No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
UPGRADING OF ELECTRIC POWER SUPPLY
IN
FUNAFUTI ATOLL, TUVALU

MAY 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
GRANT AID MANAGEMENT DEPARTMENT

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05-062

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 Upgrading of Electric Power Supply in Funafuti Atoll, Tuvalu and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tuvalu a study team from November 29 to December 19, 2004.

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.

May, 2005

Seiji Kojima
Vice-President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

May, 2005

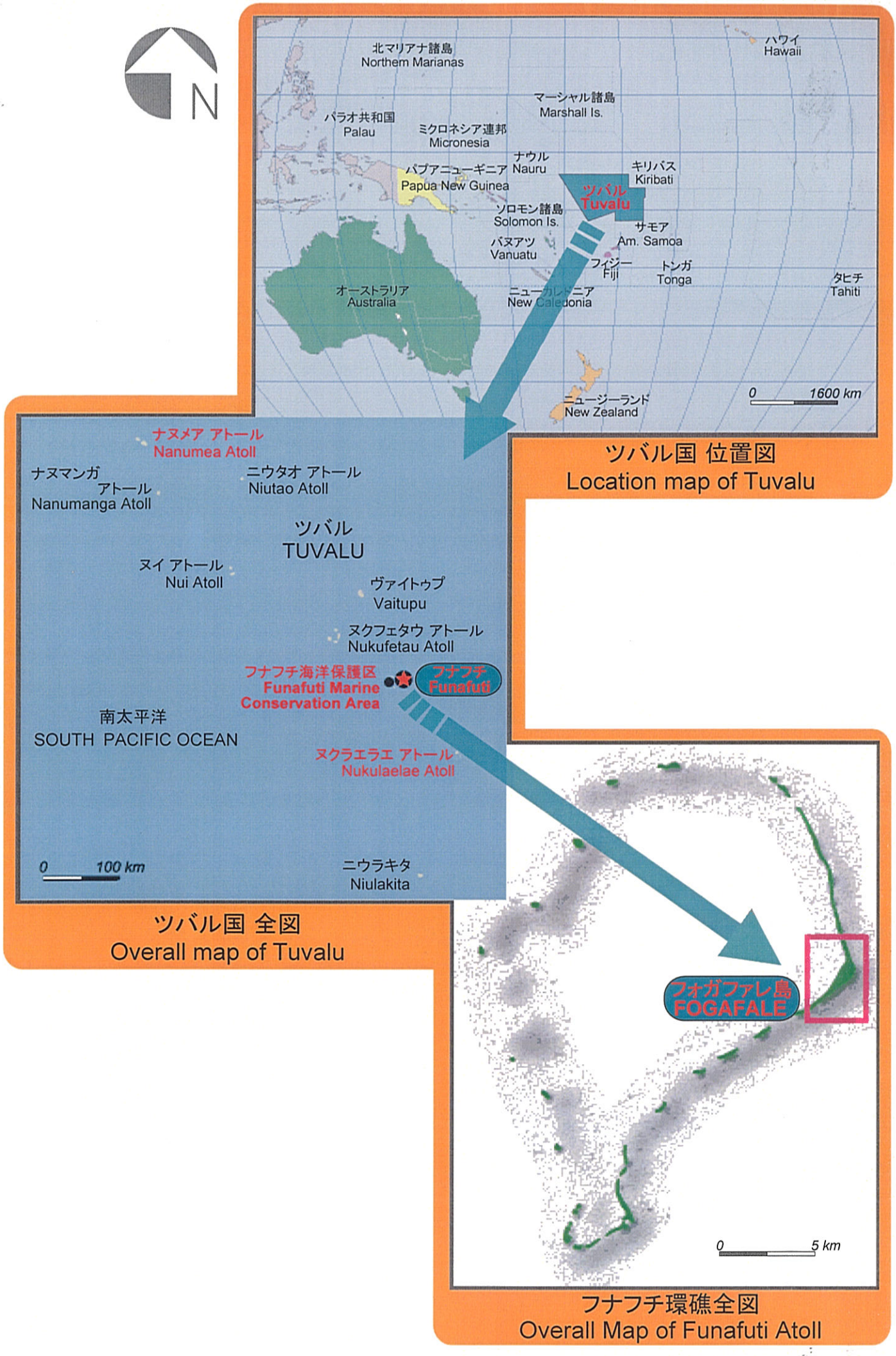
We are pleased to submit to you the basic design study report on the Project for Upgrading of Electric Power Supply in Funafuti Atoll, Tuvalu.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from November, 2004 to May, 2005. 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,

Mitsuhisa Nishikawa
Project Manager,
Basic design study team on the Project for
Upgrading of Electric Power Supply in
Funafuti Atoll, Tuvalu
Yachiyo Engineering Co., Ltd.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Kiribati
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Location map of Tuvalu
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Vaitupu
ヌクフェタウ アトール
Nukufetau Atoll
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Overall map of Tuvalu
フォガファレ島
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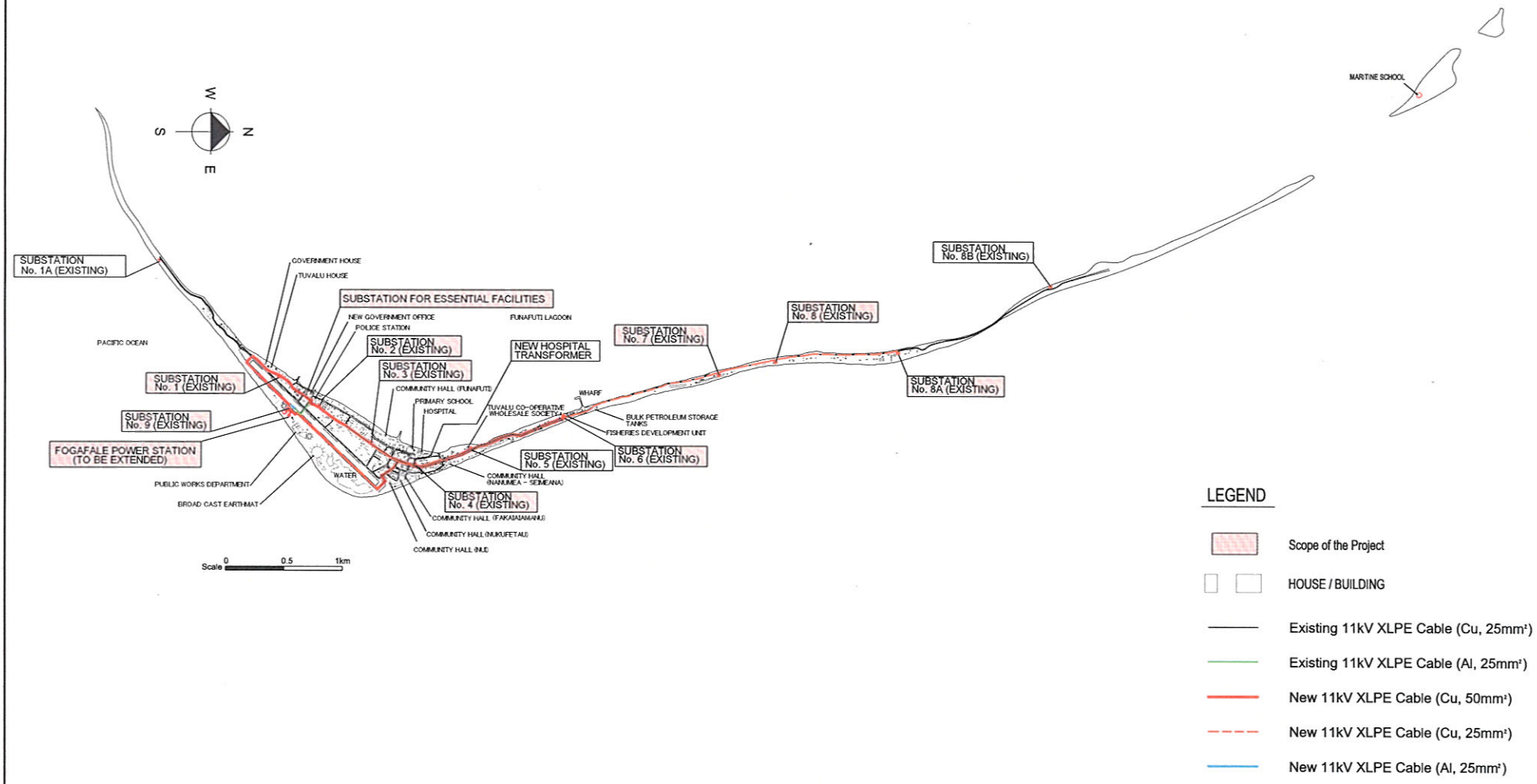
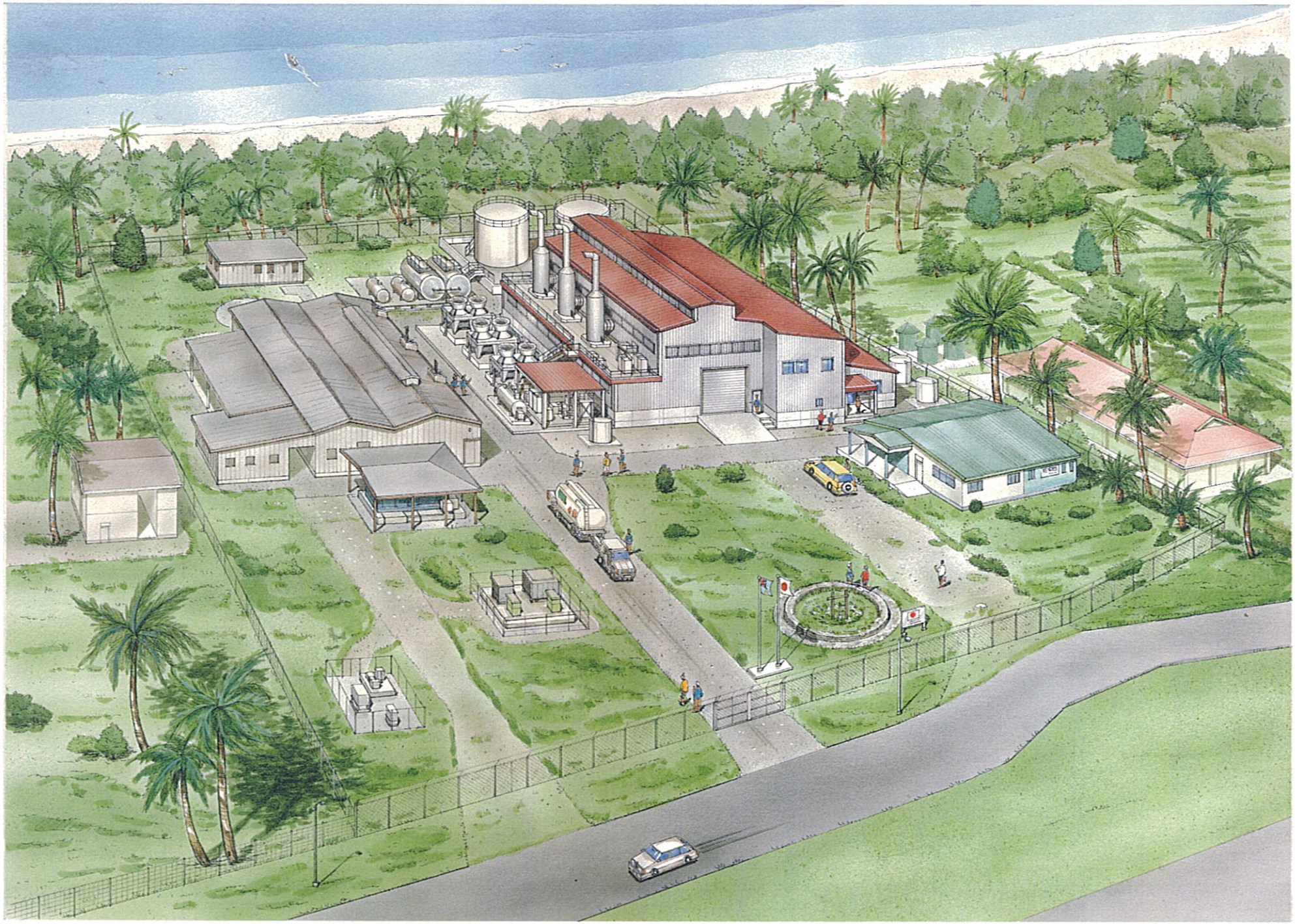
Overall Map of Funafuti Atoll



Location of Project Sites



THE PROJECT FOR UPGRADING OF ELECTRIC POWER SUPPLY IN FUNAFUTI ATOLL

LIST OF FIGURES AND TABLES

[Chapter 2]

ABBREVIATIONS

ADB	Asian Development Bank
AIJ	Architectural Institute in Japan
AS	Australian Standards
ASEAN	Association of Southeast Asian Nations
A$	Australian Dollar（1 A$=80.29JPY, Average of TTS rate from Jun. to Nov., 2004）
DEG	Diesel Engine Generator
DT	Distribution Transformer
EIA	Environmental Impact Assessment
EU	European Union
E/N	Exchange of Notes
G/C	Grant Contract
GDP	Gross Domestic Product
GNI	Gross National Income
IEC	International Electrotechnical Commission
IEE	Initial Environmental Examination
ISO	International Organization for Standardization
JEAC	Japan Electric Association Code
JEC	Japanese Electrotechnical Committee
JEM	Standards of Japan Electrical Manufacturer's Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
MCCB	Mold Case Circuit Breaker
MWE	Ministry of Works and Energy
O&M	Operation and Maintenance
OJT	On the Job Training
RMU	Ring Main Unit
TEC	Tuvalu Electricity Corporation
TTC	Tuvalu Telecommunication Corporation
XLPE	Cross Linked Poly Ethylene

SUMMARY

Tuvalu is an atoll country consisting of nine atoll islands in the south Pacific. The total land area of these islands is approximately 26 km^2 with a total population of some 96,000 (2002 Population Statistics). The GNI per capita is US$ 1,380 (2002 estimate of the Asian Development Bank).

The Vision 2015 (1998–2015), which is the national development strategy of Tuvalu, formulates development programmes for five priority areas: (i) human resources development, (ii) reform of the public sector, (iii) development of the private sector, (iv) development of remote islands and (v) development of basic infrastructure. Among these priority programmes, power supply is considered to be an important part of the programme for the development of basic infrastructure. Meanwhile, Tuvalu's National Energy Policy which was introduced in 1995 identifies such priority policies as economical and reliable power supply in urban areas, promotion of social and economic development in rural areas through economical and reliable power supply and promotion of the utilisation of renewable energies regarding energy sources.

In Tuvalu, the Tuvalu Electricity Corporation (TEC) is responsible for the planning, operation and maintenance of power generation and distribution facilities under the supervision of the Ministry of Works and Energy (MWE) and electric power is almost entirely generated by diesel generators. Power supply for Funafuti, the capital of Tuvalu, is provided by a single diesel power station (Fogafale Power Station) and the 11 kV/415 V/240 V distribution network. However, this power supply is unstable because of the insufficient capacity and deterioration of both the generating and distribution equipment as described below.

The power supply facilities in Funafuti were originally developed with the assistance of the UK, the former suzerain state of Tuvalu, and the EU. These facilities are now quite deteriorated after nearly 20 years of operation and face an overload because of an increase of the power demand. This situation is causing frequent failures of the generating as well as distribution facilities, making the stable supply of power difficult. In the 10 year period from 1993 to 2003, the peak demand doubled with an average annual increase rate of as high as 7.46% while the increase of the supply capacity has fallen short of the demand increase, necessitating regular power cuts in recent years.

The weak power supply system described above is hampering the functions of Funafuti as a political and economic centre in Tuvalu and is seriously affecting not only such government services as health, hygiene and education but also the lives of its citizens. In the face of this situation, the power sector in Tuvalu considers "the development of the supply capacity through the installation of new

generating facilities" and "improvement of the power supply reliability through renewal of the distribution facilities" to be the most urgent tasks. However, the financial difficulties faced by this sector make the achievement of these tasks difficult.
Under these circumstances, the Government of Tuvalu made a request to the Government of Japan for the implementation of a grant aid project for the installation of new generating units (600 kW x 4) and the construction of a power house at the Fogafale Power Station and the upgrading of the 11 kV distribution network for the purpose of reinforcing and expanding the power supply facilities which comprise essential social infrastructure for the maintenance of the capital's functions, the stable operation of social and public facilities and improvement of the living standard of the citizens in Funafuti.

In response to this request, the Government of Japan dispatched the JICA Preliminary Study Team to Tuvalu from 12th to 29th July, 2004 to study the relevance and urgency of the request and the situation of operation of the power sector in Tuvalu. As the findings of this Preliminary Study confirmed that the implementation of the requested Project would secure a stable power supply system to contribute to improvement of the social and economic conditions in Tuvalu, the Government of Japan decided to conduct the Basic Design Study for the Project. Following this decision, the JICA dispatched the Basic Design Study Team to Tuvalu from 29th November to 19th December, 2004. The Study Team reconfirmed the contents of the request and other details of the Project through discussions with those concerned on the Tuvalu side, conducted a study on the project site and gathered relevant information.

On its return to Japan, the Study Team examined the necessity, socioeconomic effects and relevance of the Project based on the field survey findings and compiled the draft basic design report for the optimal project and the implementation plan in the Outline of the Basic Design. The JICA then dispatched the Study Team to Tuvalu from 14th to 20th March, 2005 to explain the contents of the Outline of the Basic Design.

The Study Team also forecasted the power demand in Funafuti from 2005 to 2012 based on the field survey results. According to this forecast, the peak demand in 2012 will be 1,848 kW, suggesting a supply capacity shortage of 1,008 kW as the existing generating units (No. 3, No. 4 and No. 5 units) have a total output of 840 kW. Moreover, an island country commonly requires a reserve supply capacity which is equivalent to the output of the largest generating unit to allow for its stoppage for periodic inspection. Taking these conditions into consideration, the output capacity of each of the new generating units to be installed under the Project is determined to be approximately 600 kW in view of the scale of the load faced by the Funafuti power system. Although four generating units of

600 kW each were originally requested by the Government of Tuvalu, it is now concluded that three generating units of 600 kW each is the optimal scale for new installation under the Project based on the power demand forecast and the examination results of the suitable capacity for a single unit described above.

In the case of the 11 kV distribution network, distribution equipment (ring main units and distribution transformers) at the substations and 11 kV distribution cables of which the deterioration and/or overloading is causing power supply problems are selected for upgrading under the Project. It is planned to relocate the equipment currently experiencing overloading to other substations with a lower load in view of its continued use if this equipment is found to be reusable. It is also planned to introduce a looped distribution route for the central area of Fogafale Island where the main facilities for such political and economic activities in Tuvalu as government offices, the central bank, fire station and police station, etc. are concentrated to minimise the area of a power cut when a failure of the power distribution system occurs.

The scope of the requested Japanese assistance which is finalised based on the results of the Basic Design Study covers the entire components of the requested Project. To be more precise, this scope includes the procurement and installation of equipment and materials for “the extension of the Fogafale Power Station and “the improvement of the Funafuti power distribution network” and the construction of the power house required for the extension of the Fogafale Power Station.

The following table outlines the basic plan for the requested Japanese assistance (the Project) which has been compiled based on the results of the field survey and discussions with the Tuvalu side.

Outline of Basic Plan

Project Component	Planning Contents
Target Sites	• Existing Fogafale Power Station and Fogafale Island (Distribution Network)
Construction of Power House	• Construction of a single story building with two stories in part; floor area of some 768 m^2 • Construction of the foundations for the DEGs, fuel tank and auxiliary machinery • Construction of auxiliary facilities for the power house • Exterior work at the site
Procurement and Installation of DEGs	• Procurement and installation of three sets of DEG with output capacity of 600kW each • Procurement and installation of auxiliary mechanical systems for the DEGs - Fuel oil supply system - Lubricating oil system - Cooling water system - Compressed air system - Air intake and exhaust system - Waste oil treatment system • Procurement and installation of auxiliary electrical equipment for the DEGs - 11 kV switchgear - 11 kV/415 V station transformer - 415 V low voltage power system - Remote control panel - Cables and earthing materials - Cabling between the existing power house and the new power house
Procurement and Installation of Distribution Equipment	• Procurement and installation of the following equipment for improvement of the 11 kV distribution network - 11 kV cables - 11 kV/415 V distribution transformers - 11 kV ring main units (RMUs)
Procurement of Spare Parts, Maintenance Tools, etc.	• Spare parts (for two years' operation) and tools required for the maintenance of the generating and distribution facilities • Procurement of operation and maintenance manuals (including textbooks for OJT) and implementation of OJT • A Maintenance vehicle for the generating facilities

In the case of the Project's implementation with grant aid provided by the Government of Japan, the total project cost is estimated to be approximately ¥930 million (Japanese portion of approximately ¥926 million and Tuvalu portion of approximately ¥4.4 million). The Tuvalu side will be mainly responsible for the removal of the existing TEC office building and levelling of the project site and the removal of obstacle structures to allow the construction of the new power house building on the premises of the existing Fogafale Power Station. The total duration of the Project, including the detailed design, is expected to be some 18 months.

After the completion of the Project, the TEC which is the implementing body for the Project will be responsible for the operation and maintenance of the newly provided facilities and equipment. As the staff members of the TEC possess basic technical expertise for the operation and maintenance of diesel generating units and distribution equipment, they should be able to conduct adequate maintenance of all of the new equipment provided that OJT on operation and maintenance techniques

is conducted at the implementation stage of the Project together with (i) the supply of necessary spare parts and operation and maintenance manuals for the new equipment and (ii) technical guidance by an expert(s) at the time of the first full-scale inspection.

The Project will benefit some 4,500 residents of Funafuti. With the implementation of the Project, the available generating capacity of 2,460 kW in the target year (2012) will exceed the predicted peak demand (1,848 kW) by 612 kW. Accordingly, there will be a reserve emergency supply capacity of 72 kW even if the operation of any of the three new generating units, each of which will have the largest generating capacity at the time, is suspended for periodical maintenance. The upgrading of the distribution equipment and cables will solve the current problem of an insufficient capacity and prevent power failures originating from the deterioration and insufficient capacity of the equipment. As the resulting improvement of the stability of power supply is expected to have significant positive effects in terms of the vitalisation of Tuvalu's economy, improvement of the living standard of the people and the stable operation of social welfare and public facilities, the requested Japanese assistance is relevant for the purposes of Japan's grant aid scheme. The Tuvalu side has sufficient manpower and funds to operate and maintain all of the new equipment, etc. provided under the Project and no special problems are anticipated in regard to the implementation of the Project.

The Tuvalu side should deal with the following tasks to ensure the achievement and continuation of the positive effects of the Project.

(1) With the implementation of the Project, the reserve capacity for emergency power supply (reserve supply capacity to compensate for the stoppage of a generating unit with the largest output) will be secured up to 2012. However, it will still be necessary to develop new power sources to meet the demand increase from 2013 onwards so that there is always a sufficient reserve capacity to allow the stoppage of a generating unit for periodic maintenance.

(2) To ensure healthy financial management, the TEC should collect the electricity charge from large users, including government organizations, without fail. In addition to appropriate control of the unit generation cost through the proper management of operation, taking the fuel consumption volume and usage of the power source for auxiliary equipment, etc. into consideration, the depreciation cost of the fixed assets for power generation and distribution, including the equipment provided under the Project, should be properly accounted and the amount should be saved in the form of a reserve fund for future investment in new equipment.

(3) In regard to the operation and maintenance of the generating and distribution equipment, it is necessary to secure the budget required for proper maintenance and the procurement of spare parts while ensuring the regular storage of emergency spare parts. In this context, an appropriate operating plan for the existing as well as new generating units at the Fogafale Power Station should be prepared so that the operating rate of the new units to be provided under the Project is at least around 27% or higher. Meanwhile, the achievements of the OJT and counterpart training under the Project should be spread to all operation and maintenance staff and efforts should be made to improve the operation and maintenance skills of the staff to establish a preventive maintenance regime.

(4) The contents of the EIA and environmental management plan should be strictly complied and the environmental management plan should be reviewed from time to time so that the environmental impacts of the Project do not exceed the forecast of the EIA.

CONTENTS

CHAPTER 1

BACKGROUND OF THE PROJECT

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BACKGROUND OF THE PROJECT

The Government of Tuvalu has been developing power supply facilities in Funafuti, mainly with the assistance of the UK, its former suzerain state, and the EU. These existing facilities which were originally installed some 20 years ago being now quite deteriorated, they are facing an over load because of an increase of the power demand. This situation is causing frequent failures of the generating as well as distribution facilities, making the stable supply of power difficult.

To make the situation worse, the peak power demand has doubled in the period from 1993 to 2003 with an average annual increase rate of as high as 7.46% while the increase of the supply capacity has fallen short of the demand increase, necessitating regular power cuts in recent years.

The weak power supply system described above is hampering the functions of Funafuti as a political and economic centre in Tuvalu and is seriously affecting not only such government services as health, hygiene and education but also the lives of its citizens. In the face of this situation, the power sector in Tuvalu considers “the development of the supply capacity through the installation of new generating facilities” and “improvement of the power supply reliability through renewal of the distribution facilities” to be the most urgent tasks. However, the financial difficulties faced by this sector make the achievement of these tasks difficult.

Under these circumstances, the Government of Tuvalu has made a request to the Government of Japan for the implementation of a grant aid project, the contents of which are listed below. These contents of the requested project have finally been confirmed by the Basic Design Study.

[Outline of the Request]

(1) Construction of a new power house

(2) Installation of four 750 kVA (600 kW) diesel engine generators (DEGs)

(3) Supply of spare parts for the DEGs

(4) Renewal of the 11 kV high voltage distribution lines

(5) Construction of a new TEC office building

(6) Transfer of technology on the operation and maintenance of the generating and distribution facilities (through OJT) and implementation of special training on the rewinding of the motors and repair of the auxiliary equipment of the DEGs

(7) Supply of distribution testers and maintenance tools (including cable failure detectors)

(8) Maintenance vehicles

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Purpose

The National Energy Policy in Tuvalu formulated in 1995 identifies such priorities as the supply of economical and reliable power in urban areas and the promotion of socioeconomic development through the supply of economical and reliable power in rural areas and efforts have since been made to achieve these priorities.

The present Project aims at strengthening and improving the power supply facilities which comprise part of the essential social infrastructure for (i) maintenance of the functions of Funafuti as the capital of Tuvalu, (ii) stable operation of social and public facilities and (iii) improvement of the standard of living of the citizens of Funafuti.

2.1.2 Outline of the Project

The Project aims at stabilising the functions of Funafuti, the capital of Tuvalu, as the political and economic nerve centre of the country and also at improving the lives of its citizens by means of installing additional power generating facilities for base load operation at the Fogafale Power Station and improving the distribution network on Funafuti Atoll to establish a stable power supply system.

The components of the Project are the installation of three (3) sets of 600 kW diesel engine generator (DEG) unit at the Fogafale Power Station which is responsible for power supply on Funafuti Atoll and replacement of the 11 kV distribution cables and distribution facilities (distribution transformers and ring main units) to ensure safe and efficient power distribution.

2.2 Basic Design of Requested Japanese Assistance

2.2.1 Design Policies

2.2.1.1 Basic Policies

The scope of Japanese assistance for the Project covers the procurement and installation of three (3) sets of 600 kW DEG unit at the Fogafale Power Station for base load operation and the procurement

and installation of equipment and materials for the 11 kV distribution facilities and 11 kV distribution lines of the Funafuti Power System (FPS) to be newly installed or replaced.

The capacity of each equipment to be procured under the Project is planned in accordance with the demand forecast for the Project Area. The planned scale of the power generating facilities and distribution equipment and materials should be appropriate to meet the forecast demand in five years after commissioning.

2.2.1.2 Environmental and Social Conservation

The Environment Bureau of the Government of Tuvalu has already completed the EIA (Environmental Impacts Assessment) for the Project. Since the EIA, which was conducted by Tuvalu, includes assessment of environmental impacts and mitigation measures on the basis of secondary data, interviews and simple field surveys, it is deemed as IEE (Initial Environmental Examination) level study according to JICA Guidelines for Environmental and Social Considerations. According to the EIA report, the maximum ground concentration of NO_2 discharged by the new generating facilities will be 0.231 ppm for a one hour period and 0.0889 ppm for a 24 hour period, meeting the relevant environmental standards in Tuvalu of not more than 0.3 ppm for a one hour period and not more than 0.1 ppm for a 24 hour period. Similarly, the maximum ground concentration of SO_2 discharged by the new generating facilities will be 0.0041 ppm for a one hour period, 0.0016 ppm for a 24 hour period and 0.0027 ppm for a one year period, all of which meet the respective environmental standards of not more than 0.5 ppm, not more than 0.3 ppm and not more than 0.1 ppm. In regard to noise, the forecast value of noise generated by the new generating facilities at the site boundary is 66.8 dB (A) which meets the noise control standard of 70 dB (A) in Tuvalu. Based on such forecast, the EIA report concludes that no severe environmental impacts will occur due to the implementation of the Project. Table 2-2-1 and Table 2-2-2 show the scoping and IEE results regarding the construction and operation of the new generating and distribution facilities, indicating no severe impact on the surrounding environment. However, environmental consideration is featured in the planning of the Project and the operation of the new facilities, incorporating the measures listed in the environmental management plan of the EIA report, including the selection of low NOx producing equipment and the implementation of noise, effluent and solid waste control measures.

Table 2-2-1 Scoping Results

Environmental Items		Evaluation*		Reasons
		During Construction Period	After Completion	
Social Environment				
1	Involuntary resettlement	D	D	The planned installation of three additional generating units at the existing power station will have hardly any impact on these items. The transportation of equipment during the construction period could affect local traffic but such impact will be temporary and insignificant.
2	Split of communities	D	D	
3	Existence of indigenous people, minorities and nomads	D	D	
4	Occurrence of conflicts between communities	D	D	
5	Change of basis for economic activities	D	D	
6	Change of living infrastructure	D	D	
7	Impacts on Traffic	D	D	
8	Re-coordination of water resources and fishing rights	D	D	
9	Impacts on historical sites and cultural heritage	D	D	
10	Significant change of precious view	D	D	
Natural Environment				
11	Precious nature	D	D	The adoption of the radiator system using either supplied water or rainwater for cooling of the generating units to be installed under the Project will have hardly any impact on these items.
12	Precious species and indigenous flora and fauna	D	D	
13	Vegetation	D	D	
14	Changes of topography and coastal areas	D	D	
15	Changes of underground water	D	D	
16	Changes of water flow and level of rivers, lakes and sea areas	D	D	
17	Changes of water temperature of rivers, lakes and sea areas	D	D	
18	Air pollution	D	B	Some impacts may occur due to the NOx and SOx contained in the exhaust gas.
19	Water pollution	D	D	Hardly any impacts are expected because of the installation of an oil separator.
20	Soil pollution	D	D	
21	Noise and vibration	D	B	Some impacts by the engines.
22	Subsidence	D	D	No impacts as the new units are similar to the existing units.
23	Others	D	D	

Note

Means an item to be assessed by the IEE.

Evaluation Classification	
A:	Serious impact is expected
B:	Little impact is expected
C:	Unclear (a further survey or review is necessary as the degree of impact cannot be judged at present)
D:	No impact (impact assessment by an EIA or IEE is unnecessary)

Table 2-2-2 IEE Results

Environmental Items Assessed by IEE	Evaluation	Reasons
1. Involuntary resettlement	A	The planned installation of new DEG units at the existing power station, laying of underground distribution cables and improvement of the existing distribution facilities under the Project will use existing land and underground roadside spaces and will, therefore, not cause any involuntary resettlement or adverse impacts on the ecosystem.
2. Adverse impacts on flora, fauna and ecosystem	A	
3. Air pollution	A	Even though some NOx and SOx will be emitted, the total volumes and ground concentration will be below the relevant environmental standards in Tuvalu, causing little impact.
4. Noise and vibration	A	The noise and vibration caused by operation of the generating units during the day and at night will be below the relevant environmental standards in Tuvalu, causing little impact.

Notes
A : Hardly any adverse impacts
B : Generally satisfactory and complete with only minor impacts
C : Can be considered satisfactory by eliminating some minor impacts
D : Unsatisfactory overall although partly satisfactory
E : Unsatisfactory
F : Review of the plan is required because of anticipated grave impacts

2.2.1.3 Natural Conditions

(1) Temperature and Humidity

The mean monthly maximum and minimum temperatures in the past 70 year period (1933 – 2003) in the Project Area are 36.1°C and 28.3°C respectively while the mean monthly temperature and mean humidity are 32.3°C and 79% respectively.

As the main equipment of the new DEG units to be procured under the Project will be installed inside the power house, no special measures regarding the ambient temperature and humidity at the project site will be required. However, the design ambient temperature of 35°C and maximum allowable temperature for equipment of 40°C in general will be adopted for the design of the combustion air for the engine, cooling air for the radiator and ventilation of the power house to ensure the proper performance of the DEG units.

(2) High Tide

Given the fact that there is a record of the project site being flooded at high tide in the past, suitable measures should be planned, including raising of the floor level of the power house by

60 cm above the reference ground level at the project site as in the case of the existing power house and the foundations for the existing equipment.

(3) Salt Damage

As the planned installation site of the new DEG units is located on the coast, these units must be installed indoors to protect them from salt damage. While the radiators, oil tanks and oil piping, etc. will be installed outdoors, they will be protected by a salt-resistant paint.

The distribution facilities (ring main units and distribution transformers) will also be installed outdoors near the coastline and, therefore, it will be necessary to use materials and/or paint with a high corrosion-resistance performance.

(4) Earthquakes

As Tuvalu has no record of earthquakes, seismic force will not be considered in the design of the buildings, foundations and equipment to be constructed or installed under the Project.

2.2.1.4 Social Conditions

Most people in Tuvalu are Christians and there are no local customs, such as Ramadan of the Islamic faith, which will considerably affect the construction schedule. However, efforts should be made to facilitate understanding of the importance of installing the new DEG units and improving the distribution network among local residents by means of publicising the purpose, schedule and construction method, etc. to local residents in the neighbourhood as well as organizing meetings to explain these matters to each local community.

2.2.1.5 Local Construction Industry

As Funafuti has seen little plant construction work involving generating units, etc., local construction companies lack direct experience of installing large generating or substation equipment and usually work as subcontractors providing workers for foreign construction companies. Accordingly, only workers, small transport vehicles and small construction machinery can be procured locally.

Although locally available materials should, in principle, be used as much as possible, only minor quantities are available, even in the case of coral sand and aggregates for concrete, making the local procurement of the materials necessary for the Project impossible. It is, therefore, planned to procure the construction materials from Japan and such nearby third countries as Fiji, Australia and New Zealand.

As the site for the new power house to be constructed under the Project is adjacent to the existing power house in use, safety measures will be introduced, including protective fences to prevent damage to the existing facilities and to ensure the safety of workers during the construction period.

2.2.1.6 Use of Local Company and Materials

(1) Use of Local Company

As described in 2.2.1.5, local construction companies in Tuvalu do not have direct experience of installing equipment or constructing a power house of the planned scale under the Project. Moreover, the local procurement of the machinery/vehicles required for the planned construction work, equipment installation work and inland transportation of the equipment is impossible. Accordingly, the planned use of a local construction company is mostly restricted to the supply of labour and construction machinery will be procured in Japan and/or such nearby third countries as Fiji, Australia and New Zealand as in the case of construction materials. The dispatch of Japanese engineers for the purposes of quality control, schedule control and safety control will be necessary as in the case of Japan's grant aid projects in neighbouring island countries.

The dispatch of Japanese engineers will also be necessary to provide technical guidance to ensure strict quality control and to conduct schedule control as the installation work, including the test operation and adjustment, of the new DEG units under the Project demands a high level of skill.

(2) Use of Local Materials

As described in 2.2.1.5, the local procurement of such construction materials as reinforcing bars, forms, cement, finishing materials, doors, windows and fittings, etc. as well as small quantities of coral sand and blocks to be used as sand and aggregates for the concrete is possible. However, as the available quantities of coral sand and blocks are too small to meet the required quantities for the Project, the procurement of sand and aggregates from a third country will be necessary. However, such imported materials often have a high salt content due to their exposure to seawater during their transportation and cannot be expected to satisfy the strength and durability demanded under the Project.

For the project design, the limitations of the concrete strength should be taken into consideration and the employment of a rust-proofing measure for the reinforcing bars (use of a rust preventative material etc.) should also be considered. In regard to the composition of imported sand and aggregates and foreign matters which are present in them, their analysis results must be submitted to the Environment Bureau in advance to obtain approval.

(3) Procurement of Third Country Products

All of the generating and distribution equipment currently used in Tuvalu are foreign products, mainly made in Australia or New Zealand. Accordingly, all of the equipment required for the construction of the new generating facilities and improvement of the distribution network under the Project will be imported.

In connection with the procurement of equipment from third countries, proper examination must be conducted regarding the price, quality, delivery terms, ease of spare parts procurement after the commencement of operation and compatibility with the existing equipment.

For the implementation of the Project, the Tuvalu side strongly hopes for the procurement of Japanese products which offer excellent quality, performance, durability and after-services.

2.2.1.7 Operation and Maintenance Capability of Implementing Organization

Following their commissioning, the new DEG units will be maintained by 14 staff members of the Fogafale Power Station of the TEC as in the case of the existing generating facilities. As the generating facilities in Tuvalu are all DEG units, the TEC operators are judged to possess the necessary operation and maintenance skills, including those required for the daily checking of the DEG units and distribution equipment, because of the TEC's good performance over 20 years since 1982 in terms of the operation and maintenance of the power station and distribution equipment to the extent that the old DEGs have been maintained in relatively good condition. However, as the new DEGs to be installed under the Project will be the first experience of medium speed DEGs for the operation and maintenance staff of the TEC, the dispatch of Japanese engineers to organize OJT on the DEGs, auxiliary machinery and distribution equipment will be essential with a view to transferring the latest maintenance and inspection techniques, mainly featuring preventive maintenance, to ensure the more effective and efficient maintenance of the equipment.

2.2.1.8 Scope of Facilities and Equipment and Their Grade

(1) Scope of Facilities and Equipment

The total installed capacity of the new DEG units to be procured is planned to be sufficient to provide base load operation for the power demand forecast for 2012 (five years after commissioning) for Funafuti. As the optimal capacity of a single generating unit in an island country where the service area is relatively small, some 30% of the power demand of the entire system is set. The new DEG units will be configured to ensure the efficient as well as economical operation and maintenance of the power plant.

Meanwhile, the capacity of the distribution equipment, including the transformers and ring main units, will correspond to the demand forecast for Funafuti in 2012 as in the case of the new DEG units.

In short, the configuration, types and quantity of the equipment will be determined so that a stable power supply for domestic users and welfare and public facilities will be achieved to fulfil the purpose of the Project through the procurement and installation of new equipment and the procurement of spare parts and tools.

(2) Technical Level/Grades

Careful attention will be paid to ensuring that the specifications of each equipment to be procured under the Project which constitute part of the new DEG units or 11 kV distribution network do not exceed the technical level of the TEC which will be responsible for the operation and maintenance of the said equipment.

2.2.1.9 Construction Schedule

The construction work to be conducted under the Project must be completed in a single fiscal year in accordance with the grant aid scheme of the Government of Japan.

The planned installation site of the new DEG units to be procured under the Project is located on the premises of the existing Fogafale Power Station. As this power station is the sole source of power supply for Funafuti, the capital of Tuvalu, any stoppage of the power station is extremely likely to directly cause severe adverse impacts on socioeconomic activities in Funafuti.

Unlike the work to construct a new power station, a project to expand existing generating units or to improve an existing 11 kV distribution network requires the stoppage of the existing facilities at the time of connection to or switching over from the existing facilities. Accordingly, priority will be given to reducing any adverse impacts on socioeconomic activities as much as possible by means of minimising the duration and frequency of stoppages of the existing generating units/11 kV distribution system during the construction and installation period of the Project. At the same time, planning of the schedule and construction work will be conducted in a manner which ensures that the planned schedule and construction work are economical and technologically appropriate.

2.2.2 Basic Plan

2.2.2.1 Overall Plan

(1) Design Conditions

Having examined the various relevant conditions for the Project, the following design conditions are set to determine the applicable scale and specifications for the Project.

1) Climatic and Site Conditions

Item	Unit	Record (1933-2003)	Design Value
① Ambient temperature			
a) Maximum	°C	36.1	35
b) Mean	°C	32.3	-
c) Minimum	°C	28.3	-
② Temperature in power house	°C	—	40
③ Humidity			
a) Maximum	%	99	99
b) Mean	%	79	79
④ Rainfall			
a) Mean annual	mm/year	3,400	3,400
b) Maximum mean monthly	mm/month	400	400
⑤ Wind Velocity			
a) Mean	m/sec	5	5
b) Maximum	m/sec	30	30
⑥ Wind direction			
a) Dry season (May-October)	-	East	-
b) Rainy season (November-April)	-	West	-
⑦ Annual days of thunderstorms	days/year	15	15
⑧ Site conditions			
a) Elevation (from MSL)	m	1	1
b) Bearing capacity	tons/m^2	—	10
c) Groundwater table	m	GL - 1.0	GL -1.0
⑨ Others			
a) Salt damage	-	Yes	To be considered
b) High tide	-	Yes	To be considered

2) Applicable Standards and Units

For the design of the Project, the current design conditions adopted by the TEC and compatibility with the existing facilities will be considered. For the main functions of equipment, such international standards as IEC and ISO will be applied together with Japanese standards. In the case of electrical installation work, Japanese standards will, in principle, be used because of the absence of local standards in Tuvalu. SI units will be used for units.

① International Standardization Organization (ISO)
② International Electrotechnical Commission (IEC)
③ Japanese Industrial Standards (JIS)
④ Japanese Electrotechnical Commission (JEC)
⑤ Standards of Japan Electrical Manufacturers' Association (JEM)
⑥ Japanese Installation Standards for Distribution Facilities and Interior Wiring
⑦ Japan Electric Association Code (JEAC)
⑧ Japan Cable Makers' Association Standards (JCS)
⑨ Architectural Institute of Japan (AIJ)
⑩ Australian Standards (AS)

3) Environmental Protection Standards

The environmental impacts of the generating facilities to be installed under the Project will be assessed based on the environmental laws and regulations in Tuvalu to be supplemented by Japanese standards. The following reference values are set as the design conditions.

① NOx emission	:	less than 950 ppm (at a residual oxygen concentration of 13%)
② SOx emission	:	less than 250 ppm (at a sulphur content of fuel oil of 1%)
③ Oil contamination of effluent	:	less than 30 ppm
④ Particle emission	:	less than 100 mg/Nm^3
⑤ Noise	:	less than 75 dB (A) at the time of the sole operation of the generating facilities in question at the power station boundaries
⑥ Vibration	:	less than 65 dB at the time of the sole operation of the generating facilities in question at the power station boundaries

4) Electrical System

The electrical system shown in Table 2-2-3 will be used for the Project to ensure compatibility with the existing system.

Table 2-2-3 Electrical System

Item	High Voltage Distribution Line	Low Voltage Distribution Line	Direct Current
Nominal Voltage	11 kV	415 – 240 V	110 V
Maximum Voltage	12 kV	460 – 252 V	121 V
Wiring Method	3 phase 3 wires	3 phase 4 wires	2 wires
Frequency	50 Hz	50 Hz	
Earthing Method	Neutral direct earthing	Neutral direct earthing	(－) side earth

5) Basic Insulation Level (BIL)

For the design of the distribution and substation facilities, 75 kV (11 kV system) which is already applied to the existing facilities will be adopted as the standard BIL (Basic Insulation Level) value to ensure coordinated insulation between different equipment and the insulation strength of the entire system.

(2) Facility Layout Plan

As the new generating facilities to be installed under the Project will be constructed on the premises of the existing Fogafale Power Station, the layout plan for the new facilities will take the following conditions into consideration in addition to the ease of operation and maintenance of the generating facilities in question.

① Minimisation of any adverse impacts of noise and vibration on neighbouring residents
② Establishment of an access road for tank lorries transporting diesel oil
③ Ease of maintenance of the new fuel storage tanks
④ Minimisation of any adverse impacts on the operation of the existing power station during the construction work

Among the existing distribution equipment at the existing substations, substation equipment which is not properly functioning due to aging or corrosion or of which the capacity will fall short of the required capacity in the target years will be replaced. The existing foundations will be used as much as possible. Replacement distribution cables will be laid at the sites of existing cables and the existing cables will be left for emergency use.

(3) Basic Matters

The emphasis of the selection of equipment and facilities for the Project will be placed on a low overall project cost as a grant aid project, economy of the operating cost and easy operation and maintenance after the completion of the Project.

Given the fact that the new generating facilities will be installed on the premises of the existing Fogafale Power Station, the available land for this purpose is rather limited. For this reason, the specifications and layout of the main equipment and piping as well as wiring routes should take linked operation with the existing generating facilities into consideration. Further care should be taken in regard to the delivery route for diesel oil and the proper storage of spare parts. Although the main equipment will be installed in the new power house, some auxiliary machinery will be installed outdoors, necessitating consideration of the site conditions in terms of wind and rain, etc.

The work to replace the existing 11 kV distribution facilities will require suspension of the existing facilities for the laying of new cables and also traffic control. The work plan should, therefore, ensure the minimum disruption to citizens' lives during the work period.

1) Fogafale Power Station Extension Plan

The equipment required for improvement of the generating facilities is selected based on the following basic matters and project contents.

① Generating Method

The generating method will be diesel power generation in view of the facts that the existing facilities use DEG units and that the use of the same method will make the operation and maintenance of the new generating facilities easy for the operators and maintenance staff of the TEC given their technical expertise.

② Control Method

Both remote and local control methods will be used for the new generating facilities to ensure ease of operation and maintenance and also to reflect the methods used for the existing facilities.

While remote control will be conducted from the monitoring/control room, arrangements will be made to allow the starting and stopping of the DEG units from the equipment side in view of extra safety.

③ Fuel Oil

The fuel oil currently used at the existing Fogafale Power Station is automotive diesel oil manufactured in Singapore. The use of the same diesel oil is planned for the new DEG units and the properties of this diesel oil are shown in Table 2-2-4.

Table 2-2-4 Properties of Diesel Oil

Item	Unit	Value
Colour	-	amber
Ignition Point	°C	66
Flash Point	°C	160 – 380
Kinematic Viscosity at 40°C	cst	4.08
Specific Gravity at 15°C	kg/m^3	0.847
Water Content	Vol%	0.05

Source: BP

④ Lubricating Oil

The recommended composition of lubricating oil varies depending on the generating unit manufacturer. The use of the lubricating oil used by the existing generating units (BP: C6 Global Crankcase Lubricant) is planned under the Project to facilitate common use with the existing generating units and to minimise the required storage space.

⑤ Cooling Water

While groundwater and rainwater are available for use as cooling water for the new DEG units, rainwater will be used because of the high salinity of the groundwater originating from the site being located on an atoll island. Accordingly, one rainwater storage tank will be installed to collect rainwater from the roof of the power house so that cooling water can be supplied to the new DEG units from this tank.

2) Funafuti Power Distribution Network Upgrading Plan

The Funafuti Power Distribution Network has been developed on Fogafale Island which is the political and economic centre of Tuvalu. Underground 11 kV distribution lines stretch north and south from the Fogafale Power Station which is located at the centre of the island. Low voltage power supply (415/240 V) reaches users via 11 kV/415 – 240 V substation facilities (ring main units, distribution transformers, low voltage panels and low voltage cables) installed at 14 outdoor substations (site size of approximately 25 m^2 each)

throughout the island. The present upgrading plan targets the existing 11 kV distribution network in Funafuti where the deterioration and corrosion of the present equipment is causing, in the worst case, the loss of their functioning. The main component of the plan is the replacement of (i) distribution transformers and ring main units which will be subject to overloading in the target year of the Project and (ii) 11 kV underground distribution cables (paper insulated aluminium conductor cables) which have deteriorated. At the same time, usable existing equipment will be relocated for its continued use, including use at a new distribution substation serving the Fogafale District where the main facilities of the capital, including the police, fire station, banks and broadcasting station, are concentrated.

Low voltage panels and low voltage cables are not included in the scope of the Project.

In view of the familiarity of the operation and maintenance staff of the TEC with the existing facilities and the fact that the new facilities will be operated in an integral manner with the existing system, the same specifications as the existing facilities will, in principle, be adopted for the new facilities.

2.2.2.2 Outline of Basic Plan

Table 2-2-5 outlines the basic plan for the Project based on the (1) design conditions, (2) facility layout plan and (3) basic matters described earlier in 2.2.2.1.

Table 2-2-5 Outline of Basic Plan

Project Component	Planning Contents
Target Sites	Existing Fogafale Power Station and Fogafale Island (Distribution Network)
Construction of Power House	Construction of a single story building with two stories in part; floor area of some 768 m^2 Construction of the foundations for the DEGs, fuel tank and auxiliary machinery Construction of auxiliary facilities for the power house Exterior work at the site
Procurement and Installation of DEGs	Procurement and installation of three sets of DEG with output capacity of 600kW each Procurement and installation of auxiliary mechanical systems for the DEGs - Fuel oil supply system - Lubricating oil system - Cooling water system - Compressed air system - Air intake and exhaust system - Waste oil treatment system Procurement and installation of auxiliary electrical equipment for the DEGs - 11 kV switchgear - 11 kV/415 V station transformer - 415 V low voltage power system - Remote control panel - Cables and earthing materials - Cabling between the existing power house and the new power house
Procurement and Installation of Distribution Equipment	Procurement and installation of the following equipment for improvement of the 11 kV distribution network - 11 kV cables - 11 kV/415 V distribution transformers - 11 kV ring main units (RMUs)
Procurement of Spare Parts, Maintenance Tools, etc.	Spare parts (for two years' operation) and tools required for the maintenance of the generating and distribution facilities Procurement of operation and maintenance manuals (including textbooks for OJT) and implementation of OJT A Maintenance vehicle for the generating facilities

2.2.2.3 Equipment and Facility Plan

(1) Fogafale Power Station Extension Plan

1) Engine Output and Generator Capacity

The rated output of the new DEG units to be installed under the Project is decided based on the following conditions.

① The target year of the Project is 2012, i.e. five years after the completion of the Project (2007).
② The scale of the new DEG units should be capable of maintaining the power supply and demand balance even if the generator with the largest output, including the existing DEG units, stops operation because of inspection or breakdown.
③ The new DEG units should be capable of performing continuous base load operation (at least 8,000 operating hours/year).

Based on the above conditions, the required rated output of the three DEGs should be at least 1,008 kW in total, i.e. the peak power demand of 1,848 kW in 2012 (see Appendix 5) minus the total output of 840 kW of the existing DEGs (Unit 3, Unit 4 and Unit 5).

Assuming a DEG output factor of 95%, the number of DEGs required to deal with load fluctuations is calculated to be two as shown in Appendix 5 – Power Supply and Demand Balance. One standby DEG is also required to allow the flexible operation of the DEGs in line with load fluctuations and to permit appropriate maintenance of the DEGs. Under this arrangement, the single DEG capacity is set at 600 kW. The required engine output and rated capacity of the generator can be calculated as follows.

Because the engine specifications, etc. slightly differ from one manufacturer to another, the calculation results below should be regarded as yardsticks.

• Engine Output

$$Pe \geq \frac{P}{0.7355 \times \eta} = 906\ PS$$

Where, Pe : engine output (PS)
P : generator output (600 kW)
η : generator efficiency factor (assumed to be 0.9)

• Generator Capacity

$$P_G = \frac{P}{Pf} = 750\text{kVA}$$

Where, P_G : generator capacity (kVA)
P : generator output (600 kW)
Pf : generator power factor (0.8)

Table 2-2-6 Planned Engine Output and Generator Capacity Under the Project

Item	Value
Engine Output Pe (PS)	906
Generator Capacity P_G (kVA)	750

2) Engine Speed

For base load generating facilities with a single unit capacity of 600 kW, an engine with an medium speed of 750 rpm or lower is a common choice for Japanese and other electricity companies from the viewpoint of ensuring economical operation and maintenance. As this type of engine is widely used, the engines to be procured under the Project will be medium speed engines of 750 rpm or lower.

3) Auxiliary Mechanical Facilities

The auxiliary facilities should serve all of the new DEG units as much as possible to ensure easy operation and maintenance and also to achieve energy saving and a lower equipment procurement cost. The planned auxiliary mechanical equipment systems are outlined below.

① Fuel Supply System

Two 150 m^3 fuel storage tanks will be installed outdoors because of the operational considerations explained below.

i. Separation of Water and Foreign Matters

Diesel oil will be transferred to the tanks from a tank lorry using a unloading pump. As this fuel oil may be mixed with some water and foreign matters during its ocean transportation, it will be necessary to separate such water and foreign matters from the diesel oil in the storage tank. In general, water and foreign matters are separated from diesel oil in the storage tank if the diesel oil is kept

undisturbed in the tank for approximately three days. In view of this, a floating suction device will be introduced in the tank so that only separated diesel oil in the upper part of the tank is recovered for transfer to the diesel engine. Two tanks will be installed for actual operation and separation (capacity: two weeks' supply each). Because of the employment of the fuel supply system described above, an oil separator for the fuel oil will not be installed under the Project. Foreign matters which are separated and deposited at the bottom will be burned in the incinerator to be installed under the Project.

ii. Tank Capacity

Diesel oil is regularly supplied from Singapore. Assuming the difficult navigation of a fuel transporting vessel at the time of strong seasonal winds, the capacity of the fuel storage tank is set at the supply of a sufficient amount of diesel oil to operate two 600 kW DEG units which are in constant use for one month. Accordingly, the required tank capacity can be calculated in the following manner.

$$V = \frac{\mathrm{V1} \times 24\ \text{hours} \times 30\ \text{days}}{1{,}000} = 224kl = 250kl$$

Where, V : tank capacity (kl)
V_1 : consumption rate (310 litres/hour for two engines)

Based on the above calculation results, the required tank capacity is 125 kl for each of the two tanks. However, in consideration of the need to separate water and foreign matters contained in the fuel oil, the actual capacity is set at 150 kl each.

In addition, two fuel oil service tanks capable of supplying diesel oil to two engines for two hours (1 kl x 2) will be installed on the roof of the power house.

The fuel oil will be fed to the main storage tanks from a tank lorry using the loading pump of which the capacity is set at unloading the full load of fuel oil in a tank lorry (approximately 9.2 kl) in approximately 20 minutes.

② Lubricating Oil System

A lubricating oil tank will be installed inside the engine. This oil will be changed every 8,000 hours of operation and a centrifugal or filter type lubricating oil purifier will be

installed to reduce the maintenance cost. Lubricating oil will be directly pumped to the built-in tank in the engine from a drum.

③ Cooling Water System

To cool the engine, a closed radiator circulation system will be employed as in the case of the existing engines to minimise the water consumption in view of the difficulty of securing an ample supply of water at the project site. A high/low temperature cooling water expansion tank will be installed on the roof of the power house to supply cooling water.

④ Starting System

The starting of an engine requires a large starting torque and a compressed air starting system will be employed as in the case of the existing engines because of its ability to provide a large torque. The compressor to be selected will be able to start both the motor and the engine and will be installed in the generating room. The air tank capacity will be sufficiently large to be able to start an engine three times. The high humidity means that it is likely that the compressed air tank will accumulate water. An automatic water discharge valve will, therefore, be installed to the compressed air tank to regularly remove water from the tank.

⑤ Air Intake, Exhaust and Ventilation Systems

During the operating hours of the DEG units, the entrance of the power house will be closed to reduce the noise reaching the neighbouring facilities and private dwellings. Accordingly, a ventilation unit (blower) to intake air for engine combustion and to disperse heat from the engines will be installed in the ventilation machine room to supply the required quantity of air to the generator room. The filter density of this ventilation unit will gradually increase from the inflow side to the outflow side to reduce the pressure loss by air intake. Panel type filtering units will be employed as these can be re-used after washing and can be easily replaced. The wind velocity at the air intake of the ventilation unit is set at 2.5 m/sec or less. The unit will have a structure which prevents the penetration of rainwater during blower operation and will have an insect screen to prevent the penetration of insects into the generator room.

Exhaust gas from the engine will be discharged through a silencer which will be installed on the roof of the power house.

⑥ Sludge Treatment System

An outdoor oil separating tank will be installed to separate oil in the fuel storage tanks or inside the oil retaining wall and water (rainwater, etc.) so that the diesel oil and waste oil associated with the new DEG units to be installed under the Project do not cause any environmental pollution. The separated oil will be led to an incinerator via the waste oil treatment unit for incineration.

⑦ Piping Systems

The piping systems required under the Project are those for fuel oil, lubricating oil, compressed air, cooling water and drain. These pipes will be laid in a trench or supported inside the building to facilitate maintenance work while outdoor piping will either be installed on the ground or directly buried under the ground. That piping which is directly buried under the ground will be protected from corrosion by the use of corrosion-resistant jute or similar. Each piping system will be colour-coded to prevent erroneous operation and to facilitate maintenance.

4) Electrical Works

The main components of the planned electrical Works are described below.

① Electrical System

The following electrical system to be adopted under the Project will be the same as the existing system.

i.	Nominal voltage and phase	:	11 kV, 3 phase 3 wires	
			415 - 240V, 3 phase 4 wires	
			(3 phase + neutral)	
			DC 110 V, 2 wires	
ii.	Frequency	:	50 Hz	
iii.	Short circuit breaking current	:	11 kV system	12.5 kA (one second, symmetrical)
iv.	Earthing method	:	direct earthing	
v.	BIL	:	11 kV system	75 kV
vi.	Power frequency withstand voltage	:	11 kV system	28 kV
vii.	DC control voltage	:	DC 110 V	
viii.	Allowable voltage fluctuation	:	11 kV system	+5 ~ -5%
			415 - 240 V system	+5 ~ -5%
			DC 110 V system	+5 ~ -10%

② Generators

The generators will employ 3 phase 3 wires, synchronous, horizontal axis and air-cooling systems. 11 kV which is the distribution voltage of the Funafuti Power System (FPS) will be adopted as the generator voltage to allow single unit operation. The main specifications of the new generators are listed below. Each generator will be provided with a heater to prevent condensation.

i.	Rated operation	:	continuous
ii.	Output	:	750 kVA or higher
iii.	Voltage	:	11 kV
iv.	Frequency	:	50 Hz
v.	Power factor	:	0.8 (lag)
vi.	Speed	:	same as diesel engine (directly coupled to the engine)
vii.	Excitation method	:	brushless thyrister method
viii.	Neutral earthing method	:	direct earthing

③ 11 kV Distribution Panel

11 kV distribution panels equipped with vacuum circuit breakers will be installed in the electric room to distribute 11 kV power and to protect the generators. Those panels will also act as the connecting board with the existing generators. The panel can be controlled either in-situ or from the control room on the first floor to allow ease of operation and maintenance.

④ 415 V Low Voltage Panel

Those low voltage panels will be installed in the electric room as in the case of the 11 kV distribution panels and will have distribution feeders to supply power to the auxiliary machinery for the DEG units, auxiliary facilities and building service systems. Each of the 415 V distribution feeders will have MCCBs.

⑤ Data Logger

In the case of the existing generating facilities, the operators manually record the operation details every hour. For the new generating units to be installed under the Project, the introduction of data loggers is planned to automatically print out the following basic data to ensure the accuracy of the time of recording and ease of operation control.

i. Generator voltage, current and power factor

ii. Electric energy generated

⑥ Local Monitoring Panel for Engine

A local panel to monitor the operation status of the engine will be installed at the side of the engine to make daily checking easier.

⑦ Exciter

A brushless thyrister type exciter will be installed to properly establish the generator voltage.

⑧ DC Power System

A common DC power system will be installed to provide power to operate the circuit breakers, etc. The DC voltage will be 110 V and a lead battery (54 cells) and one charger will be installed inside the DC power panel.

⑨ Station Transformer

A station transformer to step down the generator voltage (11 kV) to 415 V will be installed in the electrical room.

⑩ Earthing Systems

The following earthing systems will be installed under the Project.

i. Earthing system to protect the total power system in the power station (direct earthing for the 11 kV and 415 V systems)
ii. Earthing system to prevent electric shocks from metal objects and electrical equipment
iii. Earthing system for the fuel storage tanks (not connected to i. or ii. above)
iv. Earthing system for the lightning rod (not connected to i, ii. or iii. above)

⑪ Cabling

The cables inside the power house will be laid in cable trenches, cable racks or conduit pipes. The cables outside the power house will be laid in conduits or directly buried. The cables to be laid in trenches, racks or conduits will not be armoured while those to be directly buried under the ground will be armored.

The cable specifications are a copper conductor because of its large allowable current and good workability and general-purpose cross-linked polyethylene for insulation.

(2) Funafuti Distribution Network Upgrading Plan

The 11 kV distribution network upgrading plan consists of the following components.

1) Ring Main Units (RMUs)

RMUs have circuit breakers and a fuse(s) inside an insulated steel box in the oil. The function of the disconnecting switch is to divide the distribution circuits while a fuse is installed to protect the distribution transformers at the time of overloading or short-circuiting incidents on the low voltage side. Switching of the disconnecting switch is manually conducted. The structure of a RMU does not allow the installation of further instruments or relays. Those RMUs of which the function has deteriorated or ceased due to aging or corrosion will be replaced under the Project.

2) Distribution Transformers (DTs)

One component of the Project is the replacement of those DTs (11 kV/415 – 240 V) of which the function has deteriorated or ceased due to aging or corrosion at sub-stations in the Project Area. The capacity of the new DTs will be determined based on the peak demand in the target year (2012) of the Project and DTs with an appropriate capacity will be selected from a range of standard capacity DTs to replace over-loaded DTs while taking the power factor (0.8) of the load into consideration.

3) Laying of 11 kV Cables

The planned distribution routes and cable size for the Project have been decided based on the peak demand in the target year (2012) of the Project and the findings of field reconnaissance work jointly conducted with TEC engineers and examination of the existing distribution routes and the allowable current, voltage drop and power loss have also been taken into consideration. The basic routes are shown in 2.2.3 – Basic Design Drawings (Appendix 6).

The 11 kV cables to be used under the Project will have a copper conductor because of its excellent conductivity and an XLPE insulation because of its excellent insulation performance. Those cables to be directly buried under the ground will be provided with armor. However, the cables to extend the existing cables will have the same specifications as the existing cables.

4) Procurement of Tools and Vehicle for Maintenance of Distribution Network

At present, the TEC does not have a vehicle to transport the equipment and materials required for maintenance of the distribution network and rents a vehicle when necessary. However, it is not always possible to rent a vehicle at the time of an emergency. To solve this problem, one pick-up truck will be procured under the Project as the necessary minimum requirement.

Moreover, in view of the poor availability of maintenance tools, a cable fault locator and other tools to meet the minimum requirement will also be procured to detect earthing or short-circuiting incidents of the underground cables and to determine the point of failure so that restoration work can be easily conducted.

2.2.2.4 Outline Specifications of Main Equipment

(1) Main Equipment for Generating Facilities

The outline specifications of the main equipment for the new generating facilities to be constructed under the Project are shown in Table 2-2-7.

Table 2-2-7 Outline Specifications of Main Equipment (Generating Facilities)

Equipment	Quantity	Outline Specifications	
(1) DEC Unit			
1) Diesel Engine	3 (1 standby)	Rated operation	: continuous
		Output	: not less than 600 kW (approx. 906 ps)
		Rotation Speed	: not more than 750 rpm
		Engine type	: 4 stroke cycle in-line engine
		Cooling method	: radiator cooling
		Fuel oil	: diesel oil
		Miscellaneous	: vibration isolation common bed
2) Generator	3 (1 standby)	Rated operation	: continuous
		Rated output	: 750 kVA
		Phase	: 3 phase 3 wires
		Rated voltage	: 11 kV
		Rotation Speed	: not more than 750 rpm
		Power factor	: 0.8 (lag)
		Frequency	: 50 Hz
		Winding connection method	: Y connection (neutral direct earthing)
		Excitation method	: brushless thyrister
3) Electrical Equipment			
① Control Panel	1 set	Desk type; including synchroniser	
② 11 kV Distribution Panel	1 set	11 kV vacuum circuit breakers	
③ Local Control Panel	1 set	Diesel engine monitoring panel	
④ DC Power System	1 set	Lead battery; 110 V	
⑤ 415 V Panel	1 set	Circuit breaker for 415 V circuits	
⑥ Station Transformer	1 set	11 kV/415 – 240 V; 3 phase; 200 kVA	

Equipment	Quantity	Outline Specifications
4) Mechanical Systems		
① Fuel Oil Supply System		
a) Fuel Oil Storage Tank	2	Vertical cone roof type; outdoor; 150 m^3/tank
b) Fuel Oil Service Tank	2	Rectangular or circular; roof top installation; 1.0 m^3/tank
c) Fuel Oil Transfer Pump	2 (1 standby)	Motor-driven gear type; outdoor; 4 m^3/hr
d) Fuel Oil Unloading Pump	2 (1 standby)	Motor-driven gear type; outdoor; 30 m^3/hr
e) Fuel Oil Flow Meter	3	Direct reading integrating type; tolerance of 0.5% (full-scale)
f) Fuel Oil Supply Pump	3	Motor or engine-driven gear type
② Lubricating Oil System		
a) Lubricating Oil Transfer Pump	1	Motor-driven gear type; outdoor
b) Lubricating Oil Purifier	3 sets	Either filtering or centrifugal type; 200 litres/hr
c) Lubricating Oil Cooler	3	Either plate or multi-tube type; capacity of 110% of required area
③ Cooling Water System		
a) Rain Water Treatment System	1	Filtering and chemical injection
b) Cooling Water Tank	1	Rectangular or circular; outdoor; 2.0 m^3
c) Cooling Water pump	2 (1 standby)	Centrifugal type; outdoor; 1 m^3/hr
d) High Temp. Expansion Tank	1	Rectangular or circular; outdoor; 1.0 m^3
e) Low Temp. Expansion Tank	1	Rectangular or circular; outdoor; 1.0 m^3
f) High Temp. Circulating Pump	1	Centrifugal type; outdoor or indoor
g) Low Temp. Circulating Pump	3	Centrifugal type; outdoor
h) Radiator		Two layer type for hot and cold water; outdoor
④ Compressed Air System	2	
a) Air Compressor	2	30 kg/cm^2; motor and engine-driven; one each
b) Air Receiver	1 set	300 litres each; capable of starting the engine three times
c) Pressure Reducing Valve		Self-actuating pressure reducing type
⑤ Air Intake and Exhaust System	3	
a) Intake Blower	3	Horizontal axial fan
b) Exhaust Gas Silencer		Vertical type; outdoor
⑥ Waste Oil Treatment System	1	
a) Oil Separating Tank	1	Rectangular; steel; 2 m^3
b) Oil Transfer Pump	1	Screw type; 1 m^3/hr
c) Oil Separator	1	1 m^3/hr; treatment to 30 ppm or less
d) Oil Check Tank	1	Steel; 0.3 m^3
e) Waste Oil Discharge Pump	1	Screw type: 0.5 m^3/hr
f) Waste Oil Collection Tank	1	Steel; 0.5 m^3
g) Waste Oil Transfer Tank	1	Screw type; 0.5 m^3/hr
h) Waste Oil Tank	1	Steel; 0.3 m^3
i) Incinerator		0.03 m^3/hr
(2) Spare Parts for Generating Facilities	16,000 hours (2 years' operation)	Oil/lubricating oil filter elements; O-ring packings; parts for fuel pump and injection nozzle; valve parts; fuse elements; lamps; relays; timers; switches, etc. (see Table 2-4-3)
(3) Maintenance Tools and Testing Apparatus for Generating and Distribution Facilities	1 set	General and special engine tools; liner extracting tools; spare pumps for main pumps; oil and water quality inspection apparatus; transformer for 100V apparatus.

(2) Outline Specifications for Distribution Equipment

1) Ring Main Units (RMUs)

① Specifications

Table 2-2-8 Outline Specifications for RMUs

No.	Item	Specifications
1	Type of Insulation	Oil or gas insulated (SF6)
2	Rated Voltage	11 kV
3	Frequency	50 Hz
4	Phase	3 phase 3 wires
5	Rated Current	≧ 300 A
6	Short Circuit Current (Duration)	≧ 12.5 kA (1 sec)
7	BIL	75 kV
8	Power Frequency Withstand Voltage	28 kV
9	Disconnecting Switch	Manual operation
10	Fuse for Distribution Transformer	16 A (DT: ≦ 160 kVA) 25 A (DT: ≦ 200 kVA) 31.5 A (DT: ≦ 300 kVA) 50 A (DT: ≦ 500 kVA)

② Quantity

Number of new RMUs to be procured and installed: 8

Number of existing RMUs to be removed/relocated: 1

③ Configuration

As the configuration of the RMUs (number of switches and fuses) varies from one substation to another, refer to 3) Substation Upgrading Plan (Table 2-2-10) for the configuration of each RMU.

④ Accessories

A Test Probe which allows cable testing without disconnecting the cable from the terminal shall be provided as an accessory.

2) Distribution Transformers (DTs)

① Specifications

Table 2-2-9 Outline Specifications for Distribution Transformers

No.	Item	Specifications
1	Cooling Method	ONAN
2	Rated Voltage High Voltage Side Low Voltage Side	 11 kV (with tap) 415 – 240 V
3	Frequency	50 Hz
4	Phase	3 phase 4 wires
5	Connection	Dyn 11
6	Impedance	Approx. 4%
7	BIL	75 kV
8	Power Frequency Withstand Voltage	28 kV

② Quantity

Number of new DTs to be procured and installed: 8

Number of existing DTs to be removed/relocated: 1

③ Capacity

Refer to 3) Substation Upgrading Plan (Table 2-2-10) for the capacity of each DT.

④ Function

A no-load tap-changer (voltage adjustment range: ±2.5%, ±5%, 4 taps) will be installed on the 11 kV side of the DT to deal with a voltage drop and the taps will be manually changed.

3) Substation Upgrading Plan

The planned contents of the substation upgrading are shown in Table 2-2-10 – Substation Upgrading Plan.

Table 2-2-10 Substation Upgrading Plan

Substation	Distribution Equipment				
	Ring Main Unit (RMU)			Distribution Transformer (DT)	
	Planned Upgrading	Switch	Fuse	Planned Upgrading	Capacity (kVA)
1A	No change			No change	
1	To be replaced	3	1 (16A)	No change	
Essential	New	3	2 (16,50A)	New	200
New Gov. Office	Included in the above			No change	
2	To be replaced	2	1 (25A)	To be replaced	150
3	To be replaced	2	1 (25A)	To be replaced	200
4	To be replaced	2	1 (25A)	To be replaced	200
New Hospital	No change			No change	
5	No change			No change	
6	To be replaced	3	1 (50A)	To be replaced	400
7	To be replaced	2	1 (16A)	To be replaced	100
8	To be replaced	2	1 (16A)	To be replaced	100
8A	No change			To be relocated from 3	160
8B	No change			No change	
9	To be relocated from 1			To be replaced	200

4) 11 kV Cables

① Cable Specifications and Approximate Length

The specifications and approximate length of the 11 kV cables to be laid under the Project are shown in Table 2-2-11.

Table 2-2-11 Outline Specifications of 11 kV Distribution Cables

No.	Description	Insulating Material	Conductor	Armor	Length (m)
1	Connection between substations				
(1)	Loop line	XLPE	3 core; stranded copper; 50 mm^2	Steel Wire	7,400
(2)	Interconnection between existing P/S and new P/S	XLPE	3 core; stranded copper; 25 mm^2	Steel Wire	110
(3)	Branch line	XLPE	3 core; stranded copper; 25 mm^2	Steel Wire	3,370
2	Connection inside substation (between RMU and DT)	XLPE	3 core; stranded copper; 25 mm^2	Steel Wire	30
3	Extension of existing cables	XLPE	3 core; stranded aluminium; 25 mm^2	Steel Wire	100

Note) XLPE: Crosslinked-polyethylene; the cable length does not include an allowance for the work.

② Installation Method

The 11 kV cables to be laid under the Project will be directly buried under the ground on the right of way within 1.5 m of the edge of the road where the existing cables are laid to comply with the relevant standards in Tuvalu. In view of maintainability and the vehicle load, the cables at road crossing sections will be laid inside PVC conduits. The

laying depth will, in principle, be 60 cm below the ground surface and caution tapes indicating the presence of live cables will be placed above the cables (at an approximate depth of 30 cm below the ground surface). In addition, cable markers indicating the location of live cables will be placed along the route (every 100 m on straight sections, at each corner and at both ends of road crossing sections).

5) Procurement of Distribution Network Maintenance Tools and Vehicle

① Specifications and Quantities

The planned tools and vehicle to be procured under the Project for maintenance of the distribution network are listed in Table 2-2-12.

Table 2-2-12 Outline of Distribution Network Maintenance Tools and Vehicle

No.	Item	Use	Quantity
1	Withstand Voltage Tester	Testing of withstand voltage for 11 kV	1 set
2	Insulating Oil Tester	Measuring of degradation of insulating oil for DTs and RMUs	1 set
3	Cable Fault Locator	Measuring of fault point of cable	1 set
4	Earth Resistance Meter	Measuring of earth resistance	1 set
5	Circuit Tester	Measuring of voltage and current, etc.	1 set
6	Phase Rotation Meter	Measuring of phase rotation of 3 phase circuit	1 set
7	Circuit Breaker Drawer	Inspection and repair of circuit breaker	1 set
8	Vehicle (2 WD; 1 ton pick-up truck)	Transportation of equipment and materials	1

2.2.2.5 Power House Construction Plan

(1) Plan Contents

The new power station planned under the Project will be constructed on the premises of the existing Fogafale Power Station and will consist of the followings.

Power house	1	:	steel structure; single story and partial two stories; building area of some 614 m^2; total floor area of some 768 m^2
Equipment foundations	1 lot	:	including foundations for the fuel oil storage tanks
Rainwater storage tank	1 set	:	5 m^3 x 1 (effective capacity)
Exterior work	1 lot	:	drainage for storm water and wall mounted outdoor lighting

(2) Site and Facility Layout Plan

The premises in question have a size of some 60 m x 80 m. The entrance side (northwest) faces a side road along the airport runway and the other side (back) faces the ocean. Because of the fact

that the width of the empty land is relatively narrow, the available land cannot be described as ample to accommodate a new power house building. Therefore, The Government of Tuvalu shall demolish the TEC's existing administration office constructed by EU before the commencement of the work by Japanese side. Regarding the demolish of the said office, the Government of Tuvalu got approval from EU through the correspondence letters with Delegation of the EU Commission for the Pacific in Fiji. For the planning of the facility layout, careful attention is required to (i) avoid noise disturbance at the office building of the Family Health Association which is located next to the power plant and (ii) allow vehicle traffic for maintenance on the premises.

(3) Main Functions of Facilities and Building Plan

The various rooms described below are planned to ensure that the new generating facilities satisfactorily function as a main power station. Given the fact that the premises have been flooded by high tide in the past, a ground floor height of 600 mm above the ground is planned for the building, taking the recorded levels of past high tides into consideration.

1) Generator Room

This room will house the three DEG units (600 kW each) and auxiliary machinery and the layout will allow sufficient space for inspection and maintenance work. Each generator measures some 6 m in length, 2.5 m in width and 3 m in height. The auxiliary machinery includes fuel oil and lubricating oil pumps, air compressor, compressed air receiver and waste oil tank. The floor dimensions are set at 20 m x 21 m to allow the suitable layout of the generators and machinery, including work space required for inspection, repair and parts replacement. A three ton overhead travelling crane will be installed to repair or replace engine parts.

2) Electric Room

This room will house the 11 kV high voltage panel and low voltage panel to be introduced under the Project. The layout will be planned to avoid any disruption to inspection and maintenance work.

3) Control Room

The control room will be located on the first floor (the second story) to monitor and control all of the equipment in the power station.

4) Office

An office for 13 staff members of the TEC will be located on the ground floor for administrative work and will have an electricity bill payment counter.

5) Ventilation Room

A mechanical room for ventilation will be located on the first floor to ventilate the generator room and to intake air for engine combustion.

6) Storage Room

A spare parts storage room will be located on the ground floor to store mechanical tools and frequently required spare parts.

(4) Floor Area and Building Services of Each Room

The floor area and the installed building services of each room are shown in Table 2-2-13.

Table 2-2-13 Floor Area and Building Services of Each Room

Room	Floor Area (m^2)	Building Services
Generator Room	320	Lighting; emergency lighting; ventilation
Electric Room	105	Lighting; emergency lighting; ventilation
Control Room	49	Lighting; emergency lighting; air-conditioning
Office	151	Lighting; emergency lighting; air-conditioning
Ventilation Room	56	Lighting; emergency lighting
Storage Room	11.3	Lighting; ventilation
Others	75.7	Lighting
Total	768	

(5) Specifications of Main Structural Parts

The specifications of the main structure of the power house building are shown in Table 2-2-14.

Table 2-2-14 Specifications of Main Structure

Part	Specifications
Foundations	RC ; spread foundations
Ground Floor Slab and Pipe and Cable Pits	RC
Floor of First Floor	RC slabs on top of a steel deck
Columns and Beams	Steel structure with a fused zinc-plated finish

Note) RC: Reinforced Concrete

(6) Finishing Plan

1) Exterior Finish

The exterior finish of the power house building is shown in Table 2-2-15.

Table 2-2-15 Exterior Finish of Power House Building

Part	Specifications
Roof	Zinc-plated, coloured and ribbed steel plates with insulation materials
Walls	Zinc-plated, coloured and ribbed steel plates with insulation materials

2) Interior Finish

The interior finish of each room of the power house building is shown in Table 2-2-16.

Table 2-2-16 Interior Finish of Each Room of Power House Building

Room	Part	Finish
Generator Room	Floor	Steel trowelled concrete with an oil-resistant paint finish
	Walls	Acoustic glasswool boards
	Ceiling	Acoustic glasswool boards
Control Room	Floor	Steel trowelled concrete with a dust-resistant paint finish
	Walls	Cement boards on a light gauge steel structure with a paint finish
	Ceiling	Acoustic panels on a light gauge steel structure
Electric Room	Floor	Steel trowelled concrete with a dust-resistant paint finish
	Walls	Cement boards on a light gauge steel structure with a paint finish
	Ceiling	Exposed steel deck plates
Office	Floor	PVC tiles
	Walls	Same as Control Room
	Ceiling	Acoustic panels on a light gauge steel structure
Ventilation Room	Floor	Concrete with a trowel finish
	Walls	Cement boards on a light gauge steel structure with a paint finish
	Ceiling	Acoustic glasswool boards
Storage Room	Floor	Concrete steel trowel
	Walls	Cement boards on a light gauge steel structure with a paint finish
	Ceiling	Exposed steel deck plates

(7) Sectional Plan

The sectional plan for the generator room will allow a hoisting height of 6.2 m for the three ton overhead travelling crane so that the crane can hoist parts of the DEG units.

(8) Structural Plan

1) Main Structure of Power House Building

The main structure of the power house building will be a steel structure. The employment of this structure will shorten the construction period and reduce the weight of the building to be supported by the foundations. Molten zinc plating will be made to the surface of the steel to prevent salt damage.

2) Structure of Foundations

The ground of the planned construction site consists of rising coral reef, providing favourable ground conditions for building construction. Accordingly, spread foundations will be employed.

(9) Building Services

The planned building services for the main rooms are described below.

1) Lighting and Socket Outlets

In principle, indoor lighting will be provided by fluorescent lamps. Vertically movable mercury lamps will be installed in the generator room. Natrium lamps will be used for outdoor lighting as in the case of the existing facilities. The planned illuminance is 200 lux for the floor of the generator room, 500 lux for the desk top in the control room and 300 lux for the desk top in the office. These will be used as the reference values for the other rooms. Single phase 240 V sockets (with earthing) will be installed in each room. Three phase 415 V sockets (with earthing) will also be installed in the generator room.

2) Air-Conditioning System

A separate type air-conditioning unit will be installed in the control room and each office.

3) Ventilation System

Combustion air for the engines will be supplied to the generator room by a blower installed in the ventilation room on the first floor. Ventilation of the generator room will also be conducted by this blower. The introduction of a mechanical fan for ventilation or natural ventilation using louver windows will be considered for the other rooms.

4) Collection and Transfer of Rainwater

For the supply of drinking water and water for miscellaneous use in the power house building, rainwater will be collected from the roof of the building for storage in a rainwater

storage tank (5 m^3 x 1) on the ground. The stored water will be pumped to an elevated water tank on the roof of the auxiliary machine yard for supply to each equipment and other places.

5) Fire-Fighting Equipment

Two ABC fire extinguishers (10 kg type) will be provided in the generator room, electric room, control room and storage room for initial fire-fighting. As the generator room will contain many combustible substances, such as fuel oil and lubricating oil, two 30 kg fire extinguishers on wheels will also be provided in this room. Each room will have a smoke detection type automatic fire detection system and fire warnings will be displayed on a warning panel in the control room.

6) Crane

An overhead travelling crane with a sufficient capacity (3 ton) to hoist such major engine parts as the cylinder, etc. for inspection or repair will be installed in the generator room.

7) Lightning Rod

Two lightning rods will be installed on the roof of the power house building and a lightning rod will be installed at the top of each fuel storage tank.

(10) Foundations for Equipment

The foundations for the DEGs, auxiliary machinery, electrical installations and fuel storage tanks and pits to house pipes and cables will be constructed.

2.2.2.6 On the Job Training (OJT) Plan for Generating Facilities

Although the specifications and grade of the DEGs to be procured and installed under the Project are decided to meet the existing technical level of the TEC for the operation and maintenance of the existing DEG units, the medium engine speed of the new DEGs of 750 rpm differs from that of the existing DEGs. The TEC engineers involved in the operation and maintenance of the DEGs are familiar with high speed (1,500 rpm) DEGs and have the necessary basic technical expertise to handle the DEGs in a competent manner. However, they lack the specific skills to operate and maintain the medium speed DEGs to be procured and installed under the Project. Moreover, it is possible that the generating system to be procured under the Project will not be used by the existing DEGs because of technological developments in recent years. It will, therefore, be necessary to plan on the job training (OJT) on operation and maintenance techniques for the TEC engineers with the dispatch of engineers of the DEG manufacturer during the installation work.

(1) OJT Plan During Installation Work

1) Plan Contents

① Period and Venue for OJT

Classroom training : approximately one week (on site)
Practical training : approximately five weeks (on site)

② Instructors

The engineers dispatched by the DEG manufacturer nominated by the Japanese contractor for the Project to supervise the installation, test operation and adjustment of the equipment on site will act as instructors for the planned OJT.

③ Trainees

The trainees receiving OJT will be the TEC staff members directly involved in the operation and maintenance of the new DEG units after their commissioning as listed below. It will, therefore, be necessary for the TEC, i.e. the project implementing body on the Tuvalu side, to appoint the trainees prior to the commencement of the DEG installation work.

Senior engineer	:	1		
Operating staff	:	Electrical engineer	:	1
		Mechanical engineer	:	1
		Electrical technician	:	2
		Mechanical technician	:	2
		Sub-Total	:	6
Maintenance staff	:	Electrical engineer	:	1
		Mechanical engineer	:	1
		Electrical technician	:	2
		Mechanical technician	:	3
		Sub-Total	:	7
		Total	:	14

④ Training Contents

i. Classroom Training

Using the operation and maintenance manuals, the following basic education will be conducted on mainly the new generating units.

- Characteristics and structure of new generating units
- Basics of operation and maintenance (schedule control; basic concept of preventive maintenance; equipment functions; basics of measures to deal with accidents and breakdowns; spare parts and tool control; drawing and document control)

ii. Practical Training

During the equipment installation, test operation and adjustment periods, the following practical training will be conducted by the Japanese contractor.

- Disassembly and maintenance of cylinder head
- Overhaul and maintenance of fuel valve
- Grinding finishing of air intake and exhaust valves
- Overhaul and maintenance of pistons
- Disassembly and inspection of crack pin bearings
- Maintenance of motor pump
- Maintenance of air intake filter and other filters
- Unit starting up and stopping
- Emergency stop at the time of breakdown
- Remote monitoring and visual inspection
- Maintenance of purifier
- Maintenance of piping
- Maintenance of cables
- Maintenance of electrical equipment
- Use of maintenance tools and testing equipment

2.2.3 Basic Design Drawings

The following basic design drawings have been prepared for the Project and are shown in Appendix 6.

Category	Drawing No.	Title
General	G-01	Layout of New Power House
	G-02	Arrangement of New DEG Unit
Power House Building	A-001	New Power House Profile and Finishing Schedule
	A-002	New Power House Fitting Schedule
	A-003	New Power House Ground Floor Plan
	A-004	New Power House 1st Floor Plan
	A-005	New Power House Elevation
	A-006	New Power House Section
Generating Facilities	E-01	Key Single Line Diagram of New Fogafale Power Station
	M-01	Symbol List
	M-02	Fuel Oil Flow Diagram
	M-03	Lubricating Oil Flow Diagram
	M-04	Cooling Water Flow Diagram
	M-05	Compressed Air Flow Diagram
	M-06	Exhaust Gas Flow Diagram
Distribution Facilities	D-01	Key Single Line Diagram: Funafuti Power Network
	D-02	11 kV Distribution Route Map in Fogafale Island
	D-03	11 kV Distribution Route Map: 1A Area
	D-04	11 kV Distribution Route Map: Central Area (1/2)
	D-05	11 kV Distribution Route Map: Central Area (2/2)
	D-06	11 kV Distribution Route Map: 7 Area
	D-07	11 kV Distribution Route Map: 8 Area
	D-08	11 kV Distribution Route Map: 8A Area

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The Project will be implemented in accordance with the framework of the grant aid scheme of the Government of Japan. Accordingly, the Project will only be implemented after its approval by the Government of Japan and the formal Exchange of Notes between the Government of Japan and the Government of Tuvalu. The basic issues and special points for consideration for the implementation of the Project are described below.

(1) Project Implementing Body

The organization responsible for the implementation of the Project on the Tuvalu side is the Ministry of Works and Energy (MWE) while the project implementing body is the Tuvalu Electricity Corporation (TEC) which is responsible for all aspects of the electricity generating and supply business, including the planning, construction, operation and maintenance of generating and distribution facilities, on Funafuti Atoll as well as other atolls in Tuvalu.

The Tuvalu side should maintain close contact and consult with the Japanese Consultant and Contractor and should select a person from the TEC to be responsible for the implementation of the Project to ensure the smooth progress of the Project. The selected person will be required to explain the contents of the Project to staff members of the Fogafale Power Station and government officials concerned. The selected person will also be required to explain the same contents to local residents living near the new power station and the 11 kV distribution network upgrading sites to obtain their understanding of such contents of the Project in addition to reminding these residents of the necessary safety precautions during the construction work and requesting their cooperation for the smooth progress of the Project and maintenance of the new equipment following the completion of the Project.

(2) Consultant

In order to procure and install the necessary equipment as well as to construct necessary facilities for the Project, the Japanese Consultant will conclude a consultancy agreement with the Government of Tuvalu and will conduct the detailed design and supervision of the site work for the Project. The Consultant will also prepare the tender documents and will execute the prequalification and tender on behalf of the project implementing body.

(3) Contractor

The Contractor, which will be a Japanese company or firm selected by the Government of Tuvalu through open tender in accordance with Japan's grant aid scheme, will conduct the construction of the new power house building and installation of the equipment procured under the Project. As it is deemed necessary for the Contractor to provide after-care in terms of the supply of spare parts and the repair of equipment breakdowns in regard to the new equipment, the Contractor must pay proper attention to continual liaisoning with the TEC.

(4) Necessity for Dispatch of Japanese Engineers

The planned work under the Project consists of the construction of a new power station and the upgrading of distribution lines and will be complex work with the construction work and installation work of the new DEG units and distribution equipment being simultaneously conducted. For this reason, the dispatch of a site manager from Japan will be essential to provide consistent management and guidance on such matters as schedule control, quality control and work safety. The dispatch of Japanese engineers will also be essential to ensure proper schedule control, quality control and safety control in connection with the construction of the new power house building, including the construction of the foundations for the generators, because of the shortage of local civil engineers.

The planned installation work for the DEGs and distribution equipment will require wide-ranging knowledge and technical expertise regarding the performance, function and configuration of generating and distribution systems. Accordingly, the manufacturers of the DEG and distribution equipment will be required to dispatch experts during the installation work period of the main equipment and also at the time of test operation and adjustment.

In general, equipment breakdowns tend to occur during three distinctive periods as shown by the bath tub curve: initial breakdown period, accidental breakdown period and aged breakdown period. The appropriate repair of initial breakdowns, which occur relatively often after the commencement of operation, is extremely important to ensure the proper life of equipment. For this reason, OJT through the dispatch of electrical and mechanical engineers within the period set by the E/N will be considered to assist local engineers to learn the necessary repair skills to deal with initial breakdowns.

2.2.4.2 Implementation Conditions

(1) Construction Industry in Tuvalu

1) While it is possible to recruit construction workers in Tuvalu, there is a shortage of local skilled workers and engineers with specialist skills regarding schedule control, quality control and safety control. It will, therefore, be necessary for the Japanese Contractor to dispatch engineers or skilled workers from Japan to Tuvalu.

2) As the employment of engineers with experience of the installation and adjustment of the medium size DEGs, i.e. medium speed, to be procured and installed under the Project is difficult in Tuvalu, the dispatch of Japanese engineers to supervise the installation work as well as schedule control is planned as described in 2.2.4.1.

3) As the procurement of even the minimum range of machinery for the construction of the new power house building and the installation of the new equipment and vehicles for the inland transportation of equipment is impossible in Tuvalu, procurement from a third country is planned.

(2) Important Points for Work Plan

1) The lowest and highest mean monthly rainfall at Funafuti in the last 43 years is 230 mm in June and 400 mm in January respectively, indicating a fairly high level of rainfall all year round. Suitable measures to deal with rain should, therefore, be included in the planning of the excavation work and joint terminal treatment work for the 11 kV cables. These measures include rain cover and storm water drainage. Planning of the work schedule should also take this high level of rainfall into consideration.

2) The installation of the new DEG units will take place at the same time as the power house building construction work and the mechanical and electrical equipment installation work to shorten the work period. Connection with the existing generating units should be conducted in a manner which minimises any adverse impacts of temporary power cuts on local residents.

3) The work plan for the upgrading of the existing 11 kV distribution lines should be formulated in a manner which minimises any adverse impacts on the lives of citizens in the form of power cuts and traffic control.

4) The excavation work for the existing 11 kV cables must be carefully conducted so as not to damage the existing telephone lines. The schedule should not overlap with the work to extend the telephone network.

5) In regard to the construction of the new power house building, the installation of the new DEG units and the building finishing and service work will be simultaneously conducted to strictly observe the specified contract period. As a result, it is likely that one type of work may be conducted above the place of another type of work, making safety control essential.

6) If the cutting of any existing trees is necessary as part of the work, the timing and scale should be confirmed with the TEC in advance. In addition, verification by the relevant government agency and the understanding of local residents should be obtained to avoid environmental destruction and/or complaints by local residents.

7) Rainwater or desalinated seawater will be required for the concrete work. As the available quantity of both of these is limited, the use of groundwater may be necessary. In this case, strict water quality control, including checking of the salinity, will be essential to ensure the proper quality of the concrete.

8) From the environmental point of view, regarding the imported sand and gravel to be used for the Project, the Japanese constructor should submit the necessary analysis data of such materials to the Department of Environment for his approval.

2.2.4.3 Scope of Work

The scope of the work to be undertaken by the Tuvalu side and the Japanese side is shown in Table 2-2-17.

Table 2-2-17 Scope of Work

Work Item	Japan	Tuvalu
1. Generating Facilities		
1) DEGs	To procure and install	-
2) Auxiliary mechanical equipment for DEGs	ditto	-
3) Auxiliary electrical equipment for DEGs	ditto	-
4) Fuel oil storage tank, cooling water system and compressed air system	ditto	-
5) Earthing system	ditto	-
6) Maintenance tools	To procure	To store
7) Repair machinery	ditto	ditto
8) Spare parts	ditto	ditto
9) Operation and maintenance manuals	To procure and explain	To study and store
10) OJT	To conduct	To attend

Work Item	Japan	Tuvalu
11) Cleaning of planned construction site, etc.	-	To conduct
2. Distribution Facilities		
1) New 11 kV RMUs and DTs	To procure and install	-
2) Existing 11 kV RMUs and DTs	To remove/re-use	To store or dispose of removed equipment
3) New 11 kV cables (including connectors and terminal treatment materials)	To procure and install	-
4) Removal of existing 11 kV cables (where possible)	To remove	To store or dispose
5) Low voltage panels and cables (including accessories)	-	To procure and install
6) Earthing equipment, locks and fencing	-	To procure and install
7) Maintenance tools	To procure	To store
8) Spare parts	To procure	To store
9) Operation and maintenance manuals	To procure and explain	To study and store
10) OJT	To conduct	To attend
11) Removal of trees and other obstacles	-	To conduct in accordance with the proper procedure
3. Power House Building and Temporary Work		
1) Removal of existing building	-	To conduct in accordance with the proper procedure
2) New power house building	To design and construct	-
3) Rainwater supply system for new power house building	To design and construct	-
4) Foundations for fuel oil storage tanks and oil retaining wall	To design and construct	-
5) Storm water drainage system	To design and construct	-
6) Furniture and curtains	-	To procure and install
7) Materials for electricity, water and telephone service lines for construction work	On the premises	Preparation of service points on the premises
8) Electricity, water and telephone charges for construction work	To pay	-
9) Fuel oil and lubricating oil for new DEGs up to non-load test	To procure	-
10) Fuel oil and lubricating oil for new DEGs after non-load test	-	To procure

2.2.4.4 Consultant Supervision

The Consultant will organize the project team in accordance with Japan's grant aid scheme and the concept and principles of the basic design in order to smoothly proceed with the implementation of the Project. The Consultant will also appoint at least one full-time on-site engineer during the construction work period to supervise the schedule control, quality control and safety control and will dispatch other expert engineers in accordance with the progress of the installation, test running and adjustment and delivery testing, etc. to supervise the work conducted by the Contractor. Furthermore, the Consultant will arrange for Japanese experts to attend the inspection of equipment manufactured in Japan or a third country at the factories and pre-shipment stages to prevent any equipment problems after delivery to Tuvalu.

(1) Supervision Principles

The Consultant will supervise the work progress to ensure punctual completion within the planned period and will supervise and guide the Contractor in order to achieve the work quality indicated in the contract without any problems at the site. The main points to be noted for the supervisory work are described below.

1) Schedule Control

The Consultant will make weekly and monthly comparisons between the actual work progress and the work schedule submitted by the Contractor at the time of signing the contract in terms of the following items. If the Consultant foresees any delay of the work, he will issue a warning to the Contractor, requesting that the latter submit a remedial plan in view of the completion of the work within the planned work period.

① Quantity of work completed
② Quantity of equipment and materials delivered
③ Work efficiency and actual number of engineers, technicians and workers

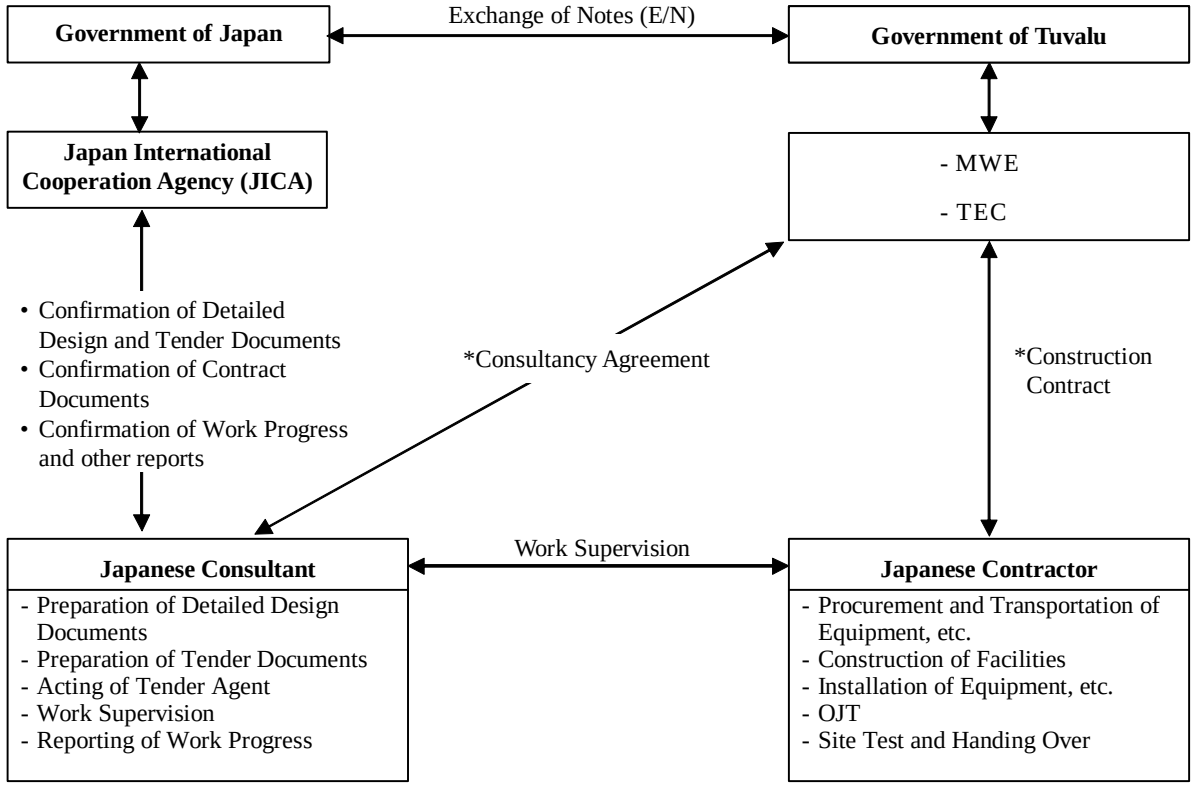
2) Safety Control

The Consultant will discuss and cooperate with the representative of the Contractor with a view to supervising the on-site construction and installation work to prevent any accidents to workers with due attention paid to the following on-site safety control principles.

① Establishment of safety control rules and selection of a person responsible for work safety
② Prevention of accidents to workers by means of periodic inspection of the construction machinery
③ Introduction of travelling routes for work vehicles and construction machinery, etc. and thorough enforcement of slow driving on site
④ Enforcement of welfare measures and days-off for workers

(2) Project Implementation Regime

The project implementation regime, i.e. relationship between the parties involved in the implementation of the Project, including the work supervision stage, is shown in Fig. 2-2-1.



Note: The consultancy agreement and construction agreement must be verified by the Government of Japan.

Fig. 2-2-1 Project Implementation Regime

(3) Work Supervisors

The Contractor will employ a local construction company as a subcontractor to employ local workers for the construction and installation work in accordance with the construction contract. It will be necessary for the Contractor to dispatch engineers with experience of similar work abroad to Tuvalu to supervise the subcontractor with a view to ensuring the strict enforcement of the schedule control, quality control and safety control by the subcontractor. Given the size and contents of the Project, the Contractor's appointment of at least the following full-time on-site engineer is preferable.

- Site Manager (1) : general management of on-site work and responsible for OJT

In addition, the Contractor should further dispatch personnel to supervise equipment installation, test operation and adjustment, etc. in accordance with the progress of each type of work.

2.2.4.5 Quality Control Plan

The Consultant will supervise the Contractor by means of the following to ensure that the latter adheres to the quality and completed quantity of the construction/installation work of the facilities and equipment indicated in the documents included in the consultancy agreement (technical specifications and detailed design drawings, etc.) If the Consultant believes that the quality does not meet the requirement, he will demand that the Contractor correct, change or modify the situation.

① Checking of shop drawings and specifications for the equipment
② Witnessing of the factory inspection of equipment or checking of the factory inspection reports
③ Checking of the packaging, transportation and temporary on-site storage methods
④ Checking of the working drawings and installation manuals for the equipment
⑤ Checking of the test operation, adjustment and inspection manuals for the equipment at the manufacturing factories and on site
⑥ Supervision of the site installation work of the equipment and witnessing of the test operation, adjustment and inspection
⑦ Checking construction drawings and work progress
⑧ Checking of the as-build drawings

2.2.4.6 Procurement Plan

None of the construction materials to be used and equipment to be procured under the Project are produced in Tuvalu and will be imported from abroad. Although some imported construction materials (cement and forms, etc.) can be locally procured in small quantities, all other materials and equipment will be procured in Japan or a third country to ensure their quality and delivery on time. The procurement sources of the DEGs and distribution equipment, which are the main equipment to be procured under the Project, are selected based on the reasons explained below.

(1) DEGs

The DEGs to be installed under the Project will be procured in Japan because of the following reasons.

1) European Products

There are several manufacturers in Europe which manufacture DEGs meeting the specifications adopted for the Project. However, the long transportation distance to Tuvalu suggests a higher project cost. Moreover, the procurement of spare parts and consumables after commissioning is likely to require a long time, creating a problem at the time of an

emergency. Not many European manufacturers have an agent in neighbouring countries of Tuvalu and, therefore, their after sales service is unsatisfactory.

2) Australian and New Zealand Products

There is no manufacturer of the planned type of DEGs in these countries. Even though there is a sales agent for the existing DEGs (made in the US) in Australia, after-service is provided from the US. The insufficient after-service system is illustrated by the fact that the response to an extraordinary situation is not very quick.

3) US Products

There is a tendency among US generating equipment manufacturers not to manufacture the medium speed diesel engine generators (continuous rating of 750 rpm or less) which are required for the Project. Instead, they mainly manufacture high speed (1,000 – 1,500 rpm) generators with a short time operation for emergency purposes. Even if a US manufacturer agrees to manufacture the DEGs required for the Project, the fact that its spare parts and consumables would not be on the normal production line will mean a long delivery period for such spare parts and consumables after the commissioning of the new DEGs and also high prices. As a result, the operation of the new DEGs is likely to be hampered.

4) Japanese Products

Many DEG manufacturers in Japan manufacture DEGs of the scale to be procured under the Project (output of 500 kW or higher) as medium speed DEGs for power utilities. Given the less expensive maritime transportation cost to that for European products, the ease of spare parts procurement in the future and the good after-service system, Japanese DEGs will be procured for the Project.

(2) Distribution Equipment

The distribution equipment and materials, such as RMUs, DTs and 11 kV cables, used in Tuvalu are mostly made in Australia, New Zealand or an ASEAN country. As their maintenance conditions are relatively good and as TEC staff are familiar with their operation and maintenance, the procurement of this equipment and materials from third countries will be considered.

Based on a general comparison and examination of the product standards, specifications, quality, production, supply reliability, ease of operation and maintenance, spare parts supply prospects and after-service to deal with breakdowns, etc., the prospective supply sources for the equipment and materials to be procured for the Project are shown in Table 2-2-18.

Table 2-2-18 Supply Sources of Equipment and Materials

Equipment/Materials	Supply Source		
	Tuvalu	Japan	Third Country
Fuel oil, lubricating oil and cooling water	○	-	-
Sand	-	-	○
Cement	-	-	○
Gravel	-	-	○
Steel bar	-	○	○
Structural Steel	-	○	○
Building service equipment and finishing materials	-	○	○
DEGs			
- Diesel engine, generator, electrical equipment, mechanical equipment, piping materials and power cables, etc.	-	○	-
- Spare parts for the above	-	○	-
- Maintenance tools for the above	-	○	-
Distribution equipment			
- DTs	-	○	○
- RMUs	-	○	○
- Cables, etc.	-	○	○
Construction machinery (excavator, dump truck, generator and submersible water pump, etc.	-	○	○
Vehicle (pick-up truck)	-	○	○

2.2.4.7 Implementation Schedule

Following approval of the implementation of the Project by the Government of Japan, the E/N will be signed by the two governments to commence the actual implementation process of the Project in accordance with Japan's grant aid scheme. The Project will largely be implemented in three stages, i.e. ① detailed design and preparation of the tender documents, ② tender and signing of the construction contract and ③ procurement and installation of the equipment. Fig. 2-2-2 shows the project implementation schedule.

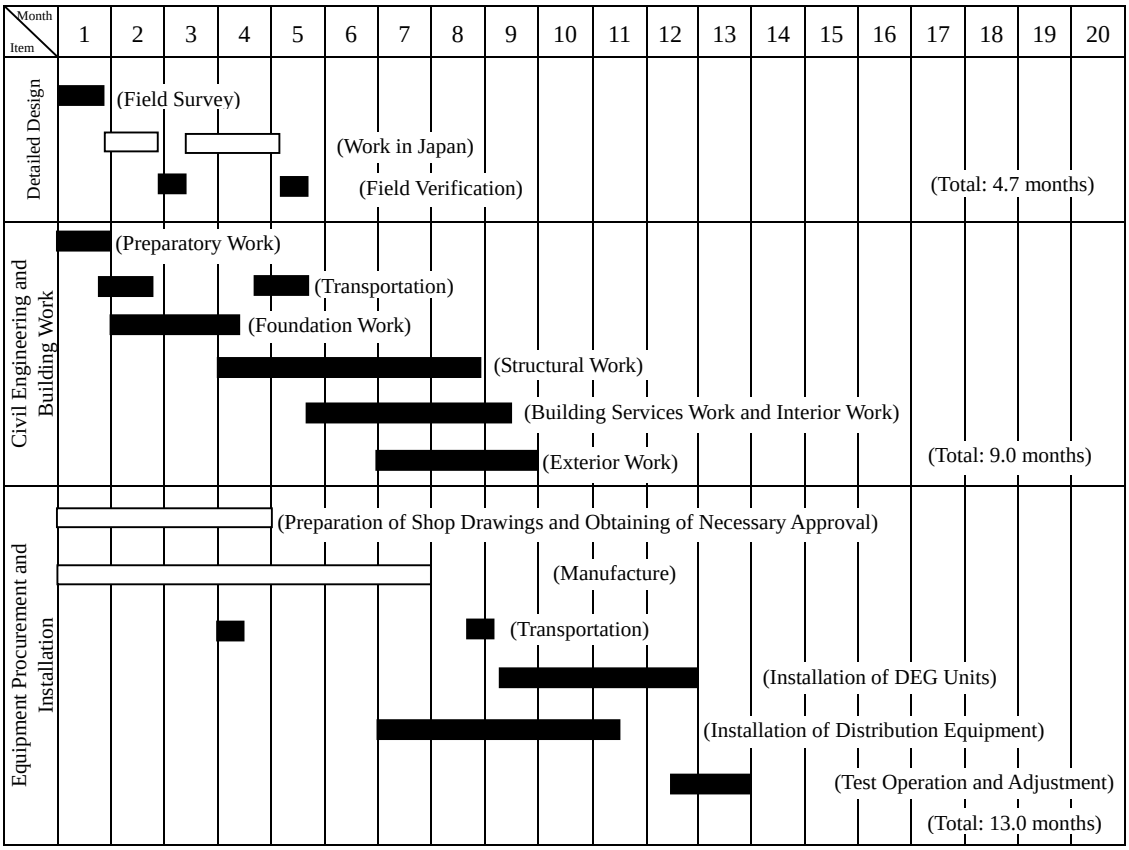


Fig. 2-2-2 Project Implementation Schedule

2.3 Obligations of Recipient Country

In connection with the implementation of the Project, the Tuvalu side has the obligation to provide or conduct the following in addition to those items listed under its responsibility in Table 2-2-17 – Division of Work.

(1) To provide necessary data and information required for the Project

(2) To secure or obtain and clear land for the new power house and new distribution equipment prior to the commencement of the construction work under the Project

(3) To ensure prompt unloading, customs clearance and tax exemption of the goods for the Project at the port and/or airport of disembarkation in Tuvalu

(4) To accord Japanese nationals whose services may be required with regard to the supply of products and services under the verified contracts for their entry into Tuvalu and stay therein for the performance of their work

(5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Tuvalu with respect to the supply of the products and services under the verified contract

(6) To bear the commission of a Japanese bank for opening bank account based on the banking arrangement

(7) To bear all expenses other than those to be borne under the grant aid scheme necessary for the implementation of the Project

(8) To appoint counterpart engineers and technicians for the transfer of operation and maintenance techniques and to witness the handing over inspection of the equipment

(9) To complete the necessary procedures and arrangements in connection with power cuts which are required during the equipment installation work

(10) To use and maintain the equipment procured under Japan's grant aid scheme in an appropriate and effective manner

(11) To procure and install the 415 V low voltage distribution equipment based on a work schedule which conforms to the required schedule under Japan's grant aid scheme

(12) To organize meetings to explain the contents of the Project to local residents living near the planned sites/routes of the distribution network upgrading work (by the end of February 2005)

(13) To secure disposal sites for the excavated soil, waste water, waste oil and recovered equipment and materials during the work period

(14) To remove obstacles on the 11kV distribution cable routes

(15) To remove the existing TEC office on the Fogafale Power Station site before the commencement of the Project

(16) To complete all necessary procedures regarding the replacement of the 11 kV distribution cables and laying of the new 11 kV distribution cables and to coordinate with other projects

(17) To store and dispose of the existing 11 kV cables after their removal

2.4 Operation and Maintenance Plan

2.4.1 Basic Principles

The most important equipment to be provided under the Project from the maintenance point of view is the generating units. The proper operation and maintenance of these units and the preservation of their operating environment are essential to ensure a stable power supply in response to daily demand fluctuations. In order to maintain the proper performance and functions of the planned generating units

to ensure a stable power supply, the implementation of appropriate preventive maintenance designed to improve the reliability, safety and efficiency of the generating unit is desirable. Fig. 2-4-1 shows the basic concept of such maintenance.

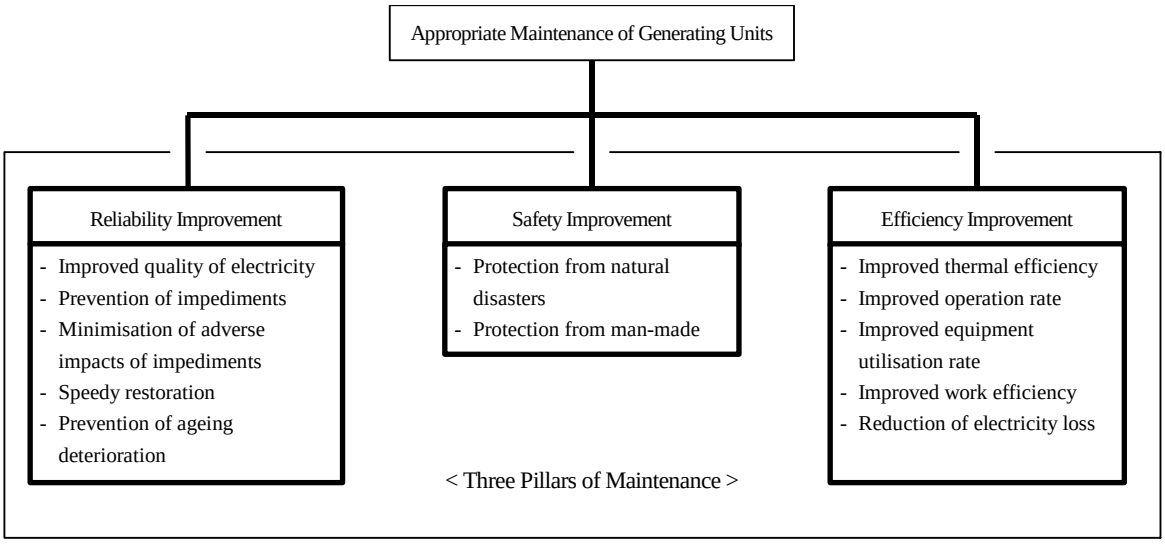


Fig. 2-4-1 Basic Concept of Generating Unit Maintenance

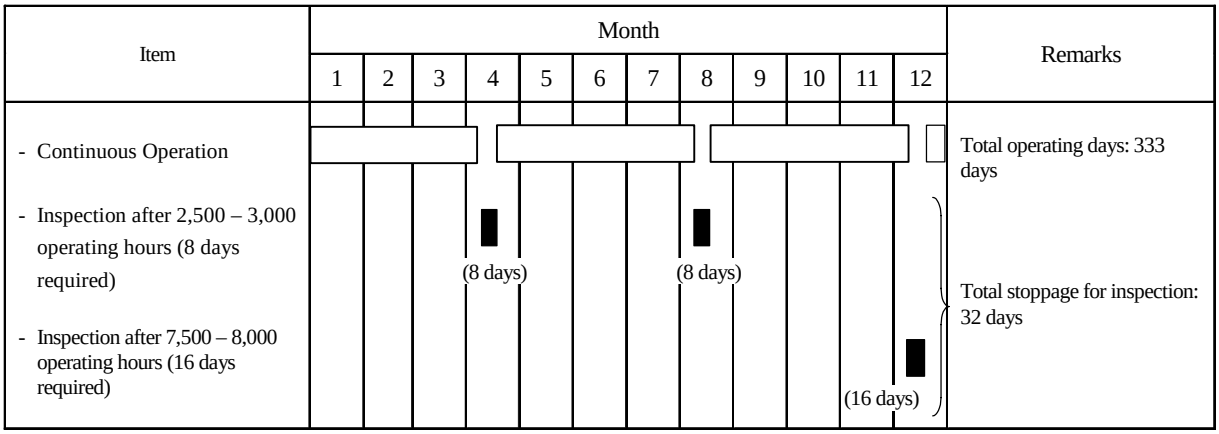
Bearing the above three principles of maintenance in mind, it will be necessary for the TEC to use the O & M techniques and skills transferred through the OJT conducted by engineers dispatched by the Japanese Contractor during the work period and the O & M manuals supplied by the Japanese side.

2.4.2 Operating Plan for New Generating Units

The planned three new generating units will provide the base load for Funafuti which is the political and economic centre of Tuvalu and the adoption of the following operating conditions is deemed appropriate.

- Annual operating rate : approximately 90% or higher
- Annual operating hours : approximately 8,000 hours

Table 2-4-1 shows the periodic inspection items required for the proper operation of the new generating units while Fig. 2-4-2 shows the annual operation programme for the same units for the first year based on the operating conditions mentioned above, taking the regular inspection items into consideration. It is expected that the operation of the new generating units will be suspended for some 32 days a year as shown in Fig. 2-4-2 for maintenance. At least two generating units among the No.3 through No.5 Units at the existing Fogafale Power Station should be used as alternative power sources during this period to compensate for the loss of power supply by the new generating units.



Note: Based on an annual operating rate of 90%.

Fig. 2-4-2 Annual Operation Programme for One New Generating Unit

2.4.3 Periodic Inspection Items

(1) Generating Units

The standard periodic inspection items for the planned generating units are shown in Table 2-4-1. The TEC will be required to prepare an operation and maintenance plan for the planned generating units in accordance with this table and the O & M manuals to be submitted by the unit manufacturer with a view to establishing the units' economical operation programme in line with the actual power demand.

Table 2-4-1 Standard Periodic Inspection Items for Generating Unit

Item	Type of Inspection	Main Inspection Item/Work
Diesel Engine	Daily Inspection	- Checking of fuel oil level of fuel oil tank and lubricating oil level of sump tank - Checking of jacket cooling water level - Checking of starting-up air receiver pressure - Visual check of appearance
	1,000 Hours Inspection	- Checking of proper tightening of nuts and bolts - Cleaning of fuel and lubricating oil filters
	2,500/3,000 Hours Inspection	- Checking of proper working of and oil leakage from intake and exhaust valves, starting valve, fuel valve, fuel pump, piston and liner, etc. - Analysis of lubricating oil quality of sump tank
	7,500/8,000 Hours Inspection	- Checking of proper working of and oil leakage from piston and cylinder liner and replacement of gasket - Replacement of piston ring, oil scraper ring and O-ring - Overhauling of cylinder head and replacement of gasket and O-ring - Inspection of intake and exhaust valves and replacement of exhaust valve O-ring - Inspection of fuel injection valve and replacement of nozzle - Inspection of crank pin bearings and replacement if necessary - Overhauling and inspection of turbo charger and replacement of bearings, etc. - Analysis of lubricating oil of sump tank and change of oil if necessary
	16,000 Hours Inspection	- All items under “7,500/8,000 Hours Inspection” - Inspection of main bearings and replacement if necessary - Inspection of exhaust valves and replacement if necessary - Overhauling and inspection of lubricating oil pump attached to engine and replacement if necessary
Generator	Daily Inspection	- Visual inspection of all sections and checking of abnormal sound and temperature
	Monthly Inspection	- Checking of abnormal vibration - Checking of lubricating oil flow and oil leakage from bearings - Necessary cleaning of components
	Annual Inspection	- Measurement of insulation resistance and inspection of lead wires and terminals - Visual inspection of accessories, including space heater - Visual inspection of bearings and cleaning if necessary

The following number of days will be required to complete the standard inspections listed in the table.

- 2,500/3,000 hours inspection : 7 – 8 days/inspection
- 7,500/8,000 hours inspection : 15 – 18 days/inspection
- 16,000 hours inspection : 20 – 25 days/inspection

(2) Distribution System

① Periodic Inspection of Distribution/Substation Equipment

Table 2-4-2 shows the standard periodic inspection items for the distribution/substation equipment to be procured and installed under the Project. As shown in this table, the inspection of such equipment can be divided into the three categories described below.

a) Patrol inspection: daily inspection of abnormal heat and abnormal sound, etc. from the equipment using the five human senses

b) Ordinary inspection: inspection of the proper tightening of bolts, etc., surface staining of insulating materials and charged parts which cannot be properly inspected by the routine patrol inspection

c) Close inspection: inspection of the functions of the interlocking mechanism, etc. and maintenance of the accuracy of instruments

Table 2-4-2 Standard Periodic Inspection Items for Distribution/Substation Equipment

Inspection Item	Inspection Contents (Method)	Patrol Inspection	Ordinary Inspection	Close Inspection
Appearance of Equipment	State of indication of on-off indicators/indicating lamps	○	○	
	Abnormal noise and/or smell	○	○	
	Thermal discolouration of terminals	○	○	
	Cracking or damage to bushing; state of dirt	○	○	
	Rust on installation case and frame, etc.	○	○	
	Abnormal temperature (use of a thermometer)	○	○	
	State of fastening at bushing end (mechanical check)	○	○	
Operating System and Control Panel	State of indication of each instrument	○	○	○
	Indication on each counter		○	○
	Condensation and/or rust on operating box and boards; state of dirt		○	○
	State of oiling and cleaning		○	○
	State of fastening at cable ends	○	○	○
	State of on-off indication		○	○
	Air or oil leakage		○	○
	Pressure (air and other) before and after operation		○	○
	Operation of performance meters		○	○
	Rust, deformation and damage of springs (repair)	○	○	○
	Abnormality of pins at tightened sections		○	○
	Inspection of auxiliary switches and relays (repair)		○	○
	Inspection of DC control power source	○		
Measuring/Testing	Measuring of insulation resistance		○	○
	Measuring of contact resistance			○
	Check of heater disconnection		○	○
	Testing of functioning of relay		○	○

In general, ordinary inspection is conducted every one or two years while close inspection is conducted approximately every four years. The replacement of fuses, instruments and relays, etc. which are liable to performance deterioration, insulation performance deterioration, abrasion of the contact points and changes of the characteristics if so required is desirable at the time of ordinary inspection and close inspection based on confirmation of the characteristics and frequency of use of these parts.

② Periodic Inspection of Distribution Lines

The most important aspect of the maintenance of the distribution lines from the viewpoint of customer service is to discover any failure, damage or breakage of a line through routine patrol inspection and to immediately conduct repair work. The main inspection items for this routine patrol are listed below.

(a) Contact between distribution equipment and trees, etc.
(b) State of fencing and locks
(c) State of circuit breaker panel and switchgear panel

2.4.4 Fuel Oil Procurement Plan

The estimated annual fuel (diesel oil) consumption volume to run the three generating units to be procured and installed under the Project is approximately 4,500m^3 based on an assumed operating rate of 90%. At present, the TEC purchases fuel oil for the Fogafale Power Station from a private oil company in Tuvalu. The TEC will be required to prepare and implement a practical fuel oil procurement plan to ensure the steady operation of the said generating units as in the case of the existing generating units.

2.4.5 Spare Parts Procurement Plan

The spare parts for the generating units and distribution/substation equipment are classified as standard spare parts which require replacement after a certain length of operation and spare parts reserved for emergency replacement at the time of an accident, etc. The Tuvalu side is required to procure an appropriate quantity of spare parts for the periodic inspection cycle.

The procurement of the spare parts required for 16,000 hours, i.e. two (2) years of operation to complete the periodic inspection cycle, is planned under the Project and the main items determined from the periodic inspection schedule are listed in Table 2-4-3. Accordingly, the Tuvalu side is required to set aside the necessary funds to procure the standard spare parts (approximately 3% of the

cost of the generating unit and distribution/substation equipment) and emergency spare parts by the end of the second year of the commissioning of the new generating units.

Table 2-4-3 Spare Parts and Maintenance Tools to be Procured Under the Project

(1) Spare Parts for Generating Units

No.	Item	Quantity
1.	**Mechanical Spare Parts**	
(1)	**Consumables**	
1)	Cylinder Cover	
	① Packing and O-Ring, etc.	six sets/cylinder x 3
	② Gasket Packing	six sets/cylinder x 3
2)	Intake Valve	
	① Valve Spring	three sets/cylinder x 3
	② Valve Seat	two sets/cylinder x 3
	③ O-Ring	two sets/cylinder x 3
3)	Exhaust Valve	
	① Valve Spring	three sets/cylinder x 3
	② Valve Seat	two sets/cylinder x 3
	③ O-ring	two sets/cylinder x 3
4)	Fuel Injection Valve	
	① Nozzle Chip	two sets/cylinder x 3
	② O-Ring	two sets/cylinder x 3
5)	Piston	
	① Piston Ring	two sets/cylinder x 3
	② Oil Ring	two sets/cylinder x 3
	③ Piston Pin Bearing	one set/cylinder x 3
	④ O-Ring	two sets/cylinder x 3
6)	Connecting Rod	
	① Nuts and Bolts	one set/cylinder x 3
7)	Fuel Injection Pump	
	① Plunger	two sets/cylinder x 3
	② Fuel Supply Valve	two sets/cylinder x 3
	③ Deflector	two sets/cylinder x 3
	④ O-Ring	two sets/cylinder x 3
8)	Turbo Charger	
	① Prefilter	two sets x 3
9)	Auxiliary Equipment	
	① Filter Mesh and Gasket for Fuel Oil System	200%
	② Filter Mesh and Gasket for Lubricating Oil System	200%
(2)	**Emergency Spare Parts**	
1)	Air Intake Valve (Complete)	one set
2)	Exhaust Valve (Complete)	one set
3)	Fuel Injection Pump	
	① Fuel Injection Nozzle (Complete)	one set
	② Fuel Injection Pump (Complete)	one set
4)	Auxiliary Pumps	
	① Fuel Supply Pump	1
	② Fuel Drain Discharge Pump	1
	③ Waste Oil Discharge Pump	1
	④ Lubricating Oil Pump	1
	⑤ Water Supply Pump	1
	⑥ Cooling Water (Hot) Circulating Pump	1
	⑦ Cooling Water (Cold) Circulating Pump	1
	⑧ Oily Water Transfer Pump	1

No.	Item	Quantity
	⑨ Sludge Discharge Pump	1
	⑩ Sludge Transfer Pump	1
2.	Electrical Spare Parts	
(1)	COnsumables	
1)	Fuses for Control Device	200% of each type
2)	Fuses for High Voltage Power Equipment	one of each type
3)	Indicating Lamps (Bulbs)	100% of each type
4)	Indicating Lamp (LED)	one of each type
5)	Fluorescent Lamps	200% of each type
(2)	Emergency Spare Parts	
1)	Glass Cover for Various Relays	one of each type
2)	Various Auxiliary Relays	one of each type
3)	Various Protective Relays	one of each type
4)	Various Timers	one of each type
5)	Various MCCBs	one of each type
6)	Various Instruments	one of each type
7)	Various Change-over Switches	one of each type

(2) Spare Parts for Distribution/Substation Equipment

No.	Item	Quantity
1.	**Expendables**	
	(1) Fuses for DTs	nine of each type
	(2) Silica Gel (not necessary if sealed type DTs are selected)	5 kg

(3) Maintenance Tools

No.	Item	Quantity	Remarks
1	For Mechanical Equipment		
	(1) Special Tool Set (for Engine and Generator)	one set	
	(2) Standard Tool Set for DEGs	one set	
	(3) Liner Extractor	one set	
	(4) Lubricating Oil Analysis Kit	one set	
	(5) Water Quality Analysis Kit	one set	
	(6) Transformer (AC 240/110 V, 1 kVA)	one set	For instruments
	(7) Chain Block (1 ton x 2.5 m)	one set	
	(8) Chain Block (2.5 tons x 3 m)	one set	
	(9) Noise Level Meter	1	
	(10) Portable NOx Meter	1	
2	For Electrical Equipment		
	(1) Withstand Voltage Tester for 11 kV	1	
	(2) Withstand Voltage Tester for Insulating Oil	1	
	(3) Cable Fault Locator	1	
	(4) Earth Resistance Tester	1	
	(5) Circuit Tester	1	
	(6) Phase Rotation Meter	1	
	(7) 11 kV CB Drawer	1	

(4) Maintenance Vehicle

No.	Item	Quantity	Remarks
1	Small Truck (for Maintenance of Distribution Lines)	1	2 WD; pick-up type

2.5 Estimated Project Cost

2.5.1 Estimated Project Cost

The total project cost in the case of the implementation of the Project with grant aid of the Government of Japan is estimated to be approximately ¥930 million. The breakdown of the cost based on the division of work between the Japanese and Tuvalu sides is outlined here based on the estimation conditions listed in (3) below. However, this estimated project cost is a provisional figure and is not necessarily the ceiling for grant aid agreed upon in the E/N. This figure will be further scrutinised at the time of examining the actual implementation of the Project.

(1) Japanese Portion Estimated Project Cost: ¥926 million

Cost Item		Estimated Project Cost (¥million)		
		Extension of Fogafale P/S	Upgrading of Funafuti Distribution Network	Total
Facilities	• Fogafale Power Station • Foundations for DEGs, auxiliary systems and fuel oil storage tanks, etc. • Building service systems • Exterior work	213	—	213
	• Upgrading of 11 kV distribution network (8 substations) • Laying of new 11 kV distribution cables • Maintenance vehicle and inspection tools, etc.	—	130	130
Equipment	• DEGs (600 kW x 3) • Auxiliary systems (fuel oil, lubricating oil, air intake and exhaust, cooling water, compressed air and other systems) • Electrical equipment and in-house electrical equipment • Spare parts, etc.	491	—	491
Detailed Design and Work Supervision		79	13	92
Total		783	143	926

(2) Tuvalu Portion AS$55,000 (approx. ¥4.42 million)

The main cost items for the Tuvalu side are listed below.

① Removal of the existing office building : AS$25,000 (approx. ¥2.01 million)
② Levelling of the new power station site and removal of obstacle structures : AS$30,000 (approx. ¥2.41 million)

(3) Estimation Conditions

① Date of Estimation : December, 2004

② Foreign Exchange Rates : AS$ 1 = ¥80.29 (TTS average from June, 2004 to November, 2004
US$ 1 = ¥109.90 (same as above)
NZ$ 1 = ¥73.94 (same as above)

③ Work Period : Both the Fogafale P/S extension work and the Funafuti distribution system upgrading work will be completed in a single year; see the implementation schedule for the detailed design, facility construction and equipment procurement/installation periods

④ Others : The Project will be implemented in accordance with the Guidelines for Japan's Grant Aid

2.5.2 Operation and Maintenance Cost

The average electricity tariff set by the TEC for the 2005 budget is AS$ 0.43 (approximately ¥34.5)/kWh and Table 2-5-1 shows the estimated income and expenditure for the Fogafale Power Station based on this electricity tariff. As the table shows, when the annual operating rate of the generating units to be installed under the Project reaches 27% or higher (2,365 hours or more a year), the resulting balance between the income and expenditure becomes favourable. The load factor (average demand ÷ peak demand) in 2003 in Tuvalu was 69%. Assuming a similar load factor for the coming years, the operating rate of the planned generating units under the Project will be 52.5% in the year of commissioning (2007) or 78.7% in the target year (2012). Accordingly, provided that the TEC conducts proper maintenance to maintain an appropriate operating rate of the new generating units to ensure profitable operation, the operation and maintenance cost will be met. The introduction of new generating units of which the generating efficiency is high under the Project will reduce the fuel oil cost per unit of electric energy generated. This means that if the electricity charge, the total amount of which will increase to reflect the increasing amount of electric energy sold, is properly collected, the overall financial balance of the TEC regarding the Funafuti Power System will certainly improve.

Given the fact that the TEC also supplies electricity on small outlying islands where the business profitability is poor, the TEC will continue to require a government subsidy to sustain its overall operation. However, the expected improvement of the TEC's financial balance at Funafuti will enable a reduction of the scale of the government subsidy.

Table 2-5-1 Estimated Income and Expenditure for Planned Generating Unit

Item			Unit	Annual Operating Rate (%)				
				26	27	50	70	90
I. Income								
1. Installed Capacity	(1)		kW	1,800	1,800	1,800	1,800	1,800
2. Annual Operating Hours	(2)		hr	2,278	2,365	4,380	6,132	7,884
3. Electric Energy Generated	(3)		kWh	4,099,680	4,257,360	7,884,000	11,037,600	14,191,200
4. Station Loss	(4)	(3) x 0.03	kWh	122,990	127,721	236,520	331,128	425,736
5. Transmission/Distribution Loss	(5)	(3) x 0.06	kWh	245,981	255,442	473,040	662,256	851,472
6. Electric Energy Sold	(6)	(3) – (4) – (5)	kWh	3,730,709	3,874,198	7,174,440	10,044,216	12,913,992
7. Average Unit Sales Price	(7)		AS$/kWh	0.43	0.43	0.43	0.43	0.43
Total Income	(8)	(6) x (7)	AS$	1,604,205	1,665,905	3,085,009	4,319,013	5,553,017
II. Expenditure								
1. Fuel	(9)	(3) x (c) x (e)	AS$	829,704	861,616	1,595,584	2,233,818	2,872,052
2. Lubricating Oil	(10)	(3) x (d) x (e)	AS$	19,974	20,742	38,411	53,775	69,140
3. Personnel	(11)	(f) x 14	AS$	91,481	91,481	91,481	91,481	91,481
4. Maintenance	(12)	(g)	AS$	44,837	44,837	44,837	44,837	44,837
5. Head Office Management	(13)		AS$	366,957	366,957	366,957	366,957	366,957
6. Depreciation	(14)		AS$	269,025	269,025	269,025	269,025	269,025
Total Expenditure	(15)		AS$	1,621,978	1,654,658	2,406,296	3,059,894	3,713,492
III. Operating Balance	(16)	(8) – (15)	AS$	-17,773	11,247	678,714	1,259,119	1,839,525
			Converted to yen	-1,426,994	903,004	54,493,922	101,094,685	147,695,449

Preconditions
(a) The average unit sales price of AS$ 0.43 (approx. ¥34.5)/kWh which is budgeted for 2005 by the TEC is adopted as the unit sales price.
(b) The station loss (3%) and transmission loss (6%) are assumed figures.
(c) The fuel cost is estimated to be AS$ 0.7814/litre.
(d) The lubricating oil cost is estimated to be AS$ 3.045/litre.
(e) The consumption volumes of fuel oil and lubricating oil are estimated as follows:
Fuel oil: 0.259 litres/kWh
Lubricating oil: 0.0016 litres/kWh
(f) The personnel cost is calculated based on an annual wage of AS$ 6,535/person for 14 staff members.
(g) The maintenance cost covers the cost of regularly replaced spare parts, etc. and is estimated to be 3% of the original equipment cost.
(h) The management cost (head office cost) is taken from the TEC's 2005 budget.
(i) The depreciation cost is calculated based on the straight line method using the main cost of the generating units in question with an expected life of 15 years and a residual value after 15 years of 10%.
(j) The foreign exchange rate used is AS$ 1 = ¥80.29 (TTS average from June to November,2004)

2.6 Other Relevant Issues

Other relevant issues which are likely to directly influence the smooth implementation of the requested Japanese assistance are listed below.

(1) Any delay of the work to install the low voltage distribution cables to be conducted by the Tuvalu side will result in the non-performance of the expected functions associated with the implementation of the Project within the work period. To avoid delays, the Tuvalu side should establish a construction team and should formulate schedule, personnel and material procurement plans to facilitate the work to be conducted by the Tuvalu side to ensure the progress of the Project as planned.

(2) The Tuvalu side should pay full attention to the possible linkage between the upgrading of the distribution network under the Project and new infrastructure development projects and should regularly check the trends, status and plans of these related projects with a view to their coordination with the Project.

(3) As any delay in explaining the purpose and contents of the planned distribution network upgrading work to local residents and obtaining the consent of local residents and any other competent authority for the work will affect the schedule for the installation of the cables, etc., the Tuvalu side should be constantly aware of the progress situation of the related procedures.

(4) The Tuvalu side should complete its obligations as planned, such as the removal of the existing TEC office building and related septic tank and water tank, etc. on the premises of the Fogafale Power Station.

(5) The Tuvalu side should complete its obligation to remove any obstacles and to level the ground at the target substation sites as planned.

(6) The Tuvalu side should formulate an environmental management plan for the new power station to be constructed under the Project, obtain its approval by the Environment Bureau and pay constant attention to environmental conservation based on the said plan.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3
PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effects

The implementation of the Project is expected to have the following effects.

(1) Direct Effects

Current Situation and Problems	Improvement Measures Under the Project	Effects and Degree of Improvement Under the Project
1. Planned load shedding is implemented in Funafuti on a daily basis because of the fact that the peak demand exceeds the available supply capacity.	Installation of three 600 kW DEG units at the Fogafale Power Station of the Funafuti Power System (FPS)	The available supply capacity in the target year (2012) will exceed the peak load by 612 kW, making planned load shedding unnecessary.
2. The insufficient reserve supply capacity in Funafuti necessitates load shedding to compensate for the insufficient reserve capacity when the operation of a generating unit is suspended due to failure or for inspection purposes.	As above	As the available supply capacity in the target year (2012) will exceed the peak load by 612 kW, there will be sufficient reserve capacity to deal with sudden failures or the planned inspection of the generating units, making load shedding unnecessary.
3. Power failures due to the aging and/or insufficient capacity of the distribution equipment frequently occur in Funafuti (63 times lasting for a total of some 25 hours in 2003).	Renewal of the distribution equipment and cables of the FPS	The renewal of the distribution equipment and cables under the Project will eliminate the capacity shortage, preventing power failures caused by the aging and/or insufficient capacity of the distribution equipment.
4. The aging and insufficient capacity, etc. of the distribution equipment in Funafuti causes a distribution loss of some 15% (2003 result) at the user end.	As above	The elimination of the capacity shortage through the renewal of the distribution equipment and cables under the Project will reduce the distribution loss from the current 15% to approximately 1%.

(2) Indirect Effects

Current Situation and Problems	Improvement Measures Under the Project	Effects and Degree of Improvement Under the Project
1. The unstable power supply in Funafuti is restraining the economic development of the city.	(1) Installation of three 600 kW DEG units at the Fogafale Power Station of the FPS (2) Renewal of the distribution equipment and cables of the FPS	The stable supply of quality power in Funafuti will vitalise economic activities in Funafuti.
2. The unstable power supply in Funafuti hampers the stable operation of public/welfare facilities in the city.	As above	The stable supply of quality power in Funafuti will stabilise the operation of public/welfare facilities in Funafuti, including administrative offices, schools and hospitals.

3.2 Recommendations

The Tuvalu side should deal with the following tasks to ensure the achievement and continuation of the positive effects of the Project.

(1) With the implementation of the Project, the reserve capacity for emergency power supply (reserve supply capacity to compensate for the stoppage of a generating unit with the largest output) will be secured up to 2012. However, it will still be necessary to develop new power sources to meet the demand increase from 2013 onwards so that there is always a sufficient reserve capacity to allow the stoppage of a generating unit for periodic maintenance.

(2) The TEC should collect the electricity charge from large users, including government organizations, without fail to make its financial management healthier.

(3) The necessary budget for the proper maintenance of the generating and distribution facilities and for the procurement of spare parts should be secured and emergency spare parts should always be held in stock to minimise the duration of any stoppage of the equipment for repair should equipment failure occur.

(4) In addition to appropriate control of the unit generation cost through the proper management of operation, taking the fuel consumption volume and usage of the power source for auxiliary equipment, etc. into consideration, the depreciation cost of the fixed assets for power generation and distribution, including the equipment provided under the Project, should be properly accounted and the amount should be saved in the form of a reserve fund for future investment in new equipment.

(5) An appropriate operating plan for the existing as well as new generating units at the Fogafale Power Station should be prepared so that the operating rate of the new units to be provided under the Project is at least around 27% or higher.

(6) The achievements of the OJT and counterpart training under the Project should be spread to all operation and maintenance staff and efforts should be made to improve the operation and maintenance skills of the staff to establish a preventive maintenance regime.

(7) The contents of the EIA and environmental management plan should be strictly followed so that the environmental impacts of the implementation of the Project do not exceed the estimated impacts of the EIA.

APPENDICES

1. MEMBER LIST OF THE STUDY TEAM

Member List of the Study Team

1. Basic Design Study

Name	Work Assignment	Position
Mr. Hiroyuki Hayashi	Leader	Traffic Infrastructure Team, Project Management Group II, Grant Aid Management Department, JICA
Mr. Mitsuhisa Nishikawa	Chief Consultant/ Power Supply Planner/ Specialist on Environmental and Social Consideration	Yachiyo Engineering Co., Ltd.
Mr. Kyoji Fujii	Generating Equipment Planner (Diesel Engine Generator)	Yachiyo Engineering Co., Ltd.
Mr. Masayuki Tamai	Distribution Planner (Substation equipment & Power cable)	Yachiyo Engineering Co., Ltd.
Mr. Susumu Imai	Generating Facility Planner	Yachiyo Engineering Co., Ltd.
Mr. Takayuki Miyamoto	Construction & Procurement Planner / Cost Estimator	Yachiyo Engineering Co., Ltd.

2. Explanation of the Draft Basic Design Study Report

Name	Work Assignment	Position
Mr. Mitsuhisa Nishikawa	Chief Consultant/ Power Supply Planner/ Specialist on Environmental and Social Consideration	Yachiyo Engineering Co., Ltd.
Mr. Kyoji Fujii	Generating Equipment Planner (Diesel Engine Generator)	Yachiyo Engineering Co., Ltd.
Mr. Masayuki Tamai	Distribution Planner (Substation equipment & Power cable)	Yachiyo Engineering Co., Ltd.

2. SURVEY SCHEDULE

Survey Schedule

1. Basic Design Study

Date			Official Member	Consultant Team		Notes and Stay at
			Mr.Hayashi (JICA)	Mr. Nishikawa, Mr. Fujii, Mr.Tamai	Mr. Imai, Mr.Miyamoto,	
1	Nov. 27	Sat	Trip (Narita 21:35 by JL761〜)			Stay on board
2	Nov. 28	Sun	Trip (〜Brisbane 07:15 by JL 761, Brisbane 12:00〜Nadi 17:35 by FJ920, Nadi 20:15〜Suva 20:45 by PC510)			Stay at Suva
3	Nov. 29	Mon	Trip (Suva 08:30〜Funafuti 10:45 by PC601) Courtesy Call to Ministry of Works and Energy (MWE) and Tuvalu Electricity Corporation (TEC), and Submission of and discussion on the Survey schedule, Inception Report and Questionnaires.			Stay at Funafuti
4	Nov. 30	Tue	Explanation of discussion on the Inception report Site survey at the existing power station, New power station site and the distribution lines.			Stay at Funafuti
5	Dec. 01	Wed	Submission of and discussion on the draft Minutes of Discussions (MD) Correction of MD			Stay at Funafuti
6	Dec. 02	Thu	Signing of M/D Detailed site survey of the existing power station and distribution lines	Mobilization of Topographic survey and Soil investigation at New power station site with the subcontractor.		Stay at Funafuti
7	Dec. 03	Fri	Detailed site survey of the existing power station and distribution lines Discussion with TEC staff for Background of the request, Present situations of Generating and Distribution facilities			Stay at Funafuti
8	Dec. 04	Sat	Technical discussion with TEC staff regarding the New power station and distribution lines			Stay at Funafuti
9	Dec. 05	Sun	Sorting of Data and information collected Internal meeting			Stay at Funafuti
10	Dec. 06	Mon	Detailed site survey of the existing power station and distribution lines			Stay at Funafuti
11	Dec. 07	Tue	Trip (Funafuti 11:30〜Suva 13:45 by PC602)	Collection of data for Environment protection regulation, Socio economic, Budget of Meet and TEC, etc		Mr. Hayashi stays at Suva, Consultant Team stays at Funafuti
12	Dec. 08	Wed	Courtesy Call and Report to Embassy of Japan and JICA Fiji office	Collection of data for Marine facilities, Oil storage/transportation situation and availability of Construction machineries, equipment and materials.		Mr. Hayashi stays at Nadi, Consultant Team stays at Funafuti
13	Dec. 09	Thu	Trip (Nadi 10:30 〜 Narita 17:00 by FJ302)	Technical discussion with TEC staff about New Power Station		Stay at Funafuti
14	Dec. 10	Fri		Technical discussion with TEC staff about New Distribution Lines		Stay at Funafuti
15	Dec. 11	Sat		Preparation of Field Report		Stay at Funafuti
16	Dec. 12	Sun		Sorting of Data and information collected, and Preparation of Field Report		Stay at Funafuti
17	Dec. 13	Mon		Survey of projects assisted by other donors and organizations. Market survey of Equipment and materials necessary for the Project.		Stay at Funafuti
18	Dec. 14	Tue		Survey of record and plan assisted project by other donor and organization. Market survey of Equipment and materials necessary		Stay at Funafuti
19	Dec. 15	Wed		Supplement field survey and Preparation of Field survey		Stay at Funafuti
20	Dec. 16	Thu		Explanation of and discussion on Field Report with TEC staff	Trip (Funafuti 12:45〜Suva 15:00 by PC602)	Stay at Funafuti (Nishikawa, Fujii, Tamai) and Suva (Miyamoto, Imai)
21	Dec. 17	Fri		Explanation of and discussion on Field Report with TEC staff	Market survey of Equipment and materials and Review of the results for Topographic survey and Soil investigation	Stay at Funafuti (Nishikawa, Fujii, Tamai) and Suva (Miyamoto, Imai)
22	Dec. 18	Sat		Explanation of and discussion on Field Report with TEC staff, and Obtain the approval from TEC	Market survey of Equipment and materials necessary for Cost Estimation	Stay at Funafuti (Nishikawa, Fujii, Tamai) and Suva (Miyamoto, Imai)
23	Dec. 19	Sun		Trip (Funafuti 14:45〜Suva 17:00 by PC604)	Sorting of Data and information collected	Stay at Suva
24	Dec. 20	Mon		Courtesy call to Embassy of Japan and JICA Fiji office Trip (Suva 16:30〜Nadi 17:00 by PC177, Nadi 20:40〜Brsibane 22:40 by FJ921)		Stay at Brisbane
25	Dec. 21	Tue		Trip (Brisbane 09:30〜Narita 17:20 by JL762)		

2. Explanation of the Draft Basic Design Study Report

No.	Day		Consultant Members Mr. Nishikawa, Mr. Fujii, Mr. Tamai	Stay at
1	12 Mar.	Sat.	-Trip[Narita: NRT(21:35)→JL761→]	Air
2	13 Mar.	Sun.	-Trip (～Brisbane 07:15 by JL 761, Brisbane 12:00～Nadi 17:35 by FJ920, Nadi 20:15～Suva 20:45 by PC512)	Suva
3	14 Mar.	Mon.	-Trip (Suva 10:00～Funafuti 12:15 by PC601) -Courtesy Call to Ministry of Works and Energy (MWE) and Tuvalu Electricity Corporation (TEC), and Explanation and Discussion on the Draft Basic Design Report (TEC)	Funafuti
4	15 Mar.	Tue.	-Explanation and Discussion on the Technical Specifications of the Equipment and Materials (TEC) -Explanation and Discussion on the Draft Basic Design Report (TEC)	Funafuti
5	16 Mar.	Wed.	-Explanation and Discussion on the Draft Basic Design Report (TEC) -Explanation and Discussion on the M/D	Funafuti
6	17 Mar.	Thu.	-Explanation of Grant Aid Scheme and confirmation of remaining data & information with TEC -Explanation and Discussion on the M/D	Funafuti
7	18 Mar.	Fri.	-Signing on M/D -Site Survey (Distribution Line Routes and Substation sites)	Funafuti
8	19 Mar.	Sat.	-Site Survey (Fogafale Power Station)	Funafuti
9	20 Mar.	Sun.	-Trip (Funafuti 13:00～Suva 15:15 by PC602)	Suva
10	21 Mar.	Mon.	-Report to JICA and EOJ -Trip (Suva～Nadi by Car, Nadi 20:40～Brisbane 22:40 by FJ921)	Brisbane
11	22 Mar.	Tue.	*Trip[BNE(09:30)→JL762→NRT(17:20)]	Tokyo

Remarks:

JICA: Japan International Cooperation Agency
MWE: Ministry of Works & Energy
TEC: Tuvalu Electricity Corporation
NRT: Narita International Airport
BNE: Brisbane
M/D: Minutes of Discussions

3. LIST OF PARTIES CONCERNED IN THE RECIPIENT COUNTRY

List of Parties Concerned in the Recipient Country

The Office of Prime Minister

Hon. Maatia Toafa	Prime Minister and Minister for Foreign Affairs and Labor
Mr. Paovapasi Nelesone	Secretary to Government, the Office of Prime Minister

Department of Environment (DoE)

Mr. Mataio Tekinene	Director
Ms. Pepetua Latasi	Environmental Officer

Ministry of Works and Energy (MWE)

Hon. Saufatu Sopoanga	Minister
Mr. Pusinelli Laafai	Secretary for Works and Energy
Mr. Isaia Taape	Assistant Secretary for Works and Energy
Mr. Molipi Tausi	Energy Planner
Mr. Am Pelosa. M Tehulu	Deputy Director of Works

Tuvalu Electricity Corporation (TEC)

Mr. Mafalu Lotolua	General Manager
Mr. Falani Boreham	Assistant Generation Engineer
Mr. Taaku Esekielu	Assistant Distribution Engineer
Mr. Tealofi Enosan	Financial Controller

Ministry of Foreign Affairs and Labor (MFAL)

Mr. Tine Leuelu	Secretary for Foreign Affairs and Labor

Embassy of Japan in Fiji

Mr. Kenro Iino	Ambassador
Mr. Motoo Sakakibara	Second Secretary
Mr. Hiroshi Watanabe	Second Secretary

Japan International Cooperation Agency (JICA)

Mr. Tadashi Ikeshiro	Resident Representative
Mr. Yasumichi Araki	Assistant Resident Representative
Mr. Satoshi Wakasugi	Assistant Resident Representative

4. MINUTES OF DISCUSSIONS

Minutes of Discussions
on the Basic Design Study
on the Project for Upgrading of Electric Power Supply in Funafuti Atoll
in Tuvalu

In response to the request from the Government of Tuvalu (hereinafter referred to as "Tuvalu"), the Government of Japan decided to conduct a Basic Design Study on the Project for Upgrading of Electric Power Supply in Funafuti Atoll (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Tuvalu the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Hiroyuki Hayashi, an officer, Traffic Infrastructure Team, Project Management Group II, the Grant Aid Management Department, JICA, and is scheduled to stay in the country from November 29 to December 19, 2004.

The Team held discussions with the concerned officials of the Government of Tuvalu. In the course of the discussions, both sides have confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Funafuti, December 2, 2004

Hiroyuki Hayashi
Leader
Basic Design Study Team
Japan International Cooperation Agency

Mafalu Lotolua
General Manager
Tuvalu Electricity Corporation
Tuvalu

(Witnesses)

Pusinelli Laafai
Secretary of Works and Energy
Ministry of Works and Energy
Tuvalu

ATTACHMENT

1. Objective of the Project

The objective of the Project is to ensure reliable and stable electricity supply in Funafuti area by the installation of new diesel engine generators at Funafuti Power Station, and upgrading of distribution network connected to the Funafuti Power Station.

2. Project Site

The Project sites are shown in Annex-1.

3. Responsible and Implementing Organizations

(1) The responsible organization is the Ministry of Works and Energy (MWE).
(2) The implementing agency is the Tuvalu Electricity Corporation (TEC).
(3) The organization charts of MWE and TEC are shown in Annex-2.

4. Components Requested by the Government of Tuvalu

After discussions with the Team, the following components were finally requested by the Tuvalu side. JICA will assess the appropriateness of the request, prioritize each component, and will recommend to the Government of Japan for approval.

(1) Construction of a new power plant building
(2) Installation of four sets of 750 kVA (600 kW) diesel engine generators
(3) Spare parts for the generators
(4) Upgrading of the existing 11 kV high voltage cable network
(5) TEC administration building
(6) Technical Training on operation and maintenance for generating and distribution facilities as the On-the-Job training and specialized training on rewinding works for motors and repair works for important component of diesel engine.
(7) Testing and Maintenance Equipments for generating and distribution facilities (Cable fault locator should be included)
(8) A vehicle for maintenance work

5. Japan's Grant Aid Scheme

(1) The Tuvalu side understands the Japan's Grant Aid scheme and the necessary measures to be taken by the Government of Tuvalu explained by the Team as described in Annex-3.
(2) The Tuvalu side promised to take necessary measures, as described in Annex-4, for smooth implementation of the Project as a condition for the Japan's Grant Aid to be implemented.

6. Schedule of the study

(1) The consultants will proceed to further studies in Tuvalu until December 19, 2004.
(2) JICA will prepare a draft report in English and dispatch a mission to Tuvalu in order to explain its contents around the middle of March 2005.
(3) When the contents of the report are accepted in principle by the Government of Tuvalu, JICA will complete the final report and send it to the Government of Tuvalu around May 2005.

7. Other Relevant Issues

(1) The Both sides confirmed that the components listed below should be excluded from the Project.
1) 11 kV power cables and submarine cables with accessories between 8B substations and new substation for Amatuku Maritime school
2) Three (3) new substations for Maritime school, new government office and new hospital.

(2) The Japanese side explained that the TEC administration building listed as 4. (5) should be excluded from the Project from the viewpoint of the priority of each component. However the Tuvalu side requested again to include the administration building in the Project due to financial difficulty. The Tuvalu side emphasized that the adequate spaces for administration nearby the power plant should be indispensable for smooth control and operation of electricity supply system. The Tuvalu side would like to see the Project as a total Japan's Grant Aid Project instead of having another donor fund for the administration building.

(3) The Tuvalu side shall submit answers to the Questionnaire, which the Team handed to the Tuvalu side, by December 10, 2004.

(4) The Tuvalu side shall provide necessary number(s) of counterpart personnel to the Team during the period of their studies in Tuvalu.

(5) The Tuvalu side submitted the Environmental Impact Assessment Report to the Japanese side in August 2005 in accordance with the Minutes of Discussion on the Preliminary Study signed on July 14, 2004 and confirmed no serious impact was found as the results of the assessment. The both sides confirmed that TEC should prepare the Environmental Management Plan (EMP) and submit it to the Department of Environment before the commencement of construction. The both sides also confirmed that the Tuvalu side already conducted the public information campaign to the affected households nearby the power plant and gathered public comments as shown in the Environmental Impact Assessment Report (August 2004). In addition to the above, the Tuvalu side agreed to conduct the public information campaign to the affected households nearby the 11 kV high voltage distribution lines and substations before the end of February 2005. The information to be given to the affected households should include the outline and tentative schedule of the Project, positive and negative impacts, contact point(s) for more information and complaint.

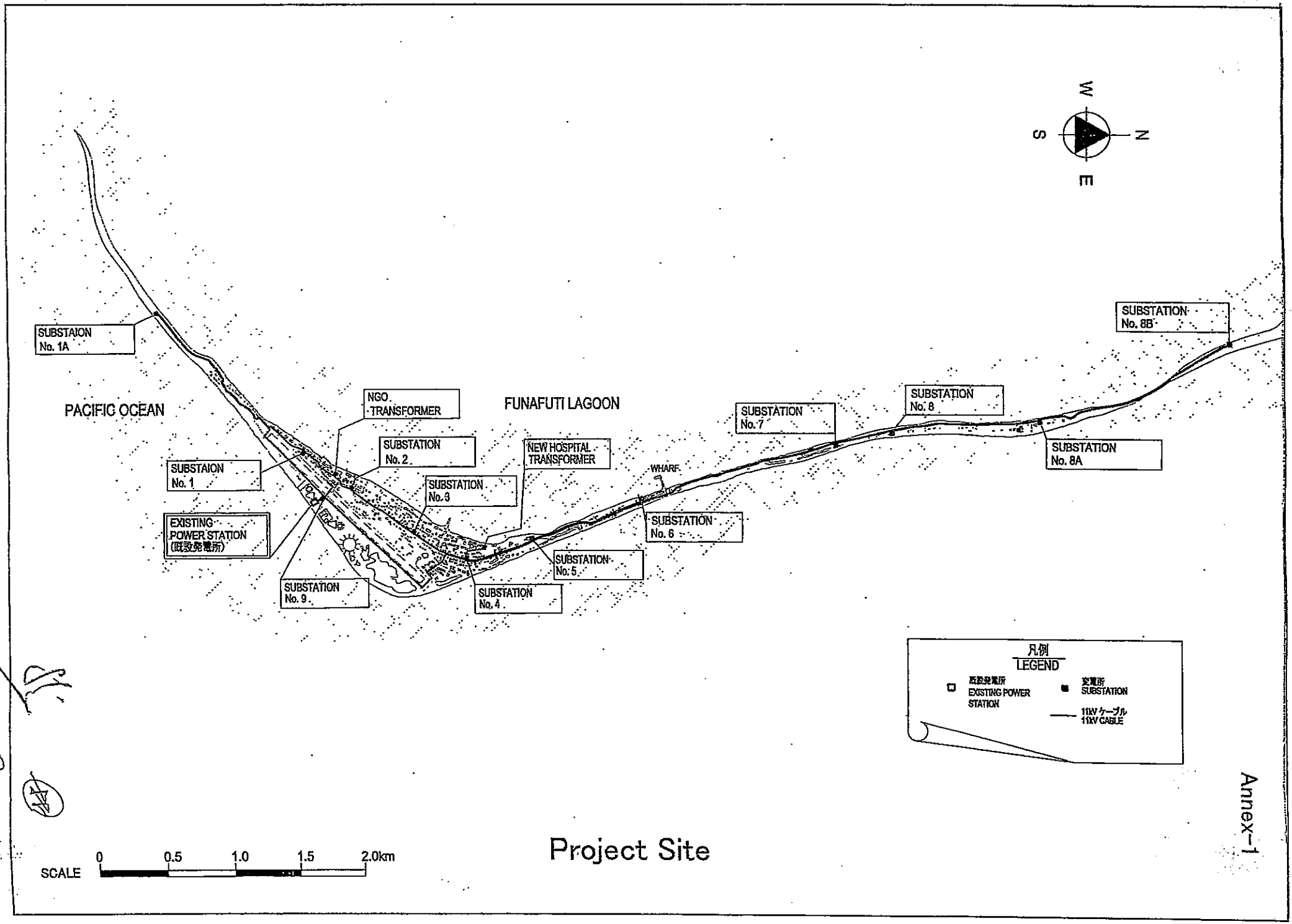
(6) The Tuvalu side should allocate necessary budget for undertakings to be done on a timely manner, which are shown in Annex-5. The Tuvalu side should remove the existing TEC administration office and water tanks, and any other obstructions which are located in the construction site before the end of October 2005. The Tuvalu side should also remove the existing facilities and any other obstructions in the substation sites and clear the land, before the commencement of the work.

(7) Regarding the sand and gravel to be used for the Project, the Japanese side agreed that from the environmental point of view, necessary analysis data of such materials should be submitted to the Department of Environment for approval.

(8) The Tuvalu side should use/maintain effectively and properly facilities and equipment constructed/installed by the Project.

(9) As for the specialized training to the TEC staffs listed as 4. (6) by dispatching the short-term experts to Tuvalu, the Team explained that official request regarding the dispatching of experts should be needed. The Tuvalu side will submit the request through the JICA Fiji Office.

(10) The Tuvalu side requested the Team to carry out the training to the TEC staffs in Japan on operation and maintenance of new facilities as technical cooperation by JICA. The Tuvalu side should submit the official request regarding training with concrete contents of trainings through the JICA Fiji Office before the end of June 2005.

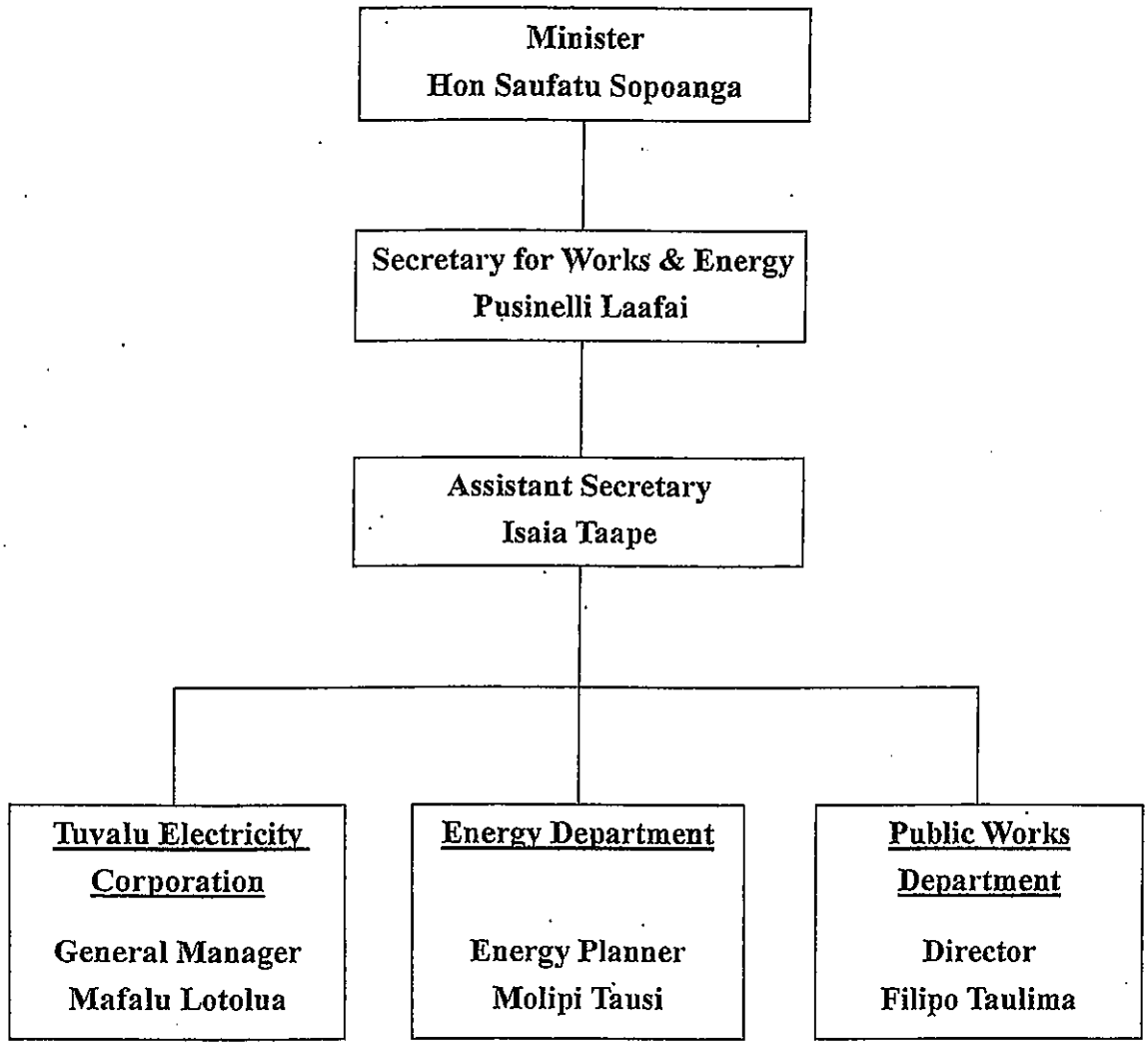


Project Site

A-8

Annex-1

Ministry of Works and Energy Organization Structure



Tuvalu Electricity Corporation Organization Structure (Fogafale & Outstations)

Total Numbers of Employees
Fogafale-35
Outstation-37
Vacant Position-7
Study Leave-4

NOTE
The overall organization Structure will be reviewed in the near future

Minister
Hon Saufatu Sopoanga

Board of Directors
Chairman — Pusinelli Laafai
Assit. Chairman — Pakai Koveu
Director: — Ionatana Peia
Director: — Lopati Tefoa
Director: — Filipo Taulima

General Manager
Mafalu Lotolua

Chief Engineer
Vacant

O/station Engineer (E)
(1 × Vacant)
- **Asst. O/station Engineer (M)** (1 × Vacant)
  - **O/Stations** Supervisors
    - **O/Station** Operators
      - **O/Station** Clerks

Generation Engineer
Fatoga Talama
- **Asst. Gen. Engineer**
Falani Boreham
  - **Mech. Supervisor**
Tofiga Paitela
    - **Mechanics**
Meauke Eli
Mose Maputoka
Brown Resture
      - **Snr. Operators**
Fepuali
Tavo
Samusamu
        - **Oparators**
Teavaomua
Telisiga
Tepou
Fatumua
      - **Welder**
Teuina Noa
        - **Handyman**
Vacant

Distribution Engineer
Brownie Manao
- **Asst Dist Engineer**
Taaku Esekielu
  - **Electrical Supervisor**
Paisi Teuki
    - **Electrian**
Paka Tofiga
Teafa Tautu
Tupa Neemia
(1 × Vacant)
      - **Electrical Worker**
Viliamu
(Temporary)

Electrical Inspector
Polu Tanei
- **Electrician**
(1 × Vacant)

Admin. & Personnel
(1 × vacant)
- **Registry Clerk**
Loise Sumeo
  - **Cleaner**
Fuga Patolo

Finance Controller
Tealofi Enosa
- **Accountant**
Trevor Tuinanumea
  - **Asst. Accountant**
Misalaima Sa'aga
    - **Snr Account Off.**
Asi Kaua
      - **Accoint Clerk**
Alafou Faalo
      - **Cashier**
Vaivasa Patolo
      - **Meter Reader**
Fakanaga Manase
  - **Stock Controller**
Lui Petelu
    - **Clerk**
Lusili Fatiga
(Temporary)

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Annex-2-2

JAPAN'S GRANT AID

The Grant Aid Scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

Japan's Grant Aid Scheme is executed through the following procedures.

Application	(Request made by the recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal &Approval	(Appraisal by the Government of Japan and Approval by the Cabinet)
Determination of Implementation	(The Note exchanged between the Governments of Japan and recipient country)

Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study) using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

(1) Contents of the study

The aim of the Basic Design Study (hereafter referred to as "the Study") conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.
- Confirmation of items agreed on by both parties concerning the basic concept of the Project.
- Preparation of a basic design of the Project.
- Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of the Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA. The consultant firm(s) used for the Study is (are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3.Japan's Grant Aid Scheme

(1) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

(2) "The period of the Grant Aid" means the one fiscal year, which the Cabinet approves, the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and final payment to them must be completed. However, in case of delays in delivery, installation or construction due to unforeseen factors such as national disaster, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

(3) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, consulting, constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(4) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

(5) Undertakings required of the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as the following:

a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land

Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site	●	
4	To construct the parking lot	●	
5	To construct temporary roads		
	1) Within the site	●	
	2) Outside the site		●
6	To construct the buildings	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities		
	1) Electricity		
	a. The distributing line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Drainage		
	The drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the site	●	
	3) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	4) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals whose service may be required in connection with the supply of the products and the services under the verified contact, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
12	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
13	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

prior to commencement of the construction,

b) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,

c) To secure buildings prior to the procurement in case the installation of the equipment,

d) To ensure all the expenses and prompt excursion for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid,

e) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,

f) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(6) "Proper Use"

The recipient country is required to maintain and use the facilities constructed and the equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

(7) "Re-export"

The products purchased under the Grant Aid should not be re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

(End)

Minutes of Discussions
on the Basic Design Study
on the Project for Upgrading of Electric Power Supply in Funafuti Atoll
in Tuvalu
(Explanation on the Draft Report)

In November 2004, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on the Project for Upgrading of Electric Power Supply in Funafuti Atoll (hereinafter referred to as "the Project") to Tuvalu, and through discussions, field survey and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain and to consult with the concerned officials of the Government of Tuvalu on the contents of the draft report, JICA sent to Tuvalu the Basic Design Explanation Team (hereinafter referred to as "the Team"), which is managed by Mr. Kyojin Mima, Group Director, Project Management Group II, Grant Aid Management Department, JICA, and headed by Mr. Mitsuhisa Nishikawa, from March 14 to 20, 2005.

As a result of discussions, both sides confirmed the main items described in the attached sheets.

Funafuti, March 18, 2005

Mitsuhisa Nishikawa
Leader
Basic Design Study Team
Japan International Cooperation Agency

Mafalu Lotolua
General Manager
Tuvalu Electricity Corporation
Tuvalu

(Witnesses)

Pusinelli Laafai
Secretary of Works and Energy
Ministry of Works and Energy
Tuvalu

ATTACHMENT

1. Contents of the Draft Report

The Tuvalu side agreed and accepted in principle the contents of the Draft Report explained by the Team.

2. Japan's Grant Aid Scheme

The Tuvalu side reconfirmed the Japan's Grant Aid scheme and the necessary measures to be taken by the Government of Tuvalu explained by the Team as described in Annex-3 and Annex-4 of the Minutes of Discussions (M/D) signed by both sides on December 2, 2004.

3. Schedule of the Study

JICA will complete the Final Report in accordance with the confirmed items and send it to the Tuvalu side around May 2005.

4. Other Relevant Issues

(1) The Tuvalu conducted the public information campaign to the affected households nearby the 11 kV high voltage distribution lines and substations on March 17, 2005 in accordance with the clause 7. (5) of the M/D signed by both sides on December 2, 2004 and the records of discussion are attached as Annex-1.

(2) The both sides reconfirmed that the some items regarding the Environmental and Social Consideration, such as noise, vibration, air pollution, soil and water contamination caused by the Project, should be managed by establishing the Environmental Management Plan (EMP) for construction period and operation stage.

(3) The Tuvalu Electricity Corporation (TEC) formulated tentative operation and maintenance teams for new power plant and distribution system as per Annex-2. The both teams will study detailed routine and periodical maintenance methods through the On-the-Job trainings and conduct proper maintenance after completion of the Project.

(4) As for the specialized training on rewinding works for motors and repair works for important component of diesel engine to the TEC staffs by dispatching the short-term experts to Tuvalu, the Japanese side examined the possibility and found it is difficult to recruit such engineers in Japan.

(5) Both sides agreed that this draft design handed to Tuvalu side from the Team is confidential and should not be duplicated or released to any outside parties.

NOTICE FOR THE UPGRADING OF ELECTRIC POWER SUPPLY IN FUNAFUTI

TUVALU ELECTRICITY CORPORATION (TEC)

THE TUVALU ELECTRICITY CORPORATION (TEC) announces the construction works for the Project for the Upgrading of the Electric Power Supply in Funafuti Atoll under the Grant Aid by the Government of Japan.

The objective of the Project is to ensure reliable and stable electricity supply to the people living in Fogafale and its surrounding areas by the installation of new diesel engine generators at the Fogafale Power Station, and upgrading of the High Voltage, 11kv distribution networks connected from the the Fogafale Power Station

All possible effort to prevent accidents to people and impacts to the environment expected during the construction period will be made by TEC. Therefore, we would like to apologize for any inconveniences that may be arise during the construction period.

The Project consists of the following:

1. Component of the Project

1.1 Construction of the Power house in the existing Fogafale Power Station

(1) Facility construction works

1) Site mobilization work.
2) Construction of a powerhouse two (2) stories building, with a maximum height of approximately 13metres from ground level.
3) Construction of foundations for diesel generators with mechanical and electrical auxiliaries and fuel tanks.

(2) Equipment Installation Works

1) Installation of three (3) set of diesel engine generators with output capacity of 750kva, 600kw each and their mechanical and electrical auxiliaries.
2) Installation of two (2) diesel oil tanks with storage capacity of 150m^3 each.

1.2 Upgrading of the 11kv Power Distribution Network between Philatelic, Substation No 1 - Substation No 8B at Lofeagai

(1) Upgrading of Substation Equipment

1) Renewal of Ring Main Units (RMU) and Distribution Transformers (DT).
2) Repairing works of foundations and fences for the above items.

(2) Upgrading of 11kv Distribution cables

1) Excavation of cable routes along with existing cables
2) Cabling works with new cables
3) Backfilling of cable trenches and repairing works of road surface if necessary.

2. Planned Construction Period

(2.1) Construction of Power House

1) Commencement on January 2006
2) Completion by December 2006

(2.2) Upgrading of the 11kv Power Distribution Networks

1) Commencement on January 2006
2) Completion by December 2006

3. The Contractor

The Contractor is a Japanese contractor, which will be selected through Japan's Grant scheme.

If you require more information regarding the upcoming project, please feel free to contact the Tuvalu Electricity Corporation during normal working hours.

4. TEC Contacts

Person in Charge: Mafalu LOTOLUA

Office Telephone: 20352

Mobil: 90686

Facsimile: 20351

FAKAPULAGA KITE FAKALEI AKEGA OTE ITI I LUGA I FUNAFUTI

TUVALU ELECTRICITY CORPORATION (TEC)

TE KAMUPANE ITI O TUVALU e fia fakapula atu mote atiakega taua tenei, tela kote fakalei akega ote tulaga ote Iti I luga I Funafuti nei mai lalo o alaga sene fesoasoani ate malo o Tiapani.

Ate polotieki tenei e aofia iei kote fakapikiga o masini tisolo mote suiga ote uaea lasi, sefulutasi afe (11kv) kola e soko mai te Fale masini.

Ate taumafaiga maluga ote polotieki tenei kote mea ke fakaseai ni fakalavelave e mafai iei o pokotia a tino pela foki mote natula ote enevalomene. E fia fakatoese atu mafai e isi ni pokotiaga e seki fakamoemoegina ite taimi e fai iei ate galuega taua tenei.

1. Ate Polotieki ka aofia iei a mea konei:

   1.1 Faitega ote fale masini

   1) Fakatokaga fakalelei ate koga koga e tuu iei ate fale masini fou.
   2) Faitega ote fale masini tela e lua ona fata kae sefulutolu (13) mita te maluga.
   3) Faitega ote fakavae o masini pela foki mo nisi mea tau makeneke mo mea tau iti.
   4) Fakapikipikiga o masini tisolo e tolu (3) kola o lotou malosi e tusa mote 750kva io me 600kw ite masini e tasi.
   5) Fakapikipikiga o tani tisolo e lua (2) kola e tusa mote 150m^3 ite tani e tasi.

   1.2 Kote fakalei akega o kope tau sefulutasi afe (11kv) kamata mai ite Fale fai sitempa, Substation Napa 1 – Substation Napa 8B I Lofeagai.

   (1) Kote fakalei akega o substation

   1) Fakafouga o suitikia (switchgear) mo tulasifoma (transformer).
   2) Faitega fakalelei o fakavae o suitikia mo tulasifoma pela foki mote pui uaea.

   (2) Kote fakalei akega ote uaea lasi (sefulutasi afe)

   1) Keliga o lua o uaea
   2) Fakamoega ote uaea lasi fou.
   3) Tanuga o lua o uaea pela foki mote faitega fakalelei ote auala mafai e manakogina.

2. Taimi fakatautau e kamata iei

   (2.1) Faitega ote fale masini

   1) Kamata Ianuali 2006
   2) Fakaotiga Tesema 2006

   (2.2) Fakalei akega ote uaea sefulu tasi afe

   1) Kamata Ianuali 2006
   2) Fakaotiga Tesema 2006

3. Te Kamupane

   Te Kamupane tela kafai neia ate polotieki tenei se kamupane mai Tiapani tela ka filigina mai lalo o alaga sene fesoasoani ate malo o Tiapani.

   Kafai e fia maina koe fakalelei kite tulaga ote polotieki tenei, fakamolemole telefoni mai kite Kamupane Iti o Tuvalu I taimi galulue.

4. Fesotaki mai kia:

   Mafalu LOTOLUA

   Telefoni Napa: 20352

   Mobile Napa: 90686

Tuvalu Electricity Corporation Organization Structure (Fogafale & Outstations)

Total Numbers of Employees:
- **Fogafale-35**
- **Outstation-37**
- **Vacant Position-7**
- **Study Leave-4**

NOTE:
- **Three or four new employees will be recruited as generation and distribution staffs before the completion of the Project.**
- **The overall organization structure will be reviewed by a Pacific Power Association's consultant in May, 2005.**

Minister
Hon Saufatu Sopoanga

Board of Directors
Chairman Pusinelli Laafai
Assit. Chairman Pakai Koveu
Director: Ionatana Peia
Director: Lopati Tefoa
Director: Filipo Taulima

General Manager
Mafalu Lotolua

Chief Engineer
Vacant

O/station Engineer (E)
(1 × Vacant)

Asst. O/station Engineer (M)
(1 × Vacant)

O/Stations Supervisors

O/Station Operators

O/Station Clerks

Snr. Operators
Fepuali
Tavo
Samusamu

Oparators
Teavaomua
Telisiga
Tepou
Fatumua

Generation Engineer
Fatoga Talama

Asst. Gen. Engineer
Falani Boreham

Mech. Supervisor
Tofiga Paitela

Mechanics
Meauke Eli
Mose Maputoka
Brown Resture

Welder
Teuina Noa

Handyman
Vacant

Distribution Engineer
Brownie Manao

Asst Dist Engineer
Taaku Esekielu

Electrical Supervisor
Paisi Teuki

Electrian
Paka Tofiga
Teafa Tautu
Tupa Neemia
(1 × Vacant)

Electrical Worker
Viliamu
(Temporary)

Electrical Inspector
Polu Tanei

Electrician
(1 × Vacant)

Admin. & Personnel
(1 × vacant)

Registry Clerk
Loise Sumeo

Cleaner
Fuga Patolo

Finance Controller
Tealofi Enosa

Accountant
Trevor Tuinanumea

Asst. Accountant
Misalaima Sa'aga

Snr Account Off.
Asi Kaua

Accoint Clerk
Alafou Faalo

Cashier
Vaivasa Patolo

Stock Controller
Lui Petelu

Clerk
Lusili Fatiga
(Temporary)

Meter Reader
Fakanaga Manase

5. DEMAND FORECAST IN FUNAFUTI POWER NETWORK

Demand Forecast in Funafuti Power Network

Revised on 14 Dec. '04

Items	Rated Output [kW]	Actural Demand		Demand forecast									REMARKS
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1. Peak Demend													Demand incresing Ratio：6%
1.1. Exsiting Consumers		731.0	774.0	820.4	1,064.7	1,227.2	1,300.8	1,463.6	1,551.5	1,644.6	1,743.2	1,847.8	
1.2. Wating Consumers													
1) Gavernment Office				184.0									
2) Cold store and Stdium					93.0								
3) Port facilities							80.0						
(Total Peak Demand)		731.0	774.0	1,004.4	1,157.7	1,227.2	1,380.8	1,463.6	1,551.5	1,644.6	1,743.2	1,847.8	
2. Generating Output (Available capacity)													
2. 1 Existing Units No. (Installed or to be replaced in)													Mega set will be exchanged with a new 400kW DEG set and be installed as No.5 in April, 2005.
Mega Set (2001)	1,005.0	(Stopped)	0.0	0.0	(Retire)								
No.2 (1995)	248.0	200.0	100.0	100.0	200.0	200.0	(Retire)						Replaced in 1995, 2003 and 2005
No.3 (2000)	248.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	Replaced in 2000
No.4 (2003)	400.0	120.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0	Replaced in 2003
No.5 (2005)	400.0	200.0	200.0	200.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0	To be replaced with 400kW in 2005
(Total Availble Capacity)		720.0	820.0	820.0	1,040.0	1,040.0	840.0	840.0	840.0	840.0	840.0	840.0	
2. 2 New Units No. (To be installed in)													
No. 1 (2007)	600.0						570.0	570.0	570.0	570.0	570.0	540.0	To be installed under the Project
No. 2 (2007)	600.0						570.0	570.0	570.0	570.0	570.0	540.0	To be installed under the Project
No. 3 (2007)	600.0						570.0	570.0	570.0	570.0	570.0	540.0	To be installed under the Project
(Total Availble Capacity)		0.0	0.0	0.0	0.0	0.0	1,710.0	1,710.0	1,710.0	1,710.0	1,710.0	1,620.0	
2.3 Total Available capacity (2.2+2.3) [kW]		720.0	820.0	820.0	1,040.0	1,040.0	2,550.0	2,550.0	2,550.0	2,550.0	2,550.0	2,460.0	
3. Power Balance (2.3 - 1.) [kW]		-11.0	46.0	-184.4	-117.7	-187.2	1,169.2	1,086.4	998.5	905.4	806.8	612.2	
4. Maximum capacity of Generating unit [kW]		200.0	320.0	320.0	320.0	320.0	570.0	570.0	570.0	570.0	570.0	540.0	
5. Firm Capacity (3. - 4.) [kW]		-211.0	-274.0	-504.4	-437.7	-507.2	599.2	516.4	428.5	335.4	236.8	72.2	

△ Completion

△ **Project target year**