BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
UPGRADING OF ELECTRIC POWER SUPPLY
AND
POWER TRANSMISSION LINES IN BABELDAOB ISLAND
IN
THE REPUBLIC OF PALAU

DECEMBER, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Palau the Government of Japan decided to conduct a basic design study on the Project for Upgrading of Electric Power Supply and Power Transmission Lines in Babeldaob Island and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Palau a study team from June 30 to July 29, 1996.

The team held discussions with the officials concerned of the Government of Palau, 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 Palau 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 the Republic of Palau for their close cooperation extended to the teams.

December, 1996

Kimio Fujita

President

Japan International Cooperation Agency

December, 1996

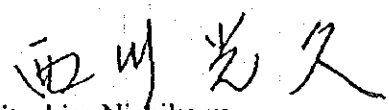
LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Upgrading of Electric Power Supply and Power Transmission Lines in Babeldaob Island in the Republic of Palau.

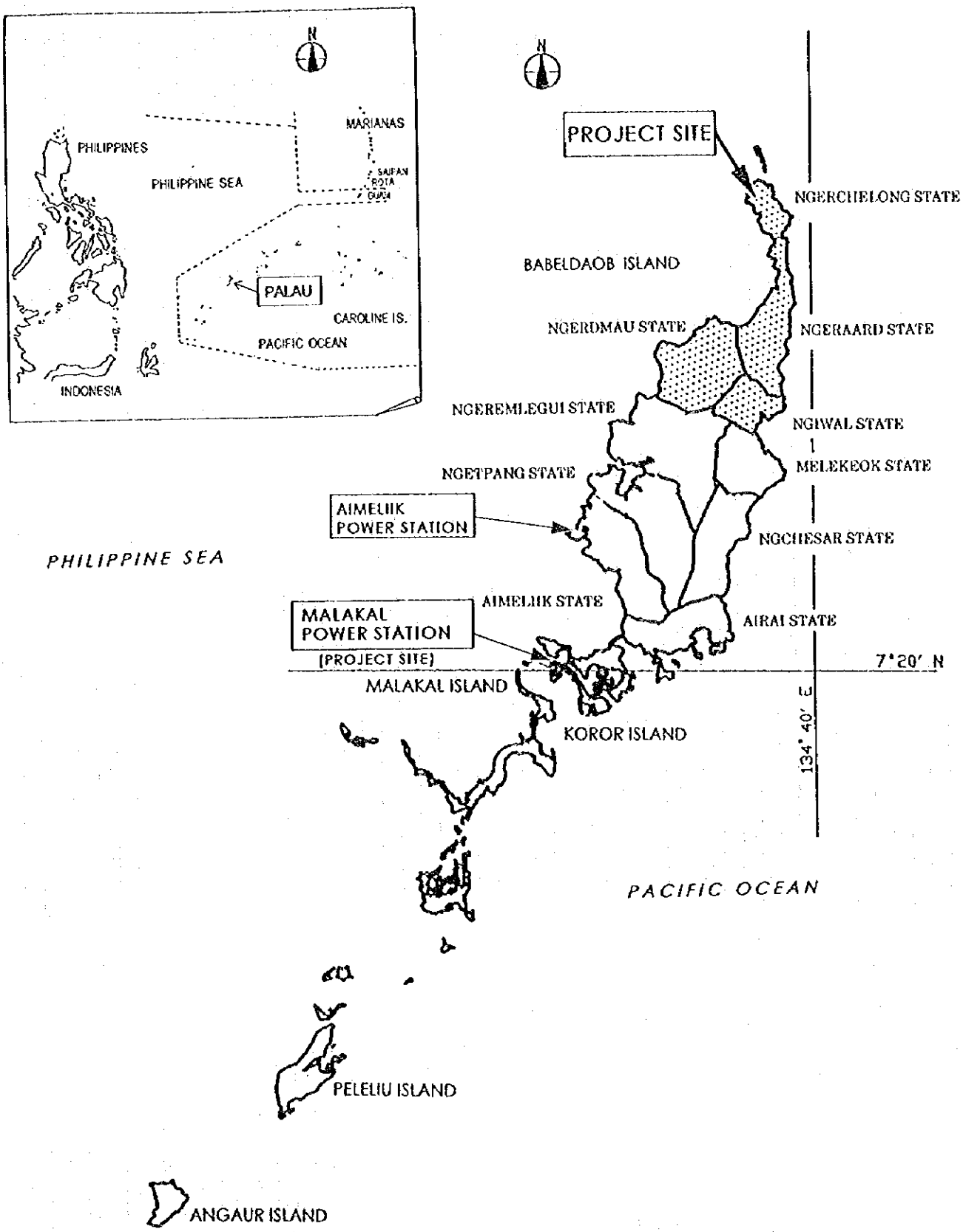
This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from June 27, 1996 to December 25, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Palau and formulated 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.

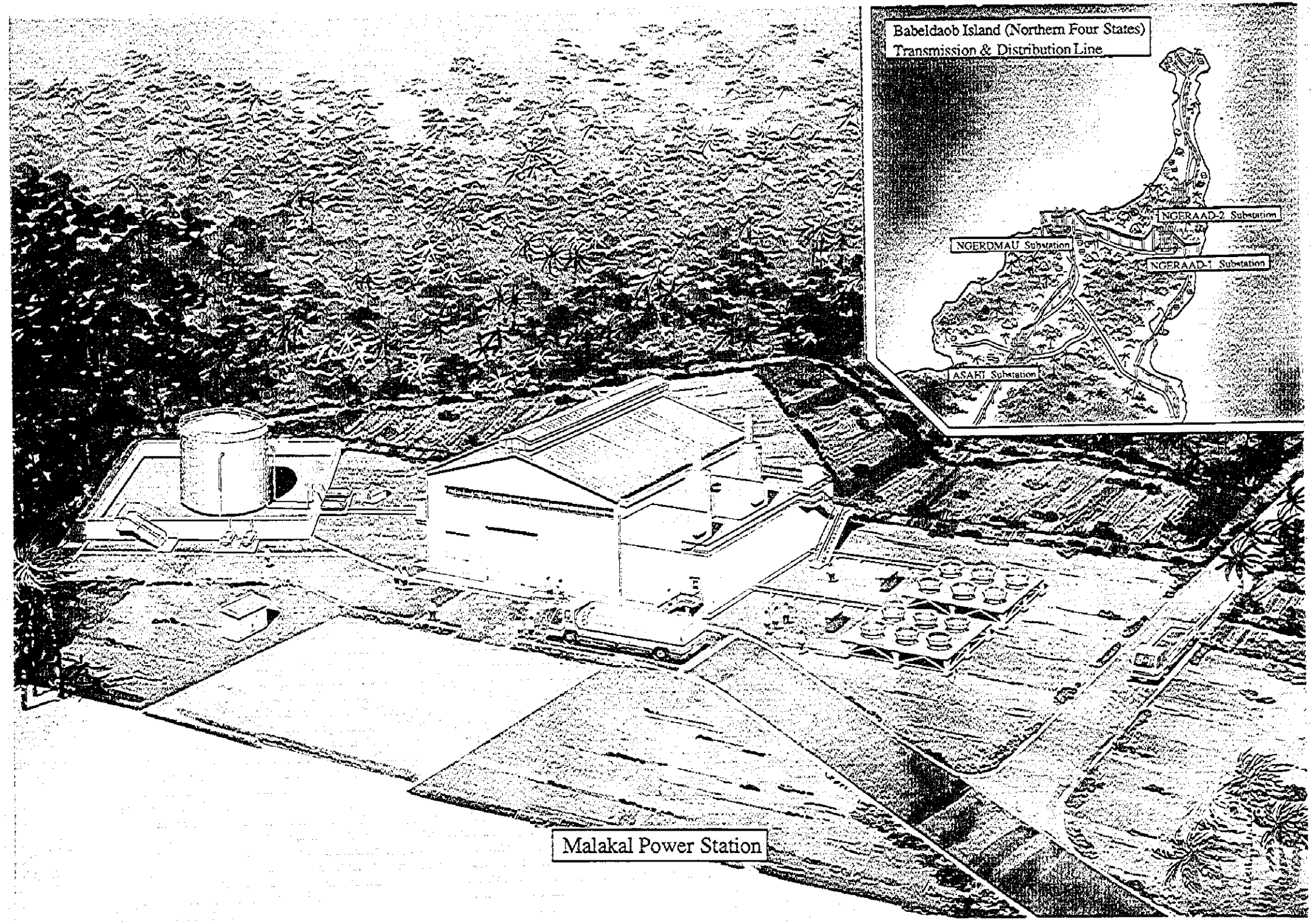
Very truly yours,



Mitsuhisa Nishikawa
Project manager,
Basic design study team on
the Project for Upgrading of Electric Power Supply and
Power Transmission Lines in Babeldaob Island
Yachiyo Engineering Co., Ltd.



Site Location Map


Babeldaob Island (Northern Four States)
Transmission & Distribution Line
NGERAAD-2 Substation
NGERDMAU Substation
NGERAAD-1 Substation
ASAHT Substation
Malakal Power Station

ABBREVIATIONS

COMPACT	The Compact of Free Association
DEG	Diesel Engine Generater
EDP	Economic Development Plan
E/N	Exchange of Notes
EQPB	Environment Quality Protection Board
GDP	Gross Domestic Product
NGP	Gross National Product
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JEAC	Japan Electric Association Code
JEC	Japanese Electrotechnical Committee
JEM	Standards of the Japan Electrical Manufacturer's Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
MRD	Ministry of Resources and Development
NMDP	National Master Development Plan
O&M	Operation and Maintenance
OJT	On the Job Training
PUC	Public Utilities Corporation
SCADA	Supervisory Control and Data Acquisition

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CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

The Republic of Palau (hereinafter referred to as Palau) was administered by the US under a UN trusteeship in the aftermath of the Second World War but gained its independence with free association with the US in November, 1993. The country consists of some 200 islands with a total national land area of 489 km^2 and a total population of 17,127 (as of 1993).

The economy of Palau still has the characteristics of a dual structure with the mixed existence of an autarchy and monetary economy and with agriculture, fisheries, etc., being engaged in mainly for self-consumption purposes. While there is no prominent local industry, it is pointed out that it is necessary for Palau to develop the tourism industry by utilizing its rich tourism potential as well as fisheries, agriculture, mining, etc., in order to attain self-supporting economic independence. Koror Island on which the capital is located is a small island, having less than 10% of the total national land area. Given the geographical limitations for development on Koror Island, integrated development efforts on Babeldaob Island, the largest island which has 75% of the total national land area and rich natural resources, and other islands are essential. The development of social infrastructure, such as power supply and road networks, on islands other than Koror is, therefore, regarded as an urgent need in Palau.

The National Master Development Plan 2020 (NMDP), which is the development plan up to the year 2020, sets such targets as "to increase real economic growth per capita on a sustained basis", "to share the benefits of economic growth on an equitable basis", etc., emphasising the importance of the development of a stable power supply capacity by the power sector as the basis for national development in the future. The funds for development projects are in the form of grants based on the Compact of Free Association (Compact) concluded at the time of the country's independence from the US. However, the amount of the fund is too small to cover the development of the entire social infrastructure, forcing the Government of Palau to rely on other donors.

Japan has a history of providing grant aid for Palau. The first aid provided for the power sector in Palau was in 1985 in the Project for Babeldaob Electrical Power Transmission Line (1985 - 1986), followed by the Project for Improvement and Development of Electric Power System (1993 - 1995) (hereinafter referred to as the previous projects). With consolidation of the transmission and distribution network, enabling the parallel operation of the Malakal Power Station in Koror State and the Aimeliik Power Station in Aimeliik State in the southwestern part of Babeldaob Island, a public power supply network was established. This network enables a 24 hour supply of power for Koror State, in which the capital is located, and for the 6 southern states of Babeldaob Island. The stable power supply has ensured the

reliable operation of such public facilities as hospitals, schools, etc., the improvement of the lives of the public and the vitalisation of industrial activities. The positive effects of the previous projects are highly evaluated by the people of Palau and Japan's consistent aid for the power sector is mentioned in the NMDP with appreciation.

Consolidation of the power transmission and distribution network through the previous projects has stimulated the demand for public power, which is both safe and convenient, and there has consequently been an unmistakable trend of a demand increase with industrial development and improvement of the standard of living. The last 3 years from 1992 to 1994 showed an annual increase rate of 14%. The NMDP forecasts a steady increase of the power demand at an annual rate of 14% based on current development progress in Palau and estimates that the maximum power demand in the year 2000 will reach 27 MW.

Despite the forecast of a steady increase of the power demand in the foreseeable future, the existing power stations are suffering from the breakdown of generators and an output decline due to ageing of the generating units and financial difficulties of the Government of Palau have made it impossible to build new generating facilities. Consequently, no improvement of the generation output has been achieved to meet the increasing demand and the resulting unbalanced supply and demand situation has caused concern in regard to possible adverse impacts on pubic life and a delay in the economic development due to a chronic power supply shortage in the coming years.

Meanwhile, the 4 northern states of Babeldaob Island, i.e., Ngerchelong, Ngeraard, Ngerdmau and Ngiwal, do not have a public power supply. Instead, consumers receive power generated by small diesel generating units provided by the state governments. As the fuel transportation cost is high because of the poor access to these states, the Government of Palau inevitably bears the extra financial burden. The diesel generators in use are designed to have short time rating. Therefore, power is supplied for only 5 - 6 hours/day in these states, causing problems for not only individual households but also for the proper operation of such public facilities as schools, dispensaries, etc. Compared to the electrified states in the south, the standard of living in these northern states is developing at as lower pace and the gap is steadily widening.

Against this background, the Government of Palau has made a request to the Government of Japan for the provision of grant aid to increase the output of the 2 existing power stations (Malakal and Aimeliik) and to extend the power supply lines to the 4 northern states of Babeldaob Island (hereinafter referred to as the Project).

[Contents of Original Request]

(1) Contents

1) Malakal Power Station Improvement Plan

① Construction of a power house building at Malakal power plant to house three (3) sets of diesel engine generators (DEG) including engine foundations, a control room, a switchgear room, cable trenches, ventilation system, a five (5) ton overhead traveling crane and necessary building services.

② Supply and install three (3) sets of DEG with output capacity 2.8 MW to Malakal power plant. Each DEG shall be complete with exhaust system, cooling water system, air starting system and fuel oil system.

③ Supply and install the required electrical and mechanical auxiliary for DEG stated above such as high voltage switchgear, station transformer, DC supply system, fuel storage tanks, lubricating oil system, synchronizing equipment, etc.

2) Aimeliik Power Station Improvement Plan

① Supply a new slow speed DEG with output capacity 3.2 MW to Aimeliik Power Plant which shall be identical with the existing units and installed on the existing foundation. The exhaust system, cooling water system, air starting system, fuel oil system and electrical & mechanical auxiliary system are already in place.

② Three (3) of the existing four (4) low speed 3.2MW DEGs are to be completely overhauled and supplied with spare parts and some tools.

3) Transmission and Distribution Network Extension Plan

Supply and construct 34.5 kV power transmission lines from Asahi substation to Ngiwal and Ngeraard states and 13.8 kV distribution lines from Ngeraard to Ngerdmau and Ngerchelong states including necessary step-down transformers.

(2) Sites

1) Power Station Improvement Plan

Malakal Power Station and Aimeliik Power Station

2) Transmission and Distribution Network Extension Plan

4 northern states on Babeldaob Island (Ngerchelong, Ngeraard, Ngerdmau, Ngiwal)

After making an investigation in regard to the Aimeliik Power Station Improvement Plan, the Study Team deemed it appropriate to exclude the Aimeliik Power Station Improvement Plan altogether from the scope of the Project due to the following reasons.

① The station was constructed with a loan provided by private UK banks and repayment of the loan is still in progress.

② The generating facilities are more than 10 years old and the same model is no longer manufactured. Therefore estimation of the repair cost is difficult, because of the envisaged difficulty of obtaining spare parts.

③ Guaranteeing of the expected output of the existing generating facilities after the repair and overhaul appears difficult.

CHAPTER 2 CONTENTS OF THE PROJECT

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2-1 Objectives of the Project

The targets of the NMDP set by the Government of Palau are "to increase real economic growth per capita on a sustained basis", "to share the benefits of economic growth on an equitable basis, etc., as already described in Chapter 1.

The objectives of the Project are ① the construction of a new generation facility at the Malakal Power Station as a part of the station which will meet the increasing power demand up to the year 2000 and ② the construction of a transmission and distribution network in the 4 northern states of Babeldaob Island as part of the island-wide development of a power network, both of which are urgently required by the power sector to successfully achieve the targets of the NMDP.

2-2 Basic Concepts of the Project

The previous projects resulted in development of the transmission and distribution network in Koror State and the 6 southern states of Babeldaob Island. The demand for a safe and highly convenient public power supply has been steadily increasing in accordance with industrial development and improving standard of living. The demand in the 3 years from 1992 to 1994 rapidly increased at an annual rate of 14% and the NMDP forecasts that this annual power demand increase rate of 14% will continue for the foreseeable future given the recent state of national development achievement.

Despite the forecast of a steady demand increase, the existing power plants (Malakal and Aimeliik), which should deal with such an increase, are currently experiencing breakdowns and an output decline due to ageing. To make matters worse, the Government of Palau is not in a situation to introduce new generation facilities due to financial problems. As a result, any rehabilitation work and/or increase of the present output to meet the actual power demand has not been implemented. There is concern that such a chronic shortage of the power supply could lead to a delay in economic and social development in the future.

The new generation facilities at the Malakal Power Station, requested by the Government of Palau, will constitute a part of future base load capacity (16 - 20 MW) in the year 2000 as planned by the NMDP and will replace the existing worn out aged generation facilities. In addition, the new facilities will contribute to the urgent improvement of the power supply situation in Palau at the time of the Project completion in 1997/98. With the commissioning of

the new facilities, the Malakal Power Station will be coordinated with the existing Aimeliik Power Station to act as base load power stations for the unitary power supply system to Koror State and Babeldaob Island which are key areas for the economy of Palau. This coordinated operation will inevitably rationalise as well as improve the efficiency of the power station operation and maintenance.

Meanwhile, the establishment of a sound economic base, which is the highest priority of the NMDP, requires the urgent development of local industries with rich potential, including fisheries, agriculture, tourism, mining, etc., on Babeldaob Island. In turn, this requirement calls for the urgent development of a road network as well as a power transmission and distribution network in the whole of Babeldaob Island. The 4 northern states of Babeldaob Island are currently outside the public power network and consumers are provided with power by small emergency diesel generating units provided by the state governments. The high cost of fuel and short time ratings of these small emergency diesel generators have resulted in a limited power supply in these states, only for 5 - 6 hours/day. This causes not only inconvenience to ordinary households but also difficulties in the running of such public facilities as schools, dispensaries, etc., resulting in widening of the standard of living gap between these states and states receiving public power supply through the network.

The establishment of a rational and efficient power supply system is urgently required by means of expanding the public power supply system to cover entire Babeldaob Island through the construction of new transmission and distribution lines in the north of the island with a view to rectifying the gap in the standard of living between electrified states and non-electrified states and facilitating social and economic development in the 4 northern states on Babeldaob Island as envisaged by the NMDP. There is no doubt that extension of the power network will eventually contribute to share the benefit of economic growth on an equitable basis.

Based on the above analysis, the basic concept of the Project is to improve the power supply network as an important element of the social infrastructure throughout Koror State and Babeldaob Island, both constituting key areas of the economy of Palau, with a view to facilitating and inducing development, thereby contributing to the vitalisation and stable operation of local industrial activities and to rectification of the regional gap in the standard of living. The actual components of the Project are the construction of new generation facilities at the Malakal Power Station to meet the power demand in 1997/98 and extension of the power transmission and distribution network to the 4 northern states of Babeldaob Island.