Ministry of Public Infrastructure, Industries and Commerce
Palau Public Utilities Corporation
Republic of Palau

PREPARATORY SURVEY REPORT

ON

THE PROJECT FOR

INTRODUCTION OF CLEAN ENERGY

BY SOLAR ELECTRICITY GENERATION SYSTEM

IN

THE REPUBLIC OF PALAU

MARCH 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

ICONS INTERNATIONAL COOPERATION INC.

SHIKOKU ELECTRIC POWER CO., INC.

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Project for Introduction of Clean Energy by Solar Electricity Generation System in the Republic of Palau.

JICA sent to Palau a survey team from 29th June to 13th July, 2009.

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 outline 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.

March 2010

Kazuhiro YONEDA
Director General
Industrial Development Department
Japan International Cooperation Agency

March 2010

LETTER OF TRANSMITTAL

We are pleased to submit to you the preparatory survey report on the Project for Introduction of Clean Energy by Solar Electricity Generation System in the Republic of Palau.

This survey was conducted by the Consortium of Yachiyo Engineering Co., Ltd., ICONS International Cooperation Inc., and Shikoku Electric Power Co., Inc., under a contract to JICA, during the period from June, 2009 to March, 2010. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Palau and formulated the most appropriate outline 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,

Tadayuki Ogawa
Project manager,
Preparatory Survey team on
The Project for Introduction of Clean Energy by
Solar Electricity Generation System

The Consortium of Yachiyo Engineering Co., Ltd.,
ICONS International Cooperation Inc., and
Shikoku Electric Power Co., Inc.

SUMMARY

SUMMARY

(1) Country Overview

The Republic of Palau (hereinafter referred to as "Palau") is located between 6°53'N and 8°12'N and between 134°8'E and 134°44'E with a total land area of 488 km^2 and a population of 19,907 (2005 National Census). Although the capital was relocated from Koror State to Melekeok State in 2006, Koror State where 64% of the total population is concentrated is still the centre of Palau's economic activities. Foreign nationals account for some 31% of the total population. The largest expatriate ethnic group is made up of Filipino settlers and workers, accounting for approximately 17% of the total population.

In 1994 Palau concluded the Compact of Free Association with the United States (hereinafter referred to as "Compact") which guaranteed financial assistance by the US for a period of 15 years until 2009 while entrusting the US with the responsibility for the national defense and security of Palau. In 2009, the Compact was extended until 2024 as "the Compact 2" after negotiating with the United States. The public finance of Palau heavily relies on grant aid based on the Compact with the US, while the financial aid of Taiwan with which Palau established a diplomatic relationship in 1999 has been increasing in recent years. The main industries are (i) the construction industry which relies on grant aid from the US and Taiwan, (ii) commerce based on the importation of foodstuffs and consumer goods and (iii) tourism.

(2) Background and Outline of the Requested Project

Electricity and energy policies in Palau previously fell under the jurisdiction of the Ministry of Resources and Development (MRD). The MRD had four bureaus, i.e. Bureau of Agriculture, Bureau of Marine Resources, Bureau of Public Works and Bureau of Land and Surveys. The Energy Office under the Bureau of Public Works was mainly responsible for promoting the introduction of renewable energies and energy conservation. However, under the restructuring of government ministries and agencies following the start of the Torivion administration in January 2009, the Energy Office was transferred to the direct supervision of the President's Office and placed in charge of energy and power policies. This restructuring may also have been influenced by the power crisis that occurred in April 2009. As an independent organization from the government, Palau Public Utilities Corporation (PPUC) is in charge of the power supply in Palau, and the PPUC conducts all segments of business from power generation to distribution and retailing.

Based on the Palau 2020 National Master Development Plan (PNMDP) formulated in 1997, the Government of Palau has enforced Executive Orders No. 234 (enacted 1994, revised 2004), No.

245 (enacted 2005) and No. 248 (enacted 2008) concerning the reduction of energy use, and these prescribe quotas and targets for energy consumption reduction as high priority items. Moreover, in order to put these executive orders into shape, the Palau Energy Conservation Strategy was compiled under support from SOPAC (South Pacific Applied Geoscience Commission), etc. in 2008. The Energy Efficiency Action Plan, which was compiled under support from the EU in November 2007, prescribes methods (spreading of compact fluorescent lights, subsidy for introduction of solar water heaters, etc.) for reducing energy consumption in both the public and private sectors.

According to the Joint Declaration on Energy Policy Priorities announced in June2009, considering that Palau currently almost exclusively depends on diesel generation for its power supply, it is planned to raise the share of renewable energy to 20% by 2020 and it is scheduled for concrete energy supply plans to be incorporated into the Palau National Energy Policy currently being formulated. According to the first draft of the Palau National Energy Policy, photovoltaic power and wind power are considered to have good potential among other renewable energies, and looking specifically at the field of photovoltaic power generation, emphasis is placed on grid-connected photovoltaic systems (grid-connected PV systems) which require no batteries.

Two grid-connected PV systems are already operating in Palau: one is the 100 kW system installed on the car park of the Federal Government office building in the capital Melekeok under the Support to the Energy Sector in Five ACP Pacific Islands project by the European Union (EU), and the other is the 153 kW system installed at Palau National Hospital by Taiwan. In the Project, the local side has requested that diffusion of grid-connected PV systems be promoted while utilizing the experience gained in these previous projects, and that preparations be made for the formation of a mechanism for realizing the utilization of clean energy appropriate for supporting the mitigation of climate change.

(3) Outline of the Study Findings and Contents of the Project

In response to the request, the Government of Japan decided to implement a preparatory survey for cooperation and consigned JICA to dispatch the Outline Design Study Team to Palau from June 29 to July 13, 2009. The Study Team reconfirmed and discussed the contents of the request with local officials, conducted surveys of the project sites and collected related materials. On returning to Japan, the Study Team examined the necessity of the Project, its social and economic effects and validity based on the local survey materials, and it compiled the outline design and implementation program for the optimum plan into the Draft Preparatory Survey Report. Based on this, JICA once more dispatched the Study Team to Palau in order to explain the contents of the Draft Preparatory Survey Report from December 12 to 19, 2009.

In the Project compiled as a result of the Study, the Japanese side will procure and install grid-connected PV system equipment to the project site of Palau International Airport with a view to substituting a portion of the power currently generated by diesel engine generators with photovoltaic power, i.e. renewable energy. In doing so, the Project aims to reduce Palau's dependence on imported fuel and enhance its energy security and support measures geared to mitigating greenhouse gas emissions. Moreover, under the soft component, the Project intends to improve the maintenance capability of the Palau Public Utilities Corporation (PPUC), which is responsible for the operation and maintenance of grid-connected PV systems, and support construction of a maintenance setup that is suited to the grid-connected PV system to be installed under the Project.

The following table shows an outline of the Project which was compiled based on the results of the field surveys and discussions with the Palau side.

Outline of the Project

	Procurement and installation of the following PV equipment	Quantity
Equipment Procurement and Installation Works Plan	Photovoltaic Module	1 set
	Mounting Structure for Photovoltaic Module	1 set
	Power conditioner	2 units
	Transformer	1 unit
	Data management and monitoring system	1 set
Equipment Procurement Plan	Replacement parts, maintenance tools and test equipment for the photovoltaic system	1 set

(4) Project Implementation Schedule and Rough Project Cost

In the event where the Project is implemented under the Japan's Program Grant Aid for Environment and Climate Change, the total cost of the Project will be determined before concluding the Exchange of Notes (E/N) and Grant Agreement (G/A) for the Project. The main items to be borne by the Palau side are, 1) procurement and installation of Watt-hour meter fitted with no reverse-rotation function, and 2) final connection of low voltage distribution cables to the existing distribution panels, and so on. The implementation period of the Project including the implementation design is around 18.0 months.

(5) Verification of Project Validity

As a result of Project implementation, it will become possible to supply electricity derived from photovoltaic power to approximately 19,000 residents of Babeldaob Island and Koror Island who currently receive power supply through the Koror-Babeldaob power system. Through doing this,

Palau will break away from its energy supply system currently almost 100% dependent on diesel power facilities, and it will become possible to promote the introduction of clean energy as a climate change mitigation support measure. Accordingly, the Project is deemed to be highly valid for implementation under the Japan's Program Grant Aid for Environment and Climate Change.

The engineers of Palau Public Utilities Corporation (PPUC), which will be responsible for operating and maintaining the Project equipment after the handover, possess basic operation and maintenance capacity acquired through working on existing diesel generation and distribution facilities. Furthermore, under the soft component of the Project, since it is intended to transfer appropriate operation and maintenance skills for the planned grid-connected PV system, it would be possible to secure the operation and maintenance capability required for the Project equipment, provided that the PPUC allocates appropriate personnel and budget.

In order for the Project effects to be realized and sustained, the main works and issues that need to be implemented by the Palau side are as follows.

1) To ensure the stable operation of the grid-connected PV system, it will be necessary to strictly observe preventive maintenance measures such as implementing daily and periodic site patrols and inspections and securing the onsite setup for protecting the photovoltaic modules.
2) It will be necessary to swiftly appoint the engineers to participate in the Project soft component and OJT and to ensure that skills are transferred to other engineers who do not take part in the said training.
3) Concerning the grid-connected PV system that will be procured and installed by the Japanese side under the Project, it will be necessary to establish a power tariff scheme that enables future investment costs to be recovered, particularly in anticipation of replacement of the photovoltaic modules and power conditioner at the end of their expected service life.

CONTENTS

Oceania

LOCATION MAP of Republic of Palau

LIST OF FIGURES & TABLES

Figures

Tables

ABBREVIATIONS

AFPAC	Automatic Fuel Price Adjustment Clause
CDM	Clean Development Mechanism
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
E／N	Exchange of Notes
EQPB	Environmental Quality Protection Board
EU	European Union
G／A	Grant Agreement
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
IEC	International Electrotechnical Commission
IEA	International Energy Agency
IEE	Initial Environmental Examination
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
MPIIC	Ministry of Public Infrastructure, Industries and Commerce
MRD	Ministry of Resources and Development
NEDO	New Energy and Industrial Technology Development Organization
O&M	Operation and Maintenance
OJT	On the Job Training
PNMDP	Palau 2020 National Master Development Plan
PPUC	Palau Public Utilities Corporation
PV	Photovoltaic
SCADA	Supervisory Control and Data Acquisition System
SHS	Solar Home System
SOPAC	South Pacific Applied Geoscience Commission

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 Background and Outline of the Requested Project

Having very limited land area and low altitude, the Pacific island nations are extremely prone to the effects of climate change and are in urgent need of strategic countermeasures. Support for measures to adapt to climate change in the Pacific island nations and the like started with the announcement of the Cool Earth Partnership – a new fund mechanism for climate change worth US$10 billion (1.25 trillion yen) in total – by then Japanese Prime Minister Fukuda at the Davos summit held in Switzerland in January 2008. Application of the Mechanism entails twofold support to developing countries that have undergone policy discussions: either support centering on assistance for access to adaptation measures and access to clean energies based on grant aid and technical aid, etc. worth 250 billion yen over five years, or yen loans for climate change countermeasures based on mitigation measures also worth 500 billion yen over five years. In the Pacific region, Palau, Micronesia, the Marshall Islands, Nauru, Kiribati, Papua New Guinea, Vanuatu, Tuvalu, Samoa, Tonga, Niue, and the Cook Islands have already joined the Cool Earth Partnership.

In view of this policy by the Government of Japan, JICA has established its basic support policy for climate change countermeasures in developing countries under the heading of “Direction of Climate Change Initiatives,” dated April 1st 2008, and within this it emphasizes the need to strengthen efforts for cooperation geared to raising the capacity of Pacific island nations to respond to climate change. Upon surveying support needs with a view to bolstering Japanese support for climate change countermeasures in the Pacific region, it was found that urgent needs exist for photovoltaic power generation projects in Federated States of Micronesia, Palau, the Marshall Islands and Tonga. Based on this information, “the Project Formation Study for promoting Grant Aid Project for Environment and Climate Change (Photovoltaic Power) in the Pacific Region” was implemented from February to March 2009, assuming the promotion of the PV Project under Program Grant Aid for Environment and Climate Change. As a result, the needs and feasibility of project implementation in each country were confirmed and official written requests for projects under Japan's Program Grant Aid for Environment and Climate Change scheme were submitted by each country’s government.

The Study here has the following objectives: 1) to collect information relating to PV introduction and to reconfirm the detailed need and validity of cooperation, 2) to compile specific cooperation plans as Japan's Program Grant Aid for Environment and Climate Change in each country and to perform outline design corresponding to the available amount of grants, and 3) to estimate the approximate project costs and prepare reference materials for tender documents.

1.2 Natural Conditions

(1) Climate

Palau has a marine tropical climate characterized by high temperature and high humidity across its entire area.

(2) Temperature

Temperature is almost constant at around 27℃ throughout the year.

(3) Humidity

The daytime humidity (12:00, monthly mean) ranges between 40~60%.

(4) Rainfall

Rain tends to fall at any time of the year but rainfall is especially high in July and October. Generally speaking, the seasons are divided into the rainy season from June to October and the dry season from November to May.

(5) Geology

In terms of geological features, the islands of Palau include volcanic islands and limestone islands comprising raised coral reefs. Babeldaob Island, which is home to the project site of Palau International Airport, consists of mainly red soil although it is a volcanic island in terms of geological makeup.

1.3 Environmental and Social Considerations

(1) Legal Systems related to Environmental and Social Consideration

Based on the Environmental Protection Law (24PNCA), it is necessary to obtain environmental authorization from the Environmental Quality Protection Board (EQPB) when implementing the following activities in Palau.

① Civil engineering works (excavation, banking, ground leveling, dredging, stone crushing, etc.)

② Drainage into ocean and rivers (discharge of sewage and other harmful substances into water bodies)

③ Construction and operation of solid waste treatment facilities

④ Installation of toilets and sewage treatment facilities

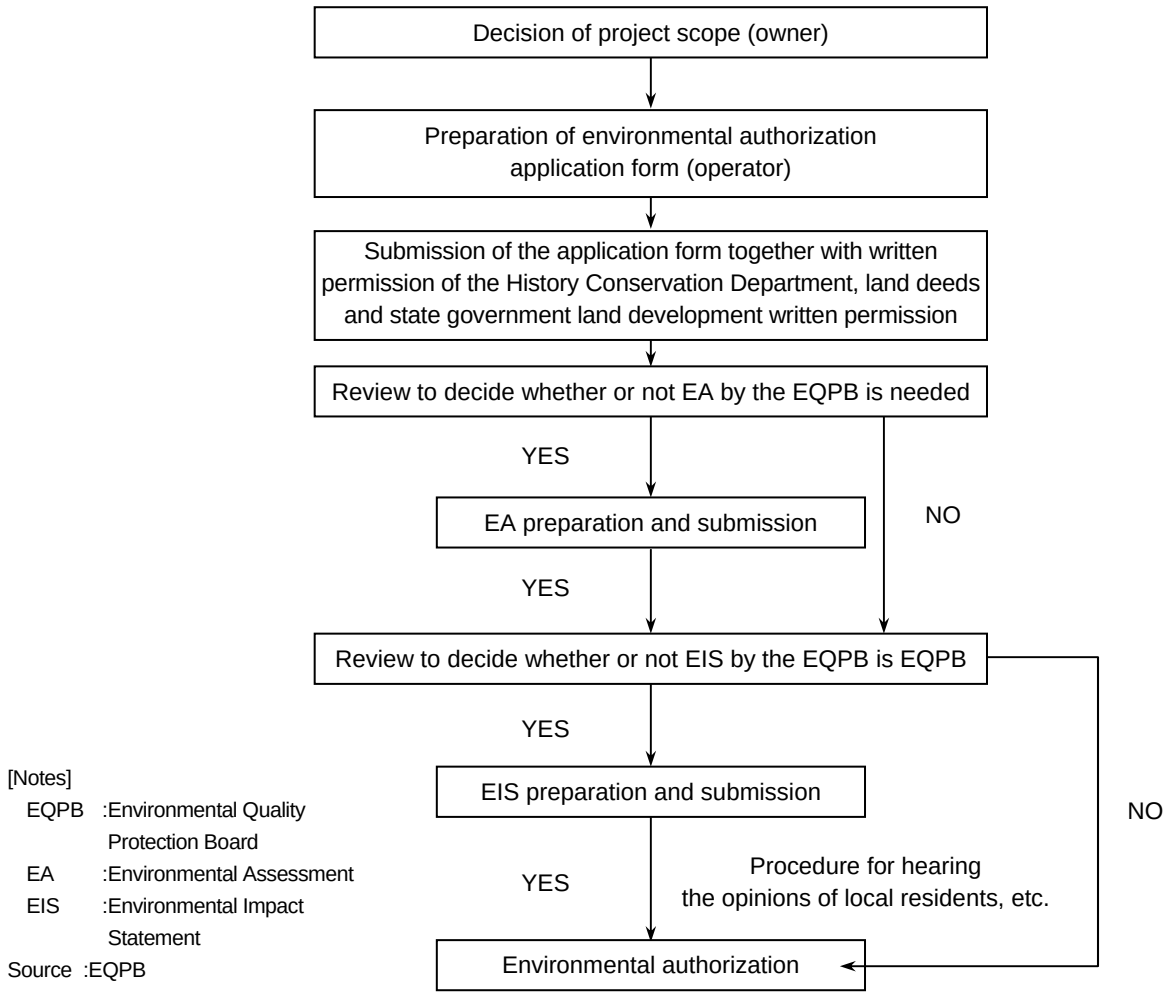
⑤ Use of agricultural chemicals

⑥ Construction and operation of public water supply systems

⑦ Construction and operation of fixed emission sources of atmospheric pollutants

⑧ Open burning

The procedure for acquiring environmental authorization is as shown below.



(2) Necessary Procedures for Environmental Assessment

The EQPB reviews the environmental authorization application presented by the owner, decides whether or not an environmental assessment (EA) is required, and in the case where it is required, it instructs the owner to prepare an environmental assessment report. Moreover, in cases where the EQPB deems there to be risk of massive environmental impact, it instructs the owner to prepare an environmental impact statement (EIS). Even when it is deemed that an EA is not required, preparation of an EIS will be required if the project is large-scale and there is concern over localized environmental impacts. The owner consigns a third party qualified (by the EQPB) consultant to prepare a draft environmental impact statement and presents it to the EQPB. The statement is distributed to related government agencies and local interested communities to hear their opinions, which are reflected in the final EIS.

Whether or not a project requires an environmental assessment (EA) and environmental impact statement (EIS) is not dependent on the type and scale of the project; rather, the EQPB makes its decision according to the extent of the environmental impact (whether or not pollutant emissions increase, emissions are within limits, the involved technology is new, development takes place on public land, land-filling is involved, cultural assets are involved and so on).

(3) Environmental and Social Consideration Procedures for Project Implementation

The MPIIC, which is the government agency with responsibility for the Project, needs to prepare an environmental authorization application for the following contents and submit it to the EQPB.

① EQPB Permit Application Form (Part I – General Information)
② EQPB Permit Application Form (Part II – Earthmoving Permit)
③ Application for Historic Clearance (by Bureau of Arts and Culture)

According to the responsible staff member in the EQPB, it takes around one month from receipt of the application form for the above environmental authorization procedure to be conducted; however, since submission of an EA wasn't demanded for the grid-connected PV systems introduced by the EU and Taiwan last year, there is a good chance that it will not be required in this Project either. The Study Team reconfirmed the above procedures with the Palau side during the field report. It was confirmed that neither the above EA nor EIA is not required for the implementation of the Project in accordance with the EQPB Permit # 152-09 which was issued on 7th August 2009.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Basic Concept of the Project

2.1.1 Superior Objectives and Project Goals

Based on the Palau 2020 National Master Development Plan (PNMDP) formulated in 1997, the Government of Palau has enforced Executive Orders No. 234 (enacted 1994, revised 2004), No. 245 (enacted 2005) and No. 248 (enacted 2008) concerning the reduction of energy consumption, and these prescribe quotas and targets for energy consumption reduction as high priority items. Moreover, in order to put these executive orders into shape, the Palau Energy Conservation Strategy was compiled under support from SOPAC (South Pacific Applied Geoscience Commission), etc. in 2008. The Energy Efficiency Action Plan, which was compiled under support from the EU in November 2007, prescribes methods (spreading of compact fluorescent lights, subsidy for introduction of solar water heaters, etc.) for reducing energy consumption in both the public and private sectors.

According to the Joint Declaration on Energy Policy Priorities announced in June 2009, considering that Palau currently almost exclusively depends on diesel generation for its power supply, it is planned to raise the share of renewable energy to 20% by 2020 and it is scheduled for concrete energy supply plans to be incorporated into the Palau National Energy Policy currently being formulated. According to the first draft of the Palau National Energy Policy, photovoltaic power and wind power are considered to have good potential among other renewable energies, and looking specifically at the field of photovoltaic power generation, emphasis is placed on grid-connected photovoltaic systems (grid-connected PV systems) which require no batteries.

The Government of Palau, which regards the need to break away from the current diesel-dependent power supply as a matter requiring urgent attention and is concerned over climate change and unstable crude oil prices and transportation costs in the energy and electric power sector, views the development of PV power and other renewable clean energies as a high priority issue. For this reason, it decided to participate in the Cool Earth Partnership that was purported by Japan as a new fund mechanism for climate change at the Davos summit in January 2008. However, the Palau Public Utilities Corporation (PPUC), which is responsible for power supply in Palau, does not possess sufficient planning capacity or operation and maintenance capability in the area of renewable energy. Accordingly, the Project here also includes support for the appropriate operation and maintenance of equipment and implementation of a soft component necessary for realizing the cooperation effect.

In the Project, which constitutes part of the efforts to address climate change in the Pacific region, grid-connected PV system equipment (solar system: PV) will be procured and installed with a view to substituting a portion of the power currently generated by diesel engine generators with renewable

photovoltaic power. In doing so, the Project aims to reduce Palau's dependence on imported fuel thereby enhancing its energy security and to support measures for mitigating greenhouse gas emissions.

2.1.2 Outline of the Project

The Project aims to procure and install the PV system equipment required to achieve the above targets, to connect the said system to the existing power grid with a view to achieving stable power supply, and to thereby promote the introduction of renewable energy to the power sector in Palau.

The cooperation basically covers the procurement and installation of the following equipment required for the target PV generating system:

- Photovoltaic (PV) Module
- Mounting Structure for Photovoltaic Module
- Junction box
- Collecting box
- Power conditioner
- Transformer
- Data management and monitoring system with display board
- Cables and Conduits
- Spare parts and maintenance tools

2.2 Outline Design of the Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Concept

Based on the request from the Palau side, as a result of conducting the detailed site survey and examining the site environment and PV system capacity appropriate to the Project, a grid-connected PV system shall be procured and installed at the Project site of Palau International Airport because of advertising effects for tourists and VIPs. Furthermore, there were no significant obstructions found against solar irradiance. The Equipment and materials to be installed for the Project shall be selected in view of some foreign models and to be suitable for the Palau for promotion of grid-connected PV systems. The PV system configuration should be along the Program Grant Aid for Environment and Climate Change of Japan.

2.2.1.2 Concept regarding Natural Conditions

(1) Temperature and Humidity

The annual average temperature in Palau is approximately 27℃ and the mean humidity ranges from 40% to 60%. Since Palau has a marine tropical climate characterized by high temperatures

and high humidity throughout the year, the Project equipment shall basically comprise specifications suited to outdoor use in consideration of corrosion caused by rainfall.

(2) Salt Damage

Since the intended PV system site is relatively close to the coastline, in consideration of salt damage countermeasures, anti-corrosive coating shall be applied to the outdoor PV module frame and the junction box, etc. used for making electrical wiring connections.

2.2.1.3 Concept regarding Social and Economic Conditions

Palau has well developed infrastructure including roads, public water supply, sewage systems, electricity supply and telecommunications, etc. ensuring convenient lifestyles for its citizens; moreover, since English is used around the Project site and Koror State, living conditions are convenient for foreign visitors. Since most of the citizens of Palau are Christians, there are no religious customs that have a large impact on the construction schedule such as Ramadan in Islamic countries. However, since tourism is a key industry and the Project site of Palau International Airport is used by numerous domestic and international passengers and important persons, it will be necessary to compile an implementation plan that takes such conditions into account.

2.2.1.4 Concept regarding Construction Situation, Procurement Conditions and Special Conditions or Customs in the Sector

The key industries of Palau, i.e. construction, commerce and tourism, have relied heavily on assistance from Japan, the United States and Taiwan, etc. and on overseas workers primarily from the neighboring Philippines. Accordingly, it is difficult to secure engineers of higher standard than simple laborers possessing only limited technical skill. Since infrastructure conditions are good and there is a good network of roads between islands as typified by the new Koror-Babeldaob Bridge which was constructed under Japan’s grant aid, the condition for transporting equipment and executing works in the Project site is favorable.

2.2.1.5 Concept regarding Utilization of Local Contractors (Construction Companies and Consultants)

(1) Utilization of Local Contractors

Since Palau has foreign-affiliated general contractors and electrical works companies, it is relatively easy to procure ordinary laborers, transport vehicles, construction works machinery and so on. Accordingly, it will be relatively easy to secure the local labor required for constructing the PV module frame and implementing the civil engineering foundation works in the Project.

On the other hand, high-level engineers will be required in order to perform configurations and adjustments with existing grid operating conditions when installing the PV system, and since it is difficult to find such personnel in Palau, it will be necessary to dispatch engineers from Japan or other countries in order to conduct quality control, offer technical guidance and manage work schedule.

(2) Utilization of Local Equipment and Materials

The aggregate, cement and reinforcing bars, etc. used in foundation works can be procured in Palau. Accordingly, when compiling the implementation plan, locally procurable equipment and materials shall be utilized as much as possible. As for the main equipment, especially PV modules, Power conditioners and Transformer, in the PV system, should be expected to be procured from Japan under consideration in order to secure high reliability and easy maintenance based on compatibility with the existing grid.

2.2.1.6 Concept regarding Operation and Maintenance

Palau has so far introduced a grid-connected PV system of 100 kW rated output under EU support and a 153 kW system under Taiwanese support; however, since technical transfer pertaining to the operation and maintenance of grid-connected PV systems has not been adequate, it will be necessary to offer technical transfer on appropriate operation and maintenance to the Palau Public Utilities Corporation (PPUC) which will be responsible for operating the system after completion of the Project.

Since the equipment and materials installed under the Project will be operated in connection with the existing distribution network, an appropriate operation and maintenance manual will be provided under the soft component, and the operation and maintenance setup following commissioning will be proposed and measures will be taken to ensure that the system is operated effectively and efficiently.

2.2.1.7 Concept regarding Setting of Facilities and Equipment Grades

Considering the above conditions, the scope, scale and technical level of equipment procurement and installation shall be compiled according to the following principles.

(1) Concept regarding the scope of facilities and equipment, etc.

To ensure a design that is both technically and economically appropriate, standard products corresponding to IEC and other international standards shall be procured as far as possible. Equipment model types shall be kept to a minimum for the sake of ensuring compatibility and the minimum necessary equipment composition, specifications and quantities shall be selected. The connection point of the PV system has been decided to be the distribution panel of the existing

distribution system in the airport. The Japanese grant provides the PV system up to the panel and the material necessary for the connection. The final connection work shall be done by PPUC so that it is smooth to work power outage and PPUC is familiar with the existing distribution facilities.

(2) Concept regarding technical level

Specifications of the component equipment in the PV system shall be selected in accordance with the technical level of the PPUC which will be in charge of the operation and maintenance after completion of the Project.

2.2.1.8 Concept regarding Construction Method, procurement Method and Works Schedule

Equipment procured in Japan and other third countries will primarily be transported to Palau by sea. The distance from Malakal Port to the Project site at Palau International Airport is roughly 30 minutes by car through downtown Koror. Accordingly, there shouldn't be any problems concerning overland transportation, however, since traffic in the city center is relatively heavy and congestion occurs during the morning, noon and evening peaks, it will be necessary to transport large objects other than such time frames.

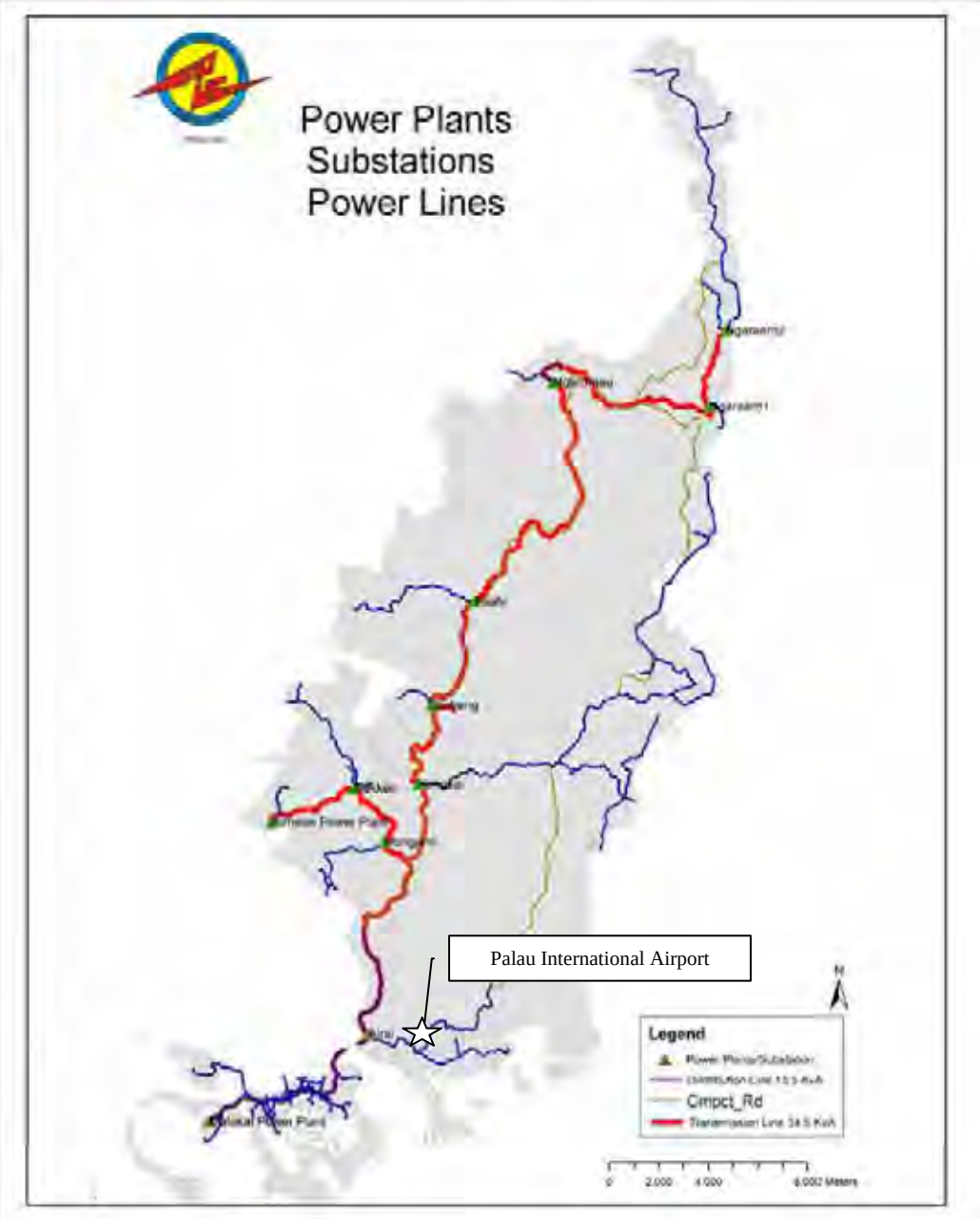
The airport is used by passengers every day. Normally, passengers leaving the country gather at the airport in the evening and flights depart until late at night. Therefore, the facilities construction will need to be implemented in a very limited time, while high-level skills will be required in order to handle the PV system and carry out the installation works including adjustments. Accordingly, from the viewpoint of ensuring quality control and keeping the intended schedule, it will be necessary to dispatch engineers from Japan or other countries in order to conduct technical guidance and schedule management.

2.2.2 Basic plan (Facility Plan / Equipment Plan)

2.2.2.1 Prerequisite of the plan

(1) Site

The project site is "Palau International Airport," and the capacity of the introduced grid-connected PV system is 180kW. As shown in Fig. 2.2.2-1, Palau International Airport is supplied with power from Aimeliik power plant and Malakal power plant. Its voltage is dropped from 34.5kV to 13.8kV at the Airai substation.



Source： created by JICA study team based on materials from PPUC

Fig. 2.2.2-1 System diagram of Transmission / Distribution line in Palau

As for the electric power load in Palau International Airport, the actual data of it did not exist. Therefore, the JICA study team interviewed with PPUC. As a result, it was confirmed that the maximum load was approximate 400kW (around 10PM) and the base load was 250 kW. Accordingly, it can be judged that the load in the airport does not exist in the time when the PV system can supply electricity (from 8AM to 4PM) at all and the electricity from the PV system is supplied to the grid mainly. As for the parallel operation with the standby diesel generator (625kVA) in the airport when the grid is interrupted, it can be judged that it is desirable not to operate together in the view point of the electric power quality based on the result of comparing the capacities of the standby diesel generator and the PV system.

(2) Irradiance estimated

In Palau, there was no irradiance data originally collected. When a PV system is designed in such countries, irradiance data indirectly measured with the satellite of NASA is usually used. However, in Palau, Japan Agency for Marine-Earth Science and Technology (JAMSTEC) set up a meteorological data observatory in Aimeliik and has been collecting irradiance data on the earth's surface since 2003. We have analyzed the data, and consequently, it was judged to be more accurate than that of NASA in view of actual design. Therefore, we determined to use the irradiance data of JAMSTEC as design parameters for estimation of the energy generated by a grid-connected PV system.

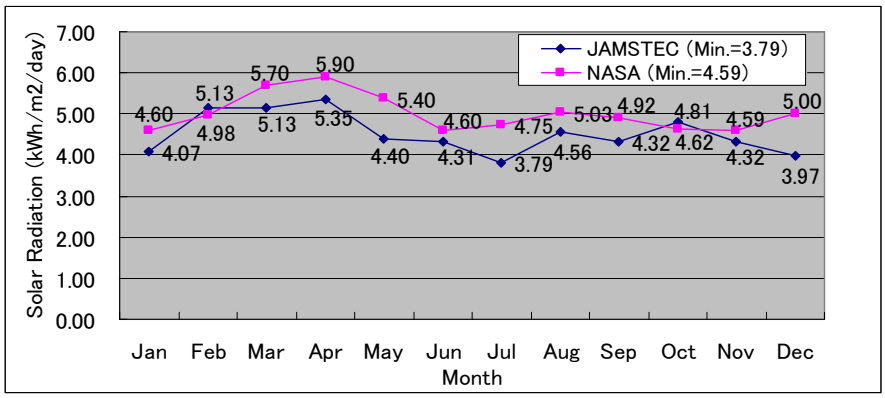
Comparison between the average irradiance (horizontal surface measurement) over the past three years collected by JAMSTEC and the irradiance indirectly measured with the satellite of NASA is shown in Table 2.2.2-1. When the minimum data of them are compared on the table, the data measured by JAMSTEC is smaller than the NASA data by 17%. It is conservative to use the former data for evaluation of the PV system design. Thus, inclined surface irradiance was calculated based on the data measured by JAMSTEC, and then the estimated generated-energy by the introduced grid-connected PV system was calculated.

Table 2.2.2-1 Irradiation (horizontal global irradiation) data measured by JAMSTEC

[kWh/m2/day]

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	3.90	5.01	5.24	5.31	4.28	4.25	3.93	4.57	4.72	4.61	4.24	4.24
2006	4.36	5.18	4.88	5.23	4.43	4.17	3.83	-	-	5.01	4.73	3.90
2005	3.95	5.20	5.27	5.52	4.48	4.50	3.62	4.55	3.91	4.80	3.99	3.78
Average	4.07	5.13	5.13	5.35	4.40	4.31	3.79	4.56	4.32	4.81	4.32	3.97

Source : JAMSTEC database



Source : created by JICA study team from JAMSTEC database and NASA database

Fig. 2.2.2-2 Comparison with JAMSTEC data and NASA data

Table 2.2.2-2 Inclined global irradiation calculated based on irradiance (horizontal global irradiation) data measured by JAMSTEC

[kWh/m2/day]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Horizontal global irradiation	4.07	5.13	5.13	5.35	4.40	4.31	3.79	4.56	4.32	4.81	4.32	3.97
Inclined global irradiation	4.01	5.05	5.04	5.28	4.34	4.26	3.74	4.50	4.25	4.73	4.26	3.91

Source : created by JICA study team from JAMSTEC database

(3) Influence of shadow by obstacles nearby

When the PV array of PV system is installed, it is desirable to choose a place where solar radiation is not obstructed by a building, etc. nearby, considering the variation of the azimuth and angle of solar radiation that depends on season and time zone in order to generate power properly. In general, if direct sunlight is obstructed by an object and a PV array is covered by shadow, generated-energy may be decreased by 10 to 20% compared to the case there is no obstacles.

In the project, it is ideal to check radiation obstacles from AM9:00 to PM3:00 at winter solstice when the shadow of obstacles become the longest. Shadow condition was checked at the parking lot of Palau International Airport, which is the Project site. Consequently, it was confirmed that no shadow which influenced the generated-energy appeared at the place where the PV panel was planned to be installed.

(4) Estimated generated-energy

As described in "(2) Influence of shadow by obstacles nearby," it is judged that there is no influence of shadow. Thus, the reduction of the generated-energy by shadow is not considered in the following discussion.

For the calculation of the estimated generated-energy, the equation below is used. Inclined surface irradiance shown in Table 2.2.2-2 is used as monthly average irradiance. The capacity of the introduced grid-connected PV system is 180kW.

$Ep = \Sigma H_A / Gs * K * P$

(Σ denotes the integrated value of the estimated generated-energies calculated month by month.)

Where

- Ep = estimated annual generated-energy (kWh/year)
- H_A = monthly average irradiance on the installation surface (kWh/m^2/day)
- Gs = irradiance in standard condition (kW/m^2) = 1 (kW/m^2)
- K = loss factor = Kd * Kt * η_{INV}

  * DC correction factor Kd : including loss corrections for soil on the solar cell surface and the fluctuation of solar irradiance, and correction for difference in characteristics of solar cells. Kd is set to 0.8 this time.

* Temperature correction factor Kt : correction factor for the variation of conversion efficiency caused by the temperature rise of solar cells by solar radiation.

$Kt = 1 + \alpha (Tm - 25) / 100$

where α: max. output temperature factor (%▪°C^{-1})

= - 0.5 (%▪°C^{-1}) [crystals]

Tm : module temperature (°C) = Tav + ΔT

Tav : monthly average temperature (°C)

ΔT : module temperature rise (°C)

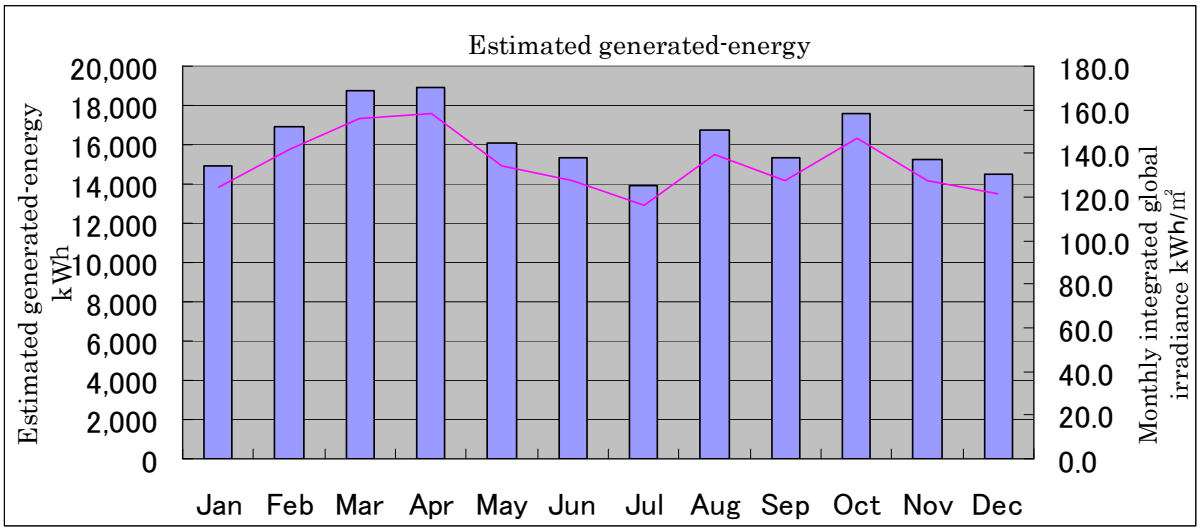
Backside open type	18.4
Roof installation type	21.5

* Inverter efficiency η_{INV} : AC/DC conversion efficiency of inverter. η_{INV} is set to 0.95 this time.

Table 2.2.2-3 Estimated annual generated-energy in Palau International Airport

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
Ha: inclined global irradiation kWh/㎡/day	4.01	5.05	5.04	5.28	4.34	4.26	3.74	4.50	4.25	4.73	4.26	3.91	-
Days / month	31	28	31	30	31	30	31	31	30	31	30	31	365
Hm: monthly cumulative irradiance kWh/㎡	124.3	141.4	156.2	158.4	134.5	127.8	115.9	139.5	127.5	146.6	127.8	121.2	1621.3
Daily mean max. temperature ℃	28.2	28.4	28.3	28.8	28.6	28.4	27.8	27.8	28.0	28.4	28.6	28.5	-
Kt: temperature correction factor	0.8765	0.87556	0.876	0.873	0.874	0.876	0.8788	0.878	0.878	0.876	0.874	0.875	-
Ep: estimated generated-energy (kWh)	14,906	16,936	18,729	18,924	16,094	15,310	13,937	16,764	15,308	17,563	15,288	14,511	**194,271**

Source : created by JICA study team



Source : created by JICA study team

Fig. 2.2.2-3 Estimated annual generated-energy in Palau International Airport

(5) Introduction model of grid-connected PV systems

The introduction models of a grid-connected PV system assumed under grant aid are shown in Table 2.2.2-4. ①and ② are the cases of introduction as PPUC's facilities, while ③ and ④ are the cases of introduction by private companies (other than public utilities corporations) or citizens as their own facilities. Through discussion with the Palau side, the followings were

decided. The target site of the Project is Palau International Airport, which is owned and managed by Ministry of Public Infrastructure, Industries and Commerce (hereinafter called "MPIIC"). PPUC becomes the owner of the facilities, and takes charge of the O&M in the same manner as ordinary power system. MOU would be concluded between MPIIC and PPUC, and the electricity tariff, etc. paid from the airport to PPUC are determined under the MOU. Thus, this program shall be implemented by the model of ②. In this introduction model, as PPUC carries out O&M of the grid-connected PV system introduced under the Project, it can acquire necessary skills for design & operation of the grid-connected PV system, and build up sufficient experience to examine and evaluate its economic efficiency. Therefore, this is considered to be an ideal model, also from the viewpoint of introduction and dissemination of grid-connected PV systems after the Project.

Table 2.2.2-4 Expected models of the introduced grid-connected PV system in Palau

No.	Introduction model	Installation site	PV facility owner	Characteristics, issue, requirement, etc.
①	PPUC installs PV facilities in its building as its facilities.	Building, etc. of PPUC	PPUC	▪ Because both PV facilities and surrounding ones are PPUC's, PV installation design is easy. ▪ Flexibility in PV installation location.
②	PPUC installs its PV facilities on the roof, etc. of the building of other entity, renting the place.	Building, etc. of other entity	PPUC	▪ Constraint in PV installation place may exist. Rent will be needed. ▪ Consultation on O&M and security is needed. ▪ Negotiation on electricity tariff considering rent, etc. is needed.
③	A building owner installs PV facilities as its power source, and sells surplus energy to PPUC.	Building, etc. of other entity	Owner of building, etc.	▪ Because the facilities are used for private purpose regularly, reverse power flow of surplus energy is small, and thus influence on distribution lines is small. ▪ Technical requirements on equipment to be added for grid connection, such as protective equipment, should be decided based on impartial standards such as guidelines. ▪ Surplus energy purchase system should be prepared.
④	An entity other than PPUC (owner of a building, etc.) installs PV facilities for wholesale power supply to PPUC.	Building, etc. of other entity	Owner of building, etc.	▪ In the case large-scale PV facilities are connected to an existing distribution line, addition of overvoltage prevention equipment, etc. should be considered in advance. ▪ System for wholesale power transaction should be prepared.

Source : created by JICA study team

(6) Laws and regulations required for introduction of a grid-connected PV system

Laws and regulations required for introduction of a grid-connected PV system, which will be installed under the Project, were ascertained. Consequently, as shown in Table 2.2.2-5, securing the power quality of the existing grid, public safety, etc. is extracted as check items in "technical

aspects," while how to treat the amount of generated-energy of the introduced PV system, and agreements on the O&M system of it are extracted as check items in "institutional aspects."

Table 2.2.2-5 Check items in laws and regulations when the grid-connected PV system of this project is introduced

Requisites to be checked		
Technical aspects	Power quality	: whether or not there are regulations on the influence of the introduced PV system on the electricity of the existing grid (voltage, frequency, flicker and harmonics).
	Safety protection	: requisites to be especially considered to secure safety, such as a protective relay to be added for the grid-connection
	Grid connection point	: requisites on classification regarding the grid-connection voltage class (high-voltage or low-voltage connection), and on the facilities for connection
Institutional aspects	Approvals and licenses on installation of generation facilities, and regulations on installation contractors and reverse power flow	
	Measuring method for energy generated by a grid-connected PV system, and how to treat the amount of generated-energy and electricity tariff.	
	O&M organization and system for the introduced PV system.	

Source : created by JICA study team

For power quality (voltage, frequency, flicker and harmonics), it was confirmed that there were no definite standards in Palau at present.

For safety protection, it was confirmed that there was no particular equipment (protective relay, etc.) that must be added specially for the grid-connection. However, considering prevention of facility damage caused by the fault inside the premises of consumers, and securing of public safety, it was determined to adopt an islanding prevention function.

For the grid connection point, it was confirmed that there was no definite voltage classification based on power demand. In view of an economic aspect, the present state of the existing facilities, etc., low-voltage connection was determined.

For the approvals and licenses on the installation of generating facilities, it was confirmed by PPUC that they are not necessary for the introduced grid-connected PV system in the Project. For reverse power flow, the power flow will enter the distribution line via the facilities of consumers by the introduction of the PV system. However, it was confirmed that there was no institutional problem.

A Watt-hour meter is installed at the grid connection point to measure the power supplied to the distribution line from the grid-connected PV system. The Palau side will discuss how to treat the amount of generated energy (and electricity tariff) hereafter.

For the O&M organization and system, we will establish the system in collaboration with the Palau side, carrying out technical transfer concerning O&M in the soft-component.

As mentioned above, all items except for the issues to be examined by the Palau side have already been checked. In view of the present conditions of the country, it is judged that no preparation for the law and regulations is required for the grid-connected PV system introduced under this project. If a law or regulation against which we must take measures is laid down in Palau in the future, we need to do it. However, it was agreed that the Palau side had the responsibility to do it in such a case.

(7) Necessity to reinforce the distribution system

When the necessity of reinforcing the distribution system is examined, the following two points should be considered when the grid-connected PV system is introduced.

① Distribution facilities (transformers and distribution lines) on the upstream of the grid connection point do not become overloaded.

② Distribution line voltage at the grid connection point does not go out of the standard voltage regulation.

① Distribution facilities (transformers and distribution lines) on the upstream of the grid connection point do not become overloaded.

The installed capacity of the grid-connected PV system installed in Palau International Airport is 180kW. However, considering the output decrease by the temperature rise of the PV module, the efficiency of the inverter, etc, it is assumed that the maximum PV generation output is about 144kW and the maximum current from the introduced grid-connected PV system to 13.8kV distribution line is about 6.0A. Under the most severe assumption that the magnitude of the reverse power flow into the existing grid is the maximum generation output of the grid-connected PV system, it was confirmed that the distribution facilities (transformers and distribution lines) on the upstream of the grid connection point did not become overloaded.

(a) Capacity of the power-receiveng transformer

The introduced grid-connected PV system is connected on the secondary side (low-voltage side; Y connection; 208V) of the power-receiveng transformer of an existing building. The capacity is 750kVA.

Since “the maximum PV generation output” 144kVA ≤ “the capacity of the power-receiving transformer” 750kVA, it is judged that there is no problem in the capacity of the power-receiving transformer.

(b) Capacity of the distribution line

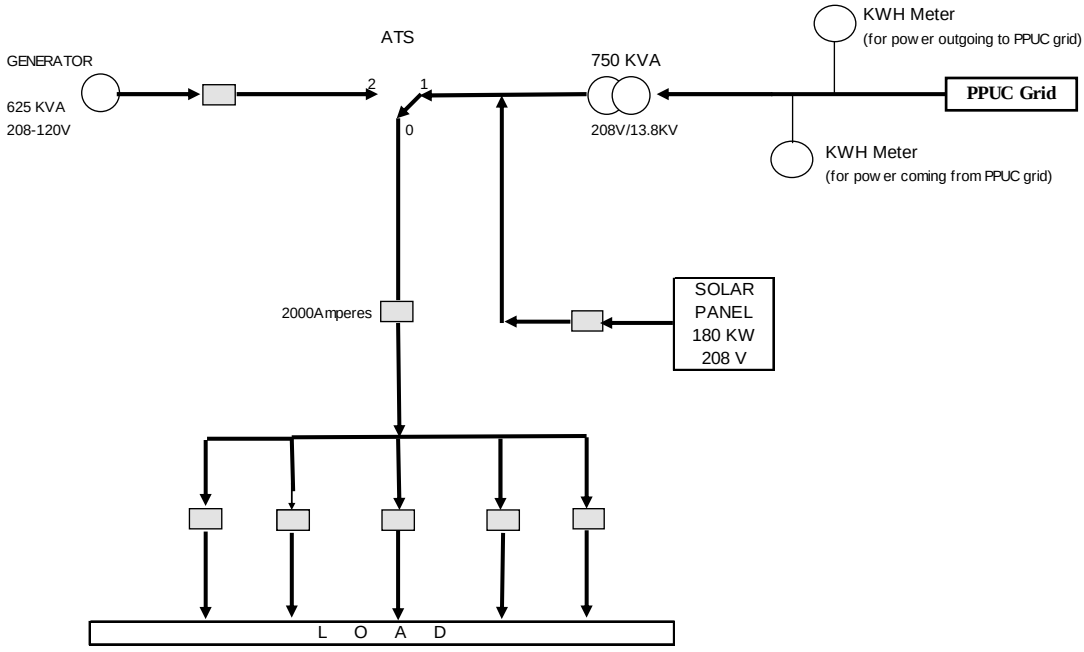
The distribution lines down to the power-receiveng transformer of Palau International Airport are all overhead lines.

The 13.8kV overhead distribution line from Airai substation to Palau International Airport is composed of two types of lines, and the allowable currents of them are 162A and 220A respectively, as shown in Table 2.2.2-6. Even if the distribution line from Airai substation is assumed to be AC38mm^2, “the reverse power flow current at the maximum PV generation output” 6.0A ≤ “the allowable current of the wire with the minimum allowable current in the distribution feeder for grid connection” 162A. Since the condition is satisfied, it is judged that there is no problem in the capacity of the existing overhead distribution lines.

Table 2.2.2-6 Distribution line from Airai substation to Palau International Airport

Substation	Distribution line	Type of conductor	Allowable current
Airai substation	13.8kV	AC38mm^2	162A
		HDCC38mm^2	220A

Source : created by JICA study team based on a hearing survey in PPUC and the electric wire handbook of SWCC Showa Holdings Co., Ltd.



Source : created by JICA study team

Fig. 2.2.2-4 Connection point of the introduced grid-connected PV system

Fig. 2.2.2-5 Inside of the main distribution board in Palau International Airport

② Distribution line voltage at the grid connection point does not go out of the control standard range.

In this examination, it is enough to confirm that the power-receiving voltage at the closest general low-voltage customer does not go out of the standard voltage regulation, considering the distribution line from Airai substation (the closest substation) to the grid-connection point. In the examination, it should be confirmed that when reverse power flow occurs from the grid-connected PV system to the existing grid under an ordinary light load condition, the power-receiving voltage at the closest general low-voltage customer does not exceed the upper limit of the standard voltage regulation. For that purpose, data of the type, size and allowable current of the wires, and that of the load of the target distribution

line under a light load, etc., are necessary. The load management conditions of PPUC were surveyed in this investigation. Consequently, it was found that these necessary data had not been acquired in Palau and the examination at a light load condition was difficult. In this examination, therefore, under a severer condition where all loads are disconnected from the distribution line, in other word, under a condition where reverse power flow occurs from the grid-connected PV system to the no-load distribution line, it was confirmed that the power-receiving voltage at the closest general low-voltage customer does not exceed the upper limit of the standard voltage regulation. Here, the examination was done based on the sending end voltage at Airai substation, which is the starting point of the distribution line.

Palau International Airport is supplied with power from Airai substation with a 13.8kV distribution line, and the distance between Airai substation and Palau International Airport is about 3.7km. AC38mm^2 and HDCC38mm^2 are used for the 13.8kV distribution line. However, the total length of each conductor is not known. Thus, for conservative examination, it is assumed that AC38mm^2 is used for all conductors in the distribution line. Because there is no information on the impedance of the conductors in Palau, the value was determined consulting the power cables handbook of SWCC Showa Holdings Co., Ltd. The PV generation output is the rated output with a power factor of 1.0. As for the standard voltage, because there is no definite standard in Palau, it was determined consulting the technical guidelines on the grid connection of distributed power sources in Japan (JEAG9701-2001, Japan Electric Association). Under these conditions, it is confirmed that the power-receiving voltage at the closest general low-voltage customer does not go out of the standard voltage regulation (240V±12V(±5%)).

Table 2.2.2-7 Examination result on the distribution line voltage at the grid-connection point and the closest general low-voltage customer

Distance between Airai substation to Palau International Airport	Sending end voltage	Type of Conductor	R [Ω/km]	Reverse power flow current from PV	Voltage rise at high voltage	Power-receiving voltage at the closest low-voltage customer
3.636km	13.8kV	AC38mm^2	0.913	6.0A	20V	240.3V

Source ： created by JICA study team based on a hearing survey in PPUC

The result of this examination shows that the power-receiving voltage at the closest general low-voltage customer is 240.3V when reverse power flow occurs from the grid-connected PV system to the no-load distribution line. Since the value is lower than the upper limit of the control standard range (252V), it is judged that there is no problem.

Based on the above examination results, it is judged that reinforcement of the distribution system is not required.

(8) Examination on power quality

When a grid-connected PV system is introduced, power quality should be examined in parallel with examination on the necessity of distribution system reinforcement. “Flicker” and “harmonics” are considered to be the examination items concerning power quality. However, as a result of a hearing investigation in PPUC, it was found that there were no definite power quality standards currently. In addition, it is judged that there would be no generation sources of these two items because there are no big factories in the power grid of Palau. Thus, the examination on power quality was omitted in this study. As for harmonics, however, measures against it have been already taken in general purpose grid-connection inverters in Japan. Thus, it was determined that the specifications pursuant to the Japanese guidelines on harmonics mitigation measures should be required as the specifications for the equipment procured under the project.

(9) Allowable capacity of the introduced grid-connected PV system

Palau International Airport was determined to be the Project site based on this study. Here, it is examined whether or not the 180kW grid-connected PV system that is planned to be introduced in this project can be interconnected with the existing grid. The examination method is as follows: The allowable capacity of the introduced grid-connected PV system, against the existing grid, is calculated, and if the capacity is 180kW or more, it is judged that the grid-connected PV system that is planned to be introduced in this project can be introduced into the existing grid without problem.

In view of securing power quality, the following two methods are considered as the examination methods on the allowable capacity of the introduced grid-connected PV system against the existing grid:

Step 1 : Examination on restrictions in view of grid operation
Step 2 : Examination on restrictions in view of distribution line operation

With regard to Step 2, as examined in “6) Necessity of enhancing the distribution system,” it is judged that there is no restriction in view of distribution line operation. Hence, the examination result on Step 1 is explained below.

Step 1: Examination on restrictions in view of grid operation

Palau International Airport is supplied with power from Aimeliik power plant and Malakal power plant. The operation method of the diesel engine generators in each plant was checked. Consequently, it is judged that because the demand condition can be monitored in real time by SCADA (Supervisory Control and Data Acquisition System) which PPUC owns, the system can respond to the demand fluctuation relatively quickly. However, switch-on/off of the generator is manually conducted by the operator with an empirical rule, it is considered to be difficult to quickly respond to the output fluctuation of the introduced PV system caused by weather change. In this examination, therefore, evaluation is done

based on the governor-free control of the diesel generators operating regularly at a light load, which is the severest condition. (See Table 2.2.2-8. The generators not operating now will be operated as soon as spare parts arrive and repair is completed. The examination condition adopted here is the severest operation condition observed during the investigation.) For frequency, since there is no definite standard value in Palau, the examination on the allowable capacity of a grid-connected PV system is done using the frequency deviation target value in Japan, 60±0.2Hz (±0.3%), which is a severe value as power quality.

For the maximum load fluctuation, the fluctuation that occurs during the pump operation in sewage plant is judged to be the maximum by the result of a hearing survey in PPUC. The value corresponds to about 2% of the maximum power (about 242kW).

As a result of a hearing survey at the power plants, it was known that the drooping rates of diesel governors were all set to 3% in diesel generators operating regularly at a light load (Pielstick-2 to 5 and Mitsubishi-13), as shown in Table 2.2.2-8. Therefore, the allowable output fluctuation range during the governor-free operation is:

11,220kW * (0.3% / 3%) = 1,122kW.

The following relationship should be satisfied.

Fluctuation of PV generation output (kW) + Fluctuation of demand (kW) ≤ Allowable output fluctuation of diesel generators operating regularly at a light load (kW)

Thus, the allowable fluctuation of the PV generation output is calculated as follows:

Allowable fluctuation of the PV generation output ≤1,122kW - 242kW = 880kW

Assuming that the fluctuation range of the PV generation output is 10 to 90% of the rated capacity based on the past verified examples, the allowable capacity of the grid-connected PV system into the existing grid is calculated to be about 1.1MW. From this result, and considering the system of 100kW at the federal government office building (EU: European Union) and the one of 153kW at Palau National Hospital (Taiwan), which have been introduced, it was confirmed that there was no problem in the grid-connected PV system of 180kW that would be introduced under the Project.

From the examination results of Step 1 and Step 2, it is judged that the 180kW system that will be introduced under the Project can be connected to the existing grid without problems.

Table 2.2.2-8 Operating Condition of Diesel Generators at Off peak and Peak

Power Station	Unit	Manufacturer	Operation (As of Jul 1st, 2009)		Rated Output, MW	Available Output, MW
			Off peak	Peak		
Aimeliik	Pielstick-2	Crossley-Pielstick	Operation	Operation	3.270	3.000
	Pielstick-3		Operation	Operation	3.270	1.500
	Pielstick-4		Operation	Operation	3.270	2.000
	Pielstick-5		Operation	Operation	3.270	2.000
Sub-Total			—	—	13.080	8.500
Malakal	Wartsila-1	SACM-Wartsila	—	Operation	2.000	0.500
	Wartsila-2		—	—	2.000	0.000
	Wartsila-3		—	—	2.000	0.000
	Mitsubishi-12	Mitsubishi	—	—	3.400	0.000
	Mitsubishi-13		Operation	Operation	3.400	2.720
	Caterpillar-1	Caterpillar	—	—	2.000	0.000
	Caterpillar-2		—	Operation	2.000	1.500
	Alco-9	Alco	—	Operation	1.200	0.500
Sub-Total			—	—	18.000	5.220
Total			**—**	**—**	***31.080***	***13.720***

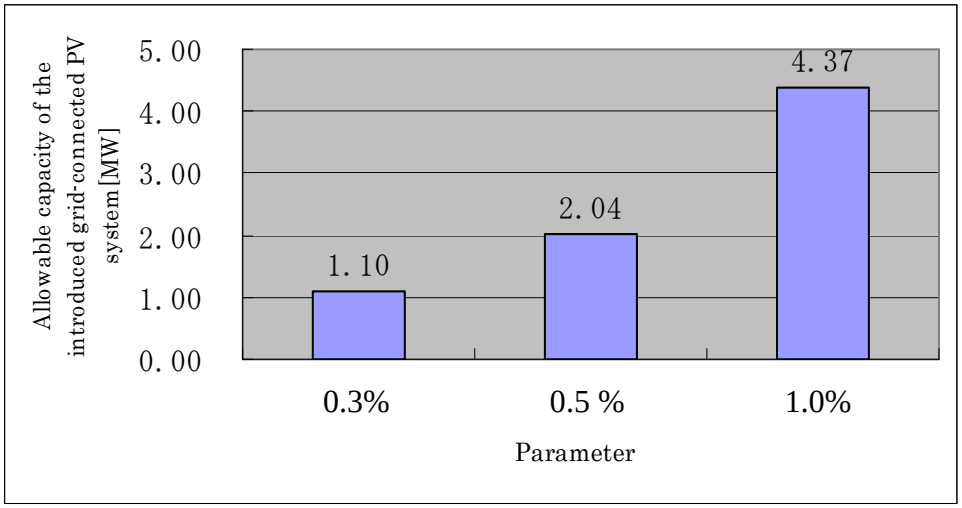
Source : Prepared by the Study Team using materials obtained from PPUC.

This examination was done based on the frequency deviation target value in Japan, which was a severe value as power quality. The allowable capacity of the introduced grid-connected PV system changes by the change of the target value. Thus, a sensibility analysis was conducted using the allowable frequency fluctuation rate as the parameter. The values below were used for the parameter.

① 60±0.2Hz (±0.3%) : frequency deviation target value in Japan

② 60±0.3Hz (±0.5%) : medium value

③ 60±0.6Hz (±1.0%) : frequency deviation target value in Thailand and Malaysia, where relatively sophisticated electricity infrastructures have been constructed in Southeast Asia



Source : created by JICA study team

Fig. 2.2.2-6 Relationship between the allowable frequency fluctuation rate and the allowable capacity of the introduced PV generating system

(10) Legal Systems and Regulations concerning Reinforcement of Existing Facilities and Buildings

Since Palau has no independent legal systems concerning structure and fire control for facilities, American standards are frequently applied, although Japanese regulations and criteria are also approved. Among past Japanese grant aid projects, the building design for the KB Bridge, the Atoll Conservation Research Center and the international airport terminal building, etc. was performed according to Japanese criteria, and each design received approval from the Government of Palau. In consideration of this, Japanese regulations and criteria shall basically be adopted in the Project while steps to ensure the minimum necessary contents and simple maintenance shall be taken upon holding discussions with the Palau side.

2.2.2.2 Overall Plan

The scale and specifications of the Project facilities and equipment shall be planned according to the following conditions.

(1) Climate and Site Conditions

Table 2.2.2-9 Climate and Site Conditions

(a) Altitude	52.3m
(b) Ambient temperature (maximum)	32.0˚C
(c) Ambient temperature (minimum)	22.0 ˚C
(d) Relative humidity (maximum)	90 %
(e) Monthly maximum rainfall	313 mm
(h) Maximum wind velocity	125 mile/hour

Source: Supplemental Aviation Weather Reporting Station (SAWRS)

(2) Electrical System Conditions

①	Distribution voltage	:	(Intermediate voltage) 3 phase 4 wire 13.8 kV (maximum 14.52 kV) (Low voltage) 3 phase 4 wire 208-120 V
②	Frequency	:	60 Hz
③	Maximum shorting capacity	:	13.8 kV system, 12.5 kA
④	Ground line	:	13.8 kV, neutral point multiple grounding
⑤	Ground resistance	:	10 Ω or less
⑥	Color	:	IEC standard (red, yellow, blue, black)

(3) Facilities Plan Conditions

The PV module frame to be installed in the Project will also act as a sunshade for the car park at Palau International Airport. Accordingly, the minimum required support frame will be designed upon considering building clearance with vehicles and securing the maximum possible electric power from the natural conditions. Moreover, in view of the voltage drop and underground cable laying work between the PV module and power conditioner, the layout plan shall be designed so that the shortest possible distance to the existing electric room is obtained. Since the Project facilities will mainly be utilized at night and it is predicted that the frame installation will obstruct visibility in the car park, consideration will be given to installing lights on the bottom of the frame.

2.2.2.3 Outline of the Basic Plan

(1) Basic Plan

Table 2.2.2-10 shows the basic plan of the Project based on the basic design concept described above (see 2.2.1).

Table 2.2.2-10 Outline of the Basic Plan

	Procurement and installation of the following PV equipment	Quantity
Equipment Procurement and Installation Works Plan	Photovoltaic Module (PV Module)	1 set
	Mounting Structure for Photovoltaic Module	1 set
	Power conditioner	2 units
	Transformer	1 unit
	Data management and monitoring system	1 set
Equipment Procurement Plan	Replacement parts, maintenance tools and test equipment for the photovoltaic system	1 set

(2) Equipment Procurement Quantities

The quantities of the main equipment to be procured in the Project are as shown in Table 2.2.2-11.

Table 2.2.2-11 Quantities of Major Equipment

	Procurement and installation of the following PV equipment	Quantity
Equipment procurement and installation plan	Photovoltaic Module (PV Module)	Being equivalent to 180kW (including 3% additional for reserve materials)
	Mounting Structure for Photovoltaic Module	1 set
	Junction box	20 units
	Collecting box	4 units
	Power conditioner	2 units
	Transformer	1 unit
	Data management and monitoring system	1 set
	Wiring materials, grounding work materials	1 set
Equipment procurement plan	PV system exchange parts, maintenance tools and test apparatus	1 set

Concerning the reserve materials, the design quantity shall be multiplied by the reserve factor upon considering breakages, etc. during ocean and inland transportation and installation. The reserve factor will be decided in consideration of experiences in similar overseas works. In the case of PV power generation, since an unexpected failure in just one panel can prevent power generation in a whole string of connected panels, it is difficult to guarantee performance. Since the project will be implemented under the Government of Japan's Environment and Climate Change Program Grant Aid scheme, the design quantity multiplied by 3% (reserve amount) shall be procured to ensure that the installation work is finished in a short time and that performance following installation is guaranteed.

(3) Outline Specifications of Equipment

Existing standards in Palau will be applied to the PV and distribution equipment procured and installed by the Japanese side as far as possible. In addition to paying attention to the ease of equipment operation and maintenance following completion of the Project, the number of specification items will be limited and standard design models will be adopted with a view to reducing the installation time. The PV module for the Project shall be mounted on the steel frame designed for the car park and should be considered architectural limit of strength and installation space. The PV module shall be crystal silicon type in consideration of long performance and reliability from the aspect of saving the future maintenance and replacement of PV modules.

Table 2.2.2-12 Specifications for PV Module

Equipment	Specifications	Required Specifications
1. PV module	(1) Applicable standard	IEC and equivalent standards
	(2) Environment of use	Salt damage area
	(3) Ambient temperature	+40℃ or less
	(4) Installation method	Car park roof installation
	(5) Type	Crystal silicon
	(6) Module efficiency	12% or higher
	(7) Module capacity	210W / module or more

Table 2.2.2-13 Specifications for Mounting Structure for Photovoltaic Module

Equipment	Specifications	Required Specifications
2. Mounting Structure for PV Module	(1) Support method	Steel frame
	(2) Environment of use	Salt damage area
	(3) Material	SS400 hot dip zinc finish
	(4) Base Frame	C type channel or equivalent
	(5) Panel Frame	3 structures / Module

Table 2.2.2-14 Specifications for Junction Box

Equipment	Specifications	Required Specifications
3. Junction box	(1) Structure	Outdoor use , wall mount type
	(2) Environment of use	Salt damage area
	(3) Ambient temperature and humidity	+40℃ or less, 70% or more
	(4) Maximum input voltage	String unit nominal open voltage (V_{OC}) or more
	(5) Input circuits	Number of sub-array unit parallel lines or more
	(6) Input current	Module nominal short circuit current (I_{SC}) per circuit or higher
	(7) Output circuits	1 circuit
	(8) Output current	Sub-array nominal short circuit current (I_{SC}) or higher
	(9) Internal devices	- Wiring circuit breaker: Number of circuits - Reverse flow prevention diode: Each string - Induced lightning protector: All input and output circuits, between wires, between earth

Table 2.2.2-15 Specifications for Collecting Box

Equipment	Specifications	Required Specifications
4. Collecting box * 1 junction box; or this can be omitted if the number of power conditioner input circuits exceeds the number of junction boxes.	(1) Structure	Outdoor use , wall mount type
	(2) Environment of use	Salt damage area
	(3) Ambient temperature and humidity	+40℃ or less, 70% or more
	(4) Maximum input voltage	String unit nominal open voltage (V_{OC}) or more
	(5) Input circuits	Number of junction boxes to be connected or more
	(6) Input current	Junction box output current or more
	(7) Output circuits	1 circuit
	(8) Output current	Sub-array nominal short circuit current x Number of input circuits or more
	(9) Internal devices	- Wiring circuit breaker: Number of circuits - Induced lightning protector: All input and output circuits, between wires, between earth

Table 2.2.2-16 Specifications for Power Conditioner

Equipment	Specifications	Required Specifications
5. Power conditioner	(1) Structure	Indoor, vertical standing type
	(2) Ambient temperature and humidity	+40℃ or less, 70% or more
	(3) Main circuit system	Self-excited voltage inverter
	(4) Switching system	High frequency PWM
	(5) Insulation system	Commercial frequency insulation transformer type
	(6) Cooling system	Forced air cooling
	(7) Rated input voltage	String maximum output voltage (Vpmax)
	(8) Input operation voltage range	The string maximum output voltage (Vpmax) and nominal open voltage (V_{OC}) shall be within range.
	(9) Input circuits	The number of collecting boxes or more
	(10) Output electricity system	3 ϕ 3W
	(11) Rated output	100 kW
	(12) Rated input voltage	DC 300V
	(13) Rated output voltage	AC 202V
	(14) Rated frequency	60Hz
	(15) AC output current distortion factor	Total current 5% or less, each order 3% or less
	(16) Power control system	Maximum Power Point Tracking (MPPT)
	(17) Rated power conversion efficiency	90% or more
	(18) Control functions	- Automatic start/stop, soft start - Automatic voltage regulation - Control for input / output current - Control for output power (by external output signal)
	(19) Grid-connected protective functions	- Over Voltage Relay (OVR) - Under Voltage Relay (UVR) - Over Frequency Relay (OFR) - Under Frequency Relay (UFR)

Equipment	Specifications	Required Specifications
		All setting values and times can be adjusted. Blocking duration after power recovery can be adjusted.
	(20) Islanding operation detection function	Both Active and Reactive method for detection. Islanding detection can be masked by switching operation.
	(21) Outside signal	- Status information, failure information, and measurement information - Communication interfaces (RS485)

Table 2.2.2-17 Specifications for Transformer

Equipment	Specifications	Required Specifications
6. Transformer	(1) Structure	Indoor, vertical self standing
	(2) Rated output	200 kVA
	(3) Primary voltage	3 ϕ 4W AC208V
	(4) Secondary voltage	3 ϕ 3W AC200V
	(5) Frequency	60 Hz
	(6) Insulation class	Class B
	(7) Vector group	Y-Δ (Yd1)
	(8) Tap Changer	Primary side: 3 taps, Secondary side: 3 taps

Table 2.2.2-18 Specifications for Data management and monitoring system

Equipment	Specifications	Required Specifications
7. Data management and monitoring system	(1) Pyranometer	
	1) Applicable standard	ISO9060 Second class or equivalent
	2) Sensitivity	6~8 mV/ (W▪m^2)
	(2) Thermometer	
	1) Type	Measurement resistor Pt100Ω 4wire
	2) Shape	With simple shelter
	3) Temperature range of use	-40℃~+60℃
	(3) Signal Transducer box	
	1) Structure	Outdoor use, wall mount type
	2) Material	Steel (Powder Coating)
	3) Input signals	Pyranometer (0-10mV), thermometer (Pt100Ω)
	4) Output signals	4-20mA x 2
	5) Power source	AC120V
	6) Housed equipment	Pyranometer signal converter, thermometer signal converter, wiring circuit breaker, induced lightning protector
	(4) Monitoring system (site side)	
	1) Data monitoring method	
	- Monitoring period	6 seconds
	- Data collection items	Inclined solar irradiance, temperature, PV power generation
	2) Equipment	- Instrumentation monitoring device (RS485→RS232C conversion)
		- Uninterrupted power supply

Equipment	Specifications	Required Specifications
		(to counter instantaneous stoppage) - Necessary rack or box
	3) Soft specifications (server side)	- Display for both momentary and accumulated value, graph and table, status information, failure information, save function for protective device information
	4) Display board	- Indoor use, wall mount type - Real-time power generation (kW), daily accumulated power generation (kWh), daily accumulated CO2 reduction (kg)
	(5) Remote monitoring system	
	1) Specifications	
	- Site side data management	Site side data is transmitted to the server and data is saved on a dedicated server.
	- Data browsing	Web browser display via the internet
	- Data download	Form data download and display and printing of forms and graphs
	2) Data access	For registered user and password management (by Palau side)

Table 2.2.2-19 Specifications for Cables and Wires

Equipment	Specifications	Required Specifications
8. Cables and Wires		
Module ~ Junction box	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	① HEM - CE cable with unilateral connector (+) ② HEM - CE cable with unilateral connector (-) ③ HEM - CE cable with bilateral connector (+) (-)
	(3) Size	① 3.5sq-1C ② 3.5sq-1C ③ 3.5sq-1C
Junction box ~ Collecting box	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	600V CVD
	(3) Size	14mm^2
Collecting box ~ Power conditioner	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	600V CV-1C
	(3) Size	200mm^2
Power conditioner ~ Transformer	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	600V CV-1C
	(3) Size	150mm^2
Transformer ~ Existing distribution panel	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	600V CV-1C
	(3) Size	400mm^2
	(4) Other	Terminal lug x 4, bolts, nuts, cable termination materials
Power Conditioner ~ Signal Transducer box, Power Conditioner ~ Display board	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	600V CV
	(3) Size	3.5 mm^2 and 2 mm^2
	(4) Communication Cable	KPEV-S 2P x 2 mm^2
Grounding works materials	(1) Applicable standard	JIS, JEC, JEM or equivalent
	(2) Type	600V IV

Equipment	Specifications	Required Specifications
	(3) Size	3.5mm^2
	(4) Other	Earth rod, grounding terminal, connector

Table 2.2.2-20 Outline of Underground Conduits and Hand-hole

Equipment	Specifications	Required Specifications
1. Underground conduits	(1) Standard	JIS, JEC, JEM or equivalent
	(2) Type	Flexible Electrical Conduit
	(3) Others	Warning tape
2. Hand-hole	(1) Type	Cast-in-place concrete, FC21
	(2) Size	900 x 900 x 1200, 900 x 900 x 1500 (2 types)
	(3) Lid	Cast iron (φ 600)

(4) Installation Method for PV Array

The PV array will be installed on a car park roof, however, rather than attaching to the roof members, PV module frame will be directly attached to steel support beams. Equipment maintenance will be carried out from underneath, so no maintenance space in particular will be provided on top.

(5) Support Frame Plan

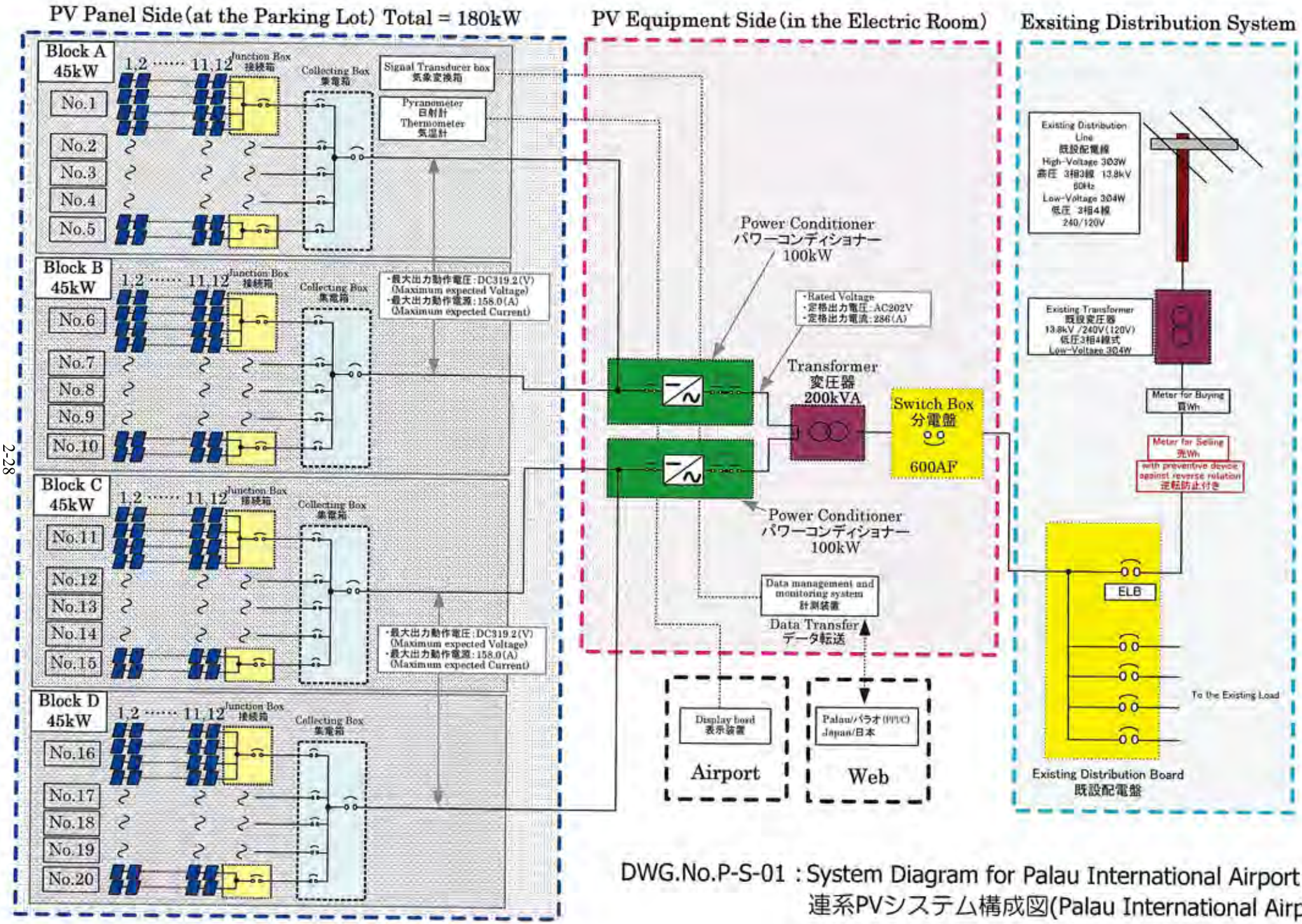
In view of the implementation schedule and the fact that the car park is for passenger service facilities, the main frame will be a steel skeleton. Height of the support frame and the beam jutting length will be kept to a minimum to allow enough building clearance for small passenger vehicles to park and in consideration of the solar panel array and shade in the parking area. All steel members will be coated with hot dip zinc (galvanizing) to provide protection against salt damage. Individual footing will be adopted for the foundations assuming the ground bearing capacity to be 50kN/m^2 around design GL-1.0m based on geological survey report data acquired at the time of airport construction.

Design load, assuming the weight of PV panels and frame to be fixed load, is assumed as 500N/m^2 over the entire roof surface. Wind load will be considered assuming the airport terminal design load of 125 mile / hour to be the maximum instantaneous wind velocity. For seismic load, an area factor of 0.15 shall be considered assuming the Seismic Zone 3 classification.

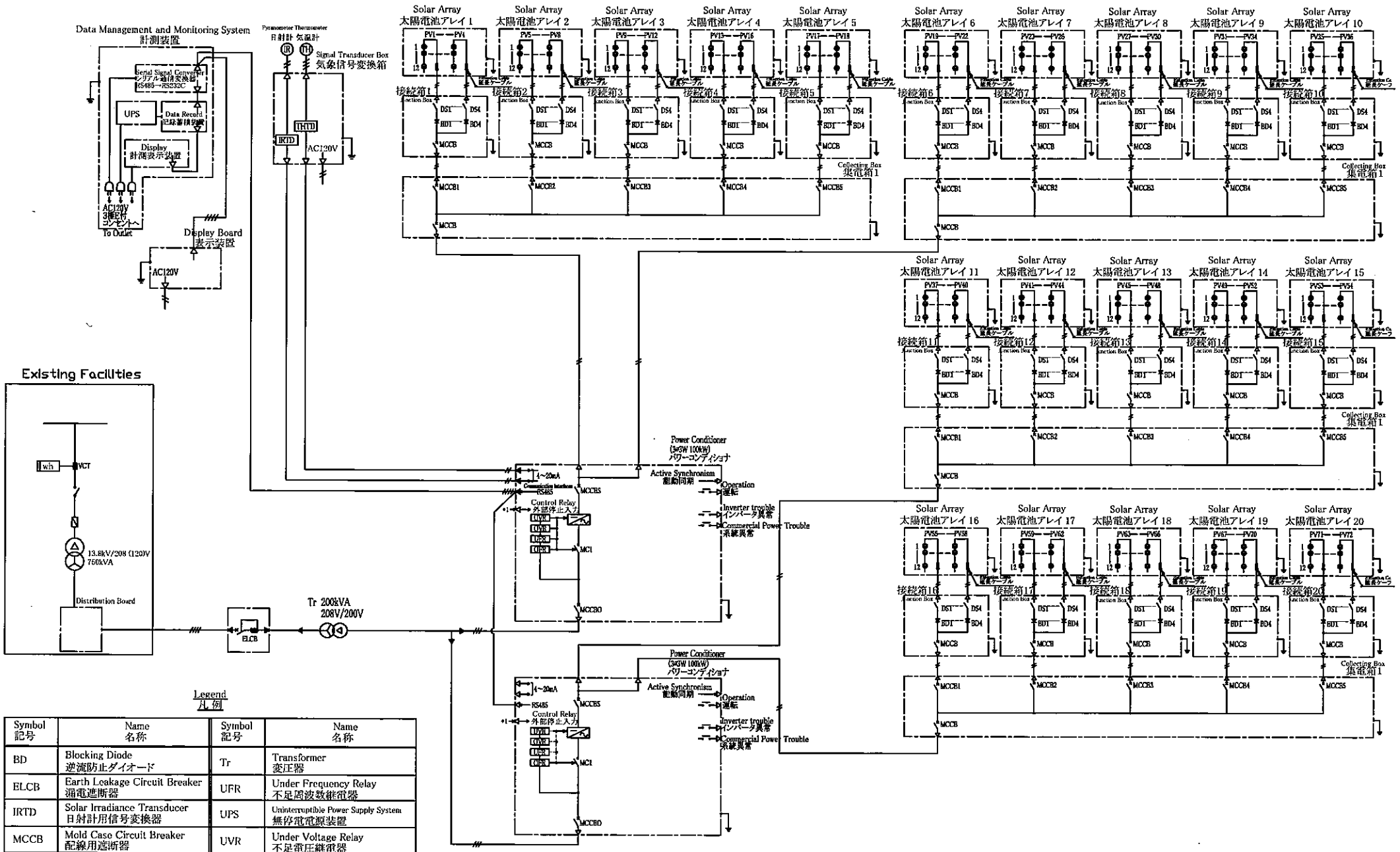
2.2.3 Outline Design Drawings

The outline design drawings for the Project are as follows.

Category	DWG. No.	Drawing Title
System Diagram	P-S-01	System Diagram for Palau International Airport
Single Line Diagram for PV System	P-E-01	Single Line Diagram for Palau International Airport
Layout Plan for PV Modules	P-L-01	Layout Plan for PV Modules for Palau International Airport
Layout Plan for Equipment	P-EQ-01	Layout Plan for Equipment for Palau International Airport
Cable Route Plan	P-C-01	Cable Route Plan for Palau International Airport
Architectural Drawing	P-A-01	Layout of the Support Frame for Palau International Airport
	P-A-02	Support Frame for Palau International Airport
	P-A-03	Support Frame Foundation Plan, Beam Plan and Member List for Palau International Airport
	P-A-04	Burial Plan for Cable Pipe for Palau International Airport
	P-A-05	Burial Plan for Hand-Hole for Palau International Airport



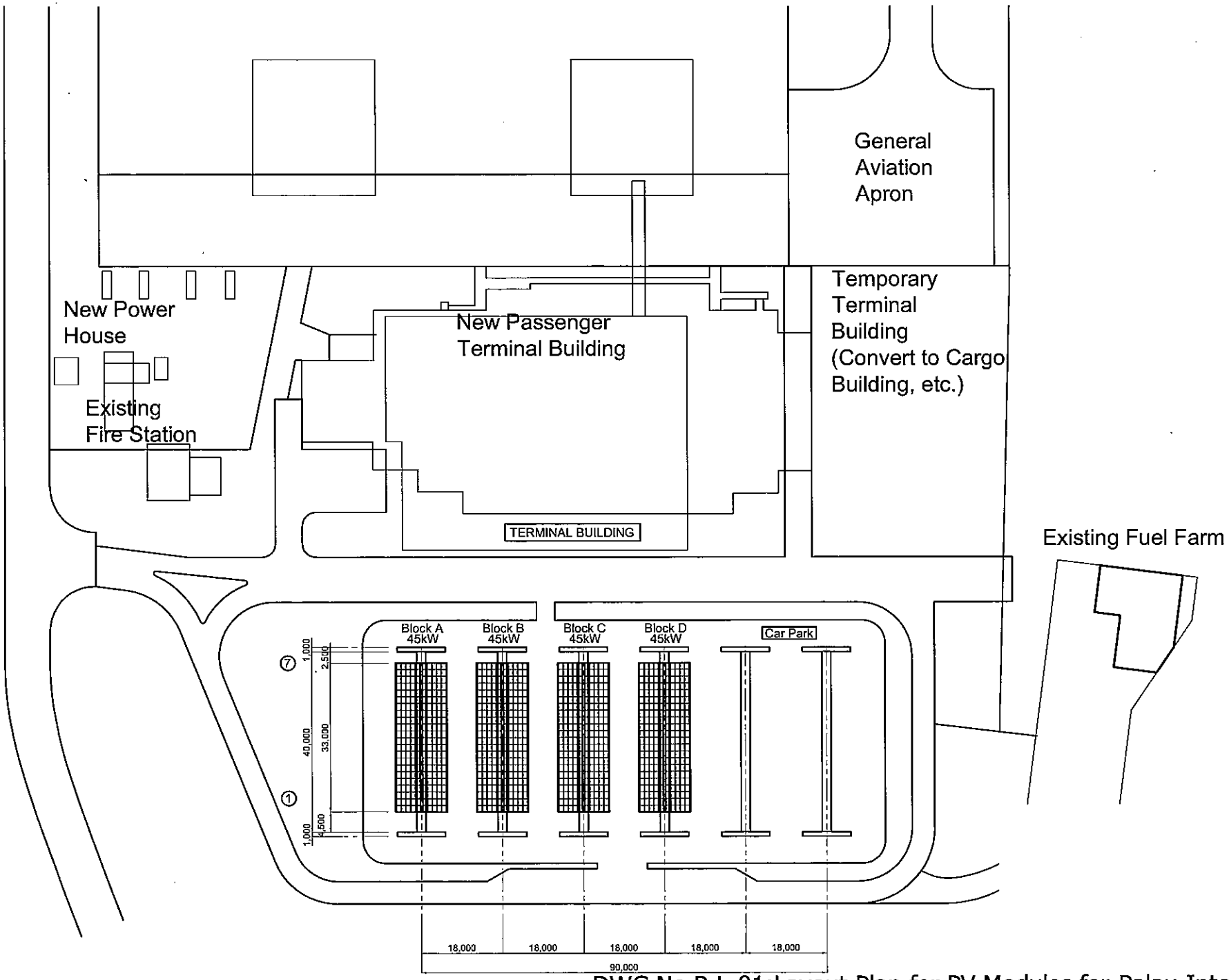
DWG.No.P-S-01 : System Diagram for Palau International Airport
連系PVシステム構成図(Palau International Airport)



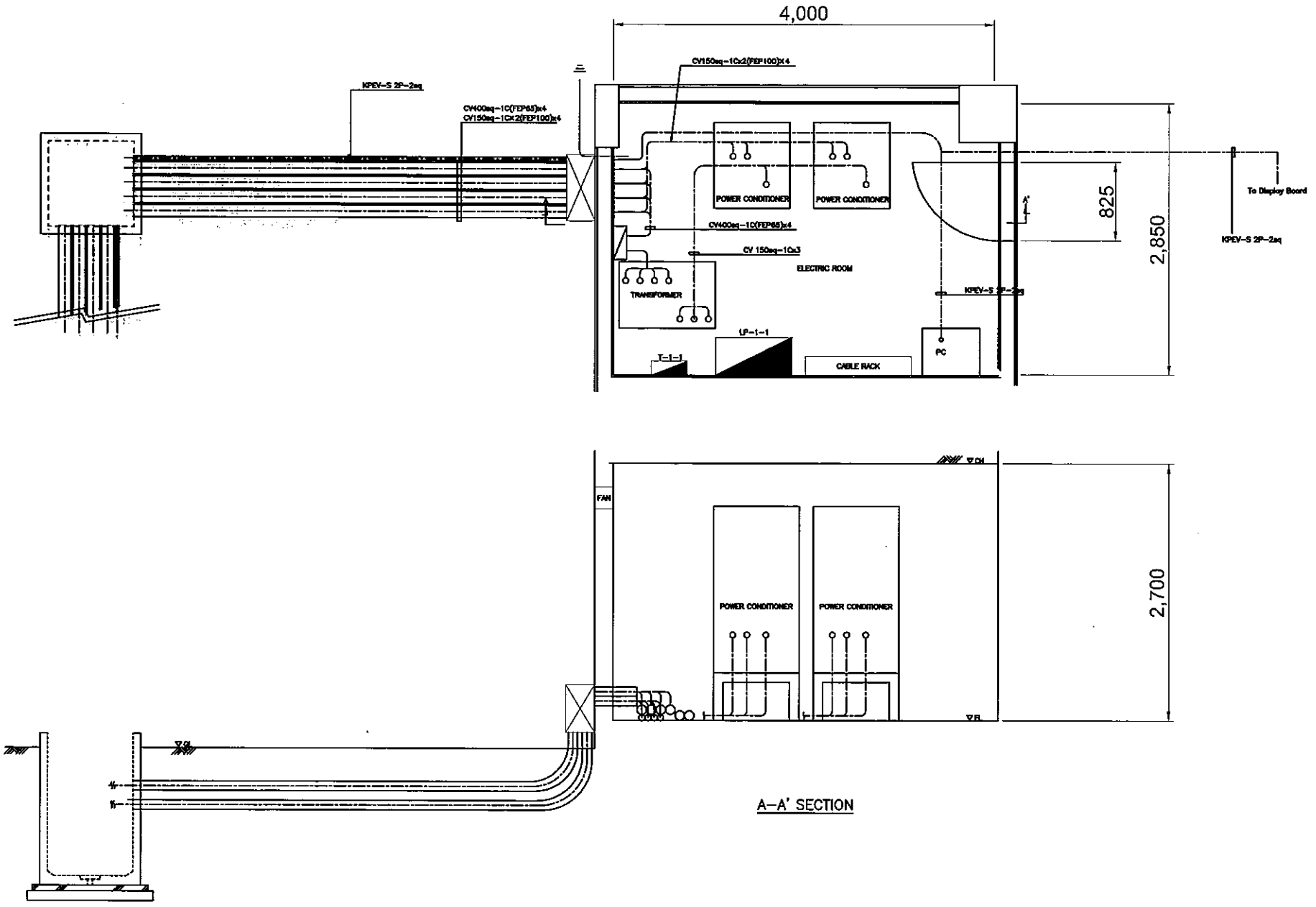
Legend
凡例

Symbol 記号	Name 名称	Symbol 記号	Name 名称
BD	Blocking Diode 逆流防止ダイオード	Tr	Transformer 変圧器
ELCB	Earth Leakage Circuit Breaker 漏電遮断器	UFR	Under Frequency Relay 不足周波数継電器
IRTD	Solar Irradiance Transducer 日射計用信号変換器	UPS	Uninterruptible Power Supply System 無停電電源装置
MCCB	Mold Case Circuit Breaker 配線用遮断器	UVR	Under Voltage Relay 不足電圧継電器
OFR	Over Frequency Relay 過周波数継電器	VCT	Voltage Current Transformer 計器用変圧変流器
OVR	Over Voltage Relay 過電圧継電器	Wh	Watt-Hour Meter 電力量計
PV	Photo Voltaic Array 太陽電池アレイ	WTD	Watt Transducer 電力用信号変換器
THTD	Thermal Transducer 気温計用信号変換器		

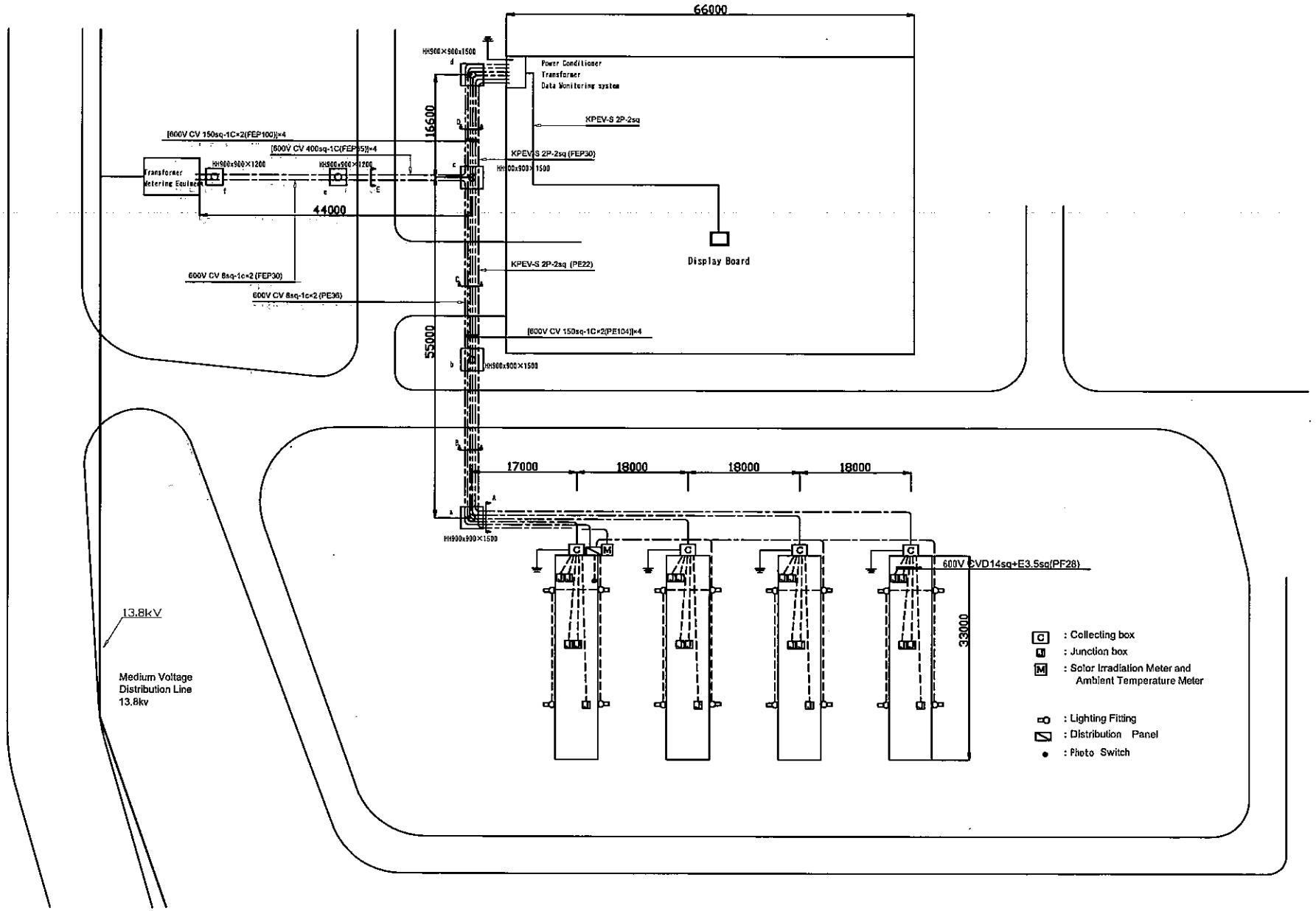
DWG.No.P-E-01:Single Line Diagram for Palau International Airport
DWG.No.P-E-01:連系PVシステム単線図(Palau International Airport)



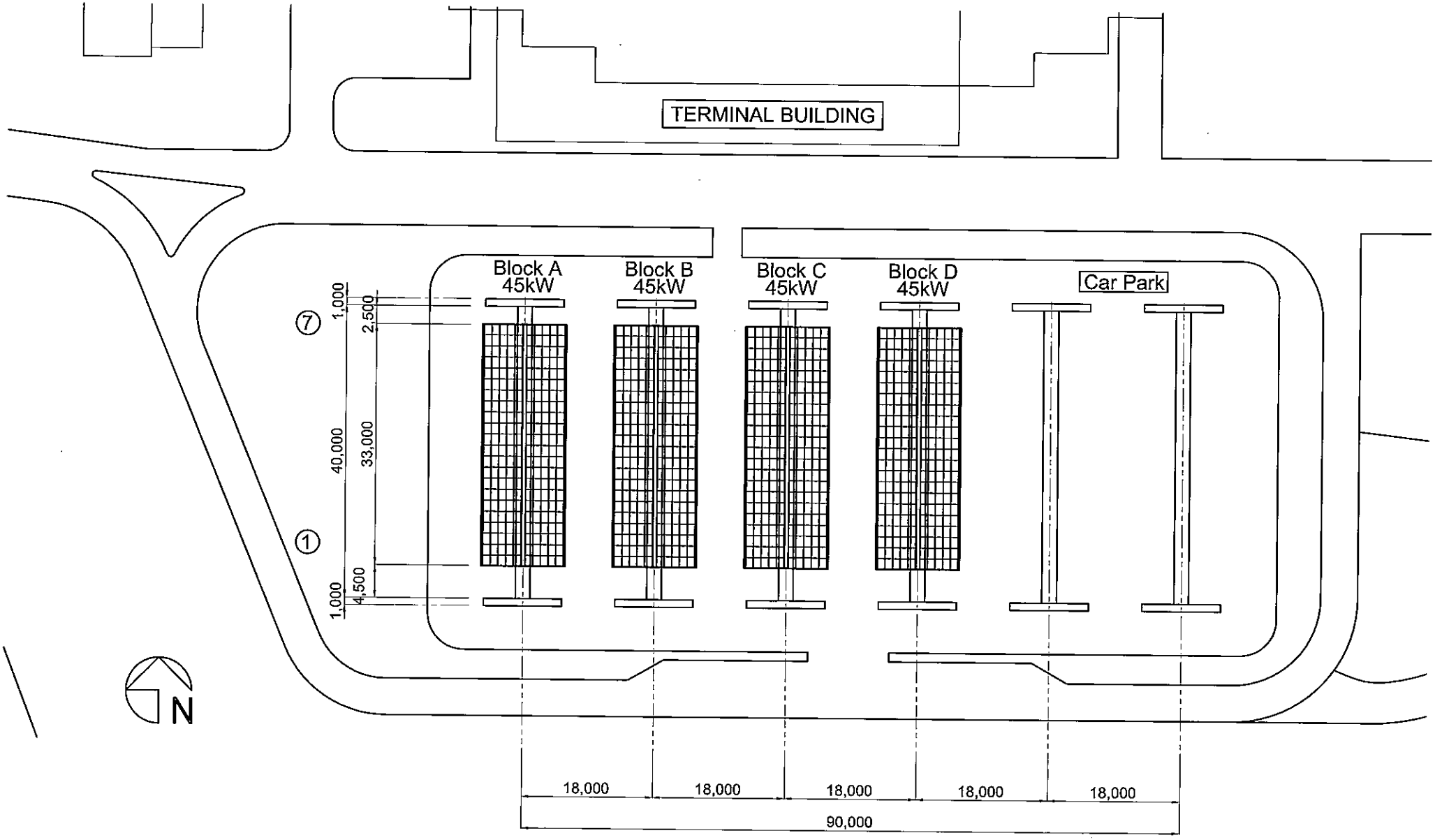
DWG.No.P-L-01:Layout Plan for PV Modules for Palau International Airport
DWG.No.P-L-01:連系PVパネル配置図(Palau International Airport)



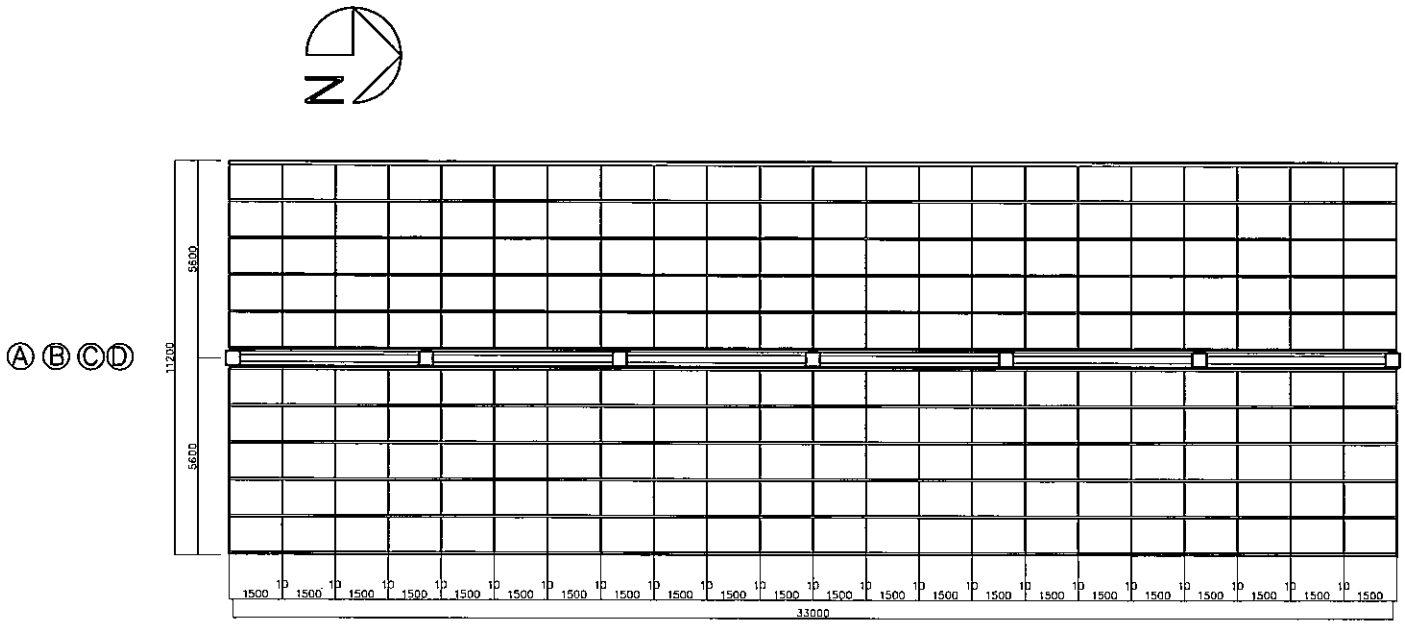
DWG.No.P-EQ-01:Layout Plan for equipment for Palau International Airport
DWG.No.P-EQ-01:連系PVシステム機器配置図(Palau International Airport)



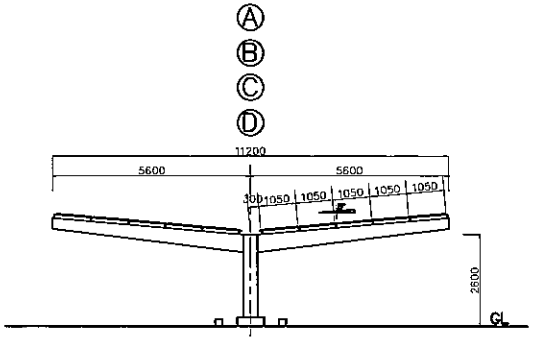
DWG.No.P-C-01:Cable Route Plan for Palau International Airport
DWG.No.P-C-01:ケーブルルート計画図(Palau International Airport)



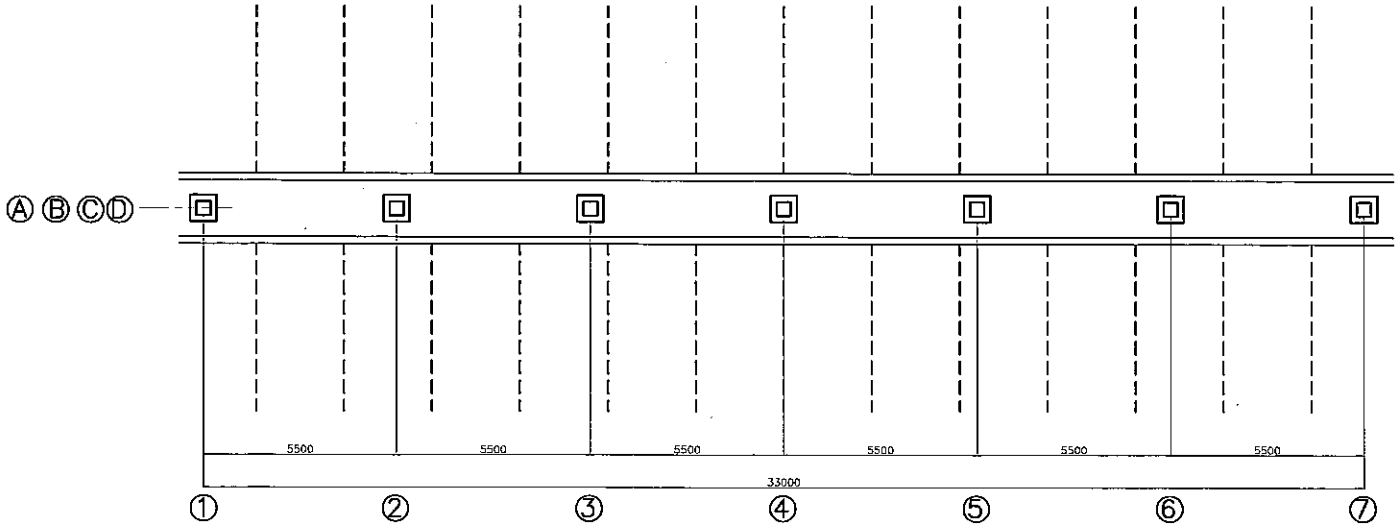
DWG.No.P-A-01:Layout of the Support Frame for Palau International Airport
DWG.No.P-A-01:支持架台位置図



Roof plan

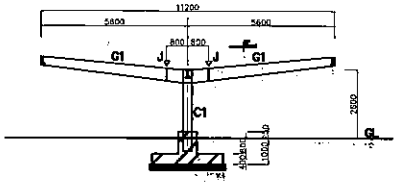


Elevation



GL Plan

DWG.No.P-A-02:Support Frame for Palau International Airport
DWG.No.P-A-02:支持架台 平面図、立面図

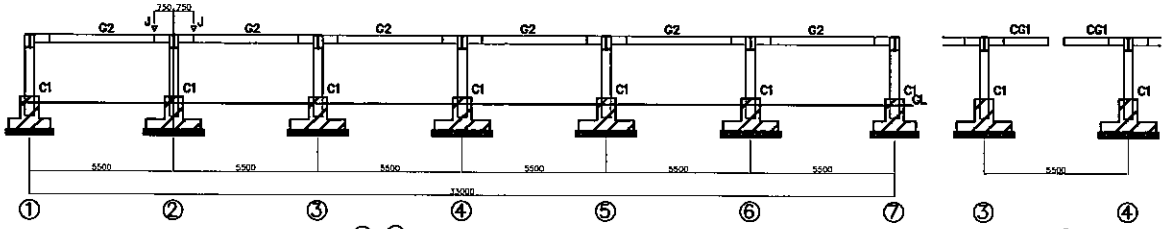


1~7 Framing elevation

MEMBER LIST

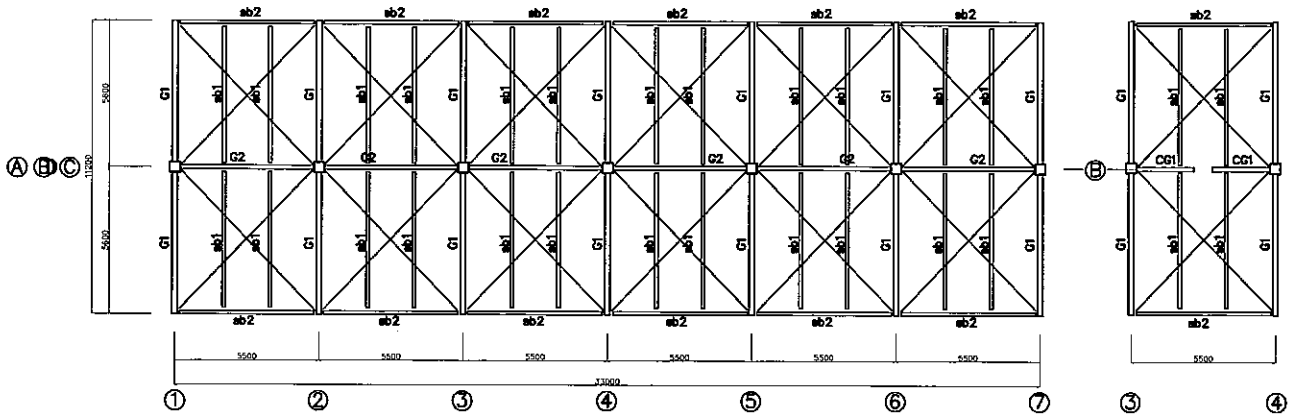
C1	□-350x350x22 (BCR295)
G1	BH-500~300x200x9x19 (SM400)
G2 CG1	H-300x150x6.5x9 (SM400)
sb1	H-250x125x6x9 (SS400)
sb2	H-250x125x6x9 (SS400)
HV1	I-M20

ALL MEMBERS ARE HOT MELT ZINC PLATED



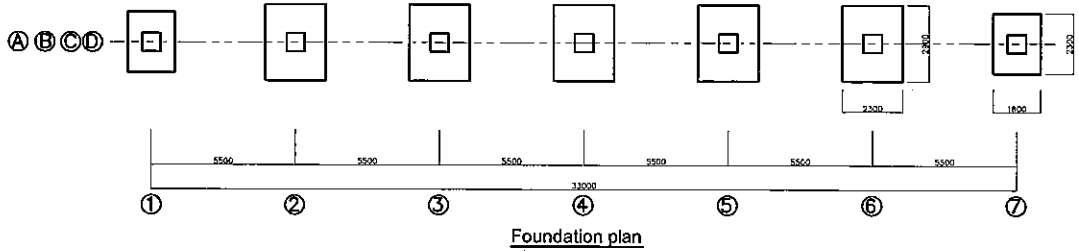
Ⓐ~ⒹFraming elevation

ONLYⒷLINE

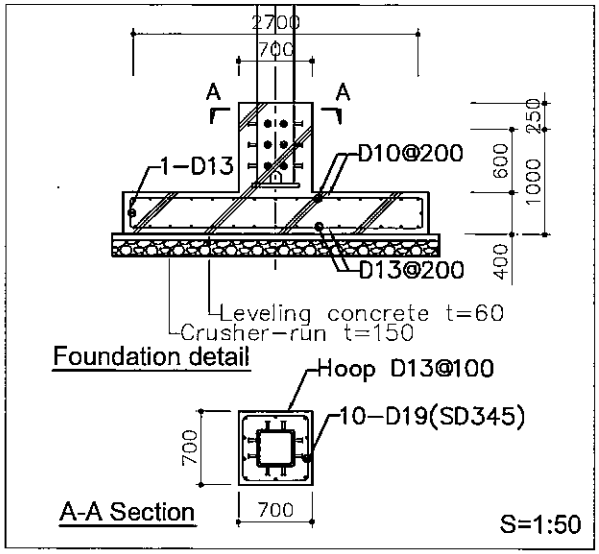


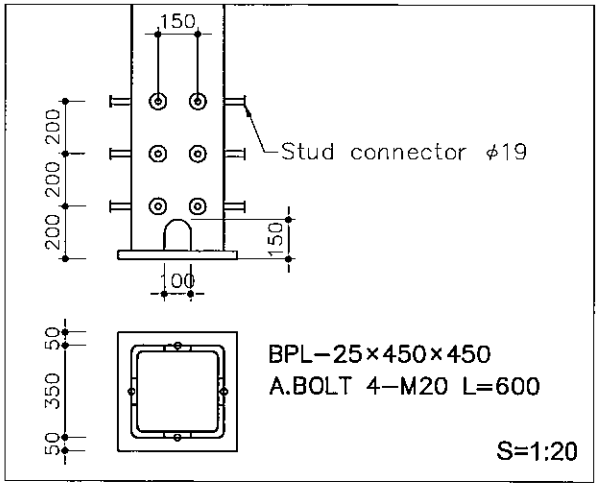
Beam plan

Beam plan



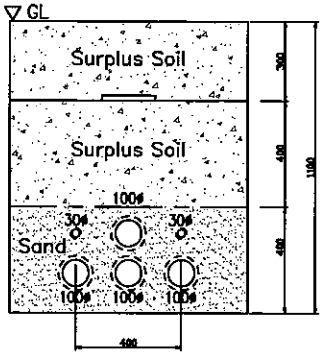
Foundation plan



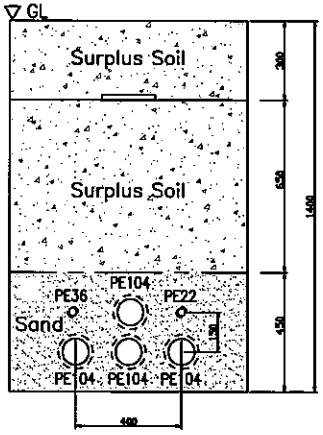


Plan and Elevation of the Structure

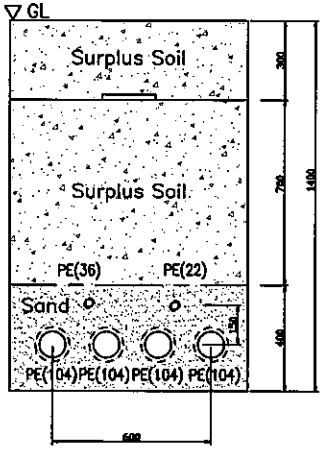
DWG.No.P-A-03:Support Frame Foundation Plan, Beam Plan and Member List
DWG.No.P-A-03:支持架台 基礎、梁伏図、断面リスト



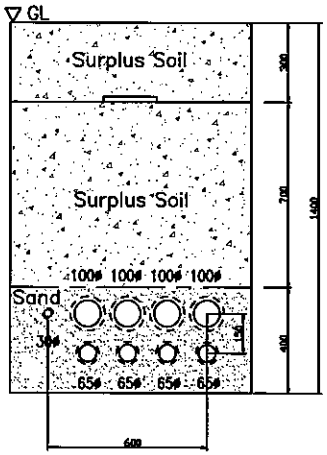
A



B



C



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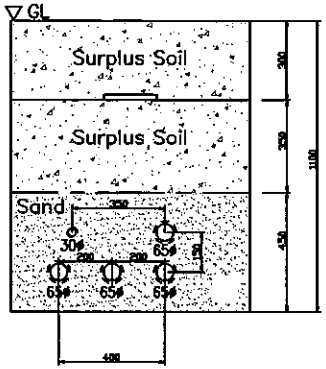
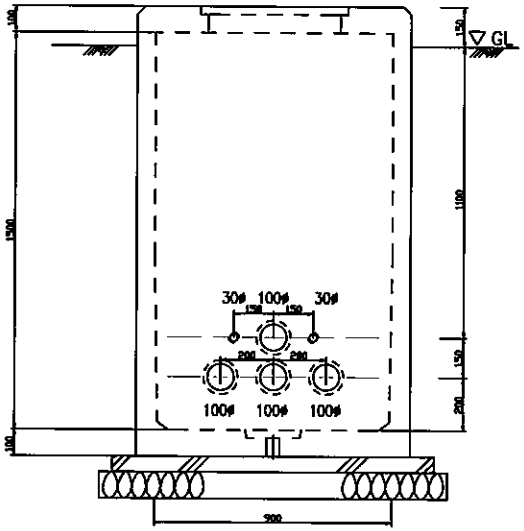


E

DWG.No.P-A-04:Burial Plan for Cable Pipe for Palau International Airport
DWG.No.P-A-04:埋設ケーブル断面図



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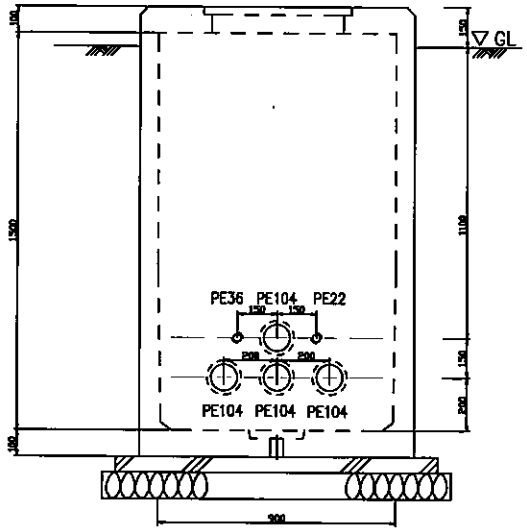

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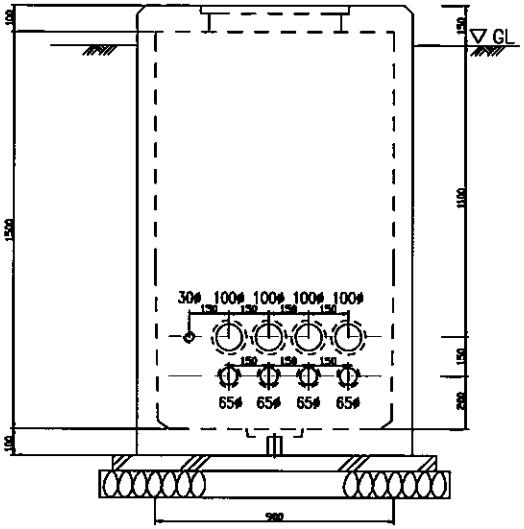

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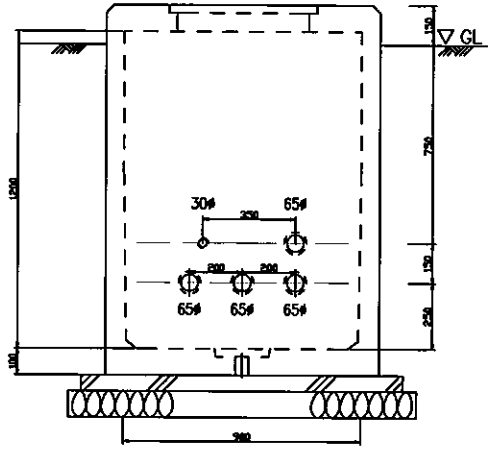

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DWG.No.P-A-05:Burial Plan for Hand-Hole for Palar International Airport
DWG.No.P-A-05:ハンドホール断面図

2.2.4 Implementation Plan

2.2.4.1 Concept of Equipment Procurement Supervision by the Procurement Management Agent

The Project will be implemented based on the Government of Japan's Program Grant Aid for Environment and Climate Change. According to this, the Project will receive approval by the Government of Japan and the both countries' governments will sign the Exchange of Notes (E/N) and the Grant Agreement (G/A) before the Project progresses to the implementation stage. The Procurement Management Agent will be recommended to Palau side by the Government of Japan, while the Ministry of Public Infrastructure, Industries and Commerce (MPIIC) as the Responsible Organization, will manage the major works to ensure that the contract (tender and equipment procurement) is appropriately and smoothly executed.

(1) Implementation Framework

After conclusion of the Exchange of Notes (E/N) and Grant Agreement (G/A) for the Project, the Government of Palau will entrust bidding and contracting of the consultant and suppliers to the Procurement Management Agent. Also, the consultant and suppliers will implement their respective duties upon binding contracts with the Procurement Management Agent.

(2) Responsible Organization

The Responsible Organization will be the Ministry of Public Infrastructure, Industries and Commerce (MPIIC).

(3) Implementing Agency

The Implementing Agency for the Project is the Palau Public Utilities Corporation (PPUC). The Project will be implemented in accordance with the scheme of "Japan's Program Grant Aid for Environment and Climate Change" based on the Agent Agreement which will be concluded between the MPIIC – the Responsible Organization on the Palau side – and the Procurement Management Agent in Japan.

Other related organization on the Palau side are as indicated below, and it will be necessary to fully share information and coordinate with each organization during the implementation stage. When coordinating with each organization, it has been confirmed that the Office of Environmental Response and Coordination will act as the focal point.

- Office of Environmental Response and Coordination
- Palau Energy Office

- Office of the President
- Ministry of State

So far Japan has implemented numerous general grant aid projects in the road, bridge, electric power and other sectors in Palau, however, Palau has no experience of tender and contract operations with the Procurement Management Agent. Therefore, it will be necessary to share necessary information with the responsible organization (MPIIC) and the Office of Environmental Response and Coordination to ensure smooth implementation. Also, the "Consultative Committee" will be established among main agencies on the Palau side and the Government of Japan to discuss the items that require confirmation at government level.

The Project implementation framework is indicated below.

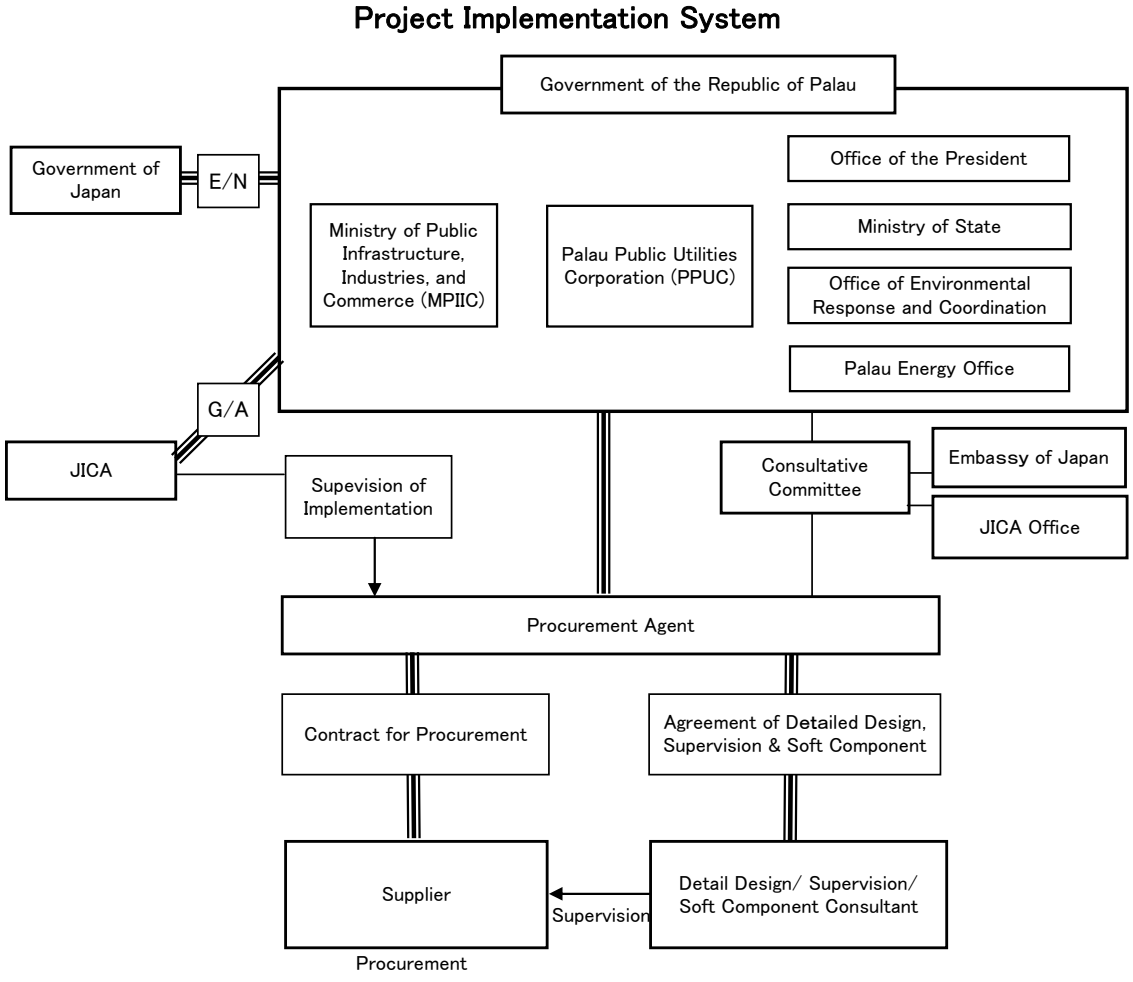


Fig. 2.2.4-1 Implementation Framework

(4) Procurement Management Agent

1) Implementation Contents

The Procurement Management Agent will prepare the tender documents for equipment procurement, thereby initiating the tender management proceedings and procurement operations for the Project. The Procurement Management Agent, which will be recommended to the Palau side by the Government of Japan, will implement and execute general supervision to ensure that the Project components are appropriately and smoothly implemented.

Concerning tender work supervision, the Procurement Management Agent will prepare documents concerning the Agent Agreement, Banking arrangements and the Contract. Also it will distribute the Tender Documents and conduct related works to the tender, evaluation and concluding the Contract with the Contractor.

In the area of works management, the supervisor dispatched by the Japanese Procurement Management Agent will conduct fund management including payments, expenditure planning in the event where excess funds arise, confirmation of implementation plan and reporting of progress to both governments, as well as maintain constant discussions, coordinate with and report to the Palau side.

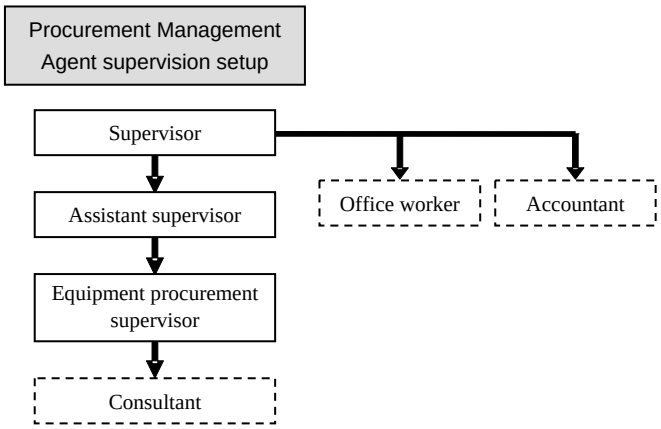
2) Implementation Setup

- Tender work management period

  The Procurement Management Agent will compile the tender documents, confirm equipment specifications and evaluate the tendering firms. The Procurement Management Agent will hire local staff, since the necessary procedures and regulations on the procurement in Palau shall be considered. Moreover, since it will be necessary to receive and answer technical questions on the tender documents and appropriately evaluate the technical proposals by tenderers, the Japanese consultant will assist in the technical parts.

- Works supervision period

  The Procurement Management Agent will conduct general management works during the period, however, this will only comprise checking of key points. Instead, Japanese consultant will provide the works supervision throughout the period under supervision by the Procurement Management Agent.



(5) The Consultant for the Supervision of Procurement and Construction Works

The technical consultant will be appointed by the Procurement Management Agent to supervise the procurement and construction works. The Consultant will supervise the quality of work, implementation schedule and safety, etc. of facilities construction, confirm quality, functions, performance and quantities in the equipment procurement, and check for exterior damage, etc. during the transportation of equipment. If it discovers any problems, it will immediately prepare a report and discuss countermeasures with related officials. Moreover, the Consultant in charge of construction supervision will assess the progress of the works done by the Contractor.

(6) The Contractor

The Contractor which shall be selected by the Procurement Management Agent by tender must fully understand and promptly and certainly execute the contents of the Contracts they conclude with the Agent.

2.2.4.2 Implementation Conditions

(1) Construction Conditions and Technical Transfer in Palau

Japanese and other foreign-affiliated general construction companies and electrical works companies can be found in Palau, meaning that it is possible to locally procure transportation vehicles and construction equipment and place an order for the distribution equipment installation works and underground cable works to local contractors. However, since the Project shall be implemented under “Japan's Program Grant Aid for Environment and Climate Change”, which requires high quality works in a short time, and considering the quality of works in similar grid-connected PV systems installed by local contractors, it will be essential to dispatch Japanese or foreign engineers to ensure the management and control for implementation schedule, quality and safety.

Furthermore, since Palau has limited experience of grid-connected PV system installation works and highly skilled engineers are required when installing equipment and conducting adjustments and tests, etc. after installation, it will be hard to find local engineers / technicians with these skills. Accordingly, when implementing the installation work, it is desirable that the Japanese or foreign contractor procures local laborers and construction equipment, and dispatches engineers from Japan or other countries. Moreover, the Japanese or foreign engineers will conduct technical transfer through On-the-Job Training (OJT) for Palau engineers during the installation period.

(2) Utilization of Local Equipment and Materials

The aggregate, cement and reinforcing bars, etc. required for building the foundations of the mounting structure for PV modules can be procured in Palau, although it will be necessary to manage and supervise quality and work schedule. Accordingly, when compiling the construction plan, locally procurable equipment shall be utilized as far as possible.

(3) Safety Measures

The Project site has relatively few problems in terms of security and safety, however, it will be necessary to display ample care for preventing theft of equipment and securing the safety of workers. Accordingly, not only is it essential that the Palau side take safety measures, but also the Japanese side will need to take steps such as assigning guards and so on.

(4) Tax Exemptions

In order to exempt customs clearance and tariffs on the Project equipment, the Contractor will need to give advance notification to the Ministry of Finance via the Office of Environmental Response and Coordination. It is possible to receive exemptions of 3% on tariffs and 4% on domestic taxes, however, it has been confirmed that this is not an advance rebate system but rather a total exemption scheme whereby the Implementing Agency in Palau avoids any tax burden.

(5) Transportation

Equipment carried to Palau by sea is usually landed and undergoes customs clearance at the country's only international port of Malakal (two berths). Unloading work here is carried out by the private firm Belau Transfer & Terminal Company. There are two transport company agents in Palau, i.e. Western Pacific Company, which is the agent for Kyowa Shipping Co., Ltd. of Japan, and Palau Shipping Company, which is the agent for Matson Navigation Co., Inc. of the United States. Malakal Port handles around 200 containers and 100 vehicles per month, although it can handle up to 400 containers at peak times. Major loading and unloading equipment includes a traveling crane (35 tons and 90 feet boom), two lifters (45 tons and 32 tons) and three forklifts (5 tons and 3 tons).

Equipment transported from Japan will be packed in such a way that it can withstand the long ocean transport, landing at port, inland transportation to the Project site and storage.

2.2.4.3 Scope of Works (Procurement, Installation and Construction)

According to the Program Grant Aid Scheme for Environment and Climate Change, Table 2.2.4-1 shows the detailed scope of works on the Japanese and Palau sides.

Table 2.2.4-1 Scope of Works on the Japanese and Palau sides

No.	Item	Japan	Palau	Remarks
1	Securing of the equipment installation site		●	
2	Ground leveling and removal of obstructions on the equipment installation site		●	
3	Installation of fences and gates		●	
4	Parking area works		●	
5	Road works			
	(1) Inside the site	●		
	(2) Outside the site (access road)		●	
6	Facilities construction works and equipment installation	●		Including temporary installation works in line with the facilities construction
7	Electrical, water supply and sanitary works			
	(1) Electrical works			
	a) Power line extension works		●	Extension to the electric energy integrating meter (primary side)
	b) Indoor wiring works (lighting, sockets, etc.)	●		(Secondary side)
	c) Installation of power receiving panel	●		
	(2) Water supply works			
	a) City water (public water supply) works		●	Extension to the Project site
	b) Indoor piping and receiving tank installation works	●		
	(3) Drainage works			
	a) Sewage mains works (sanitary sewage and storm water)		●	
	b) Indoor wiring and pit works	●		
	(4) Gas supply works			
	a) Gas main works (to site)		●	
	b) Indoor piping and pit works	●		
	(5) Telephone and IT works			
	a) Trunk line works (to site)		●	
	b) Indoor wiring and pit works	●		
	(6) Procurement and installation of furniture (desks, chairs) and other equipment			
	a) General furniture		●	
	b) Project instruments	●		
8	Commission for opening of bank account based on the B/A		●	
9	Handling of transport and customs clearance procedures and taxes			
	(1) Responsibility for ocean transport (air transport) of products related to procured equipment to the recipient country (Palau)	●		
	(2) Tax burden and customs clearance procedures at the port of unloading in Palau		●	
	(3) Transportation of procured equipment, etc. from the port of unloading to the inland site in Palau	●	●	
	(4) Exemption or bearing of domestic value added tax on procured construction materials and equipment in Palau		●	
10	OJT concerning operation and maintenance of facilities and procured equipment	●		The Palau side will select the personnel who will receive OJT
11	Operation and maintenance of facilities and procured equipment		●	
12	Other costs not covered by the grant aid		●	

Note : B/A: Banking Arrangement

● : Indicates the scope of responsibility regarding each item.

2.2.4.4 Consultant Supervision

Based on the scheme of the Government of Japan's Program Grant Aid for Environment and Climate Change, the Consultant will organize a consistent project team to smoothly conduct the detail design and construction supervision work taking the result of the outline design into consideration. The Consultant will permanently assign at least one engineer to the Project site during the construction supervision stage in order to conduct schedule control, quality control, performance control and safety control. Furthermore, the experts in Japan will attend factory inspections and pre-shipment inspections of equipment and materials manufactured in Japan with a view to preventing any troubles occur after the delivery of equipment and materials to Palau.

(1) Basic Concept of Construction Supervision

The basic concept of construction supervision by the Consultant will be as follows: to supervise the works progress to ensure they finish within the designated period, and to supervise and instruct the contractor to ensure that the quality, performance and delivery times specified in the contract are secured and that the site works are executed safely.

The important points to be considered for the supervision works are described below.

(2) Schedule Control

The contractor will compare progress with the implementation schedule decided in the contract every month or every week in order to adhere to the delivery deadline given in the contract. In cases where delays are predicted, the contractor will warn the subcontractors, present and instruct a plan of countermeasures and offer guidance to ensure that the works and equipment delivery are completed within the contract period. The comparison of the planned schedule and actual progress will be carried out according to the following items.

① Confirmation of works performance (manufacture of equipment and materials and performance of civil engineering works on site)

② Confirmation of equipment and materials delivery (switchgears, distribution equipment and materials, equipment and materials for civil engineering works)

③ Confirmation of temporary installation works and preparations for construction machinery

④ Confirmation of the yardstick and actual numbers of engineers, skilled workers and laborers, etc.

(3) Quality and Performance Control

Supervision will be carried out based on the following items to determine whether the manufactured, delivered and installed equipment and materials and constructed facilities satisfy the required quality and performance stated in the contract documents. In cases where quality and performance may not be ensured, the Consultant will immediately demand that the contractor make amendments, revisions or corrections.

① Checking of shop drawings and specifications of equipment and materials

② Attendance of factory inspections of equipment and materials and checking of the inspection results

③ Checking of packing, transportation and on-site temporary storage methods

④ Checking of shop drawings and installation guidelines of equipment and materials

⑤ Checking of trial operation, adjustment, test and inspection guidelines of equipment and materials

⑥ Supervision of the installation works for equipment and materials, and the attendance of trial operations, adjustments, tests and inspections

⑦ Checking of drawings for equipment installation work and shop drawings with actual works performance

(4) Safety Control

Discussions and cooperation with responsible officers of the contractor will be exercised for the safety control during the construction period in order to prevent site accidents and accidents affecting third parties. Important points to be considered in safety control on the site are as follows:

① Establishment of safety control regulations and appointment of manager

② Prevention of accidents through implementation of periodic inspections of construction machinery

③ Planning of the works vehicles and construction machinery operating routes and thorough enforcement of slow driving

④ Encouragement of laborers to utilize cooperate benefits and holidays

(5) Works Supervisor

The Contractor will implement the construction works for the mounting structure for PV module. Also the Contractor will procure and install PV equipment and materials, and install distribution and communications cables. In order to implement these works, the contractor will employ a

subcontractor(s) in Palau. Therefore, since the contractor will need to ensure that the subcontractor(s) complies with the works schedule, quality, performance and safety measures prescribed in the contract, it will dispatch an engineer who has experience of similar projects in overseas countries to provide instructions and advice on the site.

2.2.4.5 Quality Control Plan

The Consultant's construction supervisor will carry out supervision and checking based on the following items to ensure that the contractor secures the quality of equipment and materials for the Project and the performance for implementation and installation stipulated in the contract documents (technical specifications and implementation design drawings, etc.). In cases where doubts arise over quality and performance, the supervisor will immediately demand that the contractor make amendments, revisions or corrections.

① Checking of shop drawings and specifications of equipment and materials

② Attendance of plant inspections of equipment and materials and checking of plant inspection results

③ Checking of packing, transportation and on-site temporary storage methods

④ Checking of shop drawings and installation guidelines of equipment and materials

⑤ Checking of trial operation, adjustment, test and inspection guidelines of equipment and materials

⑥ Supervision of the installation works of equipment and materials and attendance of trial operations, adjustments, tests and inspections

⑦ Checking of construction drawings with the actual work performance on site

⑧ Checking of completion drawings

2.2.4.6 Procurement Plan

The PV modules and power conditioner to be procured and installed under the Project are not manufactured in Palau. In the grid-connected PV system that was introduced to the national hospital under support from Taiwan, PV modules made by Kyocera of Japan and an inverter made by Motech Co. of Taiwan were adopted; while in the Capital building system implemented under support from the EU, PV modules made by Scheufen Co. of Germany and an inverter made by Sunny Portal Co. also of Germany were used. However, since these PV equipment manufacturers have no branch offices or agents in Palau, there is no system for conducting post-installation service such as responding to breakdowns and repairs and procuring spare parts, etc. Furthermore, the Sunny Portal Co. inverter (Germany) that was introduced under the Taiwanese aid has already broken down for unknown reasons three times since starting operation in December 2008, and officials on the Palau

side are hoping that higher quality equipment will be procured under the Project. Accordingly, when selecting the supplier of PV equipment, it will be necessary to take local conditions, ease of operation and maintenance by local engineers, and existence of the post-installation setup for procuring spare parts and responding to breakdowns, etc. into account.

Moreover, the PPUC, which will be in charge of operating and maintaining the PV equipment after completion of the Project, is well-versed in the operation and maintenance skills of Japanese instruments and has confidence in the high performance levels and past-sales service setup of Japanese transformer manufacturers because the Japanese transformers, switchgears and distribution panels, etc. supplied in the past projects are continuing to operate smoothly without major accident. Furthermore, the PPUC recognizes that PV manufacturers in Japan are superior to those in other countries in terms of product quality and reliability, and it hopes that Japanese PV equipment will be employed under the Project.

In consideration of the above points, the suppliers of equipment and materials in the Project will be as follows.

(1) Locally procured equipment and materials

Construction materials including cement, sand, concrete aggregate, reinforcing bars, timber, gasoline, diesel oil, works vehicles, cranes, trailers and other temporary installation equipment.

(2) Equipment and materials procured in Japan

PV modules, power conditioner, grid-tie transformer, display unit, wiring materials, etc.

2.2.4.7 Operational Guidance Plan

Before the works are finished, guidance will be carried out on the methods for initial operation and maintenance afterwards. Such guidance will basically be carried out by instructors from the manufacturer or the Contractor via site OJT according to the operation and maintenance manual.

In order to advance the plan of guidance smoothly, the PPUC (the implementing agency) will need to hold close communications and discussions with the Japanese consultant and contractor and to appoint a full-time engineer to take part in the OJT. The appointed engineer will need to convey technology to other employees who cannot participate in the Project and cooperate with enhancing the maintenance capacity of PPUC.

2.2.4.8 Soft Component (Technical Assistance) Plan

(1) Background

In Palau, because almost all of the power supply in the country depends on diesel power generation at present, and there are consideration for environment and concerns for crude oil prices and transportation costs, departure from the fossil fuel dependence in the energy and electricity sector is considered an urgent task, and development of systems using renewable energy such as PV generation is considered as a priority issue in the development policy. At present, "Palau National Energy Policy" is being established mainly by Energy Office, which has become an organization directly under President Office since June, 2009. According to its first draft, the potential of PV generation and wind-power generation is considered to be promising among renewable energies, and the dissemination of grid-connected PV systems, which do not require batteries, is especially required among PV generation systems.

The responsible organization for the Plan of the Program Grant Aid for Environment and Climate Change (the Project) which will introduce the grid-connected PV system is MPIIC, because the Project site (Palau International Airport) is administered by Bureau of Aviation and Bureau of Aviation is under MPIIC. As for the implementing agency, PPUC will possess the system and will take charge of the O&M in the same manner as ordinary power equipment, because the PV system introduced by the Project will be connected to the existing grid. In addition, Energy Office of Public Works Bureau, which takes charge of the power and energy policy in Palau, also participates in to share with PPUC the data acquired from the introduced grid-connected PV system and contribute to the dissemination of the system in the future.

Power supply business is implemented by PPUC consistently. Although PPUC has not been privatized or incorporated, it is run as an organization independent from the government based on the income of electricity tariff, receiving no subsidy from the government. PPUC is composed of six departments: Auxiliary Services, Accounting and Finance, Business Office, System Control, Power Distribution and Power Generation Department. It is a relatively small organization composed of 130 staff. The management system is well organized. For example, job contents and responsibility of each worker, ability required, etc., are clearly described in the documents, and the office regulations are defined according to the duty position. However, workers who have sufficient knowledge and engineering expertise to carry out the O&M of power system are few in number, and there is no person in charge of renewable energy and energy saving. For the implementation of the Project, therefore, it is required that PPUC establishes the O&M system of the grid-connected PV system within PPUC in collaboration with Bureau of Aviation, MPIIC and Energy Office.

As for the introduction cases of PV systems in Palau, both the “stand-alone PV system” and “grid-connected PV system” have already been introduced in the past. Thus, it is considered that a base to acquire technical knowledge on PV systems has been made. However, it seems that continuous operations have not been achieved in both systems, and local staffs are requesting more fulfilling technology transfer. With regard to the “stand-alone PV system,” in particular, small-scale stand-alone PV systems mainly for household use have been introduced in large quantity in un-electrified areas since 1980’s, but most of them are not used at present due to problems in O&M. Under the conditions described above, it is difficult for staffs of the Energy Office of Public Works Bureau or the PPUC to master adequate technology on PV systems through their daily work. Therefore, the proper technical transfer on the O&M of the introduced facilities into the implementing agency of the Project, PPUC, over the broad-and-shallow range from a basic level on PV generation to an application level on the O&M of PV facilities, dividing the process into several steps and confirming the establishment of knowledge will be able to promote the continuous and smooth O&M of the grid-connected PV system introduced by the Project..

(2) Goal

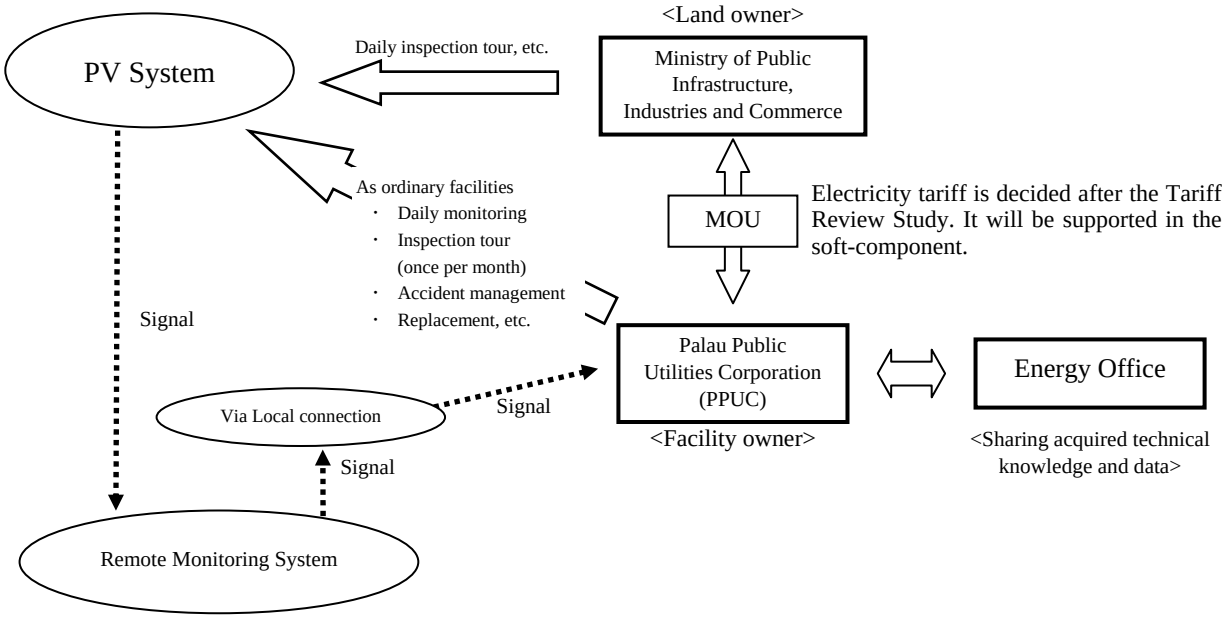
The goal is that PPUC, the implementing agency of the Project, comes to be able to implement continuous and smooth O&M assuming PPUC owns the facilities based on the O&M manual.

(3) Expected Operation and Maintenance Organization

In Palau, the “stand-alone PV system” and the “grid-connected PV system” have already been introduced. The target of the Project is the “grid-connected PV system,” and the systems having introduced with support from EU and Taiwan serve as very good references to discuss the technical support on the O&M of the target facilities of this project. From this viewpoint, proposals to establish the O&M system suited for the grid-connected PV system introduced in this project are presented as below.

By the comparison between the O&M systems of EU and Taiwan, it is judged to be proper to establish an original O&M system in this project, consulting the O&M system of EU, which seems to have well permeated into and succeeded in Palau. Specifically speaking, it is judged to be desirable that the following three organizations should participate in the system as shown in Fig. 2.2.4-2: Ministry of Public Infrastructure, Industries and Commerce, which is the land owner, Palau Public Utilities Corporation (PPUC), which is the system owner, and Energy Office, which shares the acquired technical knowledge and data. As for maintenance, PPUC will possess the system and will take charge of it in the same manner as ordinary power equipment. PPUC and Ministry of Public Infrastructure, Industries and Commerce will need to determine the electricity tariff for the energy generated in the grid-connected PV system, considering the rent of the land

and consulting the “Tariff Review Study” being done in GEF at present, and will conclude MOU. The most appropriate O&M system, the electricity tariff between PPUC and Ministry of Public Infrastructure, Industries and Commerce, etc. will be supported in the soft-component. As for the training, many people said the training of 10 days implemented by EU was not sufficient. The soft-component of this project should be planned with more fulfilling contents. Specific contents will be described in the next section.



Source: created by the JICA study team

Fig. 2.2.4-2 O&M system in this project (proposed)

(4) Current Problems and their Solutions

Table 2.2.4-2 Current problems and measures for improvement

Current problems	Measures for improvement	Applicability of soft-component
▪ O&M system on the grid-connected PV system has not been established specifically	▪ PPUC establishes the O&M system within PPUC.	▪ Make a proposal on the most appropriate O&M system, and discuss it with the persons concerned.
▪ Technical knowledge on the grid-connected PV system has not been acquired.	▪ Implement technical training on PV systems including the issues to be considered when the introduction of the grid-connected PV system.	▪ Conduct proper technical training on PV systems.
▪ Knowledge on the O&M concept and method concerning the grid-connected PV system has not been acquired.	▪ Prepare the O&M manual of the grid-connected PV system.	▪ Support implementation guidance on the manual.
	▪ Implement training on monitoring, such as the monitoring method, periodical inspection method, etc.	▪ Conduct proper technical training on monitoring.
▪ Troubleshooting on the grid-connected PV system is not properly executed.	▪ Create the O&M manual including troubleshooting	▪ Support implementation guidance on the manual.
	▪ Conduct implementation guidance on the manual and educational activities so that the O&M are properly done.	▪ ditto
▪ Electricity tariff for the grid-connected PV system has not been determined.	▪ Determine proper electricity tariff.	▪ Make a proposal on most appropriate electricity tariff, and discuss it with the person concerned.

Source： created by JICA study team

(5) Outcomes

1) The O&M manual of the grid-connected PV system introduced in this project, including troubleshooting, is created.

2) Basic knowledge on the grid-connected PV system installed under the Project is acquired, and the O&M of the facilities is carried out continuously.

3) The most appropriate electricity tariff is determined (if necessary), and a continuous and smooth O&M system is established.

(6) Contents of implementation

In Palau, both the “stand-alone PV system” and “grid-connected PV system” have already been introduced. However, it seems that continuous operations have not been achieved in both systems. One of the main reasons of that would be insufficient technical transfer. It is considered that a base to acquire technical knowledge on PV systems has been made, but the basic knowledge on them has not taken root in the country yet. Therefore, training covering a broad and shallow

range from a basic level on PV generation to an application level on the O&M of PV facilities is implemented in the Project. Table 2.2.4-3 shows the specific contents, which are divided into Category 1 to 4. The implementation process is a total of four times, one category at one time.

Table 2.2.4-3 Contents of training

Category	Specific contents (purpose)
1. Establishment of the O&M system	1.1 Clarification of the responsibility of individuals who carry out the O&M 1.2 Proposal on the most appropriate electricity tariff 1.3 Creation of the O&M manual in collaboration with Palau
2. Technical training	2.1 Principle and basic knowledge of PV systems 2.2 Characteristics of grid-connected PV systems 2.3 Matters to be examined when a grid-connected PV system is introduced. 2.4 Installation 2.5 Inspection 2.6 Operation 2.7 Maintenance 2.8 Troubleshooting
3. Institutional Training	3.1 Collection method of electricity tariff 3.2 Appropriate O&M manual 3.3 Evaluation of the O&M system
4. Monitoring	4.1 Appropriate monitoring method 4.2 Periodical inspection 4.3 Evaluation items 4.4 Report of monitoring results

Source： created by JICA study team

(7) Implementation schedule

The implementation process is shown in Fig. 2.2.4-3. The training is implemented according to the category shown in Table 2.2.4-3. The implementation time of each category is as follows:

Category 1 : Implemented before the installation of facilities because this training is done to facilitate the establishment of the O&M system, and because, by clarifying the O&M system before the facility installation, awareness as the person in charge can be raised at the time of installation.

Category 2 : Implemented in the middle of the installation work because this training, concerning the installation, inspection, operation, etc., is done using actual facilities.

Category 3 : Implemented before the operation of the facilities starts because this training is related to the O&M manual, etc., that should be prepared before the start of the operation.

Category 4 ： Implemented about four months after the completion of the installation because the focus of this training is to confirm that the Palau side can carry out the O&M by themselves.

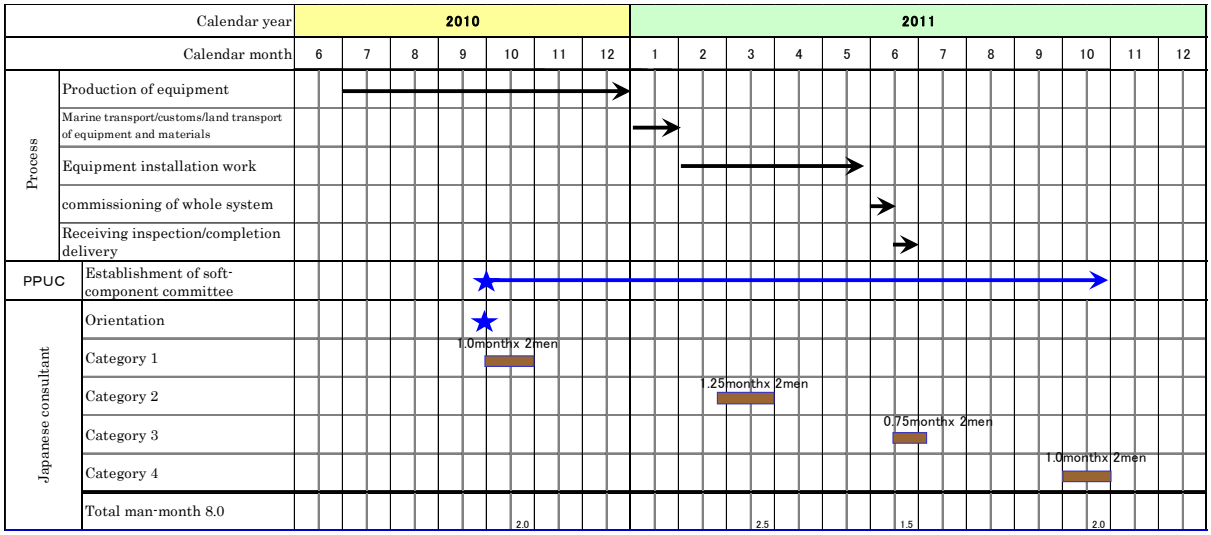


Fig. 2.2.4-3　Implementation process

2.2.4.9 Implementation Schedule

The Project implementation schedule was compiled as follows based on the scheme of the Government of Japan's Program Grant Aid for Environment and Climate Change.

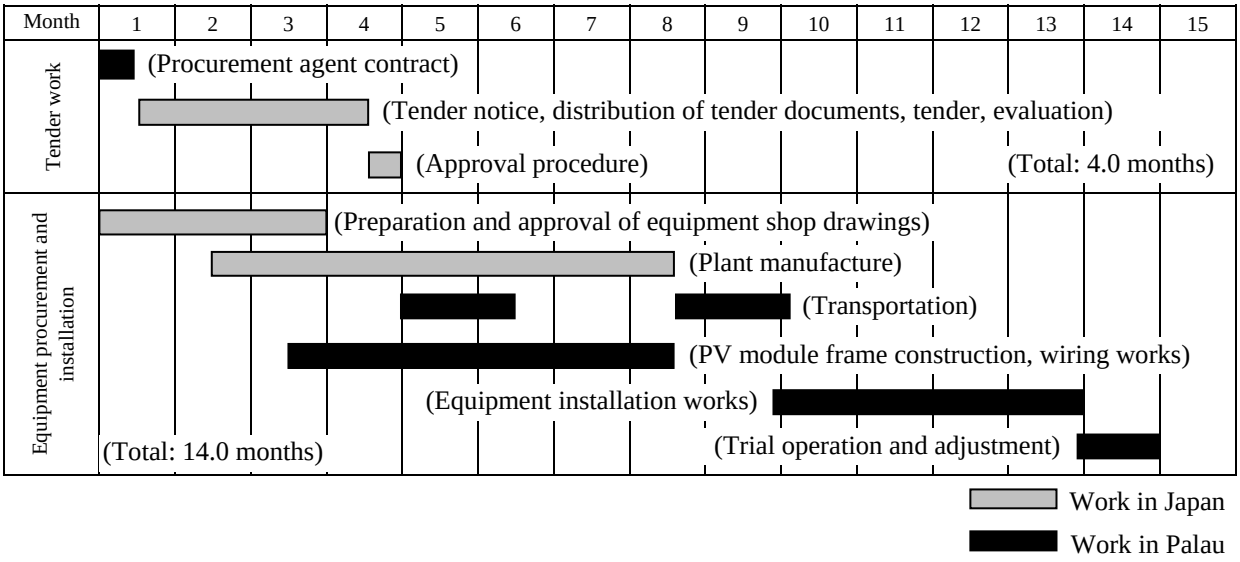


Fig. 2.2.4-4 Project Implementation Schedule Sheet

2.3 Obligations of Recipient Country

When it comes to implementing the Project, in addition to the scope of works on the Palau side indicated in 2.2.4.3 Scope of Works, Procurement and Installation, items to be implemented or borne by the Palau side are as follows.

(1) To provide information and materials necessary for the Project

(2) To secure tax exemption and customs clearance and assist the speedy unloading of products for the Project at the port of unloading in Palau

(3) To grant permission for Japanese nationals to enter and stay in Palau in relation to the products and services provided based on the authorized contract

(4) To exempt Japanese nationals from taxes and tariffs, etc. that is ordinarily levied in Palau on products and services supplied based on authorized contracts.

(5) To pay commission fees to the Japanese bank in relation to opening of the bank account for the Project

(6) To bear all items not covered under Japan's Program Grant Aid for Environment and Climate Change when implementing the Project

(7) To attend equipment and materials inspections on site and to appoint an engineer and skilled workers as counterparts for the transfer of operation and maintenance technology

(8) To formulate the power interruption plan required during the equipment installation works and to implement the necessary procedures for it

(9) To properly and effectively use and maintain the equipment and materials procured under Japan's grant aid

(10) To secure a disposal site for excavated earth, sewage, waste oil and recovered equipment and materials during the works period

(11) To implement final connections of low voltage distribution cables and existing distribution panel for outputting power from the PV equipment to be procured and installed by the Japanese side. However, the materials (terminal lugs and bolts, etc.) required for treating the ends of such cables and connecting them will be procured on the Japanese side.

(12) On the primary side of the main transformer, to replace the existing purchased power meters with meters equipped with a reverse prevention function, and to install new meters.

(13) To offer safety instruction and education to local residents

2.4 Project Operation Plan

2.4.1 Daily Inspection and Periodic Inspection Items

Since the PV system to be procured and installed under the Project will play an important part in promoting renewable energy power generation in Palau in the future, it will be necessary to establish a setup for appropriate and long-term maintenance by the PPUC. Table 2.4.1-1 and Table 2.4.1-2 show the items that need to be covered in daily inspections and periodic inspections of major equipment in standard PV systems. It should be noted, however, that these inspection items will be renewed via maintenance support in the soft component while taking into account the maintenance setup in Palau.

Table 2.4.1-1 Daily Inspection Items for Standard Equipment

Inspection Target	Inspection Item	Result
Solar array	Surface dirt, damage	
	Frame corrosion, rust	
	External wiring damage	
Junction box	External box corrosion, rust	
	External wiring damage	
Power conditioner	External box corrosion, rust	
	External wiring damage	
	Noise, odor during operation	
	Blockage of the ventilation outlet filter	
	Installed environment (humidity, temperature, etc.)	
Grounding	Wiring damage	
Power generation situation	Confirmation of normal operation via Data management and monitoring system	

Table 2.4.1-2 Periodic Inspection Items for Standard Equipment

Inspection Target	Inspection Item	Result	Measurement Test and Result
Solar array	Surface dirt, damage		Insulation resistance MΩ
	Frame corrosion, rust		
	External wiring damage		Open voltage V
	Grounding wire damage, ground wire looseness		
Junction box	External box corrosion, rust		Insulation resistance MΩ
	External wiring damage		
	Grounding wire damage, ground wire looseness		
Power conditioner	External box corrosion, rust		Display section operations
	External wiring damage		
	Noise, odor during operation		Insulation resistance MΩ
	Blockage of the ventilation outlet filter		
	Installed environment (humidity, temperature, etc.)		
	Grounding wire damage, ground wire looseness		
Grounding	Wiring damage		Grounding resistance Ω

2.4.2 Spare Parts Purchase Plan

(1) Spare Parts Categories

The spare parts targeted in the Project are classified into the following uses.

① Replacement parts : Parts required for replacement due to breakdown of equipment part

② Emergency spare parts : Necessary replacement equipment during an emergency which involves malfunction of the distribution system due to equipment failure

(2) Selection Criteria for Each Category

1) Replacement parts

These parts experience no periodic wear or degradation in everyday operation, however, assuming them to be repair parts with a high possibility of damage, adopt 100% of the amount projected to be necessary per year.

In case of accidents on a PV module connected in series, the strung PV modules shall not perform properly and may affect to another module in order not to be able to generate power and consequently 3% of designed number of PV modules shall be procured as replacement parts.

2) Emergency spare parts

A power conditioner will be procured as an emergency spare part since this could cause major interference to the PV system and would be difficult to quickly repair on site, if damaged for some unforeseen and unexpected reason. Under the Project, from the viewpoint

of procuring the minimum necessary equipment, generated power will diminish if problems arise in solar cells. In the PV system, since the publicity effect of the display board on ordinary users is great, therefore any damage would adversely affect the public image and affect the maintenance capacity of the implementing agency, it is necessary to take steps to mitigate the effects.

Moreover, since it is difficult for the Palau side to implement quick repairs of equipment on site with its existing technical levels, it will need to replace damaged equipment in order to get the system working again. However, since the implementing agency responsible for operation and maintenance in the Project does not possess the necessary equipment for conducting replacement, it will be necessary to procure a power conditioner as an emergency spare part for replacement.

(3) Test Instruments and Maintenance Tools

The minimum required test instruments and maintenance tools for conducting appropriate maintenance of the Project PV system will be procured.

Table 2.4.2-1 Spare Parts and Maintenance Tools Procured in the Project

Equipment	Unit	Quantity
1. Replacement parts		
1.1 Distribution circuit breaker 50A	Unit	3
1.2 Distribution circuit breaker 225A	Unit	3
1.3 24-hour timer	Unit	1
1.4 AC/DC converter	Unit	1
1.5 PV module	Set	25
2. Emergency spare parts		
2.1 Power conditioners (100kW)	Unit	1
3. Test instruments		
3.1 Digital multi meter	Unit	1
3.2 Insulation resistance tester	Unit	1
3.3 Voltage detector (low voltage)	Unit	1
3.4 Clamp meter	Unit	1
3.5 Power Quality Analyzer	Unit	1
4. Maintenance tools		
4.1 Driver set	Unit	2
4.2 Nipper, 150 type	Unit	2
4.3 Pliers, 150 type	Unit	2
4.4 Terminal pressure fitting pliers	Unit	2
4.5 Hammer	Unit	1
4.6 Card tester	Unit	1
4.7 Socket wrench (9~21)	Set	2
4.8 Conduction tools	Unit	1
4.9 Correction paint	Can	2
4.10 Anti-rust agent (zinc)	Can	2

2.5 Project Cost Estimation

2.5.1 Initial Cost Estimation

This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

(1) Costs to be borne by the Palau side Approx. 6,800 US$ (Approx. ¥ 0.657 million)

The contents and costs to be borne by the Palau side are as follows:

① Procurement and installation of watt-hour meters with reverse prevention function:

Approx. 1,000 US$ (Approx. ¥ 0.095 million)

② Final connection works of low voltage distribution cable to existing distribution panel:

Approx. 800 US$ (Approx. ¥ 0.080 million)

③ Payment of commission to Japanese bank for opening bank account:

Approx. 5,000 US$ (Approx. ¥ 0.480 million)

(2) Estimation criteria

①	Estimation point:	:	July 2009
②	Exchange rate	:	1 US$ = ¥ 96.59 (TTS average value from January to June, 2009)
③	Works and procurement period	:	The detailed design, and procurement and installation period for the equipment is shown in the implementation schedule.
④	Other points	:	The Project will be implemented in accordance with the Grant Aid Scheme of the Government of Japan.

2.5.2 Operation and Maintenance Costs

The equipment to be procured under the Project is basically maintenance-free, however, it will be necessary to dispatch PPUC engineers to inspect periodically and also in case of abnormal situations or breakdowns occur, and thereby incur personnel expenses. Therefore, the Palau side will need to secure budget for the following operation and maintenance expenses (annual) to ensure that no problems arise in the operation and maintenance of equipment.

① Personnel expenses Approx. 6,000 US$ (Approx. ¥ 0.6 million)

② Expenses for fuel cost for periodic and emergency inspections:
Approx. 200 US$ (Approx. ¥ 0.02 million)

Total Approx. 6,200 US$ (Approx. ¥ 0.62 million)

Since the above cost amounts to no more than approximately 0.8% of the distribution system operation and maintenance budget of PPUC in 2008 (approximately 850,000 US$/year), there should be no major problem in securing the operation and maintenance costs for the Project.

2.6 Other Relevant Issues

The following points are assumed to have a direct impact on the smooth implementation of the requested Japanese assistance.

(1) To ensure the stable operation of the grid-connected PV system, it will be necessary to strictly observe preventive maintenance measures such as implementing daily and periodic site patrols and inspections and securing the onsite setup for protecting the photovoltaic modules.

(2) It will be necessary to swiftly appoint the engineers to participate in the Project soft component and OJT and to ensure that skills are transferred to other engineers who do not take part in the said training.

(3) Concerning the grid-connected PV system that will be procured and installed by the Japanese side under the Project, it will be necessary to establish a power tariff scheme that enables future investment costs to be recovered, particularly in anticipation of replacement of the photovoltaic modules and power conditioner at the end of their expected service life.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effects

The anticipated effects of Project implementation are as follows.

(1) Direct Effects

Current Conditions and Problems	Project Countermeasures (Requested Japanese Assistance)	Project Effect and Degree of Impact
The Government of Palau regards breaking away from a supply setup dependent on diesel fuel in the energy and power sector to be an urgent issue, and it is also concerned over climate change, unstable crude oil prices and transportation costs. Accordingly, it regards development of renewable clean energies, primarily photovoltaic power, as a priority policy. However, the Palau Public Utilities Corporation (PPUC), which is responsible for electricity supply, does not possess sufficient operation and maintenance capability in the renewable energy field.	Procure and install a grid-connected PV system (connected to existing distribution lines) at the Project site of Palau International Airport. Moreover, via the soft component, improve the operation and maintenance capability of the PPUC, which will be responsible for operating and maintaining the grid-connected PV system.	(1) Reduction of diesel fuel consumption The power generated by the grid-connected PV system procured and installed in the Project will enable the operating capacity of existing diesel generating equipment to be reduced, thereby enabling approximately 48 kl of diesel consumption to be saved every year. (2) Reduction of CO_2 emissions In line with reduction in the operating capacity of diesel generating equipment, CO_2 emissions will be cut by approximately 127 tons per year. (3) Improvement of operation and maintenance capability Operation and maintenance capability for connecting the Project system to the existing distribution grid and conducting safe and stable operation will be improved.

(2) Indirect Effects

Current Conditions and Problems	Project Countermeasures (Requested Japanese Assistance)	Project Effect and Degree of Impact
Two grid-connected PV systems are already operating in Palau: one is the 100 kW system installed on the car park of the government office building in the capital Melekeok under the Support to the Energy Sector in Five ACP Pacific Islands project by the European Union (EU), and the other is the 153 kW system installed at Palau National Hospital by Taiwan. However, dissemination activities among energy sector officials and ordinary citizens in Palau are not well promoted.	Procure and install a grid-connected PV system (connected to existing distribution lines) at the Project site of Palau International Airport.	Since the Project site of Palau International Airport is used by citizens, tourists and overseas diplomatic missions, etc. as the country's sole international airport, it will be possible to publically advertise the use of PV system. Since Project implementation will spread awareness of the potential of PV power to all sections of society, this will facilitate further dissemination in the future.

3.2 Recommendations

3.2.1 Issues and Recommendations to be tackled by the Palau side

In order for the Project effects to be realized and sustained, the main issues that need to be tackled by the Palau side are as follows.

(1) To ensure the stable operation of the grid-connected PV system, it will be necessary to strictly observe preventive maintenance measures such as implementing daily and periodic site patrols and inspections and securing the onsite setup for guarding the photovoltaic modules.

(2) To promptly appoint the engineers who will take part in the Project soft component and OJT, to facilitate their attendance at the said training, and to ensure that technology is horizontally conveyed to other engineers who could not participate in the training.

(3) Concerning the grid-connected PV system that will be procured and installed by the Japanese side in the Project, it will be necessary to establish a power tariff scheme that enables future investment costs to be recovered, particularly in anticipation of replacement of the photovoltaic modules and power conditioner at the end of their expected service life.

3.2.2 Collaboration with Technical Cooperation and Other Donors

As a similar undertaking to the Project, a grid-connected PV system with rated output of 100 kW was installed on the car park of the federal government building in the capital Melekeok under the Support to the Energy Sector in five ACP Pacific Islands (Rep-5) by the EU, and this went into operation in November 2008. In this project, technical support concerning operation and maintenance of the grid-connected PV system was conducted in classroom and practical training, and these contents can be referred to when implementing the soft component in the Project. Otherwise, there has been no technical cooperation that can be presumptions for Project implementation.

APPENDICES

1. MEMBER LIST OF THE STUDY TEAM

APPENDIX 1 MEMBER LIST OF STUDY TEAM

< 1st Field Survey >

Name	Assigned Work	Current Position
Makoto NODA	Leader	Resident Representative, JICA Palau Office
Takafumi YASUMOTO	Planning Management	Assistant Director, Grant Aid Project Management Division 3, Financing Facilitation and Procurement Supervision Department, JICA
Shinichi MATSUURA	Procurement Planning & Management	Director, Office of Management Planning, General Affairs Department, JICS
Tadayuki OGAWA	Chief Consultant / Solar Power System / Environmental and Social Considerations	Yachiyo Engineering Co., Ltd.
Yoshitetsu FUJISAWA	Grid-connected PV System / Related Institutional Framework and Standard	Shikoku Electric Power Co., Inc.
Masahiko YAMAGUCHI	Equipment and Facilities Planning	Yachiyo Engineering Co., Ltd.
Makoto ABE	Procurement Planning / Cost Estimation	Yachiyo Engineering Co., Ltd.
Teruo KURUMADA	Architectural Design	Yachiyo Engineering Co., Ltd.

< 2nd Field Survey >

Name	Assigned Work	Current Position
Makoto NODA	Leader	Resident Representative, JICA Palau Office
Tadayuki OGAWA	Chief Consultant / Solar Power System 1/ Environmental and Social Considerations 1	Yachiyo Engineering Co., Ltd.
Kaname MOTOKI	Deputy Chief Consultant / Solar Power System 2/ Environmental and Social Considerations 2	ICONS International Cooperation Co., Ltd.
Yoshitetsu FUJISAWA	Grid-connected PV System 1/ Related Institutional Framework and Standard 1	Shikoku Electric Power Co., Inc.
Fumikazu DOI	Grid-connected PV System 3/ Related Institutional Framework and Standard 3	Shikoku Electric Power Co., Inc.
Makoto ABE	Procurement Planning / Cost Estimation	Yachiyo Engineering Co., Ltd.

2. STUDY SCHEDULE

APPENDIX 2 SURVEY SCHEDULE

< 1st Field Survey >

No.	Date	Day of the week	Survey Contents		Stay at
			Official	Consultant Members	
			Mr. Makoto NODA, Mr. Takafumi YASUMOTO, and Mr. Sinichi MATSUURA	Mr. Tadayuki OGAWA, Mr. Yoshitetsu FUJISAWA, Mr. Fumikazu DOI ,Mr. Yosuke Tsuruoka, Mr. Masahiko YAMAGUCHI, Mr. Makoto ABE, and Mr. Teruo KURUMADA	
1	Jun. 29	Mon		• Trip [Tokyo (10:30) → Guam (15:00) by CO962] Trip [Guam (18:50) → Koror (19:50) by CO953]	Koror
2	Jun. 30	Tue		• 9:00~ Courtesy call to JICA Palau Office • 10:00~ Courtesy call and meeting with Ministry of Public Infrastructure, Industries and Commerce (MPIIC) • Courtesy call and meeting with Palau Public Utilities Corporation (PPUC) • Courtesy call and meeting with Palau Energy Office and Office of the President • Explanation and Discussion of Inception Report, Questionnaire, etc. with MPIIC and PPUC • Site Survey at Palau International Airport, Power Stations and Distribution Lines	Koror
3	Jul. 1	Wed		• 08:00~Meeting and Discussion with PPUC • Site Survey for Interconnected PV system funded by EU (Capitol) • Site Survey at Palau International Airport, Power Stations and Distribution Lines	Koror
4	Jul. 2	Thu		• 08:00~ Meeting and Discussion with PPUC • Site Survey for Interconnected PV system funded by Taiwan (Hospital) • Meeting with Ministry of Resource and Development	Koror
5	Jul. 3	Fri		• Market Survey, Confirmation on the procedures for EIA, and others	Koror
6	Jul. 4	Sat		• Sorting of data and information collected	Koror
7	Jul. 5	Sun	Arrival at Koror	• Ditto	Koror
8	Jul. 6	Mon	• Site Survey at Palau International Airport (AM) • Site Survey at the existing Grid-connected PV systems (PM)	• Same as Official Members (Chief Consultant) • Market Survey, Confirmation on the procedures for EIA, and others (Other Members)	Koror
9	Jul. 7	Tue	• Courtesy call to EOJ and JICA Palau Office • Courtesy call and meeting with Ministry of Public Infrastructure, Industries and Commerce (MPIIC) and Palau Public Utilities Corporation (PPUC) • Explanation and Discussion on Minutes of Discussion (M/D)	• Same as Official Members (Chief Consultant) • Detailed Site Survey (Cable route, arrangement for PV Panels, Electrical Design, etc.) (Other Members)	Koror
10	Jul. 8	Wed	• Signing of Minutes of Discussion (M/D)	• Same as Official Members (Chief Consultant) • Detailed Site Survey (Cable route, arrangement for PV Panels, Electrical Design, etc.) (Other Members)	Koror
11	Jul. 9	Thu	Sorting of data and information collected (National Holiday)		Koror
12	Jul. 10	Fri	• Report to EOJ and JICA Palau Office on the result of first field survey	• Signing of Field Report • Report to EOJ and JICA Palau Office on the result of first field survey	Koror

No.	Date	Day of the week	Survey Contents		Stay at
			Official	Consultant Members	
			Mr. Makoto NODA, Mr. Takafumi YASUMOTO, and Mr. Sinichi MATSUURA	Mr. Tadayuki OGAWA, Mr. Yoshitetsu FUJISAWA, Mr. Fumikazu DOI ,Mr. Yosuke Tsuruoka, Mr. Masahiko YAMAGUCHI, Mr. Makoto ABE, and Mr. Teruo KURUMADA	
13	Jul. 11	Sat	Departure for Japan	• Sorting of data and information collected • Market Survey	Koror
				• Trip [Majuro (10:55) → Pohnpei (14:20) by CO957] (Mr. Tsuruoka)	

< 2nd Field Survey >

No.	Date	Day of the week	Survey Contents		Stay at
			Official	Consultant Members	
			Mr. Makoto NODA	Mr. Tadayuki OGAWA, Mr. Kaname MOTOKI Mr. Yoshitetsu FUJISAWA, Mr. Fumikazu DOI, Mr. Makoto ABE	
1	Dec. 12	Sat		• Trip [Pohnpei (15:00) → Guam (17:20) by CO957] • Trip [Guam (19:55) → Koror (22:25)by CO953]	Koror
2	Dec. 13	Sun.		• Sorting of data and information collected	Koror
3	Dec. 14	Mon.		• Courtesy call to EOJ and JICA Palau Office • Courtesy call and meeting with Ministry of Public Infrastructure, Industries and Commerce (MPIIC) • Courtesy call and meeting with Palau Public Utilities Corporation (PPUC) • Explanation and Discussion of Draft Final Report, and Minutes of Discussion (M/D)	Koror
4	Dec. 15	Tue.		• Explanation and Discussion of Draft Tender Documents • Site Survey at the Project Site, Power Stations and Distribution Lines	Koror
5	Dec. 16	Wed.		• Ditto	Koror
6	Dec. 17	Thur.		• Ditto	Koror
7	Dec. 18	Fri.		• Signing of M/D • Report to EOJ and JICA Palau Office on the result of second field survey	On Board
8	Dec. 19	Sat.		• Trip [Koror (02:35) → Guam (05:30)by CO892] • Trip [Guam (07:20) → Tokyo (09:55)by CO892]	

3. LIST OF PARTIES CONCERNED IN THE RECIPIENT COUNTRY

3. List of Parties Concerned in the Recipient Country

Organization and Name	Position
Ministry of Public Infrastructure, Industries & Commerce (MPIIC)	
Mr. Jackson R. Ngiraingas	Minster
Mr. Stalin Pedro	Special Assistant to the Minister
Mr. Charles I. Obichang	Director
Ms. Kimiyo Nakamura	Administrative Officer
Mr. Howard Uchel	Navigation Technician
Palau Public Utilities Corporation (PPUC)	
Ms. Rukebai Inabo	Chairperson (Board of Directors) Palau Public Utilities Corporation
Mr. Ken T.Uyehara	CEO & General Manager
Mr. Tito Cabunagan	Electrical Engineer
Mr. Rodolfo Fernandez JR.	Mechanical Engineer
Mr. Ken Sugiyama	GIS Engineer
Mr. Reynante T. Bitas	Electrical Engineer
Office of Environmental Response and Coordination	
Ms. Ngekikes Olai U. Polloi	Director
Mr. Reagan Ngiratmetuchl Blechel	Finance Officer / Support staff
Office of the President	
Mr. Hiob Mesubed	Special Assistant to the President
Palau Energy Office	
Mr. Greg Decherong	Director
Mr. Nyk Kloulubak	Energy Planner
Capital Improvement Project Office	
Mr. Brian Melairei	Manager
Environmental Quality Protection Board	
Mr. John Kintaro JR.	Environmental Officer

Belau Transfer & Terminal Co. Group

Mr. Kuniwo Nakamura	Chairman & CEO (Former President, Republic of Palau)

KJI and Associates

Mr. Kione J. Isechal P.E.	Principal

Palau National Hospital

Mr. Arseno Sabyro	Electrical Engineer

Embassy of Japan in Palau

Mr. Masayuki Takashima	Chargé d' Affaires ad intérim
Mr. Shuji Tsuji	Researcher / Adviser

JICA Palau Office

Mr. Makoto Noda	Resident Representative
Mr. Naoki Takechi	Volunteer Coordinator
Ms. Olga Singeo	Program Officer

4. MINUTES OF DISCUSSIONS

Minutes of Discussions
on the Preparatory Survey
on the Project for the introduction of Clean Energy by Grid-Connected Solar Electricity Generation System

The Government of Japan (hereinafter referred to as "GoJ") has established Cool Earth Partnership as a new financial mechanism. Through this, GoJ is cooperating actively with developing countries' efforts to reduce greenhouse gasses emissions, such as efforts to promote clean energy. A new scheme of grant aid, "Program Grant Aid for Environment and Climate Change ", was also created by GoJ as a component of this financial mechanism. According to the initiative of Cool Earth Partnership, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with GoJ, decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project for the introduction of Clean Energy by Grid-Connected Solar Electricity Generation System in the Republic of Palau (hereinafter referred to as "the Project").

JICA sent to Palau the Preparatory Survey Team (hereinafter referred to as "the Team"), headed by Mr. Makoto NODA, Representative of Office of Palau, JICA, and is scheduled to stay in the country from June 29 to July 13 as the Survey for Detailed Design.

The Team held discussions with the concerned officials of the Government of the Republic of Palau and conducted a field survey.

In the course of discussions and field survey, both sides confirmed the main items described in the attached sheets.

Koror, July 8, 2009

Mr. Makoto NODA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
JAPAN

Hon. Jackson R. Ngirainga
Minister
Ministry of Public Infrastructure, Industries and Commerce

Ms. Rukebai Inabo
Chairperson (Board of Directors)
Palau Public Utilities Corporation

ATTACHMENT

1. Current Situation

Based on the result of the previous project formulation study and the official request from the Government of Palau, Detailed Design and Draft Tender Documents shall be created under the Survey.

2. Objective of the Project

The objective of the Project is to promote clean energy utilization and achieve emissions reductions by installing the photovoltaic system to be connected to the national grid.

3. Responsible Organization and Implementing Agency

The responsible organization is the Ministry of Public Infrastructure, Industries, and Commerce (MPIIC). (The organization chart of the responsible ministry is shown in Annex-1.)

The implementing agency is the Palau Public Utilities Corporation (PPUC). (The organization chart of the implementing organization is shown in Annex-2.)

4. Project Component

4-1. After discussions with the Team, the installation of the on-grid power generating system using photovoltaic including following equipment was requested by Palau side.

(1) Photovoltaic (PV) Module (Panel) (total capacity might be around 160kW)
(2) Junction Box
(3) Power Conditioner
(4) Data collecting and display device

4-2. Project site is Palau International Airport as shown in Annex-3

4-3. The Palau side explained that there is no duplication between the contents of the Project and any other plans implemented by the other donors or the Palau side.

4-4. The Team will assess the appropriateness of the request and will report the findings to JICA Headquarters and the GoJ. The Palau side has understood that the final components and the design of the Project shall be decided (confirmed) after further survey.

5. Japan's Program Grant Aid for Environment and Climate Change

The Palau side understood the Japan's Program Grant Aid for Environment and Climate Change scheme explained by the Team as described in Annex-4, 5 and 6.

6. Schedule of the Study

(1) The Team will proceed to further survey in Palau until July 13, 2009.
(2) JICA will prepare the draft report and reference document in English and dispatch a mission to Palau in order to explain their contents in the end of November, 2009.
(3) When the contents of the report are accepted in principle by the Government of Palau, JICA

will complete the final report and reference document, and submit them to the Government of Palau and to the Procurement Agent by the end of January, 2010.

7. Other Relevant Issues

7-1 Major Undertakings to be taken by Each Government

The Palau side confirmed that major undertakings as shown in Annex-7 should be taken by Palau side at its own budget. In addition, the Palau side should be responsible for following issues;

(1) Securing necessary land
- for PV Modules
- for underground cables between PV Modules and Power Conditioners
- for Power Conditioners

(2) Temporary Stockyard during installation of the equipment and materials

(3) Procurement and installation of following two meters (no reverse rotation) to be installed at the primary side of distribution transformer;
- for power coming from PPUC grid
- for power outgoing to PPUC grid

(4) The final connection work of Low Voltage Power Cable with the existing Bus-bar inside the incoming ACB Distribution Panel shall be done by Palau side. Japanese side is responsible for the procurement of necessary terminal equipment for the same connection work.

(5) The tariff structure for power generated by PV system shall be determined by Palau side by the end of October, 2009. After concluding Minutes of Understanding (MOU) between MPIIC and PPUC, the same MOU shall be sent to JICA Palau Office for reference.

(6) Vehicles for Operation and Maintenance

(7) Tables and PCs, if necessary

7-2 Permission of Land Acquisition / Usage

The owner of the land for the above 7-1 (1) is MPIIC. Therefore, no official permission for land acquisition and / or usage is required for the implementation of the Project.

7-3 Procurement of Equipment and Materials

The Team explained that, in accordance with the policy of GoJ, products of Japan shall be procured for major equipment in the Project.
The Palau side agreed with the policy of GoJ.

7-4 Coordination with Related Organizations

The cool earth focal point shall be the focal point for the Team, and responsible for the coordination with related organizations.

7-5 Application of the Related Laws and Regulations

PPUC and Palau Energy Office shall be responsible for the application of related laws and regulations for the operation of the Grid-Connected PV system.

7-6 Property of Equipment and Materials, Demarcation for the Project Implementation

PPUC shall own the equipment and materials provided under the Project during and after implementation of the Project.

Detail demarcation between MPIIC and PPUC shall be defined under the separate MOU between MPIIC and PPUC for the joint implementation of the Project.

7-7 Environmental and Social Considerations

The Team explained the outline of JICA Environmental and Social Considerations Guideline (hereinafter referred to as "the JICA Guideline") to the Palau side. The Palau side took the JICA Guideline into consideration, and shall complete the necessary procedures. MPIIC shall obtain necessary permission by Environmental Quality Protection Board (EQPB) on or before the end of September, 2009. The Team shall provide necessary data and information for the application.

7-8 Operation and Maintenance

The Palau side agreed to secure the necessary budget and personnel for the Operation and Maintenance of Grid-Connected PV system procured and installed under the Project.

7-9 Customs and Tax exemption

The Palau side agreed that the Palau side shall be responsible for the exemption and/or reimbursement (payment/assumption) of all customs, tax, levies and duties incurred in Palau for implementation of the Project.

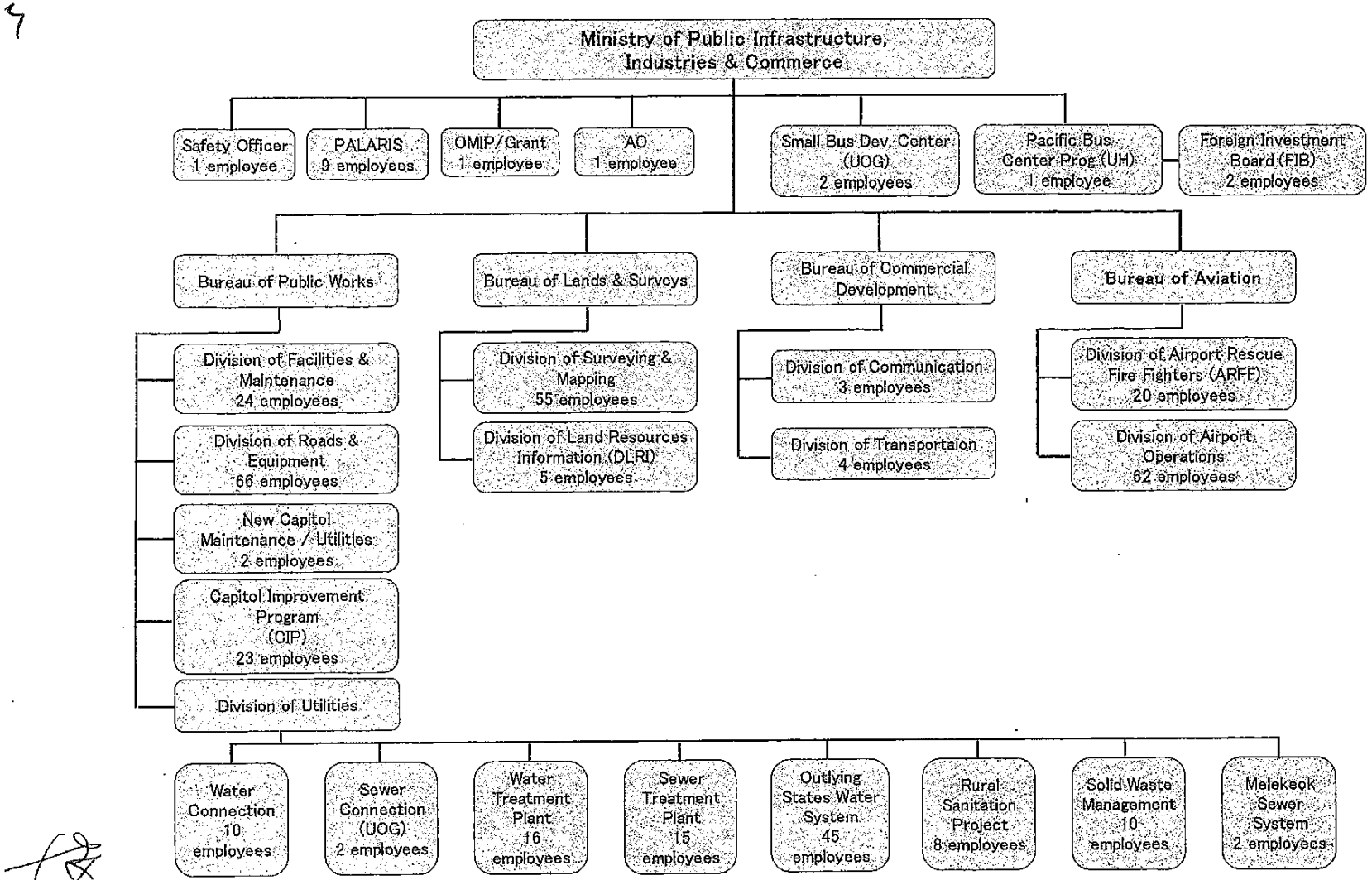
7-10 The Palau side shall ensure the security of all concerned Japanese nationals working for the Project, if deemed necessary.

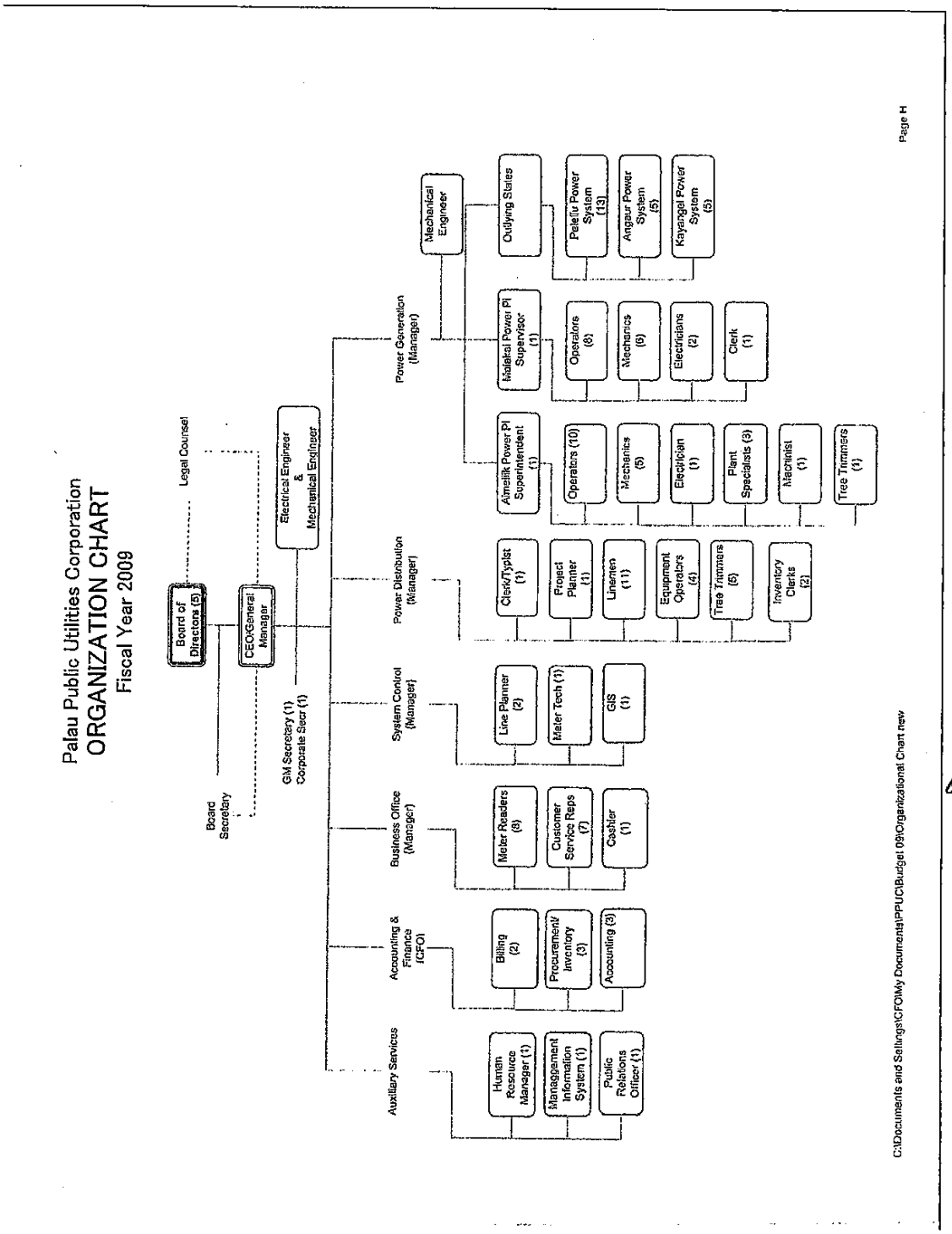
7-11 The Palau side shall provide necessary numbers of counterpart personnel to the Team during the period of their studies in Palau.

<List of Annex>

Annex-1 Organization Chart of Ministry of Public Infrastructure, Industries, and Commerce
Annex-2 Organization Chart of Palau Public Utilities Corporation
Annex-3 Project site / Candidate site of the Project
Annex-4 Japan's Environment Program Grant Aid Scheme
Annex-5 Flow of Funds for Project Implementation
Annex-6 Project Implementation System
Annex-7 Major Undertakings to be taken by Each Government
Annex-8 Terms of Reference of the Consultative Committee (Provisional)

Ministry of Infrastructure, Industries and Commerce
ORGANIZATION CHART




Palau Public Utilities Corporation
ORGANIZATION CHART
Fiscal Year 2009
Board of Directors (5)
Legal Counsel
CEO/General Manager
Board Secretary
GM Secretary (1)
Corporate Secr (1)
Electrical Engineer & Mechanical Engineer
Power Generation (Manager)
Power Distribution (Manager)
System Control (Manager)
Business Office (Manager)
Accounting & Finance (CFO)
Auxiliary Services
Mechanical Engineer
Outlying States
Pelelliu Power System (13)
Angaur Power System (5)
Kayangel Power System (5)
Maleital Power Pl Supervisor (1)
Operators (8)
Mechanics (6)
Electricians (2)
Clerk (1)
Almeliik Power Pl Superintendent (1)
Operators (10)
Mechanics (5)
Electrician (1)
Plant Specialists (3)
Machinist (1)
Tree Trimmers (1)
Clerk/Typist (1)
Project Planner (1)
Linemen (11)
Equipment Operators (4)
Tree Trimmers (5)
Inventory Clerks (2)
Line Planner (2)
Meter Tech (1)
GIS (1)
Meter Readers (8)
Customer Service Reps (7)
Cashier (1)
Billing (2)
Procurement/ Inventory (3)
Accounting (3)
Human Resource Manager (1)
Management Information System (1)
Public Relations Officer (1)
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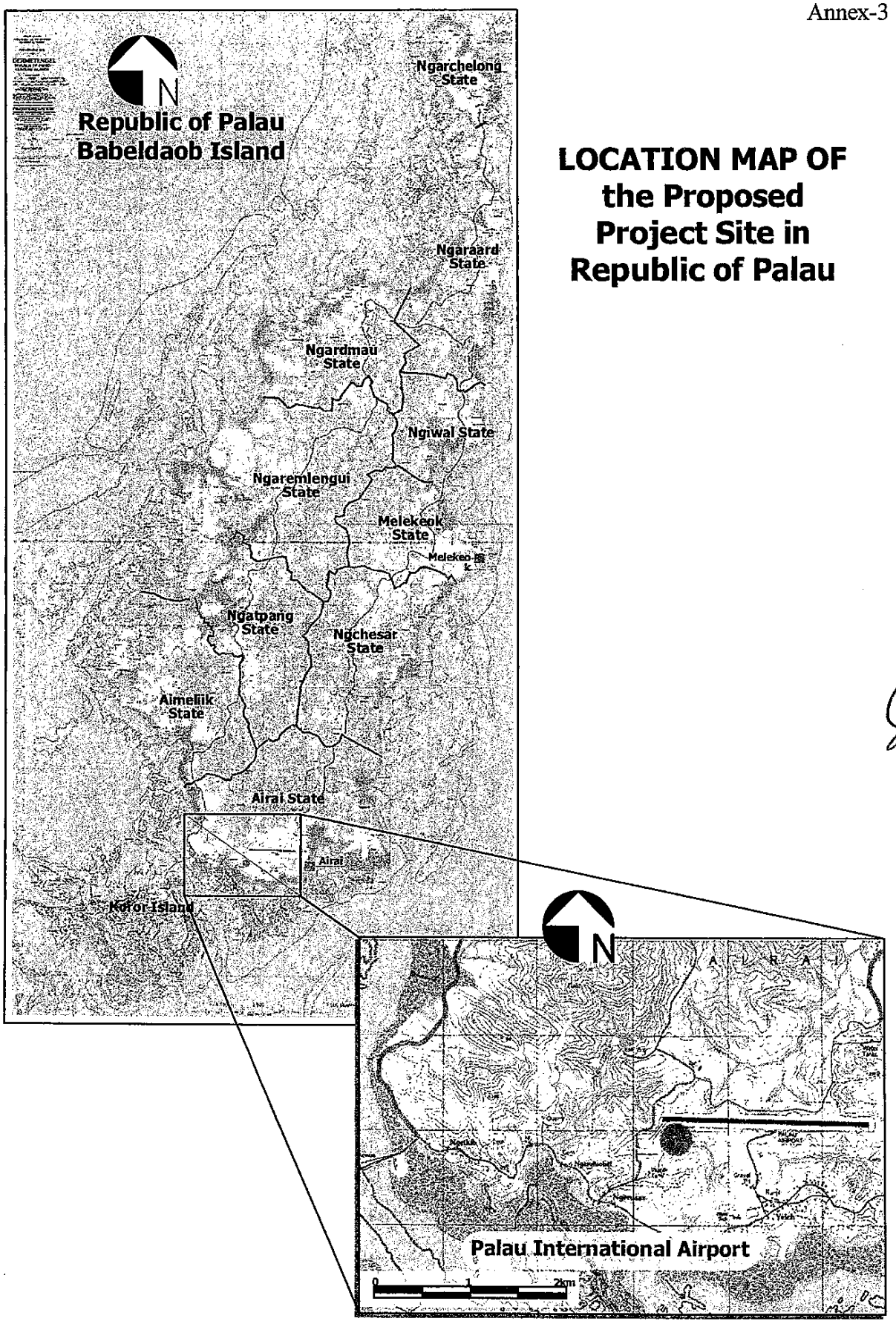
Page H



LOCATION MAP OF the Proposed Project Site in Republic of Palau

Program Grant Aid for Environment and Climate Change of the Government of Japan
(Provisional)

The Grant Aid provides a recipient country (hereafter referred to as "the Recipient") 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 relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

Based on "Cool Earth Partnership" initiative of the Government of Japan, the Program Grant Aid for Environment and Climate Change (hereafter referred to as "GAEC") aims to mitigate effects of global warming by reducing GHGs emission (mitigation; e.g. improvement of energy efficiency) and to take adaptive measures (adaptation; e.g. measures against disasters related to climate change, including disaster prevention such as enhancing disaster risk management).

1. Procedures for GAEC

GAEC is executed through the following procedures.

Preparatory Survey (Phase 1)	Preparatory Survey (Phase 1 for project identification) conducted by Japan International Cooperation Agency (JICA)
Application	Request made by a recipient country
Appraisal & Approval	Appraisal by the Government of Japan and Approval by the Cabinet
Determination of Implementation	The Notes exchanged between the Government of Japan and the Recipient Country
Grant Agreement (hereinafter referred to as the "G/A")	Agreement concluded between JICA and the Recipient
Preparatory Survey (Phase 2)	Preparatory Survey (Phase 2 for detailed design) conducted by JICA
Implementation	Procurement through the Procurement Agency by the Recipient

Firstly, if the candidate project for a GAEC is identified by the Recipient and the Government of Japan, the Government of Japan (the Ministry of Foreign Affairs) examines it whether it is eligible for GAEC. When the request is deemed appropriate, JICA, in consultation with the Government of Japan, conducts the Preparatory Survey (hereafter referred to as "the Survey") on the candidate project as Phase 1 of the Survey with Japanese consulting firms.

Secondly, the Recipient submits the official request to the Government of Japan, while the appropriateness, necessity and the basic components of the project are examined in the course of Phase 1 of the Survey,

Thirdly, the Government of Japan appraises the project to see whether it is suitable for Japan's GAEC, based on the Survey 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.

Fifthly, JICA engages Grant Agreement (G/A) with the Recipient and executes the Grant by making payments of the amount agreed in the E/N and strictly monitors that the funds of the Grant are properly and effectively used.

Procurement Management Agent is designated to conduct the procurement services of products and services (including fund management, preparing tenders, contracts) for GAEC on behalf of the Recipient. The Agent is an impartial and specialized organization that will render services according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the Agreed Minutes ("A/M").

2 Preparatory Survey

1) Contents of the Survey

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

- Confirmation of background, objectives, and benefits of the Project and institutional capacity of agencies and communities concerned of the Recipient necessary for project implementation.
- Evaluation of relevance of the Project to be implemented under the Grant Aid Scheme for Environment and Climate Change from a technical, social, and economic point of view.
- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.
- Preparation of the detailed design of the Project and reference document for tender.
- Estimation of cost for the Project.

The contents of the original request will be modified, as found necessary, in the design of the Project according to the guidelines of Japan's Grant Aid scheme.

The Government of Japan requests the Government of the Recipient to take whatever measures necessary to ensure its responsibility in implementing the Project. Such measures must be guaranteed even if they may fall outside the jurisdiction of the implementing organization of the Recipient. This has been confirmed by all relevant organizations of the Recipient through the Minutes of Discussions.

2) Selection of consulting firms

For the smooth implementation of the Survey, JICA will conduct the Survey with registered consulting firms. JICA selects the firms based on proposals submitted by firms with interest in implementing the Survey. The firms selected will carry out the Preparatory Survey and prepare a report, based on the terms of reference set by JICA.

3. Implementation of GAEC after the E/N

1) Exchange of Notes (E/N)

The content of GAEC will be determined in accordance with the Notes exchanged by the two Governments concerned, in which items including, objectives of the project, period of execution, conditions and amount of the Grant Aid are confirmed.

2) Details of Procedures

Details of procedures on procurement and services under GAEC will be agreed between the authorities of the two governments concerned at the time of the signing of the G/A.

Essential points to be agreed are outlined as follows:

a) JICA will supervise the implementation of the Project.
b) Products and services will be procured and provided in accordance with JICA's "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change."
c) The Recipient will conclude a contract with the Agent.
d) The Agent is the representative acting in the name of the Recipient concerning all transfers of funds to the Agent.

3) Focal points of "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change"

a) The Agent

The Agent is the organization, which provides procurement of products and services on behalf of the Recipient according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the A/M.

b) Agent Agreement

The Recipient will conclude the Agent Agreement, in principle, within two months after the signing of the G/A, in accordance with the A/M. The scope of the Agent's services will be clearly specified in the Agent Agreement.

c) Approval of the Agent Agreement

The Agent Agreement is prepared as two identical documents and the copy of the Agent Agreement will be submitted to JICA by the Recipient through the Agent. JICA confirms whether the Agent Agreement is concluded in conformity with the E/N, A/M, and G/A and the Procurement Guidelines for the Program Grant Aid for Environment and Climate Change then approves the Agent Agreement.

The Agent Agreement concluded between the Recipient and the Agent will become effective after the approval by JICA in a written form.

d) Payment Methods

The Agent Agreement will stipulate that "Regarding all transfers of the fund to the Agent, the Recipient will designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA")to conduct the transfer of the fund (hereinafter referred to as "the Advances") to the Procurement Account from the Recipient Account.

The Agent Agreement will clearly state that the payment to the Agent will be made in Japanese yen from the Advances and that the final payment to the Agent will be made when the total remaining amount become less than three percent (3%) of the Grant and its accrued interests excluding the Agent's fees.

e) Products and Services Eligible for Procurement

Products and services to be procured will be selected from those defined in the G/A.

f) Selection of firms

In principle, firms of any nationality could be contracted as long as the firms satisfy the conditions specified in the tender documents.

The same applies for any individual consultants who will be involved in the project and provide services necessary for the training and guidance related to the Project. The consultants that will be employed to do detail design and supervise the work for the Project, however will be, in principle Japanese nationals recommended by JICA for the purpose of maintaining technical consistency with the Survey

g) Method of Procurement

When conducting the procurement, sufficient attention will be paid to transparency in selecting the firms and for this purpose, competitive tendering will be employed in principle.

h) Tender Documents

The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by GAEC.

The rights and obligations of the Recipient, the Agent and the firms supplying products and services should be stipulated in the tender documents to be prepared by the Agent. Aside from this, the tender documents will be prepared in consultation with the Recipient.

i) Pre-qualification Examination of Tenderers

The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The pre-qualification examination should be performed only with respect to whether the prospective tenderers have the capability of concluding the contracts.

For this, the following points should be taken into consideration:

(1) Experience and past performance in contracts of similar kind
(2) Financial credibility (including assets such as real estate)
(3) Existence of offices and other items to be specified in the tender documents.
(4) Their potentialities to use necessary personnel and facilities.

j) Tender Evaluation

The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenderers which substantially conform to the technical specifications and other stipulations of the tender documents, will be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price will be designated as the successful tenderer.

The Agent will submit a detailed evaluation report of tenders to JICA for its information, while the notification of the results to the tenderers will not be premised on the confirmation by JICA.

k) Additional procurement

If there is any remaining balance after the competitive and/or selective tendering and/or direct negotiation for a contract, and if the Recipient would like to procure additional items, the Agent is allowed to conduct this additional procurement, following the points mentioned below:

(1) Procurement of same products and services
When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged not efficient, additional procurement can be conducted by a negotiated contract with the successful tenderer of the initial tender.
(2) Other procurements

When products and services other than those mentioned above in (1) are to be procured, the procurement should be conducted through competitive tendering. In this case, the products and services for additional procurement will be selected from among those in accordance with the G/A.

l) Conclusion of the Contracts
In order to procure products and services in accordance with the guideline, the Agent will conclude contracts with firms selected by tendering or other methods.

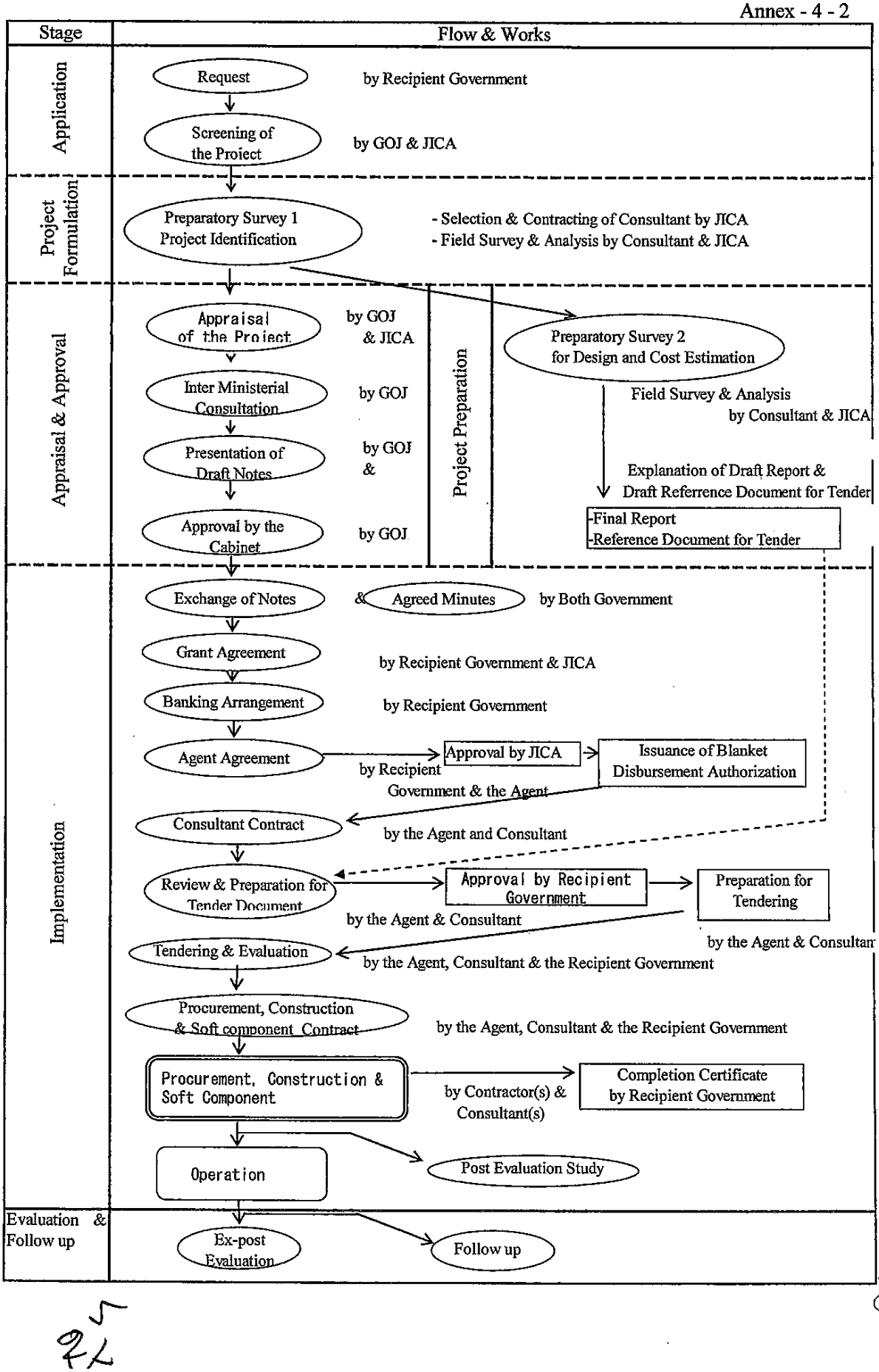
m) Terms of Payment
The contract will clearly state the terms of payment. The Agent will make payment from the "advances," against the submission of the necessary documents from the firm on the basis of the conditions specified in the contract. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

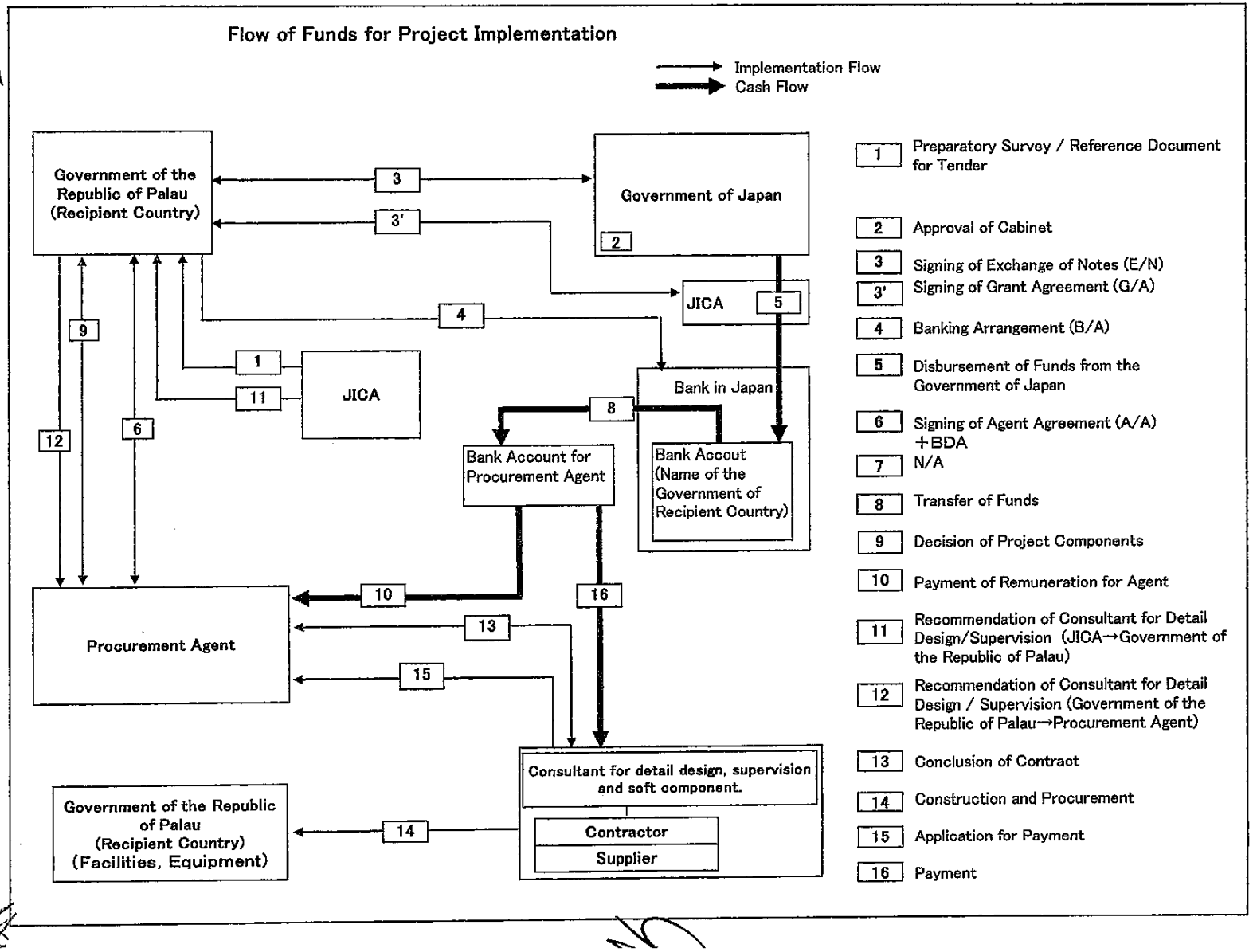
4) Undertakings required by the Government of the Recipient Country
In the implementation of the Grant Aid Project, the Recipient is required to undertake necessary measures as the following:

a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the Project.
b) To provide facilities for distributing electricity, water supply and drainage and other incidental facilities in and around the sites.
c) To ensure all the expense and prompt execution for unloading, customs clearing at the port of disembarkation and domestic transportation of products purchased under the Grant Aid,
d) To ensure that customs duty, internal taxes and other fiscal levies that may be imposed in the Recipient with respect to the purchase of the Components and the Agent's services will be exempted by the Government of the Recipient.
e) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work.

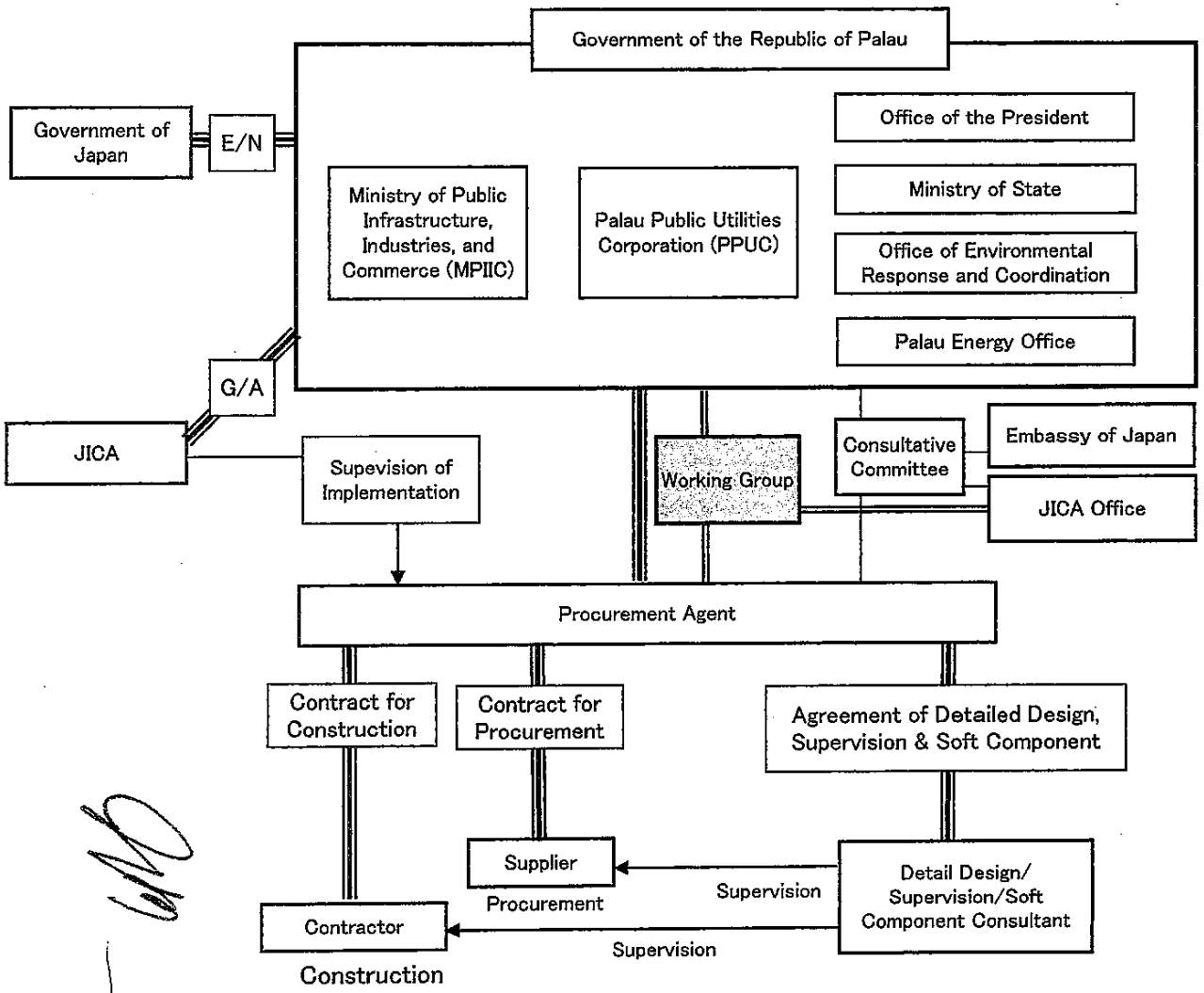
5) "Proper use of funds"
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign personnel necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

6) "Export and Re-export" of products
The products purchased under the Grant and its accrued interest will not be exported or re-exported from the Recipient.


Stage
Flow & Works
Application
Request
by Recipient Government
Screening of the Project
by GOJ & JICA
Project Formulation
Preparatory Survey 1
Project Identification
- Selection & Contracting of Consultant by JICA
- Field Survey & Analysis by Consultant & JICA
Appraisal & Approval
Appraisal of the Project
by GOJ & JICA
Inter Ministerial Consultation
by GOJ
Presentation of Draft Notes
by GOJ &
Approval by the Cabinet
by GOJ
Project Preparation
Preparatory Survey 2
for Design and Cost Estimation
Field Survey & Analysis
by Consultant & JICA
Explanation of Draft Report &
Draft Referrence Document for Tender
-Final Report
-Reference Document for Tender
Implementation
Exchange of Notes
& Agreed Minutes
by Both Government
Grant Agreement
by Recipient Government & JICA
Banking Arrangement
by Recipient Government
Agent Agreement
by Recipient Government & the Agent
Approval by JICA
Issuance of Blanket Disbursement Authorization
Consultant Contract
by the Agent and Consultant
Review & Preparation for Tender Document
Approval by Recipient Government
Preparation for Tendering
by the Agent & Consultant
by the Agent & Consultant
Tendering & Evaluation
by the Agent, Consultant & the Recipient Government
Procurement, Construction & Soft component Contract
by the Agent, Consultant & the Recipient Government
Procurement, Construction & Soft Component
by Contractor(s) & Consultant(s)
Completion Certificate by Recipient Government
Operation
Post Evaluation Study
Evaluation & Follow up
Ex-post Evaluation
Follow up


Flow of Funds for Project Implementation
Implementation Flow
Cash Flow
Government of the Republic of Palau (Recipient Country)
Government of Japan
JICA
JICA
Bank in Japan
Bank Account for Procurement Agent
Bank Accout (Name of the Government of Recipient Country)
Procurement Agent
Consultant for detail design, supervision and soft component.
Contractor
Supplier
Government of the Republic of Palau (Recipient Country) (Facilities, Equipment)
1 Preparatory Survey / Reference Document for Tender
2 Approval of Cabinet
3 Signing of Exchange of Notes (E/N)
3' Signing of Grant Agreement (G/A)
4 Banking Arrangement (B/A)
5 Disbursement of Funds from the Government of Japan
6 Signing of Agent Agreement (A/A) +BDA
7 N/A
8 Transfer of Funds
9 Decision of Project Components
10 Payment of Remuneration for Agent
11 Recommendation of Consultant for Detail Design/Supervision (JICA→Government of the Republic of Palau)
12 Recommendation of Consultant for Detail Design / Supervision (Government of the Republic of Palau→Procurement Agent)
13 Conclusion of Contract
14 Construction and Procurement
15 Application for Payment
16 Payment

Project Implementation System



Annex-7

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 urgently		●
3	To construct gates and fences in and around the site		●
4	To construct a parking lot if necessary		●
5	To construct roads		
	1) Within the site	●	
	2) Outside the site and Access road		●
6	To construct the facility and install the equipment	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities if necessary:		
	1) Electricity		
	a. The power distribution line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer for the site	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for conveying storm water, sewage, etc. from the site)		●
	b. The drainage system within the site (for sewage, ordinary waste, storm water, etc.)	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) 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	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
9	To ensure prompt unloading and customs clearance at ports of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To exempt or bear tax and customs 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 and / or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.		●
11	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country		●
12	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
13	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees.		●
14	To ensure environmental and social consideration for the Program.		●

Terms of Reference of the Consultative Committee (Provisional)

1. To confirm an implementation schedule of the Programme for the speedy and effective utilization of the Grant and its accrued interest.

2. To discuss the modifications of the Programme, including modification of the design of the facility.

3. To exchange views on allocations of the Grant and its accrued interest as well as on potential end-users.

4. To identify problems which may delay the utilization of the Grant and its accrued interest, and to explore solutions to such problems.

5. To exchange views on publicity related to the utilization of the Grant and its accrued interest.

6. To discuss any other matters that may arise from or in connection with the G/A.

Minutes of Discussions
on
the Outline Design Study
on
The Project for Introduction of Clean Energy by Solar Electricity Generation System in the Republic of Palau

(Explanation on Draft Final Report)

In December 2009, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Survey Team on the Project for Clean Energy Promoting Using Solar Photovoltaic System (hereinafter referred to as "the Project") in the Republic of Palau (hereinafter referred to as "Palau"), and through discussions, field survey and technical examination of the results of the survey in Japan, JICA prepared a Draft Final Report of the Outline Design.

In order to explain and to consult with the concerned officials of the Government of Palau on the component of the Draft Final Report, JICA sent Palau the Draft Final Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Makoto NODA, Representative of Office of Palau, JICA, from 12th December 2009 to 19th December 2009.

As a result of discussion, both sides confirmed the main items described on the attached sheets.

Koror, 18th December, 2009

Mr. Makoto NODA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
JAPAN

Hon. Jackson R. Ngiraingas
Minister
Ministry of Public Infrastructure, Industries and Commerce

Ms. Rukebai Inabo
Chairperson (Board of Directors)
Palau Public Utilities Corporation

ATTACHMENT

1. Components of the Draft Final Report

The Ministry of Public Infrastructure, Industries and Commerce (hereinafter referred to as "MPIIC") and Palau Public Utilities Corporation (hereinafter referred to as "PPUC") agreed and accepted in principle the components of the Draft Final Report explained by the Team.

2. Program Grant Aid for Environment and Climate Change of the Government of Japan

The Palau side understood components of the Minutes of Discussion signed by both sides on 8th July, 2009 (hereinafter referred to as "the previous M/D"), and would take the necessary measures confirmed on the previous M/D for smooth implementation of the Project following procedures of the Program Grant Aid for Environment and Climate Change of the Government of Japan as shown in **Annex-1**.

3. Confirmation of progress

3-1. Project site and capacity of PV module

Both sides confirmed that project site is Palau International Airport and the capacity of PV module is 180 kW.

3-2. Official permission to set the PV system on the project site

Both sides confirmed completion of necessary procedures for official permission from related organization to set the PV system in the Palau International Airport.

4. Items of Equipment to be procured

The Team explained that the items of equipment to be procured as shown in **Annex-2** based on the result of the Preparatory Survey conducted in June and July, 2009.

5. Procurement Process of the Project

Both sides reconfirmed that procurement process would be supervised by the Procurement Management Agent (hereinafter referred to as "the Agent") with necessary consultation by the Consultative Committee (hereinafter referred to as "the Committee"). And both sides also reconfirmed roles of the Agent as follows;

(1) The Agent renders the services stipulated in the provisions of the G/A as well as the E/N for the Project;

(2) The Agent will undertake the procurement procedure necessary for the Project according to the provisions of the G/A and E/N and any other concerned guidelines; and

(3) The Agent will commence the procurement according to the contents of the Final Report of the Outline Design.

6. Project Cost

The Palau side agreed that the Project cost should not exceed the upper limit of amount agreed on in E/N. Both sides also confirmed that the Project cost contains procurement cost of equipment, the cost for transportation up to the Project Site, installation cost, the Agent fee, and the cost for soft component for the technical support of operation and maintenance of equipment.

7. Confidentiality of the Project

7.1. Detailed specifications of the Facilities

Both sides confirmed that all the information related to the Project including detailed drawings and specifications of the facilities and equipment and other technical information shall not be released to any outside parties before tender for the Project.

7.2. Confidentiality of the Cost Estimation

The Team explained the cost estimation of the Project. Both sides agreed that the Project Cost Estimation should never be duplicated or released to any outside parties before conclusion of all the contract(s) for the Project. The Palau side understood that the Project Cost Estimation is not final and is subject to change by the result of examination through revision of the Outline Design Study.

8. The Consultative Committee

The Palau side understood that the MPIIC will chair the Committee in order to facilitate consultation and procurement process. The Terms of Reference of the Committee was settled in Annex-8 of the previous M/D.

The members of the Committee are as follows:

(1) Representative(s) of Ministry of Public Infrastructure, Industries and Commerce (Chair)
(2) Representative(s) of Palau Public Utilities Corporation (PPUC)
(3) Representative(s) of Office of the President
(4) Representative(s) of Ministry of State
(5) Representative(s) of Office of Environmental Response and Coordination
(6) Representative(s) of Palau Energy Office
(7) Representative(s) of JICA Palau Office

The first meeting of the Committee shall be held immediately after the JICA's approval of the Agent Agreement which shall be concluded between MPIIC and the Procurement Agent. The employment of the Agent shall be agreed between the two Governments. Further meetings shall be held upon request of either the Palau side or the Japanese side. The Procurement Agent may advise both sides on the necessity to call a meeting of the Committee.

9. Other Relevant Issues

9.1. Undertakings required by the Recipient Country

The Team requested the Palau side to abide by the following undertakings by the Palau side in addition to major undertakings described in the previous M/D. The Palau side agreed to do so.

(1) Land usage for PV system

The owner of the land for the following equipment and materials for PV system is MPIIC.

Therefore, the Palau side has reconfirmed that no official permission for land acquisition and/or usage is required for the implementation of the Project.

1) for PV Modules
2) for underground cables between equipment
3) for Power Conditioners
4) for Temporary stockyard

(2) Generated Energy by PV system

The necessary tariff structure for power generated by PV system shall be determined by the end of December, 2010 by Palau side taking the "Tariff Review Study" into consideration. The Japanese side shall assist the Palau side through soft component during the implementation of the Project.

(3) Environmental and Social Considerations

The Palau side confirmed that the MPIIC has already obtained all necessary permission from Environmental Quality Protection Board (EQPB) on 7th of August, 2009, (EQPB Permit # 152-09).

(4) Application of the Related Laws and Regulations

The Palau side agreed the structural design for the installation of PV system shall comply with the Architectural Regulation in Japan and Palau.

Electrical design for Grid-connected PV system should be done in accordance with JIS/IEC.

The Palau side agreed that the PPUC shall be responsible for the application of related laws and regulations for the operation of the PV system for interconnection with the distribution lines before commissioning of the Project. The Japanese side shall assist the Palau side to introduce necessary procedures through soft component during the implementation of the Project.

(5) Customs and Tax Exemption

The Palau side agreed that the MPIIC shall be responsible for the exemption and/or reimbursement of all customs, tax, levies and duties incurred in Palau for the implementation of the Project.

(6) Assignment of Counterpart Personnel

1) Overall project management

The Palau side agreed to assign necessary personnel for overall project management.

The Palau side shall inform the name of the following number of Counterpart Personnel to JICA Palau office by 15th of January, 2010:

- Two staff from MPIIC
- Two staff from PPUC

2) Soft Component

The Palau side agreed to assign necessary personnel for O&M of the equipment in accordance with the soft component plan proposed by the Team.

The Palau side shall inform the name of the following number of Counterpart Personnel to JICA Palau office by 15th of January, 2010:

- One staff from MPIIC
- One staff from Palau Energy Office
- Four staff from PPUC

(7) Banking Arrangement

The Palau side, being convinced that the conclusion of the Banking Arrangement (B/A) and Blanket Disbursement Authorization (BDA) constitutes a very important factor to implement the Program smoothly and without delay, shall take the necessary measures. The flow of funds is shown in the Annex-I.

By signing the BDA, the Palau side designates the Procurement Agent as the representative authorized to act in the name of the Palau side concerning all transfers of the Grant plus any interest earned to the Procurement Account.

(8) The final connection work

The final connection work of low voltage power cable with the existing Bus-bar inside the incoming ACB Distribution Panel shall be done by Palau side. Japanese side is responsible for the procurement of necessary terminal equipment for the same connection work.

(9) Arrangement for the remote monitoring system

All necessary work for the Internet connection (LAN) for the proposed electrical room in the Palau International Airport and PPUC Malakal Power Distribution Building shall be arranged by the Palau side.

The necessary payment for the Internet connection shall be borne by the Palau side.

(10) Procurement and Installation of Meters

The Palau side agreed that the PPUC shall be responsible for the procurement and installation of two meters (no reverse rotation) to be installed at the primary side of the distribution transformer.

9.2. Ownership and Operation and Maintenance (O&M) Responsibilities of Equipment

The Palau side has reconfirmed that the PPUC is the owner of Equipment and responsible for Operation and Maintenance (O&M) of Equipment. The Palau side confirmed that the Equipment procured under the Project shall be operated and maintained in accordance with the separated MOU between MPIIC and PPUC for the joint implementation of the Project. The Team explained that the Palau side was requested to secure necessary budget and personnel for the O&M of Grid-connected PV system procured and installed under the Project.

9.3. Final Report

The Palau side agreed that the Final Report should never be duplicated in any form nor released to any other party(s), because the Final Report is confidential document as it contains information related to the tender.

<List of Annex>

Annex-1 Program Grant Aid for Environment and Climate Change of the Government of Japan

Annex-2 List of Equipments

Program Grant Aid for Environment and Climate Change of the Government of Japan
(Provisional)

The Grant Aid provides a recipient country (hereafter referred to as "the Recipient") 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 relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

Based on "Cool Earth Partnership" initiative of the Government of Japan, the Program Grant Aid for Environment and Climate Change (hereafter referred to as "GAEC") aims to mitigate effects of global warming by reducing GHGs emission (mitigation; e.g. improvement of energy efficiency) and to take adaptive measures (adaptation; e.g. measures against disasters related to climate change, including disaster prevention such as enhancing disaster risk management).GAEC may contain multiple components that can be combined to effectively meet these needs.

1. Procedures for GAEC

GAEC is executed through the following procedures.

Preparatory Survey 1	Preparatory Survey for project identification conducted by Japan International Cooperation Agency (JICA)
Application	Request made by a recipient country
Appraisal & Approval	Appraisal by the Government of Japan and Approval by the Cabinet
Determination of Implementation	The Notes exchanged between the Government of Japan and the Recipient Country
Grant Agreement (hereinafter referred to as the "G/A")	Agreement concluded between JICA and the Recipient
Preparatory Survey 2	Preparatory Survey for design conducted by JICA
Implementation	Procurement through the Procurement Agency by the Recipient

Firstly, if the candidate project for a GAEC is identified by the Recipient and the Government of Japan, the Government of Japan (the Ministry of Foreign Affairs) examines it whether it is eligible for GAEC. When the request is deemed appropriate, JICA, in consultation with the Government of Japan, conducts the Preparatory Survey (hereafter referred to as "the Survey") on the candidate project as Phase 1 of the Survey with Japanese consulting firms.

Secondly, the Recipient submits the official request to the Government of Japan, while the appropriateness, necessity and the basic components of the project are examined in the course of Phase 1 of the Survey,

Thirdly, the Government of Japan appraises the project to see whether it is suitable for Japan's GAEC, based on the Survey 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.

Fifthly, JICA engages Grant Agreement (G/A) with the Recipient and executes the Grant by making payments of the amount agreed in the E/N and strictly monitors that the funds of the Grant are properly and effectively used.

Procurement Management Agent is designated to conduct the procurement services of products and services (including fund management, preparing tenders, contracts) for GAEC on behalf of the Recipient. The Agent is an impartial and specialized organization that will render services according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the Agreed Minutes ("A/M").

2. Preparatory Survey

1) Contents of the Survey

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

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- Evaluation of relevance of the Project to be implemented under the Grant Aid Scheme for Environment and Climate Change from a technical, social, and economic point of view.
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The content of GAEC will be determined in accordance with the Notes exchanged by the two Governments concerned, in which items including, objectives of the project, period of execution, conditions and amount of the Grant Aid are confirmed.

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c) The Recipient will conclude a contract with the Agent.
d) The Agent is the representative acting in the name of the Recipient concerning all transfers of funds to the Agent.

3) Focal points of "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change"
a) The Agent
The Agent is the organization, which provides procurement of products and services on behalf of the Recipient according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the A/M.

b) Agent Agreement
The Recipient will conclude the Agent Agreement, in principle, within two months after the signing of the G/A, in accordance with the A/M. The scope of the Agent's services will be clearly specified in the Agent Agreement.

c) Approval of the Agent Agreement
The Agent Agreement is prepared as two identical documents and the copy of the Agent Agreement will be submitted to JICA by the Recipient through the Agent. JICA confirms whether the Agent Agreement is concluded in conformity with the E/N, A/M, and G/A and the Procurement Guidelines for the Program Grant Aid for Environment and Climate Change then approves the Agent Agreement.

The Agent Agreement concluded between the Recipient and the Agent will become effective after the approval by JICA in a written form.

d) Payment Methods
The Agent Agreement will stipulate that "Regarding all transfers of the fund to the Agent, the Recipient will designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA")to conduct the transfer of the fund (hereinafter referred to as "the Advances") to the Procurement Account from the Recipient Account.

The Agent Agreement will clearly state that the payment to the Agent will be made in Japanese yen from the Advances and that the final payment to the Agent will be made when the total remaining amount become less than three percent (3%) of the Grant and its accrued interests excluding the Agent's fees.

e) Products and Services Eligible for Procurement

Products and services to be procured will be selected from those defined in the G/A.

f) Firm and Consultant
The firm and consultant who would contract with the Agent shall be Japanese Nationals.

The consultants that will be employed to do detail design and supervise the work for the Project, however will be in principle, Japanese nationals recommended by JICA for the purpose of maintaining technical consistency with the Study.

g) Method of Procurement
When conducting the procurement, sufficient attention will be paid to transparency in selecting the firms and for this purpose, competitive tendering will be employed in principle.

h) Tender Documents
The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by GAEC.

The rights and obligations of the Recipient, the Agent and the firms supplying products and services should be stipulated in the tender documents to be prepared by the Agent. Aside from this, the tender documents will be prepared in consultation with the Recipient.

i) Pre-qualification Examination of Tenderers
The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The pre-qualification examination should be performed only with respect to whether the prospective tenderers have the capability of concluding the contracts.

For this, the following points should be taken into consideration:
(1) Experience and past performance in contracts of similar kind
(2) Financial credibility (including assets such as real estate)
(3) Existence of offices and other items to be specified in the tender documents.
(4) Their potentialities to use necessary personnel and facilities.

j) Tender Evaluation
The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenderers which substantially conform to the technical specifications and other stipulations of the tender documents, will be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price will be designated as the successful tenderer.

The Agent will submit a detailed evaluation report of tenders to JICA for its information, while the notification of the results to the tenderers will not be premised on the confirmation by JICA.

k) Additional procurement
If there is any remaining balance after the competitive and/or selective tendering and/or direct negotiation for a contract, and if the Recipient would like to procure additional items, the Agent is allowed to conduct this additional procurement, following the points mentioned below:
(1) Procurement of same products and services

When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged not efficient, additional procurement can be conducted by a negotiated contract with the successful tenderer of the initial tender.

(2) Other procurements
When products and services other than those mentioned above in (1) are to be procured, the procurement should be conducted through competitive tendering. In this case, the products and services for additional procurement will be selected from among those in accordance with the G/A.

l) Conclusion of the Contracts
In order to procure products and services in accordance with the guideline, the Agent will conclude contracts with firms selected by tendering or other methods.

m) Terms of Payment
The contract will clearly state the terms of payment. The Agent will make payment from the "advances," against the submission of the necessary documents from the firm on the basis of the conditions specified in the contract. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

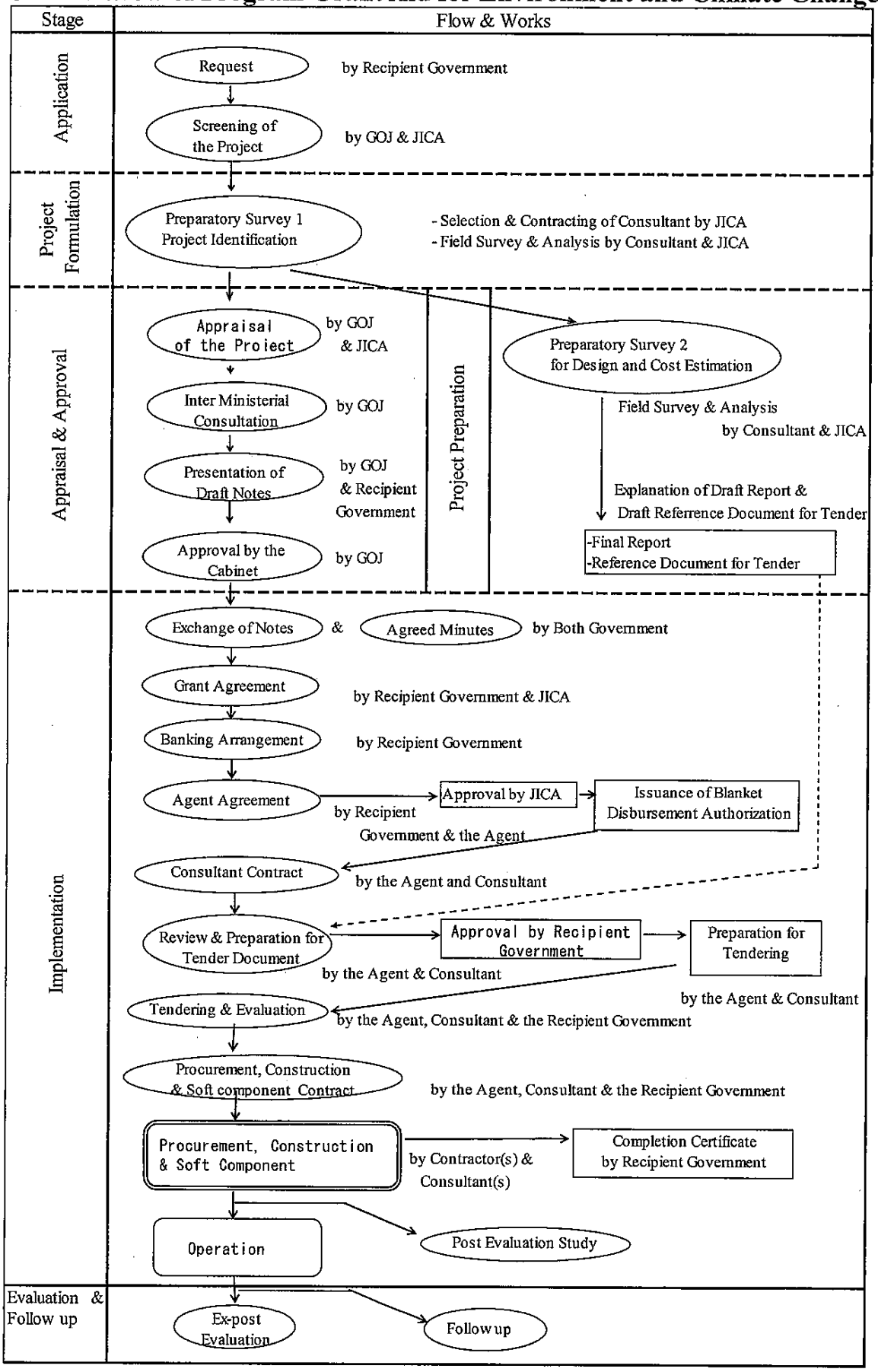
4) Undertakings required by the Government of the Recipient Country
In the implementation of the Grant Aid Project, the Recipient is required to undertake necessary measures as the following:

a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the Project.
b) To provide facilities for distributing electricity, water supply and drainage and other incidental facilities in and around the sites.
c) To ensure all the expense and prompt execution for unloading, customs clearing at the port of disembarkation and domestic transportation of products purchased under the Grant Aid,
d) To ensure that customs duty, internal taxes and other fiscal levies that may be imposed in the Recipient with respect to the purchase of the Components and the Agent's services will be exempted by the Government of the Recipient.
e) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work.

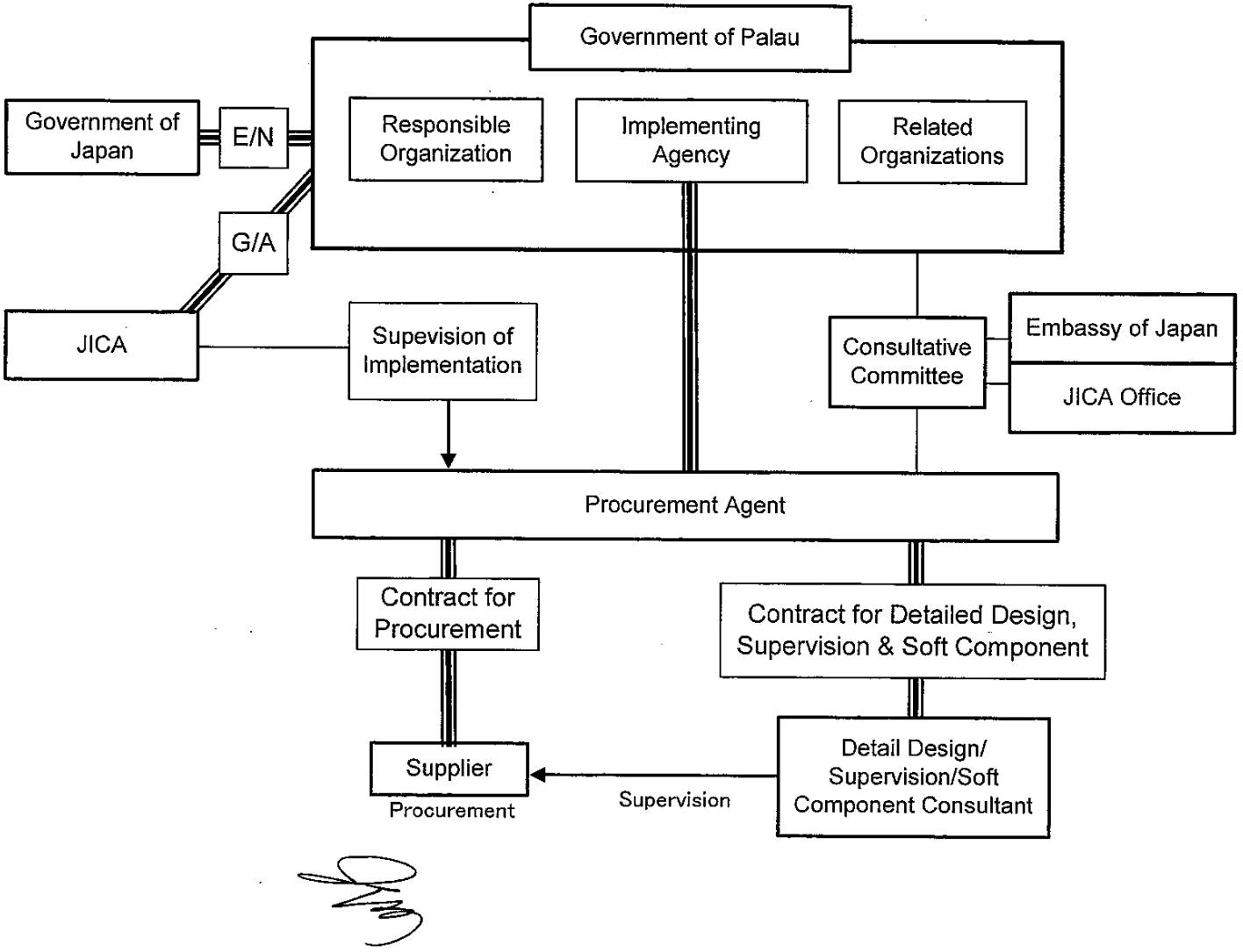
5) "Proper use of funds"
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign personnel necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

6) "Export and Re-export" of products
The products purchased under the Grant and its accrued interest will not be exported or re-exported from the Recipient.

General Flow of Program Grant Aid for Environment and Climate Change

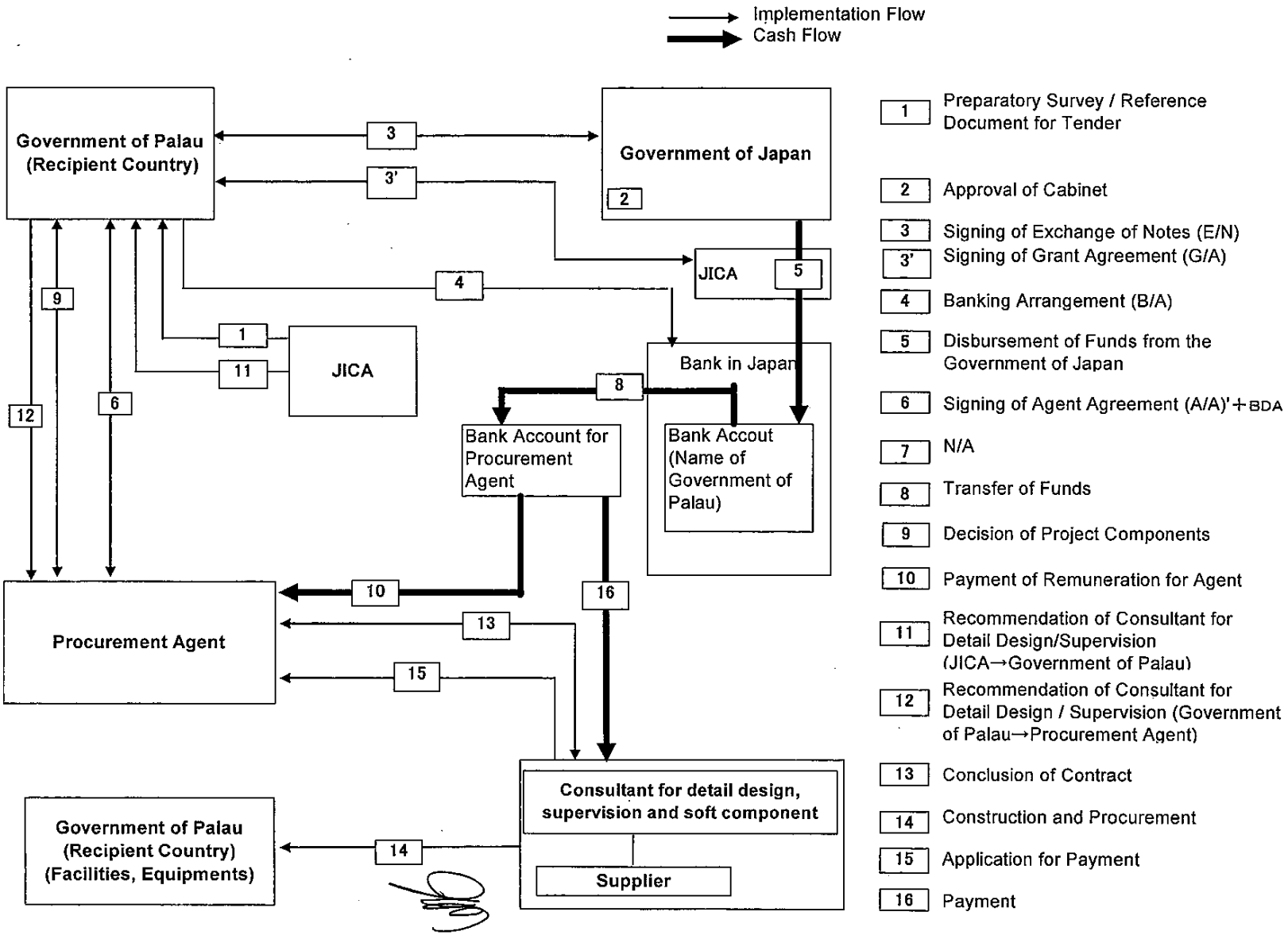


Project Implementation System



Flow of Funds for Project Implementation

Flow of Funds for Project Implementation



Annex –2

List of Equipments

1-1 List of Equipments
The following table shows a list of equipments procured under the Project.

Item No.	Name of Equipment	Quantity	Final Delivery Point (Site)
1	Photovoltaic Module	889 pcs.	Palau International Airport
2	Mounting structure for Photovoltaic Module	1 lot	Palau International Airport
3	Junction Box	20 unit	Palau International Airport
4	Collecting Box	4 unit	Palau International Airport
5	Power conditioner	2 unit	Palau International Airport
6	Transformer	1 unit	Palau International Airport
7	Display board	1 lot	Palau International Airport
8	Data management and monitoring system	1 lot	Palau International Airport
9	Cables and Conduits	1 lot	Palau International Airport
10	Test Equipment	1 lot	Palau International Airport
11	Maintenance Tools	1 lot	Palau International Airport
12	Spare Parts	1 lot	Palau International Airport

5. SOFT COMPONENT

(TECHNICAL ASSISTANCE) PLAN

5. Soft Component Plan

(1) Background

In Palau, because almost all of the power supply in the country depends on diesel power generation at present, and there are consideration for environment and concerns for crude oil prices and transportation costs, departure from the fossil fuel dependence in the energy and electricity sector is considered as an urgent task, and development of systems using renewable energy such as PV generation is considered as a priority issue in the development policy. At present, "Palau National Energy Policy" is being established mainly by Energy Office, which has become an organization directly under President Office since June, 2009. According to its first draft, the potential of PV generation and wind-power generation is considered to be promising among renewable energies, and the dissemination of grid-connected PV systems, which do not require batteries, is especially required among PV generation systems.

The responsible organization for the Plan of the Program Grant Aid for Environment and Climate Change (the Project) which will introduce the grid-connected PV system is Ministry of Public Infrastructure, Industries and Commerce (MPIIC), because the Project site (Palau International Airport) is administered by Bureau of Aviation and Bureau of Aviation is under MPIIC. As for the implementing agency, Palau Public Utilities Corporation (PPUC) will possess the system and will take charge of the O&M in the same manner as ordinary power equipment, because the PV system introduced by the Project will be connected to the existing grid. In addition, Energy Office of Public Works Bureau, which takes charge of the power and energy policy in Palau, also participates in to share with PPUC the data acquired from the introduced grid-connected PV system and contribute to the dissemination of the system in the future.

Power supply business is implemented by PPUC consistently. Although PPUC has not been privatized or incorporated, it is run as an organization independent from the government based on the income of electricity tariff, receiving no subsidy from the government. PPUC is composed of six departments: Auxiliary Services, Accounting and Finance, Business Office, System Control, Power Distribution and Power Generation Department. It is a relatively small organization composed of 130 staff (as of July, 2009). The management system is well organized. For example, job contents and responsibility of each worker, ability required, etc., are clearly described in the documents, and the office regulations are defined according to the duty position. However, workers who have sufficient knowledge and engineering expertise to carry out the O&M of power system are few in number, and there is no person in charge of renewable energy and energy saving. For the implementation of the Project, therefore, it is required that PPUC establishes the O&M system of the grid-connected PV system within PPUC in collaboration with Bureau of Aviation in MPIIC and Energy Office.

As for the introduction cases of PV systems in Palau, both the "stand-alone PV system" and "grid-connected PV system" have already been introduced in the past. Thus, it is considered that a base to acquire technical knowledge on PV systems has been made. However, it seems that continuous operations have not been achieved in both systems, and local staffs are requesting more fulfilling technology transfer. With regard to the "stand-alone PV system," in particular, small-scale stand-alone PV systems mainly for household use have been introduced in large

quantity in un-electrified areas since 1980's, but most of them are not used at present due to problems in O&M. Under the conditions described above, it is difficult for staffs of the Energy Office of Public Works Bureau or the PPUC to master adequate technology on PV systems through their daily work. Therefore, the proper technical transfer on the O&M of the introduced facilities into the implementing agency of the Project, PPUC, over the broad-and-shallow range from a basic level on PV generation to an application level on the O&M of PV facilities, dividing the process into several steps and confirming the establishment of knowledge will be able to promote the continuous and smooth O&M of the grid-connected PV system introduced by the Project.

The current issues concerning the O&M of PV system are as follows;

- ✓ The necessary structure for O&M of grid-connected PV system is not established.
- ✓ Technical knowledge and skills for grid-connected PV system is not enough.
- ✓ The concept and methodology for O&M of grid-connected PV system is not established.
- ✓ Trouble-shooting for grid-connected PV system is difficult.
- ✓ Electricity tariff structure for grid-connected PV system is not established.

Table 2.2.4-2 Current problems and measures for improvement

Current problems	Measures for improvement	Necessary soft-component
▪ The necessary structure for O&M of grid-connected PV system is not established	▪ PPUC establishes the O&M system within PPUC.	▪ Make a proposal on the segmentalization and specification of O&M system, and discuss it with the persons concerned.
▪ Technical knowledge and skills for grid-connected PV system is not enough	▪ Implement technical training on PV systems including the technical issues to be considered when the introduction of the grid-connected PV system.	▪ Conduct proper technical training on PV systems.
▪ The concept and methodology for O&M of grid-connected PV system is not established	▪ Prepare the O&M manual of the grid-connected PV system. ▪ Implement training on monitoring, such as the monitoring method, periodical inspection method, etc.	▪ Support implementation guidance on the manual. ▪ Conduct proper technical training on monitoring.
▪ Trouble-shooting for grid-connected PV system is difficult	▪ Create the O&M manual including troubleshooting ▪ Conduct implementation guidance on the manual and educational activities so that the O&M are properly done.	▪ Support implementation guidance on the manual. ▪ ditto
▪ Electricity tariff structure for grid-connected PV system is not established	▪ Determine most appropriate electricity tariff.	▪ Make a proposal on most appropriate electricity tariff, and discuss it with the person concerned.

Source: created by JICA study team

(2) Goal

The goal is that PPUC, the implementing agency of the Project, comes to be able to implement continuous and smooth O&M assuming PPUC owns the facilities based on the O&M manual.

(3) Outcome

1) The O&M manual of the grid-connected PV system introduced in the Project, including troubleshooting, is created.
2) Basic knowledge on the grid-connected PV system introduced in the Project is acquired, and the O&M of the facilities is carried out continuously.
3) The most appropriate electricity tariff is determined (if necessary), and a continuous and smooth O&M system is established.

The following activities will be implemented to achieve the above outcomes.

Concerning the grid-connected PV system, in Palau, both the “stand-alone PV system” and “grid-connected PV system” have already been introduced. However, it seems that continuous operations have not been achieved in both systems. One of the main reasons of that would be insufficient technical transfer. It is considered that a base to acquire technical knowledge on PV systems has been made, but the basic knowledge on them has not taken root in the country yet. Therefore, training covering a broad range from a basic level on PV generation to an application level on the O&M of PV facilities is implemented in the Project. Table 2 shows the specific contents which are divided into Category 1 to 4. The implementation process of each category is implemented in certain intervals to promote the steady and efficient settlement and is implemented four times totally.

Concerning the necessary number of days, the implementation contents are covered broadly from documentation (Ex; manuals) with mutual cooperation with Palau to the technical transfer and the confirmation of the settlement. Therefore, the one week is considered as the minimum unit of the necessary number of days in order to follow the steps of this plan steadily. And concerning the member of the consultant, the necessary members are 2 persons (1 manager and 1 staff), because in the preparation of the manuals, the formation of 2 teams can promote the efficiency of the work and in the lecture, 1 staff as the lecturer and other staff as the assistance can promote the effective lecture.

Table 2 Contents of training

Category	Specific contents (purpose)	Man Month	
1. Establishment of the O&M system	1.1 Clarification of the responsibility of individuals who carry out the O&M	0.25MMx2persons	Total 1.00MMx2persons
	1.2 Proposal on the most appropriate electricity tariff	0.25MMx2persons	
	1.3 Creation of the O&M manual in collaboration with Palau side	0.50MMx2persons	
2. Technical training	2.1 Principle and basic knowledge of PV systems	0.25MMx2persons	Total 1.25MMx2persons
	2.2 Characteristics of grid-connected PV systems	0.25MMx2persons	
	2.3 Matters to be examined when a grid-connected PV system is introduced.		
	2.4 Installation	0.25MMx2persons	
	2.5 Inspection		
	2.6 Operation		
	2.7 Maintenance		
	2.8 Troubleshooting	0.50MMx2persons	
3. Institutional Training	3.1 Collection method of electricity tariff	0.25MMx2persons	Total 0.75MMx2persons
	3.2 Optimizing O&M manual	0.25MMx2persons	
	3.3 Evaluation of the O&M system	0.25MMx2persons	
4. Monitoring	4.1 Optimizing monitoring method	0.25MMx2persons	Total 1.00MMx2persons
	4.2 Periodical inspection	0.25MMx2persons	
	4.3 Evaluation items	0.25MMx2persons	
	4.4 Report of monitoring results	0.25MMx2persons	
Total		4.00MMx2persons	

Source: created by JICA study team

(4) Method to confirm the achievement of outcome

The implementation schedule shall be divided into 4 steps. Category 1-4 in Table 2 shall be conducted in each step. The achievement of each step shall be confirmed and evaluated as follows;

Category 1: Evaluation and instruction for O&M Manual

Category 2: Making report for the Item 2.1-2.3 in Table 2, and making report and technical evaluation for the Item 2.4-2.8 in Table 2

Category 3: Interview survey to O&M staff and evaluation of the actual field work

Category 4: Interview survey to O&M staff and evaluation of the actual field work

(5) Activity for Soft Component

1) Content

The implementation contents of the soft component in order to understand and implement the specific methods of the O&M for the introduced grid-connected PV system are shown in Table 2.

2) Implementation of Orientation

Collaboration work among MPIIC, PPUC and Energy Office is indispensable for the implementation of soft component. The consultant will hold the orientation to explain and obtain consents on the objectives, contents, activity schedule of the soft component to the Palau side.

3) Establishment of Soft Component Committee

Soft component committee shall be established mainly by PPUC in order to implement the soft component and promote the sustainable operation of the system. The committee shall act as the liaison function of the soft component, and shall be periodically held in order to ensure sustainable operation and maintenance of the PV system during the implementation of the Project. The committee shall be considered as the opportunity to check the progress of the soft component, exchange opinion and discuss among concerned parties.

And the consultant shall support Palau to carry on the elements of the soft component committee in this plan, if Palau will judge the carrying on the elements of the soft component committee is necessary.

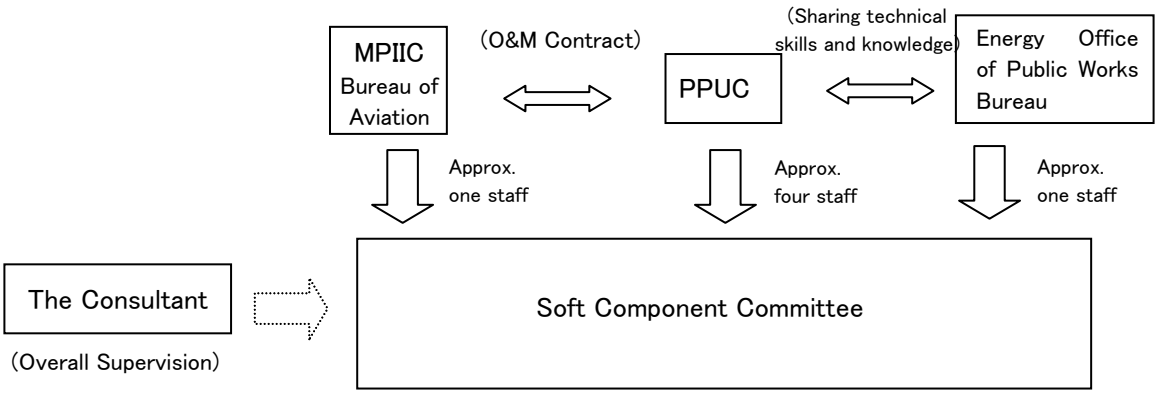
4) O&M Manual

During the implementation of the Project, PPUC is requested to work out the O&M Manual in collaboration with the consultant. In order to draw the initiative from Palau side, PPUC shall be the main body to make the draft of the Manual while the consultant will evaluate, provide necessary comments and feedback on it. The Manual shall also contain the method for trouble-shooting.

(6) Procurement of necessary resources for Soft Component

In order to implement the soft component effectively and efficiently, the soft component committee shall be established. The soft component committee, together with close collaboration with the consultant, shall be the main body for the operation and maintenance of PV system after installation of the Project. The Committee shall be constructed mainly by PPUC in collaboration with Bureau of Aviation in MPIIC and Energy Office. Specifically, the Committee shall be composed of approximately four members (the staff in charge of O&M, his or her manager),

approximately one staff from Bureau of Aviation in MPIIC, and approximately one staff from Energy Office. Proposed framework for the implementation of soft component is shown as follows.



Source: created by JICA study team

Figure - 1 Proposed Framework for the implementation of Soft Component

Table - 3 The Role and Responsibility of each Party

Responsible Party	Japanese Consultant	PPUC	MPIIC Bureau of Aviation	Energy Office
Member of Soft Component Committee	2 staff	Approx. 4 staff (O&M staff & Managers)	Approx. 1 staff (O&M staff)	Approx. 1 staff (O&M staff)
Operation Method for Soft Component Committee	Management of the overall progress	➢ Management of the overall work ➢ Actual O&M	Actual O&M	Sharing actual data
Electricity Tariff	Propose	Examination and final decision	Examination and final decision	Advice
Workshop	Explanation	Main body	Assistance	Assistance
O&M Manual	Advice	Making Draft	Advice	Advice
Follow-up for O&M	Management and guidance	Submission of the result	Advice	Advice
Reporting to	Embassy of Japan in Palau and JICA Office	Japanese Consultant	-	-

The introduced grid-connected PV system in the Project is going to be the Japanese products and is going to conform to the guidelines for technical requirements of the interconnection concerning power quality in Japan. Therefore, it is desirable that the implementer in this plan is Japanese consultant who knows the guideline totally.

(7) Implementation Schedule for the Soft Component

The implementation process is shown in Figure 2. The training is implemented according to the category shown in Table 2. The implementation time of each category is as follows:

Category 1 : Implemented before the installation of facilities because this training is done to facilitate the establishment of the O&M system, and because, by clarifying the

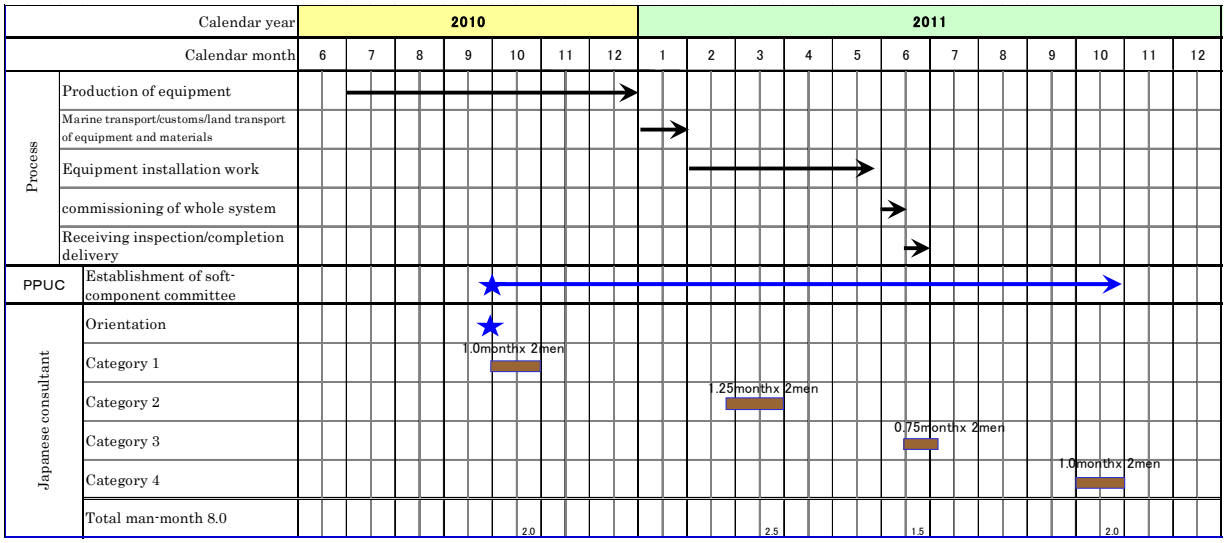
O&M system before the facility installation, awareness as the person in charge can be raised at the time of installation.

Category 2 : Implemented in the middle of the installation work because this training, concerning the installation, inspection, operation, etc., is done using actual facilities.

Category 3 : Implemented before the operation of the facilities starts because this training is related to the O&M manual, etc., that should be prepared before the start of the operation.

Category 4 : Implemented approximate four months after the completion of the installation because the focus of this training is to confirm that the Palau side can carry out the O&M by themselves.

The O&M structure shall be established from the beginning in the Project, because the equipment and materials are newly procured and installed under the Project. Therefore, the soft component shall be commenced before the installation works start.



*The progress report will be submitted after each category

Figure - 2 Proposed Schedule for the implementation of Soft Component

(8) Output of the Soft Component

Following output shall be obtained through implementation of the soft component.

1) Record for holding the Orientation

2) Minutes of Discussion for the Soft Component Committee

3) Progress Report

4) Report to confirm the actual understanding

5) Result of the interview survey to O&M staff and actual work progress by the O&M staff

6) O&M Manual

(9) Required Responsibility to the Palau side

1) PPUC shall establish the Soft Component Committee in collaboration with Bureau of Aviation in MPIIC and Energy Office.

2) PPUC shall prepare necessary work space and rooms in collaboration with Bureau of Aviation in MPIIC and Energy Office.

3) PPUC, Bureau of Aviation in MPIIC and Energy Office shall provide necessary staff for the implementation of the soft component.

4) Soft Component Committee shall work out the O&M Manual in coordination with the Consultant.

5) PPUC and Bureau of Aviation in MPIIC shall examine and determine the most appropriate electricity tariff for the introduced Grid-connected PV system based on the proposal by the Consultant.

6) PPUC, Bureau of Aviation in MPIIC and Energy Office shall appropriately operate and maintain the Grid-connected PV system based on the O&M Manual.

7) PPUC shall submit the report of the result and the progress of the operation and maintenance to Japanese Consultant during the period specified under the O&M Manual.

6. EXPECTED BENEFITS OF THE PROJECT

APPENDIX 6 Expected Benefits of the Project

(1) Reduction effect of diesel fuel consumption

Fuel consumption per unit generated-energy (kWh) was calculated as follows based on the operation records of diesel generation facilities in Aimeliik power plant and Malakal power plant in 2008 and 2009 obtained from PPUC.

Table - 1 Fuel consumption in the diesel power plant

	2008			2009					Ave. over 9 months
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Generated energy [kWh]	7,022,425	6,634,519	7,124,622	7,003,895	6,119,674	6,977,381	5,925,488	6,964,466	-
Fuel consumption [liter]	1,939,105	1,847,288	1,987,806	1,962,405	1,704,556	1,967,261	1,692,656	1,972,708	-
Fuel consumption per kWh [liter/kWh]	0.28	0.28	0.28	0.28	0.28	0.28	0.29	0.28	0.28

Source: created by JICA study team based on a material from PPUC

Using the above result, diesel fuel reduction until 2016, which is the target year of this project, is calculated as shown in Table-2.

Table – 2 Yearly diesel fuel reduction

	2011	2012	2013	2014	2015	2016	Total
Yearly diesel fuel reduction [liter]	54,472	54,472	54,472	54,472	54,472	54,472	326,835

Source: created by JICA study team

(2) Reduction effect of CO2 emission

Based on the calculation result of the yearly diesel fuel reduction shown in Table-2, the reduction effect of CO_2 emission is calculated using the following factor.

CO2 reduction [kg] = CO2 emission factor of light oil * Diesel oil reduction
= 2.62 [kg-CO2/liter] * Diesel oil reduction [liter]
* The emission factor is cited from "Guideline for the calculation of the amount of emission" by Global Environment Bureau of the Ministry of the Environment (March, 2007).

Consequently, yearly CO_2 emission reduction is calculated as shown in Table-3. CO_2 emission can be reduced by a total of 761 ton during six years from 2011 to 2016.

Table - 3 Yearly CO2 emission reduction

	2011	2012	2013	2014	2015	2016	Total
CO_2 emission reduction[kg]	142,718	142,718	142,718	142,718	142,718	142,718	856,306

Source: created by JICA study team