# BASIC DESIGN STUDY REPORT

# ON THE PROJECT FOR

# CONSTRUCTION OF THE INTER-ISLAND VESSEL

# FOR OUTER ISLAND FISHERIES DEVELOPMENT

# IN TUVALU

**January, 2001**

**Japan International Cooperation Agency**

**Fisheries Engineering Co., Ltd.**

## PREFACE

In response to a request from the Government of Tuvalu, the Government of Japan decided to conduct a basic design study on the Project for Construction of the Inter-Island Vessel for Outer Island Fisheries Development in Tuvalu and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tuvalu a study team from August 1 to August 28, 2000.

The team held discussions with the officials concerned of the Government of Tuvalu, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tuvalu in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

January, 2001

Kunihiko Saito
President
Japan International Cooperation Agency

January, 2001

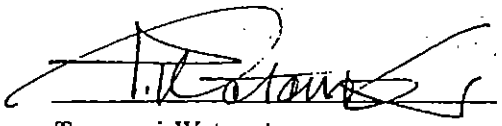
## Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Construction of the Inter-Island Vessel for Outer Island Fisheries Development in Tuvalu.

This study was conducted by Fisheries Engineering Co., Ltd., under a contract to JICA, during the period from July 28, 2000 to January 19, 2001. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tuvalu and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

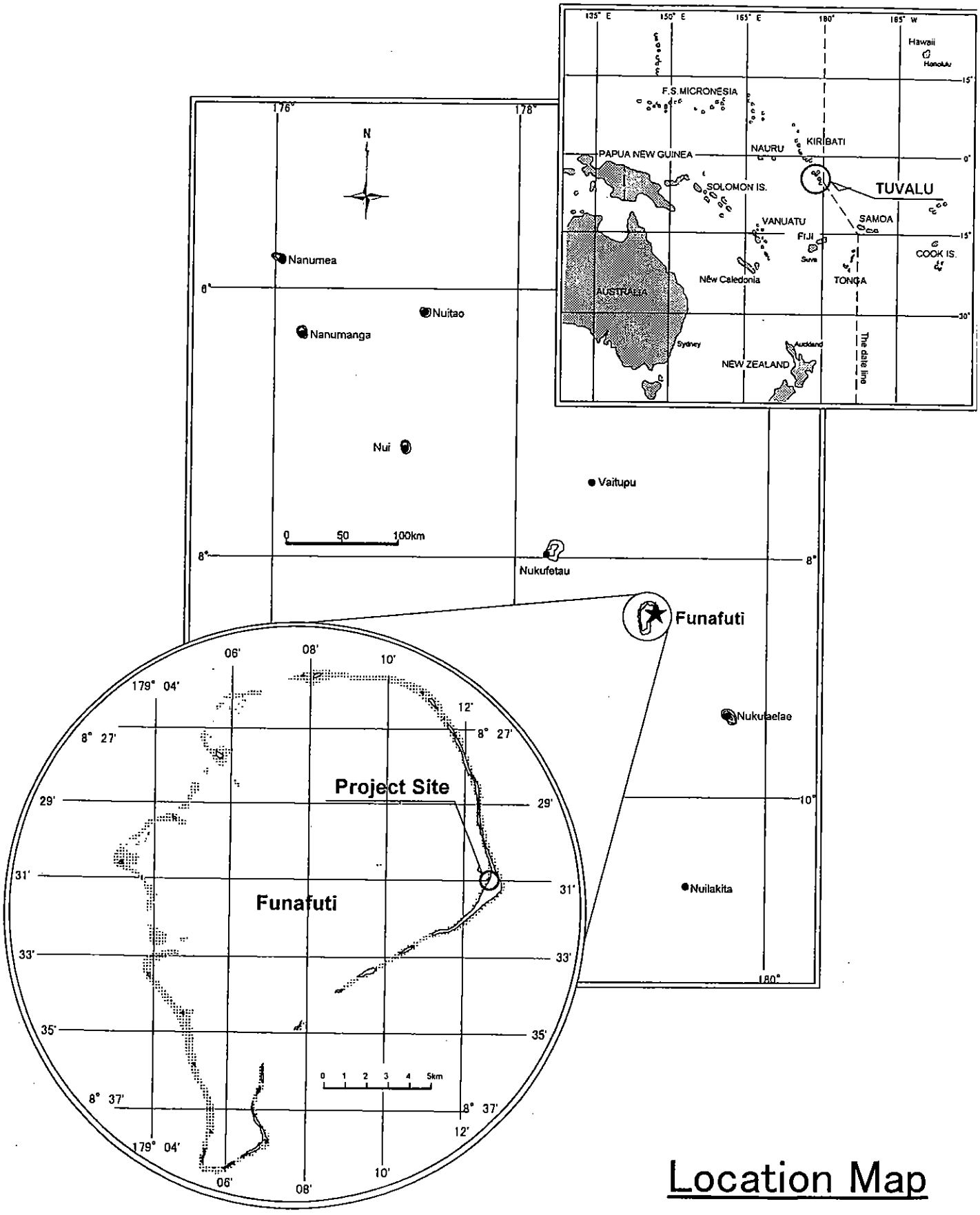


Toyonori Watanabe

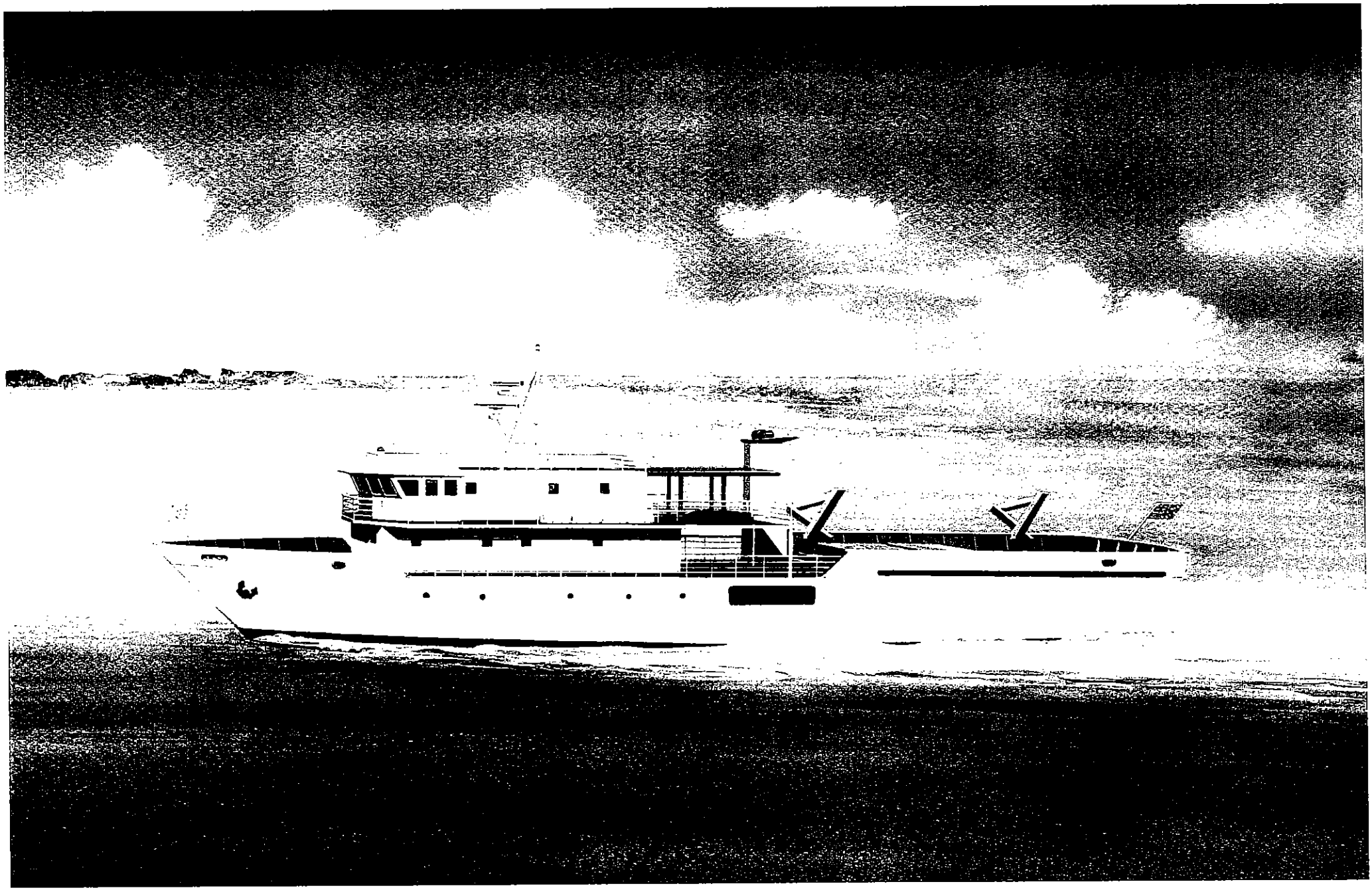
Project Manager,

Basic Design Study Team on the Project for Construction of the Inter-Island Vessel for Outer Island Fisheries Development in Tuvalu

Fisheries Engineering Co., Ltd.




# Location Map



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## Abbreviation

| | |
|---|---|
| CFC | Community Fisheries Centre |
| GMDSS | Global Maritime Distress and Safety System |
| HF | High Frequency |
| IMO | International Maritime Organization |
| ISO | International Organization for Standardization |
| JICA | Japan International Cooperation Agency |
| MNRE | Ministry of Natural Resources & Environment |
| MWEC | Ministry of Works, Energy & Communication |
| NAFICOT | National Fishing Company of Tuvalu, Ltd. |
| NCC | National Coordination Centre |
| PC | Pacific Community |
| PMP | Preventive Maintenance Policy |
| SOLAS | Safety of Life at Sea |
| SPF | South Pacific Forum |
| STCW | Standard of Training, Certification, and Watchkeeping for Seafarers |
| TCS | Tuvalu Cooperative Society Ltd. |
| VHF | Very High Frequency |

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Appendix

# Chapter 1 Background of the Project

Tuvalu is an island country, with a total population of 9,043 (1999), located in the South Pacific just west of the International Date Line. The nation has a total land area of 26 $km^2$, comprised of nine atoll-type islands: Funafuti (the capital island), Nanumea, Nuitao, Nanumanga, Niu, Vaitupu, Nukufetau, Nukulaelae, and Nuilakita. With a dearth of land-based usable resources and the location far removed from the major markets, Tuvalu is handicapped by a host of unfavorable conditions standing in the way of national economic development. The country is, however, endowed with a vast 200-mile exclusive economic zone covering some 770,000 $km^2$.

The Tuvalu government has been making major efforts in its developmental plan to resolve these various problems, such as an undue concentration of population and jobs in the capital, by seeking to promote economic development on the outer islands (containing 60% of the total population) and thereby rectify the economic disparities vis-à-vis the capital island of Funafuti.

Since the fishing industry forms the nucleus of the national economy in an atoll island country, the Tuvalu government has been funding the organization of Community Fishing Centres (CFC) on the outer islands. While a regular supply of basic materials to the other islands, along with the transport of local products, is an indispensable factor in stimulating economic activity on these outer islands, starting with the CFCs, the present inter-island passenger/cargo vessel (Nivaga II)) has been saddled with the entire burden of domestic passenger and cargo traffic since entering service. This vessel has found it very difficult to provide regularly scheduled service to all islands, owing to frequent diversion to meet emergency transport demands, a requirement for servicing international routes, along with a steady deterioration in operating ratios. There have even been occasions when it has been necessary to resort to foreign charters to transport foods and other necessities vital to maintaining living standards of the local population.

Against this background, the Tuvalu government wishes to build a new transport vessel as a means of improving maritime transport -- the only means of inter-island transportation -- and thereby promote economic activity centered on the development of the fishing industry in outer-island communities. The government has, accordingly, requested a grant-aid for this purpose from the Government of Japan. The items contained in this request are shown below:

One multi-purpose inter-island vessel, and surfboat and insulated fish box

| | |
|---|---|
| Type of vessel | Multi-purpose inter-island vessel |
| Service | International passenger/cargo vessel |
| Length overall | 46.5 m |
| Breadth molded | 9.40 m |
| Depth molded | 3.70 m |

| | |
|---|---|
| Design draft | -- |
| Gross tonnage | 580 ton approx. |
| Max. speed | 12.5 knot |
| Service speed | 11.0 knot |
| Main engine | 735 kW (1,000 ps) x 1 |
| Complement | Total 108 persons (12p. cabin, 68p. sitting rm, Total pax. 80p., Crew 18p, Trainee 10p) |
| Chilled / refrigerated hold | One 20$m^3$ hold at +2℃<br>One 20$m^3$ hold at -20℃ |
| Dry cargo hold | 190 $m^3$ |

# Chapter 2 Contents of the Project

## 2-1 Objectives of the Project

The 9 atolls of Tuvalu comprise 6 islands north and 2 islands south of the capital island of Funafuti, forming an oval pattern over a distance of 150 km from east to west and 700 km on a north-south axis.

The distance between Funafuti and the northernmost island (Nanumea) is approximately 450 km, which is covered in about 25 hours by the existing inter-island vessel, Nivaga II, but with just over once a month trip. Under these conditions, the population has tended to concentrate on the capital island of Funafuti, which accounts for over 40% of total population. For this reason, the Tuvalu government has been striving to raise living standards by promoting regional development on the outer islands and thereby narrow the economic disparities between Funafuti and the other islands. As fishing is the prime economic activity on all of these islands, the government has been promoting the establishment of Community Fishery Centres (CFC) on each island as the nucleus of local fishing activity, and this program is completing on all islands except Nui and Nuilakita. Together with the completion of electrification projects on the various islands, which have been carried out in tandem with the CFC program (due to be completed in 2000), full-scale activity at the CFCs will soon begin in earnest. By way of supporting the operations of the CFCs, which constitute core facilities for fishing communities on each island, it is essential that the transport of goods and fish catches be put on a sound footing, based on a stable inter-island transport vessel providing reliable scheduled service.

The Nivaga II is a steel vessel, owned by the Tuvalu Government, which was built in the UK in 1987 and is the only passenger/cargo vessel operating on the country's domestic and international routes. This vessel is hard-pressed to cope with a wide range of unpredictable demands, including passenger and cargo traffic to support the people's livelihood, responding to emergency transport calls, carrying students to and from the nation's only high school on Vaitupu island, providing transport for Tuvaluans living in Fiji and Nauru, and sailings to Suva or Auckland for dry docking. However, with the vessel now 13 years old, there has been a steady escalation in repair frequency, but the time that can be devoted to regular maintenance is hardly sufficient. This, in turn, invites a vicious cycle of breakdowns and still lower transport capacity, and this shortfall can only be met by using the nation's precious foreign exchange reserves to charter foreign vessels in order to maintain the requisite means of transport, which is a prime lifeline for the Tuvalu people.

For Tuvalu, as an island country lacking domestic air service, securing an inter-island transport vessel is an indispensable element for maintaining a stable standard of living. In order to provide reliable inter-island transport service, the Tuvalu government has already positioned this sector as an

activity of high public significance and has been subsidizing transport operations as a means of responding to the desires of its citizens. The subject Plan, accordingly, is to improve the domestic transport system, whose instability has been a serious obstacle to fishery and general economic development in the various islands, by providing a new passenger/cargo vessel to meet the demand for service to outer-island communities.

## 2-2 Basic Concepts of the Project

The scale of the Plan vessel will provide a hull size commensurate with domestic service requirements, with the main engine horsepower below 1,000 ps, comprising two engines and two propellers so as to improve operational economy and maneuverability.

The design will improve on the exposed deck system used by the existing vessel for passenger transport by providing enclosed passenger quarters to enhance safety and comfort. In addition, in order to cope with temporary surges in demand for passenger transport, as when carrying students to and from the high school on Vaitupu, special consideration will be given to safety equipment so as to be able to secure temporary transport permits for supplemental passenger loads. With respect to cargo movements, in addition to staples and a variety of general cargoes for island residents, the new vessel must also respond to the demand for moving frozen and chilled foods on outward voyages and carrying fresh and frozen fish on the return trip to Funafuti.

For these purposes, the vessel must be designed to provide a high degree of mobility, as by establishing separate holds for both dry and chilled cargoes. As to cargo handling, since, apart from Funafuti, none of the outer islands have berthing docks for cargo vessels, the Plan vessel will have to be anchored at outer sea outside the atoll, with a surfboat required to land and board passengers and cargoes. Since a key factor contributing to the improvement of domestic transport services will be how to handle cargoes safely and efficiently via surfboats in swelling open sea waters, the surfboats to be attached to the vessel will be given flat bottoms and will be both safe and functionally convenient for landing cargoes on shore.

Based on Plan implementation, a new inter-island transport vessel will be put into service. By concentrating its operations on domestic routes, it will be possible to provide scheduled service to the outer islands, based on regular annual schedules, which has not been feasible with the existing vessel, thereby leading to an overall improvement in the domestic transport infrastructure.

## 2-3 Basic Design

### 2-3-1 Design Guidelines

(1) Safety Considerations

In connection with vessel safety requirements (relating to structure, stability, fire fighting, life-saving, radio communications, machinery installations, passenger facilities, etc.), vessels engaging on international voyages must abide by SOLAS (Safety of Life at Sea), as compiled by the IMO (International Maritime Organization) as well as other international maritime conventions. However, in the case of a ship such as the Plan vessel, which is to be used only in domestic waters, the domestic law of the flag state -- in this case, Tuvalu is applicable. However, since certain safety standards are not yet fully established in Tuvalu's maritime law, to supplement Tuvalu legislation, we have also applied the ship safety regulations of Japan, along with relevant laws, to avoid any possible deficiencies in safety arrangements.

(2) Fish Hold/Refrigerated Cargo Hold

So that the fish hold/refrigerated cargo hold can be used as a hold for fish as well as foodstuffs, appropriate hold temperatures will be maintained for each type of load. In addition, consideration will be given to a design that will permit clean separation of fresh and frozen fish, meats, dairy and other products. The design will also include a layout plan for efficient loading and unloading along with a freezing plant.

(3) Dry Cargo Hold; Loading/Unloading Facilities

The dry cargo hold and deck cargo space will be arranged and outfitted to facilitate cargo loading and classification for different cargoes and destinations. The cargo hold hatch will be given dimensions appropriate for stowing large cargo (e.g., small trucks), while the hatch cover will be durable yet easy to handle.

Cargo cranes will be of good stability for lifted cargo and deployed to cover the entire cargo loading (stowing) area.

(4) Passenger Safety Considerations

As the Plan vessel will make long-distance, including overnight, trips, there should be important safety considerations when passengers are carried on deck during rough weather and/or at night. In the interest of safety, therefore, the Plan vessel will carry no deck passengers, with all passengers to be quartered indoors.

Improvements will be to make in the decrease of rolling motion of the vessel for care of seasick passengers in heavy seas as well as in moving passengers safely into surfboat at the outer islands.

(5) Redundancy in Machinery and System

When a piece of machinery fails, considerable time is needed to repair it, with a resulting impact on vessel operations as well. It is, therefore, found important to build a redundancy factor into all major items of equipment, including main engines, generators, freezing equipment for the fish hold/refrigerated cargo hold, steering gear, cargo crane and air-conditioning equipment. This will be accomplished via the use of duplicate or alternate equipment to ensure continuing operations under such conditions.

(6) Maintenance and Long-life Policies

Vessels are normally equipped with an onboard workshop to cope with a minimum number of minor repairs, and such a facility was also incorporated into the existing vessel, Nivaga II. As Tuvalu is quite remote from the international markets, both parts procurement and after-service can be quite time-consuming. In the interest of efficient operations for the Plan vessel, a Preventive Maintenance Policy (PMP) will be instituted, since it is vital that planned maintenance be provided regardless of the state of the equipment (i.e., whether it is in operating order or out of service). At the same time, a well-furnished workshop will be provided inside the vessel to permit regular maintenance. This workshop will be equipped to maintain the parts of the main engine and other small components. The workshop will, therefore, be equipped with a small lathe, drill machine, welding equipment and other machine tools, along with a work table and parts storage area.

Even with a fully functional workshop, care must be taken to make the hull and equipment on the Plan vessel of durable material to minimize breakdowns, ensure ease of maintenance, and provide resistance to corrosion and abrasion. For example, use of heavier bottom shell plating to withstand corrosion while also applying anti-corrosive coating to the interiors of sea water pipes will be considered.

## 2-3-2 Basic Plan

### 2-3-2-1 Design Procedure

The design of the Plan vessel has been based on the background and contents of the Request, results of the scale determination, and design policies. It has been carried out in accordance with the following procedures:

(1) determining the hull dimensions and block coefficient for proper service displacement (deadweight plus light weight),

(2) calculating water resistance and propeller efficiency to validate the vessel's ability to generate the required cruising speed,

(3) calculating vessel stability under various loading conditions to validate stability in conformity with rule requirement,

(4) making effective use of space in the layout design for living quarters and giving balanced consideration to providing ample and efficient work space and ease of movement, and giving careful consideration to the placement of stairways and corridors to ensure orderly evacuation in the event of an emergency,

(5) giving careful consideration to placement of the fish hold/refrigerated cargo hold, dry cargo hold, and cargo hold hatch as well as to deployment of cargo cranes so as to achieve efficient loading operations,

(6) giving consideration to the placement and design of the engine room, efficient work space, and piping work, providing, in particular, the requisite space and dimensions around equipment to assure suitable access for inspections and maintenance,

(7) paying particular attention in the structural design to structural continuity so as to prevent vibration and stress concentration.

### 2-3-2-2 Review of Scale of the Plan Vessel

#### (1) Passenger Capacity

The passenger capacity of the existing vessel (Nivaga II) is 168 persons, with 6 in first-class cabins, 18 in second-class cabins, and 144 deck passengers. The Nivaga II was originally built as a passenger/cargo vessel but problems exist with passenger discomfort, such as the unsafe condition of passengers spending several days on the exposed deck and the lack of air conditions in the cabins.

Table 1 presents data on domestic cargo movements and passenger traffic on the Nivaga II during 1999. The Marine Department introduced computers during 1998 at Funafuti Port to record passenger and freight data so that, from 1999 onward, the data have been found to be accurate, with a high degree of reliability, forming a sound basis for measuring passenger demand.

Table 1 Nivaga II Domestic Cargo and Passengers in 1999

| Voyage No.*** | Dept. from Funafuti Date (mon./day) | Arrive in Funafuti Date (mon./day) | Destination* | Cargo (m³) Outgoing | Incoming | Total | Passenger (Person) Outgoing | Incoming | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1/10 | 1/31 | Central/Southern/ Suva | 183.087 | 21.137 | 204.224 | 170 | 126 | 296 |
| 2 | 2/14 | 2/20 | Central/Northern | 188.125 | 30.235 | 218.360 | 169 | 90 | 259 |
| 3 | 2/28 | 3/3 | Southern Is. | 13.859 | 17.121 | 30.980 | 126 | 78 | 204 |
| 4 | 3/5 | 3/8 | Central/Northern | 153.750 | 29.562 | 183.312 | 156 | 110 | 266 |
| 5 | 3/10 | 3/13 | Central Is. | 145.083 | 20.000 | 165.083 | 200 | 150 | 350 |
| 6 | 3/17 | 3/21 | Northern Is. | 188.005 | 22.536 | 210.541 | 140 | 100 | 240 |
| 7 | 3/22 | 3/25 | Central/Northern | 159.914 | 25.009 | 184.923 | 35 | 20 | 55 |
| 8 | 3/27 | 3/29 | Central Is. | 107.261 | 19.552 | 126.813 | 160 | 119 | 279 |
| 9 | 3/30 | 4/3 | Southern Is. | 18.637 | 15.200 | 33.837 | 105 | 60 | 165 |
| 10 | 4/5 | 4/8 | Northern Is. | 164.461 | 31.284 | 195.745 | 50 | 15 | 65 |
| 11 | 4/9 | 4/22 | Central Is. | 177.942 | 22.535 | 200.477 | 120 | 200 | 320 |
| 12 | 4/26 | 4/29 | Southern Is. | 41.669 | 15.251 | 56.920 | 156 | 95 | 251 |
| 13 | 5/3 | 5/7 | Central/Northern | 129.386 | 26.020 | 155.406 | 97 | 68 | 165 |
| 14 | 5/8 | 5/10 | Vaitupu | 74.117 | 16.119 | 90.236 | 53 | 30 | 83 |
| 15 | 5/10 | 5/18 | Central/Northern | 290.129 | 31.226 | 321.355 | 182 | 88 | 270 |
| 16 | 5/19 | 5/20 | Central Is. | 149.439 | 20.191 | 169.630 | 129 | 140 | 269 |
| 17 | 5/22 | 6/9 | Suva/Central / Southern | 229.130 | 28.560 | 257.690 | 174 | 107 | 281 |
| 18 | 6/10 | 6/14 | Central Is. | 174.132 | 19.621 | 193.753 | 150 | 66 | 216 |
| 19 | 6/15 | 6/18 | Southern Is. | 29.000 | 14.250 | 43.250 | 63 | 43 | 106 |
| 20 | 7/14 | 7/22 | Central/Northern | 270.000 | 41.118 | 311.118 | 117 | 127 | 244 |
| 21 | 8/17 | 9/10 | Southern/Suva | 27.200 | 17.005 | 44.205 | 169 | 166 | 335 |
| 22 | 9/11 | 9/12 | Vaitupu | 48.000 | 17.121 | 65.121 | 145 | 70 | 215 |
| 23 | 9/14 | 9/19 | Central/Northern | 104.200 | 27.110 | 131.310 | 70 | 47 | 117 |
| 24 | 9/20 | 9/25 | Central /Southern | 116.400 | 23.506 | 139.906 | 200 | 80 | 280 |
| 25 | 10/5 | 10/20 | Central/Northern | 310.000 | 45.060 | 355.060 | 150 | 45 | 195 |
| 26 | 10/27 | 10/30 | Central Is. | 102.600 | 25.002 | 127.602 | 194 | 122 | 316 |
| 27 | 11/1 | 11/6 | Northern Is. | 118.200 | 21.610 | 139.810 | 74 | 87 | 161 |
| 28 | 11/8 | 11/12 | Central/Northern | 158.200 | 35.652 | 193.852 | 174 | 234 | 408 |
| 29 | 11/13 | 12/5 | Southern/Suva | 34.000 | 15.000 | 49.000 | 127 | 89 | 216 |
| 30 | 12/10 | 12/12 | Central Is | 159.000 | 30.402 | 189.402 | 169 | 189 | 358 |
| 31 | 12/17 | 12/20 | Northern Is. | 143.400 | 27.600 | 171.000 | 194 | 90 | 284 |
| | | | | 4,208.326 | 751.595 | 4,959.921 | 4218 | 3051 | 7269** |

(Source : Marine Department data, partially estimated)

* Average cruising range and days by route are as follows. In many cases, Nivaga II navigates on combined routes as Central/Northern Is., etc.

| Route | Port of call | Day required | Distance |
|---|---|---|---|
| Northern Islands | Nanumea, Nanumanga, Niutao | 4 days | 525 n.m. |
| Central Islands | Nui, Vaitupu, Nukufetau | 3 days | 321 n.m. |
| Southern Islands | Nukulaelae, Niulakita | 3 day | 292 n.m. |

** The above data include a total of 1,331 passengers on the Suva route (688 on the outbound, 643 on the return voyage), leaving a total of 2,408 for domestic routes (3,530 outbound and 2,408 return).

*** Logbooks were not available for sailings from Funafuti port for trips 1, 2, 20, 29, 30, 31. This data, therefore, had to be based on estimation.

The total number of outbound passengers from Funafuti in 1999 was 3,530 persons, substantially greater than the number carried on the return voyage (2,408). However, since

data on tickets issued at intermediate islands for inbound trips are inaccurate, only outbound data were used for subsequent analysis. Moreover, passenger traffic by island are not clear from the passenger data. In Table 1, the maximum passenger load on outbound voyages for the Nivaga II was shown to be 200 and the minimum 35, indicating major fluctuations from trip to trip. While the rated passenger capacity for this vessel is 168, this limit was exceeded on certain trips, based on special permits.

The maximum passenger traffic reflects the movement of students to the high school in Vaitupu at the beginning and conclusion of each three semesters. This school is the only institution of secondary learning in Tuvalu, and the total enrollment runs about 530, with some 80% of the student body (420 students) commuting to Vaitupu from other islands each semester. Accordingly, out of the annual passenger load of 3,530 persons, students attending the Vaitupu high school account for 1,260, leaving a total of 2,270 general passengers.

While the general passenger figure includes official/business trips by government officials and persons affiliated with private and non-profit organizations, it may be presumed that passenger demand by island correlates directly with island populations. Taking the ratio of island population outside Funafuti and assuming that traffic demand from Funafuti is generated in accordance with this ratio, average passenger traffic demand by island for 1999 has been calculated from estimated general traffic demand by island along with the number of port arrival, as shown in Table 2.

Table 2 Average Passenger Demand by Island Based on Population Ratios

| Navigation Route | Northern islands | | | Central islands | | | | Southern islands | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Name of island | Nanumea | Nanumanga | Niutao | Nui | Vaitupu | Nukefetau | Funafuti | Nukulaelae | Nuilakita | |
| Population | 824 | 644 | 749 | 606 | 1,202 | 751 | 3,839 | 353 | 75 | 9,043 |
| Ratio of population (Without population of Funafuti) | 15.8% | 12.4% | 14.4% | 11.7% | 23.1% | 14.4% | -- | 6.8% | 1.4% | 100% |
| Distribution of 2,270 passengers | 359 | 281 | 327 | 266 | 524 | 327 | -- | 154 | 32 | 2,270 |
| Number of port arrival (times in 1999) | 14 | 15 | 14 | 15 | 23 | 12 | -- | 11 | 10 | -- |
| Average no. of passengers / call | 26 | 19 | 23 | 18 | 23 | 27 | -- | 14 | 3 | -- |

The Nivaga II normally operates on 3 rotes: the Northern Route (to 3 islands: Nanumea, Niutao, and Nanumanga); the Middle Route (to 3 islands: Nui, Vaitupu, and Nukufetau), and the Southern Route (to 2 islands: Nukulaelae and Nuilakita). Average passenger demand, as estimated from the population ratios by island, is as follows.

| | |
|---|---|
| Northern islands | 26 + 19 + 23 = 68 persons |
| Central islands | 18 + 23 + 27 = 68 persons |
| Southern islands | 14 + 3 = 17 persons |

As is clear from Table 1, in view of the wide variation in traffic, the passenger capacity for the Plan vessel has been set higher than the 68-person average demand figure shown above so as to allow a certain leeway to cope with these fluctuations.

Meanwhile with regard to the 17 trips geared to general passengers (excluding trips to Suva (4), trips to carry junior high school students to and from Vaitupu (9), and another carrying cargo and a small group of government officials), after breaking out the number of passengers carried on the Central and Southern Routes, the average passenger loads per trip are as follows:

For the 3 northern islands:

total passengers/number of trips = 674/9 = 75 persons

For the 3 central islands:

total passengers/ number of trips = 1229/11 = 112 persons

For the 2 southern islands:

total passengers/ number of trips = 323/4 = 81 persons

For purposes of setting passenger capacity for the Plan vessel, the average passenger load for the Central Route have to be taken into account, where demand is highest (112 persons). However, this is the average value for domestic trips by the Nivaga II, which have necessarily been limited in number, owing to the international trips it makes to Suva. This vessel makes 20 trips a year on the Central Route (including trips carrying Vaitupu students), as opposed to the 28 trips (also including these students) programmed for the Plan vessel (cf. Section 3.2.1: "Cruising Plan"). Adjusting for this difference, the average demand per trip, as shown for the Nivaga II (112 passengers) has been lowered to 80 persons for the Plan vessel:

112 persons × 20/28 = 80 persons

On the premise that general passenger demand runs in direct proportion to island population, average demand works out to 68 persons. If, however, we base our estimates on the actual traffic on the present 3 routes, including fluctuations by route, the average comes to 80 persons. The fluctuation factor by course, using the latter figure, becomes smaller, with the capacity figure for the Plan vessel falling between the above 2 cases, and so it was concluded that the capacity should be set closer to the latter (higher) forecast. With regard to

fluctuations, since this capacity figure exceeds anticipated demand, the wide variations experienced by the Nivaga II would not carry over to the Plan vessel. Furthermore, with respect to the middle bound, as mentioned below, given the short distances involved, this capacity should amply cover fluctuations due to special capacity permits, and so there is no need to give undue consideration to such fluctuations. Accordingly, it is concluded that a rated capacity of 80 passengers for the Plan vessel would be appropriate.

Over and above this capacity level of 80 passengers, consideration must also be given to meeting the demand for transporting students to Vaitupu. Fortunately, the cruising distance between Vaitupu and Funafuti is relatively short (7 hours). A special permit can be obtained to accommodate this extra load during the daytime crossing, with additional capacity available, and besides by mobilizing the Nivaga II if necessary.

The student complement on this daytime voyage will naturally have to be accommodated in the sections of open deck with awning over, which have been arranged for use by passengers during daytime trips. An area of about $80m^2$ can be set aside for this purpose, so that, allowing $1m^2$ / person, an additional 80 passengers can be boarded, which would suitably cope with the concentrated group of students commuting to and from the high school on Vaitupu. Although this extra load would not influence hull dimensions or layout, life-saving equipment would be required for the additional 80 passengers (life-rafts and life-jackets) to insure their safety.

(2) Passenger Quarters

The passenger capacity of the Nivaga II is 168 persons, of which cabin capacity is 24 (in 12 cabins) and deck capacity 144. The major problems in connection with passenger transport on the Nivaga II are the inferior levels of safety, especially during night voyages, and general discomfort, owing to the fact that the great bulk of the passengers are accommodated on the exposed deck. As a result, the policy on the new Plan vessel will be to house all passengers inside the vessel.

In the original request by the Government of Tuvalu, the composition of the cabin area was set at 12 persons in regular cabins and 68 passengers in a large sitting room. However, during the field survey, the request was amended to 12 persons in cabins (with private toilet), 48 in cabins (common toilet), and 20 in the large sitting area. This amended request doubtless reflects the fact that, on the present Nivaga II, cabin demand is extremely high, with passengers scrambling to secure one.

Based on interviews with passengers on the Nivaga II, it was confirmed that the desire for a

cabin is particularly strong (for reasons of privacy) on long-distance routes. While recognizing the need to provide some additional cabin facilities, the reduced sitting capacity in the amended request (from 68 to 20 persons) would accommodate only 25% of the total passenger capacity of 80 persons. It was frankly difficult to consider this an acceptable ratio on a cargo/passenger vessel serving the general public. At this point, certain examples in Japan were reviewed to find a benchmark for fixing the proportion of common large room capacity and the appropriate cabin composition.

First, with regard to the ratio of common large room capacity to total, determination was made from the standpoint of conditions on long-distance passenger ferries in Japan that would be comparable to the Tuvalu routes in terms of night cruising and cruising times (i.e., excluding short-distance routes with no scheduled night cruising or sleeping facilities). That is to say, study was made on the ratios of large common rooms to total passenger capacity on virtually all 46 of the targeted long-distance ferries sailing in and around Japan. The results of these analysis revealed that the ratio of large-room accommodations to total passenger capacity averaged 40% (less than half). However, the standard deviation was 19%, representing a considerable dispersion around the average. In the Plan vessel, considering also the wide dispersion pattern in the large-room ratio even in Japan, and taking account of the arrangement plan (discussed below) for cabins and berths (beds), it was concluded that the proper ratio of large-room space to total passenger capacity should be set at 55% (or slightly more than half).

Turning next to the cabin composition, which will accommodate less than 50% of passenger load on the Plan vessel, the number of cabins (with private toilets) was reduced from 12 cabins (for 24 occupants) in the Nivaga II to the lowest feasible level, leaving the bulk of the cabin space for middle-class units with beds (compartments with a corridor of about 70 cm alongside the beds, with shared toilet). In this way, policy to enable many more general passengers to utilize cabin space was realized. Considering the cabin arrangement, 5 private cabins to accommodate 14 occupants and 9 bed compartments to accommodate 22 occupants were found available. Based on the above considerations, it was concluded that the following cabin arrangements would be suitable for the Plan vessel:

| | | |
|---|---|---|
| First Class<br>（W / Private toilet） | 14 p（17.5%） | 2 p/rm.×3 rms.(also serves as a sickbay) +<br>4p/rm.×2 rms. |
| Second Class<br>（Using Public toilet） | 22 p（27.5%） | 2p/rm.×7 rms. + 4 p/rm. x 2 rms. |
| Third Class<br>（Using Public Toilet） | 44 p（55%） | |

With regard to the sickbay, after hearing the views of staff members at the Princess Margaret

Hospital, it was decided to assign 3 private cabins (double occupancy, accommodating 6 persons in all) for priority use by ill passengers. In these special cabins, instead of re-circulated ventilation, air will be ventilated directly to the outside, and door will be broad to permit the entry and removal of stretchers. Princess Margaret is the only general hospital in Tuvalu; only clinics are found on the outer islands. For this reason, the present vessel carries a few sick people to Funafuti on every trip. In August 2000, 7 patients were being brought in from Vaitupu on the return voyage of a chartered vessel.

### (3) Crew Capacity

The crew of the Plan vessel is planned at 18 persons, with the composition shown in Table 3. This size crew will satisfy mandatory manning scale under South Pacific Maritime Code and is deemed appropriate also from the standpoint of vessel size and passenger capacity.

Compared with the crew size on Nivaga II (the existing vessel), which exceeds 1,000 tons and is capable of serving international voyage, the deck part carries 3 licensed officers including the Captain, but on the Plan vessel two officers should suffice, since it will sail only in domestic waters. The Plan vessel will carry 5 sailors, as compared with 7 on the Nivaga II, but this is considered an appropriate number in view of the smaller hull and differences in servicing area.

In the engine part, since the main engine of the Nivaga II exceeds 750 kW, 3 certified duty engineers are required, with a total complement of 6 persons, including ratings. In the case of the Plan vessel, however, since it will sail only in domestic waters and will be equipped with main engines of less than 750 kW in total, 2 certified duty engineers will be appropriate, along with 5 engine ratings.

As to the catering section, as opposed to the 7-man staff on the Nivaga II, which must also handle foreign trade matters on its international routes, the Plan vessel will be given staff of 5 persons, which is appropriate considering the much lower passenger loads (only about half of the Nivaga II) and the absence of foreign duties.

It was originally intended to board 10 trainees from the Tuvalu Maritime School as part of their curriculum. However, this plan was dropped because the strictly domestic route pattern of the Plan vessel would not qualify as at-sea qualifications. This part of the curriculum will, therefore, continue to be handled by the ocean-going Nivaga II.

Although not part of the original plan, 4 cadets will be boarded on the Plan vessel and given practical training as staff candidates. Whereas trainees from the Tuvalu Maritime School are boarded under the budgetary jurisdiction of the Ministry of Public Works, Energy, and Communications, apprentice officers have already earned their vessel licenses and credentials

as ratings, and will board the Plan vessel under the budgetary jurisdiction of the Ministry of Education for purposes of practical training in preparation for their officers licenses. Four such cadets serve onboard the Nivaga II, where they are accorded private quarters. On the Plan vessel as well, comparable quarters will have to be provided in the crew section, with the apprentice officers to be formally included in the regular crew complement.

Table 3 Crew Composition on the Plan Vessel as Compared with the Nivaga II

| | Plan vessel | Nivaga II |
|---|---|---|
| Captain | 1 | 1 |
| Chief officer | 1 | 1 |
| Second officer | 1 | 1 |
| Third officer | 0 | 1 |
| Boatswain | 1 | 1 |
| Quarter master | 1 | 1 |
| Sailor | 3 | 5 |
| Deck Part Total | 8 | 11 |
| Chief Engineer | 1 | 1 |
| Second Engineer | 1 | 1 |
| No.1 Oiler | 1 | 1 |
| Oiler | 2 | 3 |
| Engine Part Total | 5 | 6 |
| Chief Steward | 1 | 1 |
| Assistant Steward | 0 | 1 |
| Waiter | 1 | 2 |
| Writer | 1 | 1 |
| Chief Cook | 1 | 1 |
| Cook | 1 | 1 |
| Catering Part Total | 5 | 7 |
| Total Number of Crew | 18 | 24 |
| Trainee | 0 | 16 |
| Cadet | 4 | 4 |
| Grand Total | 22 | 44 |

(4) Fish Hold/Refrigerated Cargo Hold

Fish hold/refrigerated cargo holds will be provided on the Plan vessel for use in transporting fresh and refrigerated fish from the outer islands to the capital, Funafuti, as well as frozen meat and fish and chilled vegetables on outbound voyages from Funafuti for consumption on the outer islands. On the Nivaga II, two 10-ft reefer containers have been installed on deck in fore part of cargo hold hatch.

Since the cargo carried from Funafuti to the outer islands is presently considerably larger than incoming cargoes therefrom, the scale of the subject hold has been determined based on analysis of distributor demand for outgoing, rather than incoming, cargoes. The demand in Tuvalu for chilled and frozen foods for shipment to the outer islands may be estimated from

the value of chilled and frozen food landed at Funafuti. Under domestic distribution patterns in Tuvalu, all imported goods are first unloaded at Funafuti port and then transshipped to the outer islands. The transport demand for island-bound cargoes may be derived by simply subtracting consumption in Funafuti from the total chilled and frozen imports.

In 1999, cargo imports into Funafuti port, combining containers and breakbulk cargo, totaled 8,245,5$m^3$, of which container number was as shown in Table 4.

Table 4 Number of Containers Unloaded at Funafuti Port

(Unit : number in TEU)

| Kind of Container | 1998 | 1999 | 2000* |
|---|---|---|---|
| Dry Container | 64 | 209 | 177 |
| Reefer Container | 38 | 80 | 73 |
| Cooler Container | 12 | 37 | 43 |
| Total | 114** | 326 | 293 |

(Source : Marine Department)

* Actual receipts through August, 2000

** 1998 data on imported container numbers may be questionable, since that was the year electronic data processing was introduced.

In 1999, 209 dry containers were imported, along with 80 reefer and 37 cooler containers. All frozen and chilled items were imported in containers.

Imported frozen and chilled foods are consumed in the capital, Funafuti, where some 40% of the Tuvalu population live, and on the 8 outer islands. Domestic distribution, including Funafuti, is handled by the Tuvalu Cooperative Society (TCS), to which the vast majority of the populations belong. The TCS handles a broad line of essential products ranging from food products to everyday necessities, fuel, machineries and sundry items. Other import distribution channels, apart from TCS, include equipment and materials for public works projects along with a very small volume of personal imports. Total TCS cargo shipments from Funafuti to the outer islands in 1999 are shown in Table 5.

Table 5 Total Volume of TCS Cargo Shipments to Outer Islands (1999) (in $m^3$)

| Name of Island | Food Stuff | Hardware | Textile & Garment | Fuel | Total |
|---|---|---|---|---|---|
| Nanumea | 207.2 | 101.6 | 12.9 | 92.9 | 414.5 |
| Nanumanga | 216.1 | 174.9 | 10.1 | 102.4 | 503.4 |
| Niutao | 230.2 | 167.8 | 13.9 | 86.8 | 498.7 |
| Nui | 177.8 | 83.0 | 10.3 | 99.6 | 370.8 |
| Vaitupu | 513.6 | 300.9 | 31.2 | 251.4 | 1097.1 |
| Nukufetau | 178.3 | 138.3 | 7.3 | 100.5 | 424.4 |
| Nukulaelae | 109.9 | 64.9 | 6.7 | 84.5 | 266.0 |
| Niulakita | 0.1 | 0.1 | 0.1 | - | 0.2 |
| Total | 1633.1 | 1031.6 | 92.4 | 818.0 | 3575.1 |

(Source : TCS)

As shown in Table 5, the total volume of TCS cargo shipments to the outer islands in 1999 came to 3,575$m^3$, while domestic cargoes in that year shipped via the Nivaga II on outbound voyages from Funafuti totaled 4,208$m^3$ (c.f. Table 1). Based on this data, TCS handled an estimated 85% of total cargo shipments during that year:

3,575 $m^3$ / 4,208 $m^3$ = 84.95% → 85%

The volume of frozen and chilled foods shipped to the outer islands is equivalent to total Tuvalu imports minus that portion consumed in Funafuti. From actual TCS sales figures by product group, it is possible to calculate the ratio of Funafuti food sales to total Tuvalu food turnover. Assuming that this ratio also applies to frozen and chilled foods, estimation of the total cargo demand from the outer islands for frozen and chilled food is possible.

Table 6 Total TCS Food Sales (1999) by Island, in Value and Percentage Shares

(in A$000)

| Funafuti | Nanumea | Nanumanga | Niutao | Nui | Vaitupu | Nukufetau | Nukulaelae | Total |
|---|---|---|---|---|---|---|---|---|
| 3,249.1 | 307.1 | 227.9 | 298.3 | 213.7 | 434.6 | 270.3 | 163.2 | 5,164.2 |
| 62.9% | 5.9% | 4.4% | 5.8% | 4.2% | 8.4% | 5.2% | 3.2% | 100% |

(Source : TCS)

As shown in Table 6, during 1999, some 63% of TCS food sales were made in Funafuti, with the remaining 37% distributed on the outer islands. On this basis, it may be estimated that 63% of imported frozen and chilled products were consumed in Funafuti, while 37% were shipped to the other islands.

As shown in Table 4, imports of frozen and chilled products in 1999 totaled 80 and 37 containers respectively. A 20 ft container, as used for frozen and chilled foods, has an inside measurement of about 26 $m^3$, but the actual volume that can be loaded into these containers varies widely, based on the form of shipment, the specific contents, and the preferences of shipper and buyer. In this report, actual volume has been ignored. In the calculations, it was assumed that, when frozen and chilled imports landed in containers are reshipped to the outer islands, the required ratio of actual / interior capacity is the same as at the time of importation. The container volume of frozen and chilled imports at Funafuti in 1999 has been calculated as follow.

Reefer container 80 nos.×26 $m^3$ = 2,080 $m^3$
Cooler container 37 nos.×26 $m^3$ = 962 $m^3$

Further assumed was that the ratio of frozen and chilled imports shipped on to the other islands was the same as for other food products.

Taking as an example the Northern Route, where the demand for frozen and chilled food shipments is highest, during 1999 the Nivaga II made 14 port calls at Nanumea, 14 at Nuitao, and 15 at Nanumanga. (cf. Table 2). TCS sales on the 3 islands were, respectively, 5.9%, 5.8%, and 4.4% of total sales. Accordingly, the demand for cargo space for frozen foods came, respectively, to 122.7$m^3$ (2,080 $m^3$ x 5.9%), 120.6$m^3$, and 91.5 $m^3$. Dividing cargo volume by the number of port calls at each islands, the average transport requirement per call for each island was estimated at 8.8$m^3$, 8.6$m^3$, and 6.1$m^3$ respectively. Thus, when the Nivaga II takes the Northern Course, it must satisfy the demand for an average total of 23.5$m^3$ for frozen food shipments (8.8 + 8.6 = 6.1 = 23.5$m^3$). Applying the same calculations to chilled foods, the average total cargo requirement comes to 10.9$m^3$. Thus, the total requirement for frozen and chilled cargoes combined comes to 34.4$m^3$.

Next, the possibility of dispersion around these averages was considered and it was found that shipping demand for frozen and chilled products tends to peak just after being imported at Funafuti. That is to say, if imports arrive at fixed intervals, dispersion will be small but, if the intervals are irregular, they will be large.

During 1999, 23 vessels landed import cargoes at Funafuti. If these arrivals had been evenly spaced, one could expect an arrival almost every 16 days. Then the deviations in actual arrival times for the 23 vessels around an evenly spaced pattern were measured. On average, the deviations worked out to 4.7 days, which corresponded to about 29% vis-a-vis the theoretical interval of 16 days. On this basis, the probability of dispersion was estimated at about 30%. To allow for this possibility, the total transport demand for frozen and chilled products must be increased to. 34.4$m^3$ x 1.3 = 44.7$m^3$.

The original request for a chill hold in the plan vessel was for a freezer compartment (20$m^3$, -20℃) and a chill compartment (+2℃, 20$m^3$) for a total capacity of 40$m^3$. Based on the introduction of the Plan vessel, an increase from present levels is expected in transport capacity to the outer islands. From this standpoint, it was determined that the total in the request is quite proper. However, in light of an almost 2:1 ratio between movements of frozen and chilled products a rigid even division of this hold space would not be advisable, since the freezer compartment would then be inadequate for frozen shipments, while the chill section would be far too large. To avoid this problem, it was found proper to divide the total capacity of 40$m^3$ into 3 compartments, with temperatures in each compartment adjustable over a range of -20℃ to +2℃. In this way, on outbound trips, 2 chambers could be used for frozen products and the third for chilled. On the return voyage, there would be a demand for fresh fish and other chilled products from the outer islands. At present, based on its long-term plan, Tuvalu has targeted infrastructure improvements on all islands, with the island CFCs expected

to be all electrified and operating during 2000. In tandem with the fishery development initiatives on the various islands, a growth of fresh and frozen fish shipments is expected in the future both for the domestic and export markets. Using all 3 compartments on the Plan vessel, the maximum carrying capacity for fresh fish would be approximately 7,000 kg, which would not only permit an increase in fish supply at Funafuti but would also contribute to fishery development on the outer islands, based on stable inter-island transport of catches throughout the country.

(5) Cargo Hold Capacity

The cargo hold capacity of the existing vessel (Nivaga II) is 450$m^3$. Even based on outbound cargo shipments, as shown in Table 1, insofar as domestic traffic is concerned, present cargo hold capacity is more than ample to meet demand. Cargo volume is particularly low on the Southern Route, giving rise to an inefficient structure. The cargo hold on the Nivaga II has a depth of about 4m from hatch to floor and, since there is no interior partitioning or shelving, stacking of general cargo, coming in a variety of packing, is quite inefficient while, as a result of the large depth, the space cannot be fully utilized. Against this background, a capacity of about 190$m^3$ has been requested as the dry cargo hold in the Plan vessel. The cargo hold requirement will be set on the basis of actual 1999 shipments via the Nivaga II.

In 1999, 8,245.5$m^3$ of cargo were imported into Tuvalu, which is the total of both 20-ft containers and breakbulk cargo. The container cargoes are removed at Funafuti, with all island shipments in breakbulk form. Domestic cargo shipments on the Nivaga II for 1999 totaled 4,208 $m^3$ on outbound voyages and 753 $m^3$ on return trips. Dry cargo shipments by island have been estimated on the basis of TCS shipments to the outer islands and TCS's 85% share of domestic cargo. TCS cargo shipments from Funafuti to the various islands during 1999, as shown in Table 5, totaled 3,575.1$m^3$.

As in the case of the fish hold/refrigerated cargo hold, average TCS cargo volume was obtained from the number of port calls by island. Then, based on an overall TCS share of 85% of cargo volume to all islands, the average cargo load per vessel call by island was calculated. The results of this analysis are presented in Table 7.

Table 7 Average Cargo Shipments for 1999 to the Outer Islands

| Nanumea | Nanumanga | Niutao | Nui | Vaitupu | Nukufetau | Nukulaelae |
|---|---|---|---|---|---|---|
| 34.8 $m^3$ | 39.5 $m^3$ | 41.9 $m^3$ | 29.1 $m^3$ | 56.1 $m^3$ | 41.6 $m^3$ | 28.5 $m^3$ |

Based on Table 7, average dry cargo demand by island per trip assuming that the Plan vessel serves the Northern, Central, and Southern Routes, is as shown below.

| | |
|---|---|
| Northern Islands（Nanumea、Nanumanga、Niutao） | 34.8 + 39.5 + 41.9 $m^3$ = 116.2 $m^3$ |
| Central Islands（Nui、Vaitupu、Nukufetau） | 29.1 + 56.1 + 41.6 $m^3$ = 126.8 $m^3$ |
| Southern Islands（Nukulaelae） | 28.5 $m^3$ |

Accordingly, the cargo hold will require a net capacity of 126.8$m^3$ on the Middle Route. When sundry goods are stored in the hold, the empty space is estimated at about 20%, based on data from a private shipping line in Japan. There is also a need for a safe working area for classifying cargoes bound for the 3 islands during Plan vessel operations, with a width of 0.7m around the hold entrance, which has been calculated as follows:

(6 + 3) x 2 x 0.7 x 2.5 = 31.5$m^3$

Accordingly, the total required capacity of the Plan vessel cargo hold has been set at: {126.8 / (1 - 0.2) } + 31.5 = 190$m^3$.

### 2-3-2-3 Design of the Vessel

#### (1) Rules to apply

Pacific countries form South Pacific Forum (SPF) and adopted South Pacific Maritime Code (SPMC), which is the common maritime regulations, in 1986. Tuvalu, as one of SPF countries, incorporated SPMC into the national maritime rule to formulate safety regulations for domestic service vessels in Tuvalu.

SPMC, however, does not sufficiently specify safety standard for domestic passenger vessels, and thereby Japanese maritime regulations will apply to supplement SPMC.

Accordingly following rules and regulations will apply.

- Tuvalu Merchant Shipping Act
- South Pacific Maritime Code
- Classification Society's Rules
- Japanese Maritime Rules (for the scope not covered by above rules and for the interpretative purpose)

SPMC has not ever been updated since adopted in 1986 and now some of its regulations have become outdated. In this circumstances SPF is now working in cooperation with IMO to develop new safety regulations, called Safety Regulations for Non-Convention Sized Ships (SRNCSS), scheduling adoption of final text within year 2000. After the adoption by SPF, Tuvalu will incorporate SRNCSS into the national maritime regulations in place of SPMC. Depending on the progress of SRNCSS final text, the Plan vessel may be required to apply SRCNSS as a part of Tuvalu Merchant Shipping Act. Draft text of SRCNSS is thoroughly

checked and found no practical influence on design and building cost, and thereby it is concluded that no problem is left on dealing with SRCNSS in this Project. It should be noted, however, that the scope of application of SRCNSS should be determined, prior to the start of the Project.

(2) Classification Society

On behalf of Tuvalu Government, Classification Society undertakes inspection of the Plan vessel during construction and periodical survey after entering into service.

Classification Society is the organization recognized internationally to undertake vessel's inspection, e.g. Nippon Kaiji Kyokai in Japan, Lloyd's Register of shipping in the UK and American Bureau of shipping in the USA.

Existing inter-island vessel M/V Nivaga II was built in UK and classed under Lloyd's.

Classification Society should be nominated evaluating Society's service during construction as well as for periodical survey to maintain classification in Tuvalu after entering into service. Tuvalu side confirms either of Lloyd's Register or Nippon Kaiji Kyokai is acceptable.

(3) Service draft

Among nine islands of Tuvalu, the capital island Funafuti only has wharf to accommodate the Plan vessel. As the Funafuti wharf is designed to accept container vessel, water depth including passage is sufficiently deep. Other eight outer islands have no wharf, so that the inter-island vessel has to anchor offshore. Therefore, restrictions on hull dimensions, water draft and air draft need not be considered on designing the Plan vessel. However, considering also shallow reef, the service draft of the Plan vessel follows approximately 3.10 m for M/V Nivaga II. The service draft shall be finally decided taking other design factors into consideration.

(4) Gross tonnage

The gross tonnage will be above 500 tons. International trade vessels of over 500 tons gross are subject to applying international SOLAS Convention, but the Plan vessel does not engage on international voyage and not subject to SOLAS. No important rule requirements for the vessel over 500 tons gross are found in the rules and regulations enumerated in (1) Rules to apply. Therefore it is concluded that the gross tonnage need not be controlled in the design process.

(5) Voyage license

The Plan vessel is licensed to navigate domestic waters, but will have to go to Fiji or New Zealand for dry dock. Such international voyage is possible for the Plan vessel under temporary license to go to dry dock, so that the Plan vessel needs not to keep international voyage license. Tuvalu side confirms that the Plan vessel engages only on domestic voyages

except for dry dock and need not to have international voyage license. The Plan vessel is classified as non-international, limited greater coasting service, passenger vessel according to Japanese Maritime Regulations. (Cargo passenger vessels carrying passengers of more than 12 persons are classified as passenger vessel.)

(6) Speed

Round trip schedule of the inter-island vessel is decided from (1) sailing hours between islands, (2) cargo discharging hours at an island, (3) business hours for touring officers, etc. (1) is decisive on ship speed, (2) is influenced greatly by restriction of work at night and by tide level, and for (3) judge, doctor, etc. are given 8 hours day time for their business. Therefore, the round trip schedule is rather decided by factors than ship speed, but faster speed sometimes brings possibility to shorten round trip schedule by e.g. arrival before sunset by faster speed and immediate passenger disembarkation not waiting for next morning.

Schedule of M/V Nivaga II depends on 10 knots speed, but in the Plan vessel possibility of faster speed should be studied for better round trip schedule.
As the result, maximum speed of 13.5 knots and ordinary service speed of 12.6 knots were found available, and main engines of 368 kW (500 ps) x 2 sets was found appropriate.
Study was made with following procedure.

- Main engine horsepower should not exceed 736 kW (1,000 ps). Higher engineer's license is required if exceeding 736 kW, so that recruit of crew for the Plan vessel may become difficult.
- Hull form should be optimized for minimum water resistance: optimum block coefficient through adequate displacement (light ship weight plus deadweight).
- Maintaining speed of workable level and safe maneuverability to withstand heavy sea should be ensured, not only aiming at good speed in calm seas.

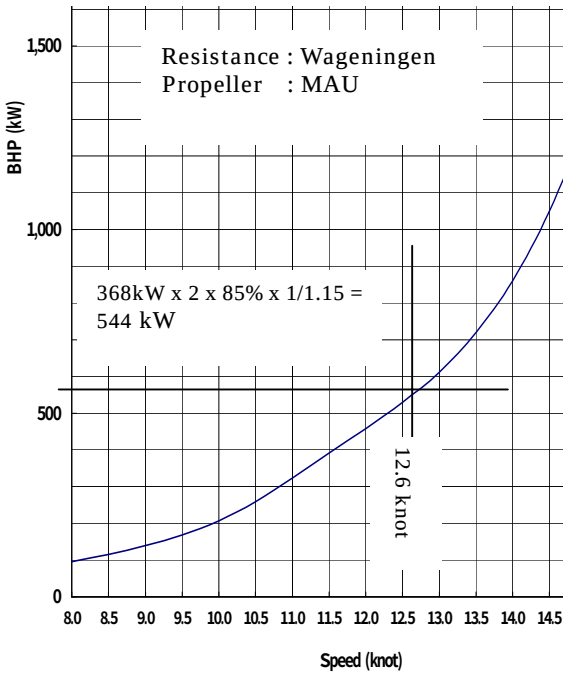



Fig 1 Speed-Output Curve

Fig.1 power curve shows 12.6 knots service speed, obtained by optimized hull propelled by two 368 kW (500 ps) main engines.

Next, speed drop and maneuverability are studied under strong wind of 26 m/s (standard severe wind force for greater coasting and deep sea vessels, specified by Japanese safety regulations). The results of study are summarized in Table 8 for two cases of main engine output, 4/4 horsepower and 3/4 horsepower, i.e. 2 x 368 kW (500 ps) and 2 x 276 kW (475 ps).

Table 8 Speed drop and maneuverability under strong wind

| Main engine horsepower | Service speed | Speed under 26 m/s wind | Speed drop | Windage moment around midship | Rudder force moment around midship |
|---|---|---|---|---|---|
| 368kW x 2 | 12.6 knots | 9.3 knots | 3.3 knots | 630 kN.m | 430 ~ 790 kN.m |
| 276kW x 2 | 11.6 knots | 7.4 knots | 4.2 knots | 630 kN.m | 280 ~ 680 kN.m |

In the case of 276kW (376 ps) x 2, speed drops to 7.4 knots (13.2 km/h) which will influence sailing schedule considerably.

Vessels must have maneuverability to maintain safe heading against heavy sea. It is concluded that the rudder force obtained by main engines 276 kW x 2 is not sufficient and that 368 kW x 2 is sufficient but marginal.

According to the above, main engines of 368 kW x 2 with service speed of 12.6 knots are concluded adequate.

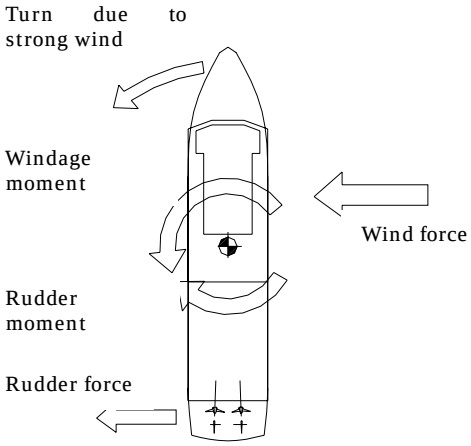



Fig.2 Relation between wind force and rudder force

(7) Number of propellers

Propulsion plant should be two-engine two-shaft system according to following.

Generally, two-engine two-shaft system is superior in technical performances and one-engine one-shaft system has advantage in building cost and maintenance, as compared in Table 9.

Table 9 General comparison of one-engine one-shaft and two-engine two-shaft systems

| | One-engine one-shaft | Two-engine two-shaft |
|---|---|---|
| Speed | Moderate | Higher |
| Fuel oil consumption | Moderate | Lower |
| Maneuverability | Moderate | Better |
| Redundancy (to cover breakdown) | No | Yes (one engine go-home possible) |
| Maintenance cost | Lower | Higher (twice in parts nos.) |
| Familiarization of crew | Problem expected | Already familiar |
| Building cost | Lower | Higher |

Generally, higher propeller efficiency resulting in faster speed and lower fuel oil consumption is obtained in two-engine two-shaft system. Speed and fuel oil consumption is compared in table 10.

Table 10 Comparison of speed performance and fuel oil consumption

| | One-engine one-shaft | Two-engine two-shaft |
|---|---|---|
| Main engine horsepower | 736 kW (1,000 ps) x 1 | 368 kW (500 ps) x 2 |
| Propeller efficiency | 60 % | 68 % |
| Service speed | 12.1 knots | 12.6 knots |
| Engine horsepower for 12.1 knots | 736 kW | 320 kW x 2 |
| Fuel oil consumption at 12.1knots | 3.1 tons/day | 2.8 tons/day |

Maneuverability of two-engine two-shaft system is considerably superior to that of one-engine one-shaft system. Two-engine two-shaft ship can turn at a position by operating two propellers and rudders, whereas one-propeller one-shaft ship can only make large turn.
Crew of Nivaga II is familiar with the maneuverability of two-engine two-shaft system, and crew will certainly face to difficulty on poor maneuverability of one-engine one-shaft system.

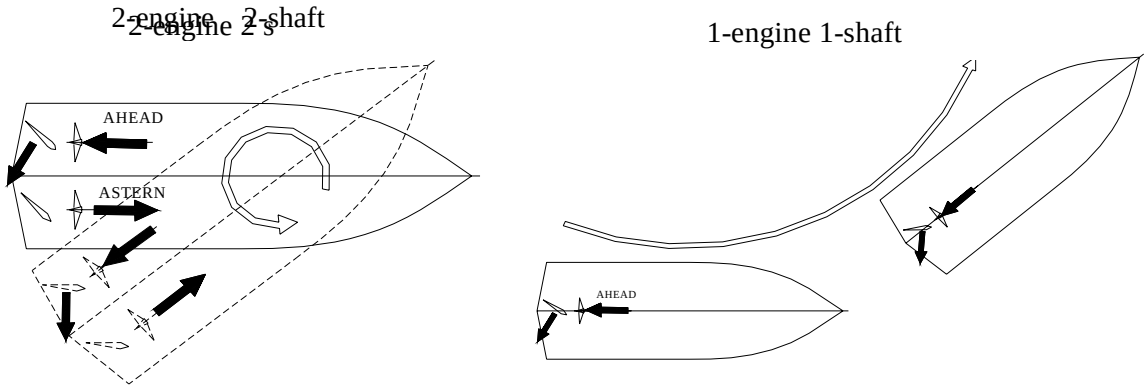



Fig.3 Maneuvering by 2-engine 2-shaft and 1-engine 1-shaft

(8) Surfboat

Among nine islands in Tuvalu, capital island Funafuti only has wharf to berth inter-island vessel. Other eight outer islands have no wharf, so that the inter-island vessel has to anchor offshore outside reef, and cargo/passenger transfer has to be all worked by surfboats between the vessel and shoreside.

The surfboat must be robust possible to land on rocky coral beach, and must be large to carry cargoes as much as possible at once. Such special surfboat cannot be manufactured in Tuvalu and no surfboat is arranged in outer islands. M/V Nivaga II carries two surfboats (Fig. 4) onboard, but present surfboat has several important problems to be improved, i.e. insufficient hull strength, inefficient cargo handling and passenger transfer between the vessel and the

surfboat.

Finding that the surfboat is the component having important role on improvement of operational efficiency and on safety of passengers, it is concluded that the surfboat be supplied as a component in this Project.

The surfboat needs to be lightweight for shallow draft. As aluminum alloy and FRP material cannot be repaired in Tuvalu, hull material for the surfboat is limited to wood, but the bottom of the boat is likely damaged by rocky coral beach. Partially steel material should be used to reinforce bottom hull, although steel makes weight of the boat heavier. It is also important to consider the boat hull being of structure possible to repair easily even in case of damage.

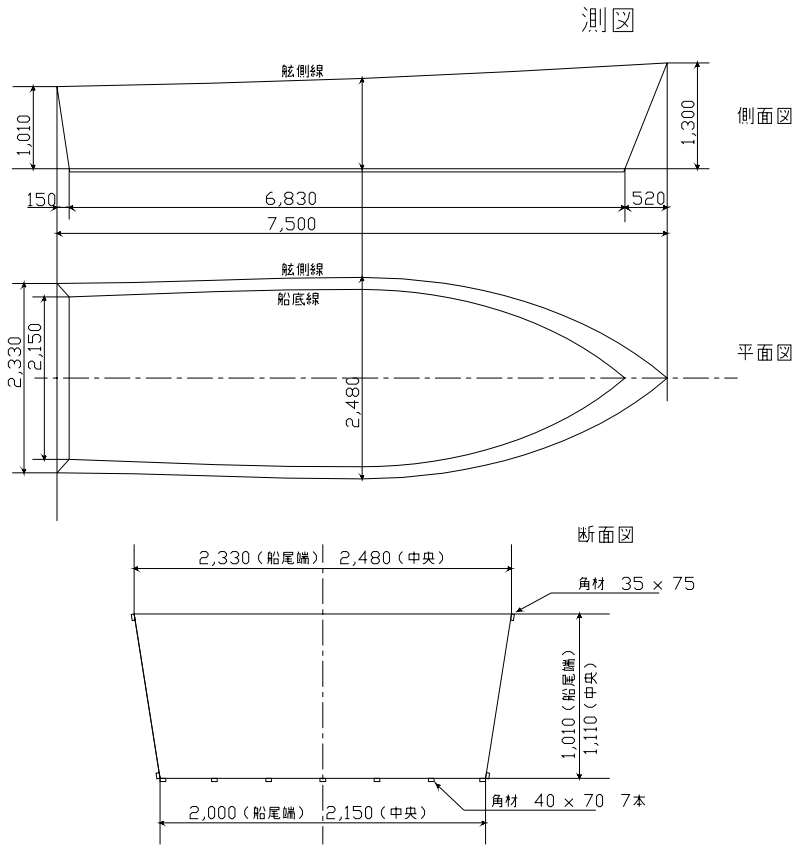



Fig. 4 Surfboat of Nivaga II

Two cranes onboard the vessel can quickly handle the cargo between the vessel and the surfboat, but as no crane facility is available at the shoreside, cargo handling has to be done all by manpower. For efficient cargo handling at shoreside, ramp arrangement is proposed to allow cargo handling by wheeled carrier.

Number of the surfboats to be supplied should be two, from view points that two surfboats will have to work jointly to carry large cargoes, that cargo discharging time has to be shortened by two boats, and that cargo operation has to be continued even in case of damage on one boat.

Regarding embarkation and disembarkation of passengers, the present problem is on the safe transfer of passengers between the vessel and the surfboat. As the vessel anchors offshore where swell is often high, the vessel and the boat moves so differently that passengers often fail to find timing to jump to/from the boat and sometimes injured. Wide and flat platform should be provided at the same height on the vessel's side and the boat's side for safer transfer of passengers.

Technical particulars of surfboats onboard M/V Nivaga II and the Plan vessel are shown in Table 11.

Design of surfboat for the Plan vessel is shown on Fig. 5.

Table 11 Technical particulars of surfboats onboard M/V Nivaga II and the Plan vessel

| | Plan vessel | Nivaga II |
|---|---|---|
| Length | About 7.8m | 7.5 m |
| Breadth | About 3.2m | 2.5 m |
| Depth | About1.2m | 1.1 m |
| Engine | About 40ps outboard | 40ps outboard |
| Material | Wood | Wood |
| Shape | Flat bottom, square bow | Flat bottom, shaped bow |
| No. of boats | 2 | 2 |

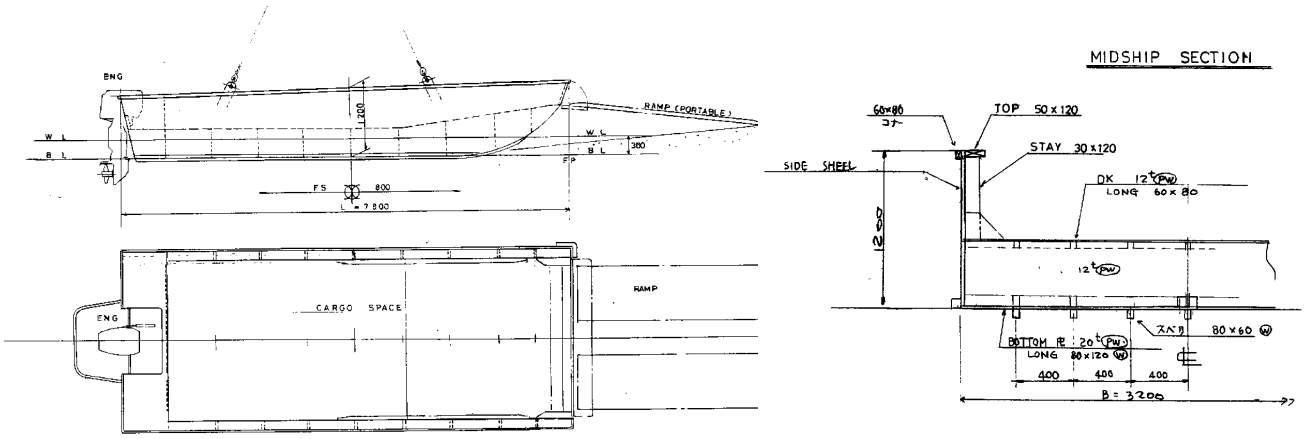



Fig.5 Surfboard of Plan Vessel

(9) Fuel oil tank

Double bottom space is mostly allocated for fuel oil tank. More than 105m$^3$ is estimated in the double bottom, and this allows cruising radius of about 6,000 nautical miles. Round trip mileage of northern bound route, middle bound route and southern bound route is 1,138 nautical miles altogether, which is well covered by 85 m$^3$ fuel oil tank. In the annual drydock, 750 nautical miles to drydock of Suva, Fiji and 1,800 nautical miles to Auckland, New Zealand are also covered by 105 m$^3$ fuel oil tank.

(10) Freshwater tank and desalination equipment

Freshwater tank of more than 50 $m^3$ will be arranged in the fore and aft parts of the hull and desalination equipment will be installed to support fresh water consumption even without shore supply.

The Japanese Maritime Code refers to potable water of 20 lit./man/day, but no reference to washing water consumption. The UK regulations (old version) say potable water of 4.5 lit./man/day and washing water 45.5 lit./man/day, altogether 50 lit./man/day, meantime the US maritime laws stipulate total volume of freshwater as 110 lit./man/day. Since 40 to 50 liters/man/day consumption on shower use is commonly observed on vessels, it has been decided that freshwater consumption on the Plan vessel is assumed 50 lit./man/day, equivalent to the old version of the UK regulations.

80 passengers are assumed onboard for 4 days in northern route, 3 days in middle route and 3 days in southern route. In short voyages, like Funafuti to Vaitupu, water consumption for shower will be less. Each one day of such short voyage is assumed in the middle and southern bound voyages, and water consumption in short is assumed at half. Thereby effective days of water consumption are 9 days (10 days – 2 days x 50 %), thus:

Freshwater consumption by passengers = 50 lit./man/day x 9 day x 80 pax = 36,000 lit

Crew member of 22 persons stay onboard for 17.5 days for all round trips including 2.5 days at Funafuti between trips, thus:

Freshwater consumption by crew = 50 lit./man/day x 17.5 day x 22 crew = 19,250 lit.

Therefore, total of passengers and crew consumption is:

36,000 lit. + 19,250 lit. = 55,250 lit.

Average consumption per day = 55,250 lit. / 17.5 day = 3,200 lit./day = 3.2 $m^3$/day

Freshwater supply in Tuvalu depends on rainwater collection. Tuvalu generally enjoys plenty rainfall, but rainfall is not stable, and accordingly inter-island vessel can face to difficulty on freshwater supply. In the circumstances, installation of desalination equipment is necessary to support freshwater consumption without shore supply.

Desalination equipment should be of capacity to cover 3.2$m^3$/day consumption.

Forepeak and after peak spaces of about 50 $m^3$, difficult to utilize for other purpose, is used as freshwater tanks to store freshwater by desalination equipment, or to fill freshwater in Funafuti and continue services even in case of damage on desalination equipment.

(11) Countermeasure against rolling

The Plan vessel navigates in the open sea of Tuvalu waters where average swell height is 1.9 m, which is equivalent to or severer than that in the sea route of Japanese long distance ferries.

As a result of the field survey, it is realized that seasickness onboard is very hard and desire on countermeasures against rolling is very strong.

ISO standard refers to vertical acceleration of 0.25 m/s$^2$ for passengers onboard over 8 hours. 0.25 m/s$^2$ corresponds approximately to 15 degrees roll angle, whereas 30 degrees roll angle can be frequent during voyages.
M/V Nivaga II is fitted with bilge keel (see below) only, but for the Plan vessel active roll damping system should be installed in addition to bilge keel for greater roll damping.
Countermeasures against rolling are as shown in Table 12.

Table 12 Roll damping devices

| System | | Operation | Roll reduction | Place to install | Mechanical parts to maintain | Cost |
|---|---|---|---|---|---|---|
| Fixed system | Bilge keel | Long and narrow fin welded along bilge corner of hull Adopted in most ships | Low | None | None | Very low |
| Active system | Anti-rolling tank | Reduce rolling by movement of water inside tank extended over ship's beam; occupy large area and require bigger hull | About 30 % | Very large | Frequency control valve | Moderate |
| | Fin stabilizer | Reduce rolling by movable fin fitted at bilge corner; automatic fin control; very expensive | About 50 % | Large | Hydraulic power system and fin mechanism | Very high |
| | Rudder roll stabilizer | Reduce rolling by the movement of rudder; automatic rudder control | About 40 % | Very small | None (rudder is separately maintained by rule) | Moderate |

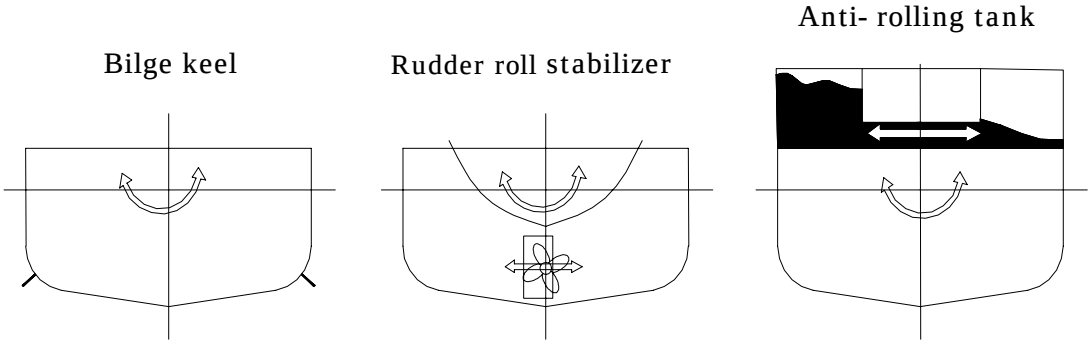



Fig. 6 Sketch of roll damping device

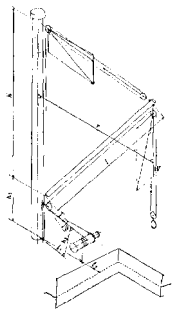
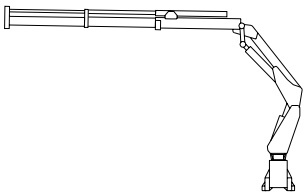
Bilge keel will be fitted as normal. As an active system, rudder roll stabilizer system is considered suitable for the Plan vessel, from the view of effectiveness, reliability and less space to occupy. It is further noted as satisfactory that control unit of the rudder roll stabilizer is fitted independently from control unit of steering system, allowing the control of the rudder roll stabilizer disconnected whenever necessary and thus ensuring safe functioning of the steering gear at priority.

(12) Crane

Inter-island vessel has to undertake loading cargoes at Funafuti wharf, handling surfboats / discharging cargoes / loading fishes at outer islands. Being no crane at Funafuti and at outer islands, crane onboard the Plan vessel is indispensable.

Two types of crane is considered for the Plan vessel as shown in Table 13.

Table 13 Types of crane

| Type | Features |
|---|---|
| Derrick boom | Simple gear and widely adopted in the past but seldom adopted in the new ships due to low efficiency and skill-depend operation.<br>Hook position being fixed, cargo handling at different position is inconvenient.<br>Cargo swings under wire rope and position of cargo is not stable.<br>  |
| Knuckle boom crane | Simple to operate and compact.<br>Widely adopted as cranes of small cargo vessel, fishing boats and workboats.<br>Free to spot at any position within jib radius, i.e. possible to reach cargo at any position.<br>Cargo does not swing and position of cargo is stable, as cargo is hooked at jib top.<br>  |

For the Plan vessel, the crane to be adopted should be safe and efficient knuckle boom type, which is simple to operate, possible to pickup cargoes at any positions, and stable hook point without swinging. M/V Nivaga II has two derrick boom cranes, 7 tons lifting capacity each or 2.5 tons capacity when working together, but cargo operation is not efficient due to fixed lifting position and re-set operation of derrick boom is dangerous job requiring an experienced operator.

Lifting capacity of the crane for the Plan vessel should cover surfboat of about 1.9 tons, cement bags on pallet of about 1.5 tons, small truck of about 2 tons within maximum jib

radius. Two cranes working together can handle any heavier cargoes.
Number of cranes should be two sets according to following:

- Even in case of damage of one crane, other crane can continue cargo operation.
- As cargo loading area is too wide to be covered by the working radius of one crane, tow cranes should be arranged apart, fore and aft of cargo space, to cover all cargo loading areas.
- Two cranes should be used for heavy cargoes.

(13) Navigation equipment

Radar, magnetic compass, gyrocompass, speed log, echo sounder, GPS, etc. should be installed according to the rule requirement.

(14) Radio installation

International SOLAS (Safety of Life at Sea) Convention rule requires GMDSS rule applies to all cargo ships over 300 gross tons. In Tuvalu, however, with no GMDSS station on shore, the safety radio installation onboard the Plan vessel has to be either long distance ship radio station relying on New Zealand shore station, or local ship radio station partially applying GMDSS. Discussing with NCC (National Coordination Centre of Tuvalu: the unit in the police organization, undertaking 24 hours radio watch keeping on VHF and HF) it is concluded that the ship radio station should be based on VHF radiotelephone equipment and HF SSB radiotelephone equipment. Tuvalu Government shall issue Exemption Certificate regarding partial exemption from GMDSS requirement to declare this way of applying GMDSS.

The existing communication system between the Nivaga II and the outer islands is maintained by twice daily radio broadcast from Funafuti at fixed time, which contains present position of the vessel and the estimated time of arrival. This one-way communication hampers effective operations of Nivaga II in the lack of real time exchange of information regarding sea conditions of the entering place, disembarking/boarding passenger details, landing/lading cargo volume/contents, preparations for cargo handling etc. To cope with these situations, inclusion of VHF radio equipment are planned in this project to secure bilateral communications between the Plan vessel and each island.

VHF radio normally covers 30 to 40 nautical mile range and thus effective in the communications for the period of several hours before the estimated time of arrival of the Plan vessel, however direct, real time communications between the vessel and the place of arrival will enhance the effective operations by eliminating major problems already mentioned. VHF radio equipment will be supplied to 8 islands except Niulakita, the southernmost island.

The operation of VHF radio equipment does not require licensed staff nor complicated installation work. The MWEC will bear responsibility of setting the equipment at the ticketing office of each island as well as of operation and maintenance of the equipment.

(15) Generator

Accommodation air conditioning, galley loads, etc. occupy major part of electric demands during navigation, and load from cargo gear is added during cargo loading. As electric loads when the vessel rests alongside the wharf is too low to be fed from main generator for navigation, small harbor generator should be installed. Main generator should be two sets to continue electric supply even in case of one generator in failure. Harbor generator may be one set.

Capacity of the generators should be determined collecting all data of electric consumers and calculating electric balance.

(16) Air conditioning

Accommodation area should form watertight structure. Windows are normally required to close to stop shipping water. Exposed steel surfaces are heated up and ship inside becomes hot and humid. According to these conditions particular to ships, simple ventilation arrangement cannot provide adequate living environment inside ships, which are sailing in tropical waters.

M/V Nivaga II is not fitted with air conditioning but fitted only with ventilation. Passengers onboard M/V Nivaga II point out hot and uncomfortable accommodation as one of the important problems on M/V Nivaga II.

Air conditioning system is found indispensable to obtain minimum level of living environment considering temperature condition in the Plan vessel's sailing area and considering also particular situation of ship structure.

(17) Countermeasures against sea pollution

Means to prevent sea pollution (from oil and sewage) in coral reef seas, especially in lagoon side should be provided according to MARPOL convention. M/V Nivaga II is fitted with oily water separator and sewage collecting tank, and the Plan vessel also should be fitted out similarly.

Oily water separator equipment against pollution from oil spillage, to treat oily water onboard, will be installed in engine room.

Sewage from toilet will be collected in sewage holding tank and will be discharged overboard in the open seas outside 12 miles or over from the land, as allowed by MARPOL Convention.

(18) Workshop

Tuvalu is far from major international markets, so that spare parts and after service takes long

time to obtain. Once important machinery should break down, vessel is obliged to stop its service. To maintain vessel's service without break, daily maintenance is among others important.

For the Plan vessel, preventive maintenance policy (PMP) should be introduced. PMP carries out maintenance work according to pre-determined schedule and procedure even if the subject machinery is not in failure. PMP consists of (1) workshop installation, (2) line-up of spare parts, (3) PMP working procedure manual and (4) leader and workers. Regarding (1), workshop onboard should be prepared as no adequate shore workshop is available in Tuvalu. Regarding (2) and (3), this Project should supply spare parts and manual. Regarding (4), Captain and Chief Engineer as the leaders should play important role in PMP, and besides dispatching expert of ship management in the frame of technical assistance of Japan is desirable.

Working procedure is, e.g. to exchange all cylinder heads of starboard main engine with stowed spare cylinder heads, to clean and prepare removed cylinder heads and stow on the workshop shelves, and after 12 months to change cylinder heads of portside main engine similarly. Repeating this procedure, cylinder heads will be renewed at every two years. Similar parts exchange will be done for piston, attached pump, bearing, etc. along schedule and procedure on manual.

Necessary spares and tools should be prepared, and shelves to stow spares and tool lockers/racks should be fitted out in the workshop.

Machine tools should be of suitable for small parts, not for large parts of engines, i.e. small lathe, drilling machine, grinder, electric welder, gas cutting equipment, etc. should be installed and working table should be sufficiently wide.

(19) Other Equipment

In this section, insulated fish box will be discussed for fish transportation.

At present, Nukufetau and Nukulaelae CFCs supply fish to the capital Funafuti using the research and extension boat of Fisheries Department "Manaui". The Nivaga II have onboard only two container type freezers on the deck, and the vessel is not adequate for transport of fish, with the lack of reliable scheduled cruise as another reason. However, fish from two CFCs are carried to Funafuti in the fish hold of Manaui without using insulated box, and consequently quality of fish deteriorates during loading and discharging process.

The Plan vessel will have three refrigerated holds to transport on outbound voyage from Funafuti frozen meat and diary products for consumption in the outer islands, and on inbound voyage fresh and frozen fish in the refrigerated holds. Since all three holds will be alternatively utilised for meat, diary product, fruit and fish transport depending on the level of demand, fish must be transported in a watertight, closed box to avoid sanitary and odor problems in the hold.

This Plan will therefore includes insulated fish box intended for use in Nukukfetau and Nukulaelae CFCs which has already started fish collection/supply activities. For the size of insulated fish box, 160-liter capacity is deemed adequate as being the maximum size to be handled by manpower and thus widely used in other Pacific island countries. According to 6-month delivery data since April 2000, the average weight of 8 shipments from two CFCs comes to 651kg. About 75kg of fresh fish can be contained in the 160 lit. insulated fish box when stored with crushed ice, then 9 containers will be required to carry 651kg of fresh fish, and for two CFCs, 18 insulated fish boxes are necessary. Since the Plan vessel may call two CFCs in the same one voyage, spare box in the same number in use must be delivered at the time of collecting fish from each CFC, thus making the total required number of insulated fish box to 36 pieces for the CFC of two islands.

The insulated fish box will be used under the responsibility of Naficot, which is the public organization undertaking fish distribution in Funafuti. Naficot will lend fish boxes to each CFC and is fully responsible in the handling of the box regardless of whether onboard the Plan vessel or in use at CFC, thus ensuring effective utilization of fish box which otherwise tends to disperse easily.

### 2-3-2-4 Technical Particulars of the Plan Vessel

Based on the above design procedures, following particulars of the Plan vessel has been enumerated.

| Item | | Feature | Remark |
|---|---|---|---|
| **Principal particulars** | | | |
| | Kind of the vessel | Inter-island Vessel | |
| | Service | Inter-island of Tuvalu (non-international) | Possible to go to Fiji for dry dock under temporary license |
| | Subject to transport | Pax (over 12p), break bulk caro, frozen stuff, petroleum (on deck) | Classified as the passenger vessel |
| | Flag | Tuvalu | |
| | Classification | Nippon Kaiji Kyokai | |
| | Rules to apply | Classification rules | |
| | | Tuvalu Merchant Shipping Act and Regulations | |
| | | South Pacific Maritime Code (1986) | As specified by Merchant Shipping (Safety) Regulations, 1990 |
| | | Japanese Maritime Rules | For the scope not covered by above rules and for the interpretative purpose |
| | Length overall | About 46.50 m | |
| | Length between pp | About 41.00 m | |
| | Breadth, molded | About 9.40 m | |
| | Depth, molded | About 3.70 m | |
| | Design draft, molded | About 3.10 m | Same as Nivaga II draft of 3.10 m. |
| | Gross tonnage | About 580 t | |
| | Max. speed, laden | 13.5 knots | |

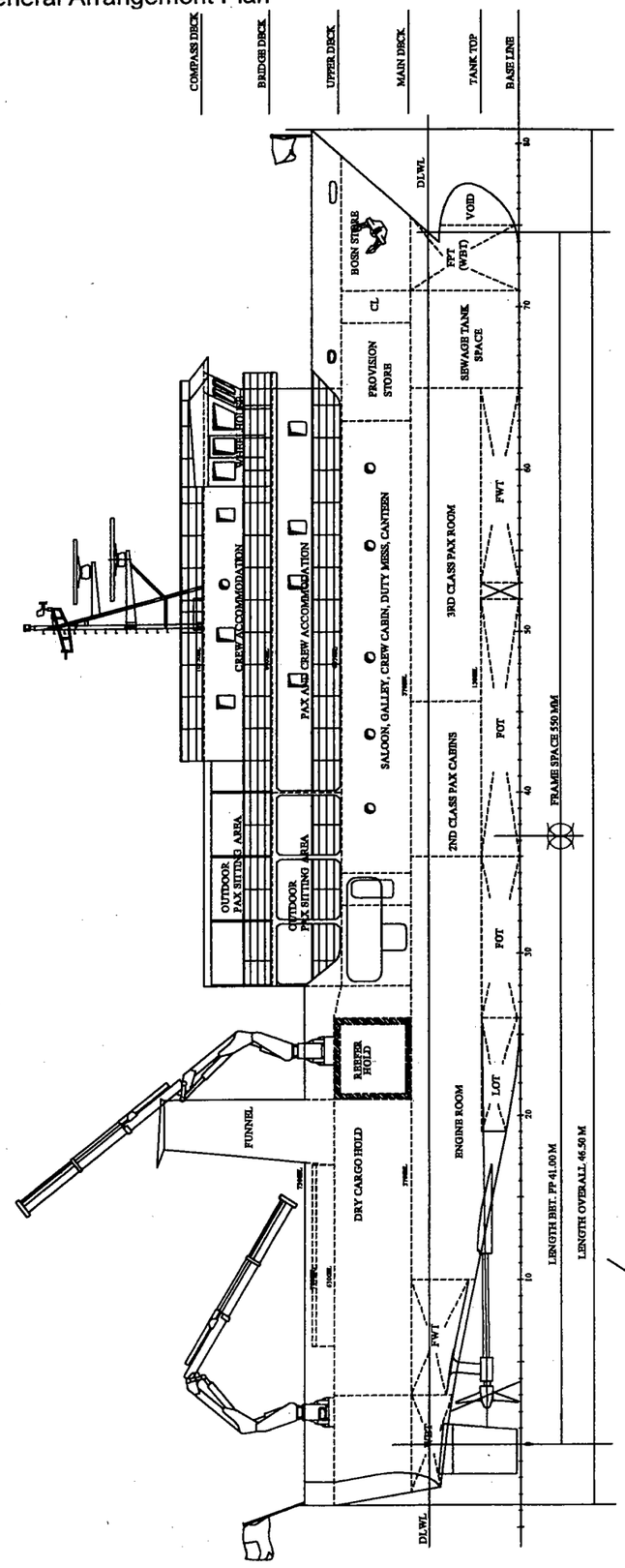
| Item | Feature | Remark |
|---|---|---|
| Service speed, laden | 12.6 knots | |
| Main engine | 368 kW (500 ps) x 2 | Efficient in fuel consumption and maneuvarability |
| Endurance | More than 6,000 n. miles | |
| Complement | Total 102 persons:<br>18 crew<br>4 cadet<br>14 1st class pax<br>22 2nd class pax<br>44 3rd class pax | |
| Fuel oil tank | About 105 $m^3$ | |
| Fresh water tank | About 50 $m^3$ | Including reverse osmosis type desalination plant of 3.2t/d capacity |
| **Cargo hold outfitting** | | |
| Dry cargo hold | 190 $m^3$ | Suitable to stow break bulk cargoes. Wooden bottom and side sparring. Hold inside to be separated into sections to allow grouped stowage. |
| Reefer hold<br>(+2℃～-20℃) | 3 compartments, total 40 $m^3$ | To carry meat, dairy and vegetable from Funafuti, and fish (fresh and frozen) from outer islands. |
| **Accommodation** | | |
| 1st class pax rooms | 3 x 2 bunk and 2 x 4 bunk cabins with toilet and shower | 3 x 2 bunk rooms offered for patients at priority. |
| 2nd class pax rooms | 7 x 2 bunk and 2 x 4 bunk cabins | |
| 3rd class pax rooms | Sitting room to accept 44 pax | 0.85$m^2$/person |
| Outdoor sitting areas | Smokers and daytime areas under sun awning and side screen against sun/rain; wooden floor.<br>For extra 80 pax in daytime short voyage. | |
| Captain's room | Single room with own toilet and shower room | As Nivaga II. |
| Chief Engineer's room | Single room with own toilet and shower room | As Nivaga II. |
| Chief Officer's room | Single room | |
| 2nd Engineer's room | Single room | |
| Writer and Chief Steward | Double bunk room | |
| Junior Officers' room | Double bunk room x 1 | |
| Petty Officers' room | Double bunk room x 1 | |
| Crew's room | 5 double bunk room x 1 | |
| Cadets' room | 2 double bunk room x 1 | |
| Saloon | Mess tables and chairs, 20 seats | |
| Duty mess | Mess tables and chairs, 11 seats | |
| Galley | To serve saloon and duty mess | |
| Canteen | To serve snacks and light drinks | |
| Common toilet | 2 Gents and 2 Ladies | |
| Common shower | 2 Gents and 2 Ladies | |
| Crew toilet | 1 | |
| Crew shower | 1 | |
| Provision store | Dry provision, vegetable room and meat room | |

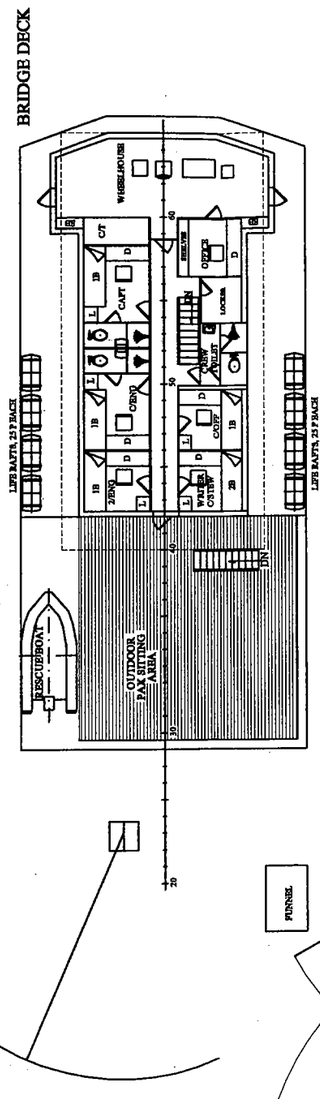
| Item | Feature | Remark |
|---|---|---|
| Sickbay | 3 x 2 bunk rooms to be suitable as sickbay: not allowing vent air recirculation; wider door for stretcher.<br>Medical chest in C/O room. | Advised by Princess Margaret Hospital. |
| Luggage room | To be divided in 3 sections for different island destinations. | |
| **Cargo handling system** | | |
| Cargo hatch | Steel pontoon watertight hatchcover<br>L x B = 6.05 m x 3.0 m | Possible to stow light truck in cargo hold |
| Crane | Elec-hyd knuckle boom crane x 2<br>About 20 kN (2.0 tf) SWL at about 8.4m radius | To handle cement bags on pallet 1.5 t, light truck 2t, surfboat 1.9 t, etc.<br>Two cranes can work together to handle heavy cargoes. |
| Surfboat | About 7.8 m Length, flat bottom, wooden, two outboard motors, flat bottom ceiling, with internal ramp and shore ramp, 2 boats | For efficient cargo discharge in outer island. |
| Petroleum transport | On deck to be fitted with railing and oil spill coaming for stowing drum cans to transport petroleum: petrol, kerosene and diesel oil.<br>Pumping and filling arrangement for diesel oil from double bottom to drum cans. | |
| **Deck machinery** | | |
| Windlass | Electric 1.5kW x 1 set | |
| Capstan | Electric 7.5kW x 1set | No stern anchor |
| Steering gear | Electro-hydraulic 2 rudders in parallel 1.5kW x 1 set | |
| Controlled roll damping device | Active rudder roll stabilizer | For ease of passengers |
| Bowthruster | Not fitted. | |
| **Lifesaving appliance** | | |
| Life raft | Inflatable type for 25persons x 8 | Merchant Shipping/SPMC, RFD<br>Capacity to include 80 pax on deck |
| Rescue boat | 3.8m, about 18.4 kW outboard x 1 | |
| Life jacket | All person (182) + duty crew (4) + kids (30) | Merchant Shipping/SPMC<br>Capacity to include 80 pax on deck |
| Radio lifesaving appliance | Two-way VHF radio x 2, EPIRB x 1, SART x 1 | |
| Other | Lifebuoy, distress signals | |
| **Fire fighting equipment** | | |
| Hydrant | Engine room, accommodation, deck | As specified by applicable regulations |
| Portable fire extinguisher | Powder and foam | |
| Fire detector | Engine room and accommodation | |
| **Ventilation** | | |
| Engine room | Mechanical supply fan x 23.7kW | |
| Engine workshop | Mechanical exhaust fan x 10.4kW | |
| Dry cargo hold | Mechanical supply fan x 12.2kW | |
| Galley and toilet | Mechanical exhaust fans 0.4kW | |
| Air conditioning | Accommodation, etc | Each room to be fitted with electric supply point for wall fan. |

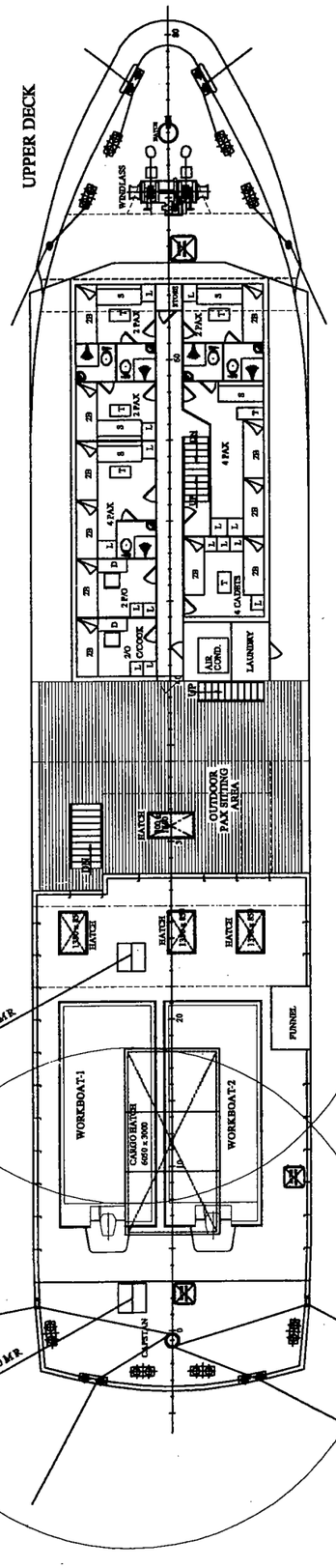
| Item | Feature | Remark |
|---|---|---|
| **Machinery installation** | | |
| Main engine | 4 cycle medium speed diesel engine<br>368 kW (500 ps) x 2 | Make familiar to Tuvalu engineers.<br>To be of robust engine to allow continuous running at maximum horsepower. |
| Reduction/reverse gear | Hydraulic multi-plate clutch | |
| Propeller | 4blades fixed pitch x 2 | To be of design giving best efficiency. |
| Main generator | AC225V 50Hz about 170kVA x 2<br>About 155 kW (210ps) diesel driven | |
| Harbor generator | AC225V 50Hz about 60kVA x 1<br>About 55 kW (75ps) diesel driven | |
| Main air compressor | Electric 2.2kW x 2 | Not installed when main engine starts by cell motor |
| Main cooling SW pump | ME driven 7.5kW x 2 | |
| FO transfer pump | Electric 2.2.kW x 1 | |
| Bilge/GS/fire pump | Electric 2.2kW x 2 | |
| FW pump | Electric 2.2kW x 2 | |
| SW service pump | Electric 0.4kW x 2 | |
| AC, fish hold ref. plant cool SW pump | Electric 2.2kW x 2 | |
| Engine rm bilge pump | Electric 0.4kW x 1 | |
| Sludge transfer pump | Electric 1.5kW x 1 | |
| LO filter | CJC x 2 | |
| Water maker | Reverse osmosis type, about 3.2t/day x 1 set | Also rainwater collecting arrangement |
| Cargo hold refrigeration plant | For frozen hold and chilled hold (+2℃～-20℃) | |
| Provision store refrigeration plant | Vegetable room and meat room (+2℃～-20℃) | 2 refrigeration units |
| Oily water separator | 1 set, 15ppm | 2 refrigeration units |
| Sewage collecting tank | About 2m$^3$ with discharge pump x 2 sets | To collect in the harbor and discharge in the open sea |
| Engine watch room | Main switchboard and engine monitor | |
| Workshop | Parts store: For deck, engine and electric parts.<br>Machine tools: Work bench, vice, small lathe, drill machine, grinder, elec. welder, gas cutting, etc. | |
| **Inboard communication** | | |
| Engine telegraph | 2 | |
| Common battery Telephone | Wheelhouse, crew cabins, mess room, galley, engine room and steering gear room | |
| Public addressor | Amplifier and speakers | |
| Alarms | General alarm and fire alarm | |
| **Navigation equipment** | | |
| Magnetic compass | 1 | |
| Gyro compass | 1 | |
| Steering control including autopilot | 1 | |
| Radar | 2 (main and aux) | |

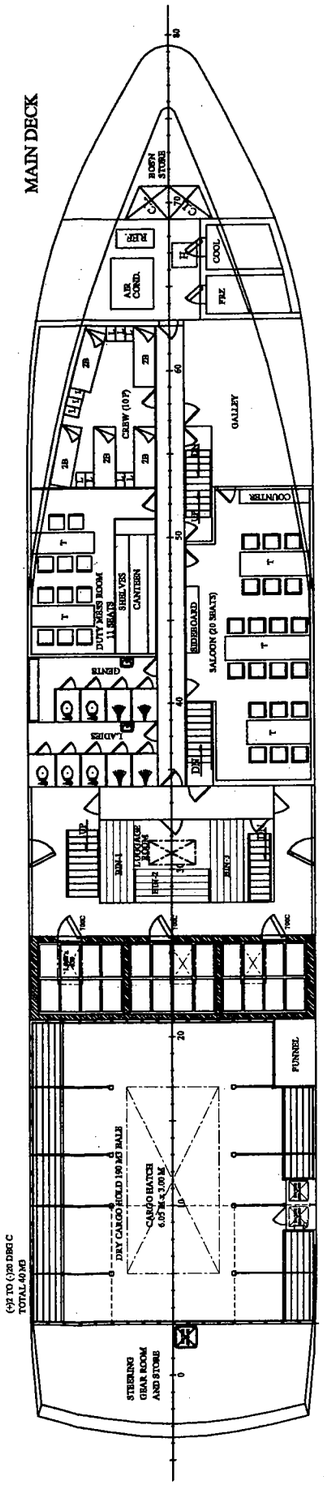
| Item | | Feature | Remark |
|---|---|---|---|
| | Echo sounder | 1 | |
| | Doppler speed log | 1 | |
| | Weather fax | 1 | Required by NCC. |
| | GPS | 1 | No shore station for DGPS. |
| | Air horn or motor horn | 1 | |
| | Search light | 2 (large and small) | Wheelhouse top |
| **Radio equipment** | | | |
| | GMDSS area | A1 | As advised by NCC |
| | International VHF | 1 (GMDDS DSC and DSC WR) | Watched 24hrs by NCC |
| | MF/HF SSB radio | 1 (about 150 W) | Watched 24hrs by NCC |
| | Walkie talkie | 6 (VHF or UHF) | |
| **Other equipment** | | | |
| | Insulated fish box | 160 lit. capacity, 36 pcs | For CFC of two islands |
| | VHF radiotelephone | Output 25W with rechargeable battery and charger, 8 pcs | For 8 islands except Nuilakita |

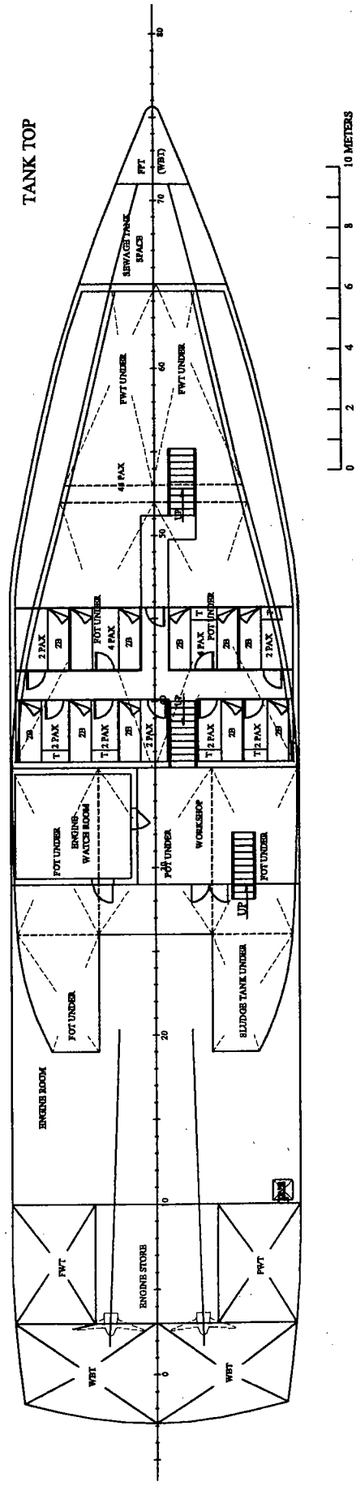
## 2-3-3 General Arrangement Plan



## 2-4 Implementation Structure

### 2-4-1 Organization and Personnel

The responsible organ for the subject Plan is the Ministry of Natural Resources and Environment (MNRE), while the implementing organ is the Ministry of Works, Energy, and Communications (MWEC).

The MNRE is headed by a Minister, Secretary, and Assistant Secretary responsible for Ministry Headquarters and 4 Departments: Agriculture, Fisheries, Lands and Survey, and Environment. The staff numbers 91 persons in all.

The subject plan is related to the inter-island vessel for outer island fisheries development, which is needed to promote fisheries development in a most concrete form, with a view to accelerating economic development on Tuvalu's outer islands. Thus, the Fisheries Department within MNRE will essentially be in charge of the project.

The Fisheries Department is dedicated to the goal of utilizing the nation's marine living resources so as to bring maximum benefits to its people. The Department operates a fisheries extension vessel that was donated in 1989 by the Government of Japan. This vessel is 18.4 m long, powered by a 200ps main engine, and equipped with an 8 m3 fish hold. The Department also operates and guides a network of Community Fishery Centres (CFCs), while also conducting experimental and research programs in the field of aquaculture, principally targeted at shellfish. It also handles negotiations on fishing license for foreign vessels in the country's vast 200-mile zone, while exercising surveillance over these waters, and cooperates closely with the PC (formerly called SPC). The Department also operates a mechanical workshop in Funafuti, geared mainly to maintaining small fishing vessels donated by Japan, and furnishes supporting staff for this facility. The Fisheries Department staff totals 35 persons.

The implementing organ for the subject Plan is the Ministry of Works, Energy, and Communications (MWEC) which, as the agency in charge of marine transport, operates the present inter-island vessel, Nivaga II. The Plan vessel too will be operated jointly with the existing vessel, which should greatly enhance efficient and mobile deployment of the two ships. This Ministry is, therefore, highly qualified to serve as the implementing body for the project.

The Ministry of Works, Energy, and Communication is headed by a Minister, Secretary, and Assistant Secretary and comprises Ministry Headquarters, and 5 subsidiary Departments: Meteorology, Marine, Energy, Public Works, and Aviation. Its staff numbers 152 persons, the bulk of whom are concentrated in 2 Departments; Public Works, which has various field departments, such as

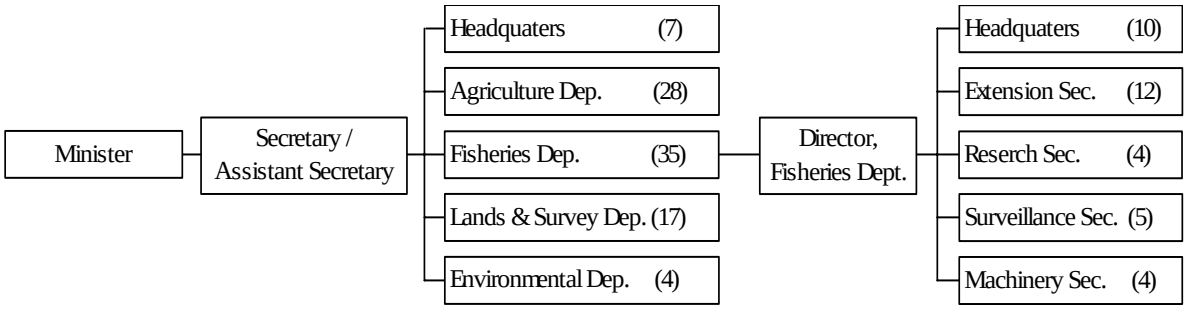
road maintenance and building repairs: and Marine, which incorporates the crew of the Nivaga II.

The main activities in the Marine Department involve management of all maritime affairs, port and channel maintenance, and the operation of inter-island marine transport. The Department is divided into 4 sections: Maritime Affairs, which oversees such areas as conformance with international maritime conventions and seamen (crew) licenses and qualifications; Shipping, which operates the Nivaga II; Port and Harbour, which performs loading and discharging operations at the Funafuti Port; and Warehousing, supervising bonded warehouses for imported cargo. Total staff of the Marine Department is 46 persons but this figure includes the officers and other licensed crew members (11) and ordinary seamen (20) serving onboard the Nivaga II.

Organization charts for the responsible body (MNRE) and implementing organization (MWEC) are shown below. The figures in parentheses after the organization name denote staff size.

(1) Responsible Organ

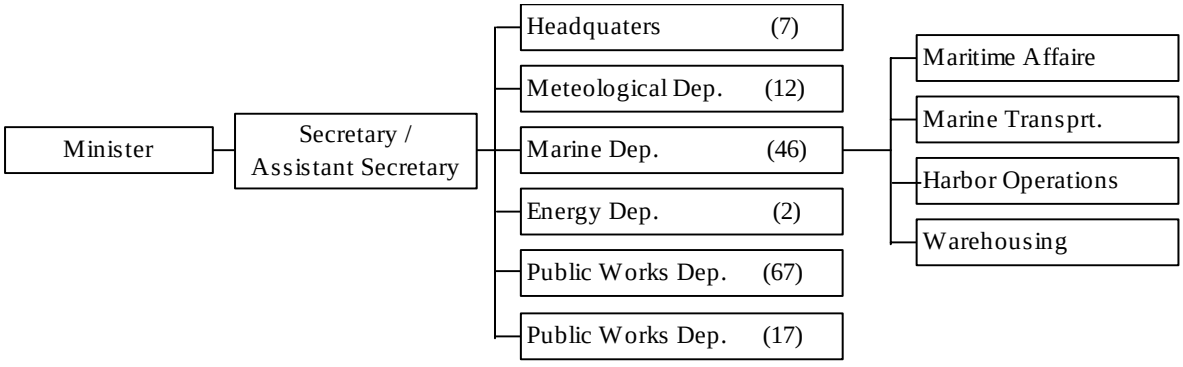
Ministry of Natural Resources and Environment (MNRE)




(91)

(2) Implementing Body

Ministry of Works, Energy and Communications (MWEC)




(152)

## 2-4-2 Budgets

Operating budgets for the MNRE and MWEC are presented in Table 14.

Table 14 Operating Budgets for MNRE and MWEC (in A$)

| Year / Organizations | 1998 | 1999 | 2000* |
|---|---|---|---|
| MNRE | 885,123 | 1,043,722 | 1,547,939 |
| Fisheries Department | 264,832 | 282,145 | 491,924 |
| MWEC | 1,965,180 | 1,954,745 | 2,622,634 |
| Maritime Department | 520,113 | 793,400 | 1,251,507 |

* 2000 figures are budget

National revenues in Tuvalu have been quite stable over the past 3 years, standing at A$27,350,000 in 1998, A$23,120,000 in 1999, A$26,510,000 in 2000. Meanwhile, current expenditures have been rising slowly, from A$11,330,000 in 1998 to A$12,160,000 in 1999, and A$14,550,000 in 2000. These surpluses have been used for developmental funding and augmenting the Tuvalu Trust Fund.

Current expenditures for 2000 show a gradual rise in both Ministries, with their shares of total national expenditures in that year at 10.6% for MNRE at 18.0% for MWEC.

The operating budget for the Fisheries Department includes an operating guidance budget for the CFCs along with operating costs for the Manaui, its fishery extension vessel. And, apart from the operating budget, A$549,000 have been appropriated as a developmental budget, intended mainly for a resource evaluation of reef fish, improvements in aquaculture ponds in Vaitupu, and the inauguration of a data analysis system.

The operating budget for the Marine Department incorporates A$688,000 (some 55% of total) for transport-related expenses for the Nivaga II. The total development budget totals A$543,000, which is intended for the purchase of loading and unloading equipment at Funafuti Port.

As an indispensable means of supporting the daily life of the people living in outer islands, the Tuvalu government has been appropriating a subsidy of about A$500,000 annually toward operating costs for the existing vessel, Nivaga II, and this subsidy is paid out of the government's Special Development Expenditure. The special development expenditure is intended for something unforeseeable payment of the government and the 2000 budget for this item is about A$10,014,000 and so, even anticipating about the same level of burden to the government owing to new operation of the planned vessel, it has been determined that the Government will be able to make the necessary budgetary arrangements for operating the planned vessel.

## 2-4-3 Personal and Technical Levels

In addition to the crew on the Nivaga II, 18 new crew members will have to be employed for the Plan vessel. The two groups of crew will be merged for deployment on either vessel. Officers will be mainly recruited from among licensed Tuvaluans currently serving on foreign vessels, while ordinary crew will be drawn also from graduates of the Tuvalu Maritime School.

There are at least 24 Tuvalu officers that would be capable of serving on the Plan vessel, but most of them are already working on foreign vessels. For this reason, it is considered that preparations should begin to develop some sort of recruitment incentive program, such as offering premiums over domestic salary scales, in order to induce qualified talent to serve on the Plan vessel.

The Tuvalu Maritime School has received certification under the STCW Convention and turns out each year 40 graduates who have earned certification as duty crew in deck and engine parts. Almost all of these graduates work for German steamship companies, where they are highly regarded. Therefore, while there will be no problems with technical levels when hiring vessel staff, in order to assemble outstanding talent, such as those with experience on foreign vessels, consideration must be given to developing a personnel incentive program whereby, for example, scholarships would be offered to help such persons acquire senior certification on a par with ship officers.

# Chapter 3 Implementation Plan

## 3-1 Implementation Plan

### 3-1-1 Implementation Conditions

When this Plan is carried out on the basis of a grant-aid from the Government of Japan, construction of the Plan vessel will proceed in the following sequence:

(1) Exchange of Notes between the Government of Japan and the Government of Tuvalu.
(2) Conclusion of a consultant contract between a consultant recommended by JICA and the responsible organ of the Government of Tuvalu.
(3) Verification of the consultant contract by the Government of Japan.
(4) The consultant will undertake the detail design and prepare the draft tender documents for approval by the Government of Tuvalu. These documents include criteria of pre-qualifications, technical specifications, general and engine room arrangements, mid-ship sections and other plans, project cost estimates, and a draft of ship building contract.
(5) Based on the approved procedures, the consultant will assist the Government of Tuvalu to make a public notice of tender in Japan, to pre-qualify applicants for the tender, who shall be Japanese nationals, and to call for the tender for the Project.
(6) After opening of the tender in the presence of the Tuvalu authority, the consultant will prepare a tender evaluation report, in which tenders will be evaluated financially and technically, and a successful tenderer will be recommended to the Government of Tuvalu for awarding the contract for the Project.
(7) The consultant will assist in contract negotiations between the Government of Tuvalu and the successful tenderer and will witness the shipbuilding contract.
(8) Government of Japan will verify the shipbuilding contract.
(9) Based on the shipbuilding contract, the shipbuilder will build, conduct trial runs for, and deliver the Plan vessel. The consultant will, in accordance with the consultant contract, provide construction supervision, and be present at various tests and the hand-over of the vessel.

The following basic items must be carefully considered in connection with project implementation.

1) The Project Implementing Agency

The agency responsible for this Project within the Government of Tuvalu is the Ministry of Natural Resource and Environment (MNRE), while the implementing agency is the Ministry of Works, Energy and Communications (MWEC). In connection with project implementation, the MNRE assisted by the MWEC will review tendering qualifications, approve tender conditions, technical specifications, and contract documents, receive monthly reports on construction

supervision, and take delivery of the Plan vessel. MWEC will serve as the liaison window in all dealings with concerned agencies of the Government of Tuvalu with regard to such matters as the issuance of a Provisional Certificate of Nationality and import procedures.

2) Consultant

Assuming that this Plan is carried out under a grant-aid from the Government of Japan, following the Exchange of Notes, a consultant contract will be signed between a consultant company recommended by JICA and the MNRE. As the proxy for the Government of Tuvalu, the consultant will prepare tender documents, including technical specifications, and assist, as required, in the tendering and contract phases, while also inspecting the construction work in the shipbuilder's yard. In the course of carrying out this inspection function, responsible engineers from the consultant will be dispatched to the shipyard at appropriate intervals during the construction period. Other specialists in charge of vessel outfitting and equipment will also be dispatched as required.

3) Shipbuilder

The shipbuilder will be selected in accordance with the following process. After evaluating the pre-qualification documents presented by companies of Japanese nationals in accordance with the tender notice, competitive tender will be solicited, based on the tender and contractual procedures established in advance. The successful tenderer under this process will sign a shipbuilding contract on lump-sum basis with the Government of Tuvalu. The shipbuilder will then construct the Plan vessel, conduct trial runs, and sail the ship to Tuvalu for hand- over.

4) Construction Plan

In connection with the vessel construction plan, the Shipbuilder will, based on the shipbuilding contract and the technical specifications, design the hull and outfitting in a manner best suited for the conditions at its shipbuilding facilities.

The sequence of vessel construction stages, following construction designs by the shipbuilder, will be as follows: hull construction, outfitting work (deck work, equipment work, electrical work), all tests, and sailing to Tuvalu. The followings points should be given careful consideration when examining the construction Plan.

a) Assuming that this Plan is implemented on the basis of a grant-aid from the Government of Japan, scrupulous adherence to the construction schedule will be a major premise. The construction plan, therefore, must be prepared so as to fulfill all contract conditions within the term of validity stipulated in the Exchange of Notes.
b) With regard to the delivery deadlines for engines and other equipment, careful consideration must be given to preventing disruption of the construction work flow by maintaining tight

control of the equipment procurement and linking the hull and outfitting stages to the delivery schedules for the related equipment.

c) Various tests are to be carried out, as determined by the Classification Society, Tuvalu Maritime Code and Japanese rules. The required trial runs are to be performed upon completion of the construction phase to verify vessel performance.

d) At the final stage of the construction phase, engineers will be invited from MWEC to be present during the trial runs and turnover inspection. These engineers will also travel aboard the new vessel to Tuvalu, receiving appropriate guidance en route so as to acquire competence in and familiarity with new vessel operations.

e) After accepting the provisional certificate of nationality from Tuvalu government, the vessel will be brought from the dockside of the shipyard to Funafuti port under the responsibility of the shipbuilder. On its arrival at Funafuti port, the vessel will be checked of its main performance, and then turned over to the Government of Tuvalu.

f) Over one month after the turnover, two engineers sent from the shipbuilder provide training program on operation and maintenance of the ship. The implementing agency has to secure the crew, fuel and proceeding for navigation before the start of the program.

## 3-1-2 Special Considerations with regard to the Building Work

(1) The Plan vessel has to be a safe vessel as a whole and *inter alia* for passengers, applying safety standards: Tuvalu Merchant Shipping Act, South Pacific Maritime Code, and Japanese Ship Safety Regulations to supplement aforementioned regulations.

The shipyard is required to be well acquainted with this requirement to build the Plan vessel.

It is necessary for the shipyard to read Tuvalu Maritime Regulations and South Pacific Maritime Code from early stages, because those regulations are relatively unfamiliar to the Japanese shipbuilders.

(2) It is necessary to draw up and execute a detailed construction schedule, in order to complete the hull construction work, outfitting work for accommodations, machinery and cargo hold, within the set schedule.

## 3-1-3 Allocation of Building Responsibility

### (1) Responsibilities to be assumed by the Government of Japan

Assuming the Plan is carried out under a grant-aid from Japan, the Government of Japan will assume responsibility for the following phases:

1) Construction of the planned vessel and its transportation to Tuvalu

2) Procurement and delivery of the equipment

3) Consultant services, including the detail design, assistance of the tender process as well as building supervision.

(2) Responsibility to be assumed by the Tuvalu Government

As both building of the Plan vessel and equipment procurement are carried out in Japan, the Government of Tuvalu has no responsibility for these matters. It is necessary however to complete the employment of new crew for the vessel in order to receive instruction on navigation and maintenance, as soon as the turnover of the vessel at Funafuti port.

## 3-1-4 Construction Supervision Plan

Following conclusion of the shipbuilding contract, the consultant, based on the consultant contract with the Government of Tuvalu, will approve the construction plans prepared by the shipbuilder and conduct inspections on equipment manufacture. In addition, it will implement a program of construction supervision by dispatching engineers to the shipyard for required periods of time. Also, as construction progresses, the Consultant will dispatch personnel in charge of outfittings and equipment to manufacturing plants and the shipyard for attendance during inspections and tests. Moreover, the consultant will attend to the turnover of the Plan vessel as well.

## 3-1-5 Materials and Equipment Procurement Plan

(1) Main Outfittings

The main engines, generators, cranes, navigational aids etc. are to be sourced in Japan, since these products are manufactured in Tuvalu. Following are the planned procurement source arrangements for the main of outfitting items incorporated in the Project.

Table 15 Sources for Procurement

| Main Outfitting | Sources |
|---|---|
| Main engine | Japan |
| Generator engine | Japan |
| Radio navigational aids | Japan |
| Cargo cranes | Japan |
| Paint | Japan |
| Other equipment of outfitting | Japan |

(2) Surfboat

Surfboats for the Plan vessel to be used to unload cargoes and transport the passengers will be procured in Japan, since it is difficult to be built in Tuvalu.

## 3-1-6 Implementation Schedule

In preparing the construction progress schedule, it is necessary to examine the nature of each phase, determining those phases which must be finished in advance of the main construction work, those that can proceed simultaneously, and those which can be completed independently. After further consideration of equipment procurement, construction period, and construction costs, an optimum construction period has been established. It is presumed that the various outfitting items will be procured in Japan.

The principal construction phases and the nature of the work involved in each phase may be broadly classified as follows.

### (1) Hull construction

Hull construction phase is for assembling hull structure, which maintains necessary buoyancy and structural rigidity to withstand external and internal forces, e.g. wave loads, cargo loads, etc.

This work generally comprises individual block section construction and block assembly work to form the hull structure.

### (2) Deck outfitting

This phase follows completion of the hull work. It comprises installation work of mooring equipment, steering gear, galley, sanitary fixtures and other amenities, air conditioning, lifesaving and fire-fighting equipment, and other relevant construction.

### (3) Machinery outfitting

This phase will comprise installation work on the main engine, generator sets, and pumps in the engine room, along with relevant auxiliaries and piping work.

### (4) Electrical outfitting

Installation of switchboards and cabling work will be performed to furnish and control power supply to the various equipment that have been installed during the aforementioned outfitting work phases.

### (5) Commissioning tests and sea trials

Pursuant to the above construction phases, a series of tests will be performed, as required by the Classification Society and other rules and regulations, along with trial runs at sea to confirm satisfactory performance of the ship, e.g. structural strength, stability, speed, etc.

### (6) Transportation

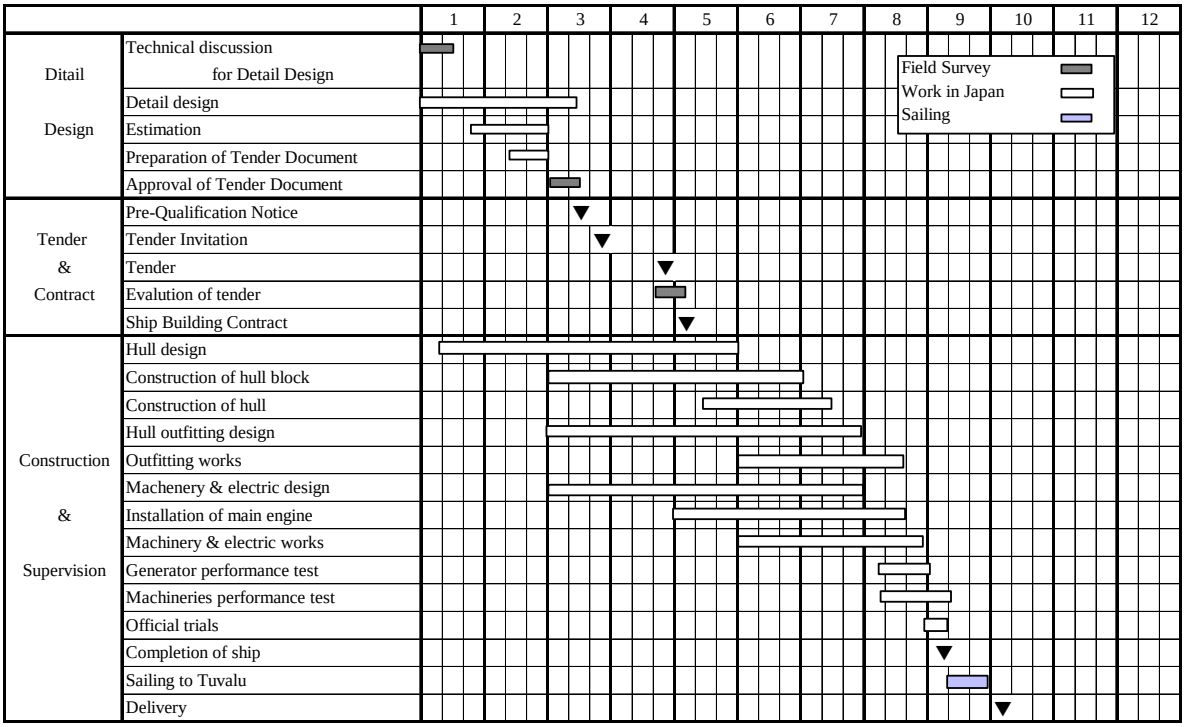
Following the trial runs and completion of the Plan vessel at the shipyard, the vessel will be

delivered to the Government of Tuvalu. The shipbuilder however is responsible under the contract for transporting the vessel from the shipyard to Tuvalu.

The time required for project implementation is estimated at about 2.5 months for the detail design, about 1.5 months for the tender procedures, about 2.5 months to keel laying, 4.5 months before launching, another 2 months for delivery at the shipbuilder, and 1 month for transportation to Funafuti port and handover to the Government of Tuvalu. Consequently, it will take 13.5 months to complete the Project, from the detail design to handover.

The construction progress schedule is shown in the following table.

Table 16 Construction progress schedule




## 3-1-7 Obligations of recipient country

Assuming that the Plan is carried out on the basis of a grant-aid from Japan, the Government of Tuvalu will be responsible for the following items:

(1) Maintenance of port facilities, navigation channels, berthing jetty and mooring areas, as required for Plan vessel operations
(2) Obtaining those permits and approvals that must be issued in Tuvalu in connection with construction and sailing of the new vessel, such as a provisional certificate of nationality.
(3) Duty exemptions and prompt customs clearance in connection with importation of the Plan vessel and all related equipment and materials into Tuvalu during Project implementation.

(4) Exemption from taxes and surcharges on Japanese nationals rendering project-related services in Tuvalu.

(5) Making banking arrangement with a bank in Japan and issuing Authorization to Pay in connection with project-related contracts verified by the Government of Japan.

(6) Any other items required for Project implementation that are not specifically included in the areas of responsibility assumed by the Government of Japan.

## 3-2 Operation and Maintenance Plan

### 3-2-1 Cruising Plan for the Plan Vessel; Income and Outgo Forecasts

#### 3-2-1-1 Cruising Plan

The Plan vessel will be placed in service exclusively on domestic routes The Plan vessel will be faster than the Nivaga II, but actual cruising plans are not determined solely on the basis of sailing time to destination but are also affected by the required moorage times and tidal conditions on arrival at the outer islands. In setting the cruising plan for the new vessel, it is essential that priority be given to maintaining regular schedules, which has been the major deficiency of the existing vessel.

While the Nivaga II establishes an operating schedule each year, it has not operated according to plan as a result of various factors, such as emergency transport demands. Table 17 compares the 1999 cruising plan with actual operating results.

Table17 Planned and Actual Times of Call by Island (1999)

| Name of Island | Nanumea | Niutao | Nanumanga | Nui | Vaitupu | Nukufetau | Nukulaelae | Nuirakita |
|---|---|---|---|---|---|---|---|---|
| Calling plan | 15 | 15 | 14 | 16 | 28 | 17 | 13 | 7 |
| Actual calling | 14 | 14 | 15 | 15 | 23 | 12 | 11 | 10 |

With the exception of Vaitupu and Nukufetau, where port calls were limited in number, few differences were observed between planned and actual times. However, in terms of the number of voyages, only 31 of the planned 49 trips were actually made. This means that, with the reduced number of voyages, the vessel was, in practice, assigned to many islands, obliging it to make many detours -- e.g., by covering Northern and Central or Central and Southern routes on the same voyage. These meandering courses were the essential cause of the breakdown in schedules.

It is anticipated that the Plan vessel will find it much easier to maintain schedules than previously. This is because the new vessel will presumably be subject to fewer breakdowns than the present vessel while, in cases where the planned schedule cannot be kept, the Nivaga II will still be available to assist. Accordingly, the cruising plan for the Plan vessel will not be substantially altered from the 1999 plan for the existing vessel. The annual number of trips by the new vessel will be set at 56, with 28 for the Central route, 15 for the Northern, and 13 for the Southern. Of the 28 Central route trips, 17 will call at all 3 Central islands, while 11 will sail only to Vaitupu. The required mooring time at Funafuti Port for loading/unloading and reprovisioning will be set at 2.5 days per trip.

In addition, the Plan vessel will have to go Fiji or New Zealand for annual dry dock servicing, which will require about 13 days for the round trip crossing.

Additional time must also be set aside for regular servicing in Tuvalu on the hull and machinery. Based on the above considerations, the annual number and breakdown of operating days for the Plan vessel have been developed as shown in Table 18.

Table 18 Annual Number of Operating Days for the Plan Vessel

| Navigation Route | No. of Navigation | No. of Days / Navigation | Total Navigation Days |
|---|---|---|---|
| Northern Islands | 15 times | 4 days | 60 days |
| Central Islands | 17 times | 3 days | 71 days |
| Vaitupu only | 11 times | 2 days | 22 days |
| Southern Islands | 13 times | 3 days | 39 days |
| Total Navigation Days | | | 192 days |
| Mooring days at Funafuti Port | 56 navigation x 2.5 days | | 140 days |
| Days for maintenance service | | | 20 days |
| For Dry Dock in Fiji or N.Z. | | | 13 days |
| Total | | | 365 days |

### 3-2-1-2 Revenue Plan

In this Section, forecast is made on revenue for the Plan vessel based on a scheduled 56 voyages per year. Revenue sources for the new vessel, as with the existing vessel, break down into 3 categories: canteen proceeds, passenger fares, and freight revenue. Since the Plan vessel will operate on the same tariffs as in the 1999 operating plan for the Nivaga II, revenue has been calculated on the basis of 1999 forecasts for the latter vessel. The initial 1999 revenue forecast for the Nivaga II totaled A$367,000, distributed as follows: canteen A$57,000, passenger A$210,000, and freight: A$100,000.

The above revenue forecasts for the Nivaga II in the canteen and passenger categories included passenger receipts during the trips to Suva in Fiji, but cargo revenues were solely of domestic origin. Thus, extracting the estimated canteen and passenger receipts for the Funafuti-Suva crossings and assuming that the Plan vessel will serve only domestic routes, a revenue forecast has been prepared, as shown below:

| | |
|---|---|
| Canteen | 21,100 A$ |
| Passenger | 126,300 A$ |
| Freight | 100,000 A$ |
| Total | 247,400 A$ |

### 3-2-1-3 Operating Expenses

Operating expenses for the Plan vessel have been estimated on the basis of the following breakdown: fuel costs, crew wages, maintenance costs (including dock charges) , and other expenses.

#### (1) Fuel Costs

Engine composition for the Plan vessel includes: 2 main engines -- 368 kW (500 ps), 2 generator engines-- 155 kW (210 ps), and a harbour generator-- 55 kW (75 ps).

Estimating fuel consumption per hour for each engine and projecting their respective operating hours from cruising distances, based on an annual schedule of 56 trips, and multiplying fuel consumption by diesel prices in Tuvalu, and then finally setting lubrication oil costs at a flat 2.5% of fuel costs, we arrive at the following annual fuel budget:

| | | |
|---|---|---|
| Diesel oil | 432kl x 790 = | 341,280 A$ |
| Lubrication oil | | 8,530 A$ |
| Total | | 349,810 A$ |

The details of fuel oil consumption are shown in Appendix 5-1.

#### (2) Crew Wages

Annual crew wages for the Plan vessel have been based on the 2000 Tuvalu wage scale for government employees plus 10% for pension reserves and 30% for other allowances and compensation. Total wages for vessel personnel have been calculated at A$138,500.

Adding 10% for pension service and 30% for other allowances, total crew salaries and related costs come to A$194,000. The salary structures are indicated in Appendix 5-2.

(3) Maintenance Costs

In the case of a new vessel kept in prime condition, maintenance costs over the initial 3 years can be expected to run less than half normal maintenance charges. In the case of the Nivaga II, annual maintenance costs for years without major repairs have run A$180,000-220,000. On this basis, we have appropriated an annual maintenance budget for the first 3 years of life in the order of A$90,000.

(4) Other Expenses

A$75,000 is appropriated for crew provisions which is 75% of the actual expenditures on the Nivaga II for 1999 (after pro rata adjustment for the smaller crew on the Plan vessel). Provision must also be made for other costs, such as linens (as required on a passenger vessel), communications, purchase of safety equipment, and inspections. A$20,000 is appropriated for these expenditures, the same amount as incurred by the existing vessel.

The operating costs for the Plan vessel, as calculated above, are shown in the income/outgo table on the following page.

## 3-2-2 Operating Income and Expenditures

The balance of income and outgo for the Plan vessel is forecast as follows:

Table 19 Operating Income and Expense for Plan Vessel

| (1)Revenue | A$ |
|---|---|
| Canteen | 21,100 |
| Passenger | 126,300 |
| Freight | 100,000 |
| Total Revenue | 247,400 |
| (2)Expenditure | |
| Fuel | 349,810 |
| Crew wages | 194,000 |
| Maintenance Cost | 90,000 |
| Provisions | 75,000 |
| Expendable Items | 5,000 |
| Inspection Fees | 15,000 |
| Total | 728,810 |
| (3)Balance | |
| (1) – (2) | -481,410 |

As shown above, based on 56 trips a year, the Plan vessel will require about A$730,000 for the operating expenditure. Out of this expenditure, the maintenance cost is estimated at about A$90,000 per year for the first three years of operation, however this cost will increase relative to vessel's age, as indicated by the maintenance cost of Nivaga II, which is now more than 13 years after completion and costs about A$180,000 to 220,000 per year. In the case of the Plan vessel however, the secular increase

in the maintenance cost will be lower than the existing vessel, on account that the Plan vessel will be supplied with extra spare parts of the principal equipment onboard and that the Preventive Maintenance Policy is expected to be applied, as recommended by this report, in the maintenance program.

The operating income on the other hand is expected at about A$247,000 per year, which is almost the same level as the existing vessel and thus deemed rather conservative estimation. The total amount of the Tuvalu government's operation subsidy required for the Plan vessel will therefore run at about A$480,000 a year.

There will be certain ways of improving on this performance. Direct costs could be reduced by allowing either the Nivaga II or the Plan vessel to make special trips to purchase fuel or reprovision in Fiji, while administrative costs could also be lowered. On the revenue side, in line with electrification projects on the outer islands, local governments might be induced to defray a portion of the fuel shipments, thereby increasing cargo revenues. We have, nevertheless, come to the conclusion that, for the time being, the Plan vessel should be given the same size governmental subsidy as the Nivaga II in light of the considerable benefits the Tuvalu people will receive from the much improved scheduling and reliability that this Plan will bring to the nation's only domestic transport system.

### 3-2-3 Utilization Plan for the Present Vessel

When the Plan vessel will commence its service in Tuvalu, the existing vessel Nivaga II will support the Plan vessel by providing extra domestic transport in case of emergency or during the dry dock of the new vessel. Based on these alternative transport means, the new vessel can keep on the regular schedule, and reliable inter-island shipping service structures will be made available for the first time in Tuvalu, which are expected to boost the economic activities including fisheries on the outer islands.

While the Nivaga II is not in service, the Government of Tuvalu is planning to use the existing vessel to transport Tuvalu people mainly to Suva, Fiji through the international voyage. There are some 750 Tuvalu nationals presently reside in Fiji, of these about 500 are students. Currently, there are 2 scheduled flights a week between Funafuti and Suva, all in 30-seat aircraft. However, airfares are high: A$510 one-way. For this reason, there is a brisk demand for vessel transportation and the Government intends to meet such demand not only for students but for the general public in Tuvalu. In this case however, consideration should be made for the economic return of such voyage to and from Fiji, and the Nivaga II should therefore engage in transport of breakbulk cargo from Fiji together with passengers, as Nivaga II is capable of carrying some 200 $m^3$ of breakbulk cargo per trip. If the Nivaga II could offer even slightly more favorable cargo rates than container vessels, it should be able to earn the cooperation of TCS, which is a leading cargo importer in Tuvalu. From the above point of view, the Tuvalu Government's plan to utilize the existing Nivaga II can be deemed appropriate if passenger and cargo transport setup can be realized.

## 3-3 Maintenance and Management Plan

### 3-3-1 Maintenance program

Tuvalu is far from industrial countries, and generally taking long time to procure spare parts and after-services, thereby suspension of operation can happen due to breakdown of important machinery. Therefore, daily maintenance is important especially in Tuvalu.

For the Plan vessel, preventive maintenance policy (PMP) should be introduced. PMP carries out maintenance work according to pre-determined schedule and procedure even if the subject machinery is not in failure. To start the system, initial investment on preparation of spare parts is necessary, but breakdown due to excessive wearing and lack of maintenance will become minimum, and life of parts will be longer, so that purchase of spare parts will become less.

### 3-3-2 Maintenance program of important machinery

Standard timetable of parts replacement is specified in the manual for every part of machinery. According to timetable, parts is removed and replaced with stowed spare parts. The removed parts are cleaned, prepared, stowed on spare shelves, and made ready for next replacement.

Fig. 1.4-3 shows schedule of cylinder head replacement for main engines or main gensets. Cylinder heads are replaced at every 12 months for one engine, so that one engine will have new cylinder heads at every two years. Interval of parts replacement depends on respective parts. Pistons and cylinder liner usually allows longer interval than cylinder heads. Suitable replacement interval should be determined according to standard running hour for replacement recommended by engine maker. Such parts as not possible to overhaul in the workshop, like governor, should be sent to the maker for overhaul after removal.

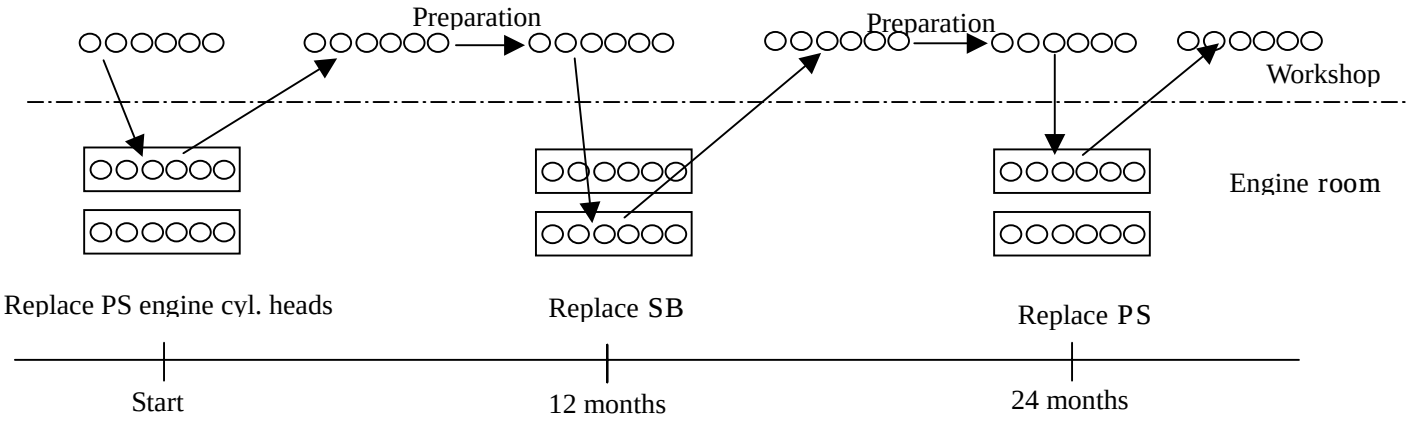



Fig. 7 Parts replacement program for cylinder

Spare parts of major engine plant necessary for PMP will consist on following.

| | | |
|---|---|---|
| Cylinder head assembly | 1/2 of working nos. | for periodical exchange |
| Piston and connecting rod | 3 | for periodical exchange |
| Cylinder liner | 3 | for periodical exchange |
| Main bearing | 1/2 of working nos. | for periodical exchange |
| Fuel injection pump | 1/2 of working nos. | for periodical exchange |
| Governor | 1 | for periodical exchange |
| Turbocharger | 1 | for periodical exchange |
| Attached pump parts | each 1 | for workshop maintenance |
| | Fuel oil supply pump to be complete spare | |
| Fuel injection valve | 2/2 of working nos. | for workshop maintenance |
| Suction valve | 2/2 of working nos. | for workshop maintenance |
| Exhaust valve | 2/2 of working nos. | for workshop maintenance |
| Piston ring | 2/2 of working nos. | for workshop maintenance |
| Gasket and consumables | 2 times of working nos. | as consumable |

Shafting

| | | |
|---|---|---|
| Propeller (ps and stb) | each 1 | for exchange in dock |
| Propeller shaft (ps and stb) | each 1 | for exchange in dock |
| Stern tube bearing | 2 | as spare in emergency case |

# Chapter 4 Project Evaluation and Recommendations

## 4-1 Assessment of Project Appropriateness and Benefits

The subject Plan is intended to fund an inter-island passenger/cargo vessel, dedicated to domestic routes, and to energize fishing and other economic activity on the outer islands of Tuvalu by improving the stability and reliability of domestic maritime transport, which is the nation's only means of inter-island transportation. In this section, we will discuss the problems that are to be resolved by Plan implementation as well as the nature, scope, and effectiveness of the benefits that this project will bring.

### ⑴ Improvement in the Regularity and Reliability of Domestic Marine Transport

The Nivaga II, which serves as the existing inter-island transport vessel, has been experiencing an increase in non-operating hours, owing to super-annuation, while also being subject to calls to meet emergency domestic transport demands. As a consequence of these factors, domestic scheduling has broken down, causing delays in the transport of both passengers and cargoes and increasing concern over the status of the people's livelihood. For example, the original annual cruising plan for 1999 called for 49 cruises, of which only 31 were consummated. This made it necessary to increase the number of islands visited per trip, resulting in shortages of basic necessities and fuel oil, as required by the fishing industry, along with a decline in administrative services on these islands. This situation has not only had a serious impact on the full spectrum of everyday life on the outer islands (home to some 60% of the nation's population) in terms of economic activity, health care, education, and diet, but the country has also been compelled to draw down its precious foreign exchange reserves to charter foreign vessels to meet domestic transport requirements.

Based on the addition, under the subject Plan, of a new passenger/cargo vessel dedicated solely to domestic transport, it will be possible to share the functions provided by the existing vessel and thereby supplement domestic transport capability. A major improvement is planned in the regularity and reliability of inter-island transport, with a projected 20% increase in the number of trips and a minimum 10% increase in the number of port calls, as compared with the performance of the present Nivaga II.

### ⑵ Stimulation of Economic Activity on the Outer Islands

As a nation far removed from the major international markets, with severe constraints on agricultural production imposed by its limited land area and soil and a dearth of land-based natural resources, Tuvalu is saddled with various handicaps in economic development. In this

context, development of the marine resources within Tuvalu's extensive 200-mile zone has been recognized as a leading sector contributing to national economic growth.

Fishery activity has an important role in providing animal proteins to the country's population; for example, according to the 1991 Population and Housing Census, some 75% of the nation's households were found to be engaged in some form of fishing activity. In Tuvalu, which has been compelled to rely on a single inter-island transport vessel for the movement of all cargoes and passengers among the various islands, it would hardly be logical, from a macro-economic standpoint, to provide a domestic transport system geared solely to fishery development.

In the subject Plan, general cargoes as well as shipments of fish, meats, dairy products, and vegetables will all be efficiently moved. In addition, at islands lacking landing facilities, surf boats are to be provided to permit efficient loading and unloading operations. And, with respect to passenger traffic as well, the intent is to expand accomodation areas and ensure safe movement among the various islands for both the general population and government officials. In this way, while achieving a smooth flow of goods to the various islands, it will also become possible to deliver to each island an equitable share of public services, including medical care. By expediting the movement of both people and cargoes, it can be expected that fishery development, centering around the CFCs, along with other forms of economic development, will be fostered on the various islands.

### ⑶ Enhanced Social Benefits based on the Use of Vessels Dedicated to Their Intended Operations

Under existing conditions, when the Nivaga II is unable to operate on domestic routes, only two Tuvalu-owned vessels can be mobilized to fill the void: a patrol boat and a fishery extension vessel. Even using both vessels, their combined transport capacity would not even begin to approach that of the Nivaga II, but this is presently the only option available for responding to emergency transport calls and so, in the past, both vessels have been frequently enlisted to meet domestic requirements. Since the patrol boat, in particular, has a high cruising speed, heavy demands are made on this vessel for emergency transport needs, often forcing it to abandon its regular duties to provide such services. However, since its surveillance duties within the 200-mile zone are also vital to the nation's interests, the practice has been to refrain from calling on this vessel to perform emergency services beyond its normal range of duties, other than in matters affecting human life.

The fishery extension vessel is small, with inferior carrying capacity. Its maximum cruising speed is about 8 kt but, being highly suitable for shipments between nearby islands, it is quite frequently used for cargo purposes. In 1999, for example, whether calculated in terms of the

number or length of trips, the usage ratio for the vessel's intended functions was only about 55%, with the remainder divided among a variety of uses, such as education, police, Tuvalu Cooperative Society (TCS), Tuvalu Broadcasting, and charter service for foreign survey groups.

Based on the introduction of the Plan vessel, it is expected that calls on the above two vessels to engage in domestic transport operations will noticeably decline. It is particularly significant that the time that can henceforth be devoted by the fishery extension vessel to its original functions will greatly expand. With a chilled/refrigerated hold of $8m^3$, this vessel is well suited to experimental fishing and resource survey activities. As a matter of fact, during 1999, its normal operations included the transport of CFC catches, equipment, and fuel together with experimental fishing, transport of fishery extension personnel, and environmental protection duties.

With the completion of the CFCs on the outer islands, there will be a mounting need for operational support and technical guidance on the part of the Fisheries Department, in which fishery extension activity will play an essential role. And when CFC operations get fully on track, the fishery extension vessel can be expected, under the guidance of this Department, to make a direct contribution toward raising cash incomes on the outer islands.

## 4-2 Project Connections with Technical Cooperation and Other Donors

In order to lower future maintenance costs for the Plan vessel, it is planned to introduce, under the subject Plan, a Preventive Maintenance Policy (PMP). The essence of PMP is a system of parts replacement at fixed time intervals, as opposed to replacing components only when they break down or wear out, with replacement components kept on hand. We believe that present technological levels in Tuvalu will be adequate to cope with PMP requirements. However, considering the fact that the maintenance techniques for the Plan vessel will be new to Tuvalu, even in the case of parts that have not broken down or worn out (i.e., are still serviceable), we have concluded that technical cooperation from Japan or other countries with advanced maritime transport know-how would be effective in the area of maintenance methods.

In the case of the above-mentioned patrol boat, maintenance is presently carried out at a specialized workshop on shore, which has benefited greatly from technical guidance from the Australian specialists, resulting in high standards of maintenance for this vessel. Judging from this experience, we feel that the maintenance program for the Plan vessel would be greatly enhanced by the dispatch of a specialist under a technical cooperation arrangement.

With respect to Plan implementation, there is no plan to seek assistance from any other country or international organization.

## 4-3 Special Considerations and Recommendations

The main area of focus in connection with Plan implementation involves lowering of vessel operating costs or to provide still greater benefits with the same level of costs to the Tuvalu people.

Cost reductions may be categorized into direct operating costs and those operating costs that are recoverable through an increase in operating revenues.

Reductions in direct costs can take two forms: (1) curtailment based on rationalization within the operating organization; and (2) long-term reductions in maintenance costs based on improvements in maintenance methods. While 18 crew members and relief personnel will be newly hired by the Plan vessel, current salary scales for government workers in Tuvalu will hardly be sufficient to attract qualified Tuvalu seamen currently serving on foreign vessels. Rather it will be necessary, in recruiting new staff, to offer supplementary allowances and other incentives to secure superior personnel. However, in terms of crew administration, we believe it would be advantageous to achieve economies in overall operating costs on the basis of administrative reforms – for example, by strengthening the captain's authority over crew management or introducing a system of job evaluation which would be reflected in the salary structure. Alternately, the vessel side could, whenever feasible, carry out painting and other hull maintenance work on its own, applying the resulting savings over foreign dry-dock costs to the crew wage budget.

It is clear that long-term reductions in operating and maintenance costs can be achieved by faithfully executing the Preventive Maintenance Policy (PMP), as discussed above. It is vital, therefore, that this system by smoothly implemented.

With regard to an effort to increase operating income, revenues could be expanded by initiating a program of shipping fuel to the network of power generating stations that is being built and in the course of completing electrification programs on the outer islands. Based on this plan, a total of six 100-kva and twelve 60-kva generators are to be installed on the outer islands (i.e., excluding Funafuti), and these facilities should tentatively result in a maximum fuel demand of 5,000 drums annually. How this fuel can be efficiently carried will indeed have a major bearing on the Tuvalu economy in the years ahead. Leaving aside the issues of establishing fuel transport rates and fixing responsibility for determining their level and form, it should be recognized from the outset that the Plan vessel will play a major role in efficiently transporting generator fuel to the outer islands. We have, thus, concluded that the opportunity to ship this fuel will enable the Plan vessel to provide a new benefit to the Tuvalu people, one that the existing vessel (Nivaga II) would not be in a position to deliver.