267	258
4	588	79	667	-	361	361	306	250	236
5	588	79	667	-	361	361	306	233	217
6	588	79	667	-	361	361	306	218	199
7	588	79	667	-	361	361	306	204	182
8	588	79	667	-	361	361	306	191	167
9	588	79	667	-	361	361	306	178	154
10	588	79	667	-	361	361	306	166	141
11	588	79	667	-	361	361	306	156	129
12	588	79	667	-	361	361	306	145	119
13	588	79	667	-	361	361	306	136	109
14	588	79	667	-	361	361	306	127	100
15	588	79	667	-	361	361	306	119	92
Total	8,820	1,185	10,005	2,800	5,415	8,215	1,790	182	Δ110