KOSRAE UTILITIES AUTHORITY (KUA)
FEDERATED STATES OF MICRONESIA

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR
POWER SECTOR IMPROVEMENT
FOR THE STATE OF KOSRAE
IN
FEDERATED STATES OF MICRONESIA

APRIL 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Yachiyo Engineering Co., Ltd..

The survey team held a series of discussions with the officials concerned of the Government of the Federated States of Micronesia, and conducted a field investigations. As a result of further studies in Japan, 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.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Federated States of Micronesia for their close cooperation extended to the survey team.

April, 2016

Yoshinobu IKURA
Director General,
Industrial Development and Public Policy Department Department
Japan International Cooperation Agency

SUMMARY

(1) Country Profile

The Federated States of Micronesia, having a population of approximately 110,000 and area of approximately 702 km^2, is situated in the northern Pacific Ocean. It is an island nation composed of four states, namely Yap, Chuuk, Pohnpei, and Kosrae. In terms of economy, the Federated States of Micronesia has no major industries other than fisheries, agriculture and tourism, and it depends on imports to provide almost all daily necessities. In 1986, the Government of the Federated States of Micronesia concluded the Compact of Free Association with the United States which guaranteed financial assistance by the US for a period of 15 years until 2001. The Compact was renewed in December 2003, guaranteeing the continuation of financial support from the United States for another 20 years from 2004 to 2023. Economic assistance under the Compact has amounted to approximately US$92,000,000, making this an important source of funds for the Micronesian economy.

(2) Background of the Grant Aid and Outline of the Request

In Kosrae State, based on the FSM National Energy Policy that was compiled by the Government of the Federated States of Micronesia in 2010, Kosrae State Energy Action Plans 2013 have been compiled with the following stated objective: “To supply economical, reliable and environmentally friendly energy and improve the lives of all people in Kosrae State.” In the Project site of Kosrae State (population approximately 6,600, area approximately 110 km^2), the power utility is operated by the Kosrae Utilities Authority (KUA), which operates three diesel generators with combined capacity of 2,600 kW (as of January 2016)) with respect to a peak power demand of 1,140 kW (November 2014). However, two out of three of these units have already exceeded their intended service lives and are experiencing frequent troubles and unscheduled interruptions due to deterioration, thereby imparting serious impacts in terms of harming he living environment and quality of public services for the residents of Kosrae State and damaging the tourism industry. In addition, the associated power distribution equipment (1975) and underground cables (1986) are also badly deteriorated as a result of long-term exposure to the local harsh natural conditions. Meanwhile, since there are plans to construct a new hospital, factory and port facilities and the demand for power is expected to grow from now on, it is urgently necessary for Kosrae State to achieve the efficient and stable supply of power in order to support people’s lives. Against such a background, the Government of the Federated States of Micronesia made a request to the Government of Japan for the provision of grant aid to renew primary diesel generating facilities and associated distribution facilities in Kosrae State.

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

In response to the request, JICA dispatched the Preparatory Survey Team to Kosrae State on January 12 till January 22, 2015 (the first field survey), March 8 till March 29, 2015 (the second field survey), and October 4 till October 14, 2015 (additional field survey) in order to reconfirm the contents of the request and discuss the contents of implementation with the related parties in Kosrae State (the Line agency: Kosrae State Government (KSG), and the Executing agency: Kosrae Utilities Authority (KUA)), and to survey the Project site and collect associated materials.

After returning to Japan, the Survey Team examined the necessity, social and economic effects, and validity of the requested Project and compiled the findings into the Project Preparatory Survey Report (draft). JICA dispatched the Survey Team to Kosrae State for the third field survey (outline explanation) between January 22 and January 30, 2016, during which the Team conducted explanations and discussions of the Project Preparatory Survey Report (draft) and reached a basic agreement with the related officials on Kosrae State side.

The Project that was compiled as a result of the Survey aims to procure and install two 600 kW diesel generators and construct a generator house at Tofol Power Station, and to conduct the full renewal of the Lelu Island distribution network and underground cables leading to Okat Area. The following table shows an outline of the basic plan of the Project.

Outline of the Project

Contents of Plan		Number of Units
Procurement and installation of equipment	1. Diesel engine generator	
	1.1 Diesel engine	2 units
	1.2 AC generator	2 units
	1.3 Common board	2 units
	2. Diesel generator auxiliary unit (mechanical)	
	2.1 Fuel supply equipment	1 set
	2.2 Lubricating oil equipment	1 set
	2.3 Cooling water equipment	1 set
	2.4 Compressed air equipment	1 set
	2.5 Ventilation equipment	1 set
	2.6 Waste oil disposal equipment	1 set
	2.7 Wire materials and pipe	1 set
	3. Diesel generator auxiliary unit (electrical)	
	3.1 13.8 kV circuit breaker equipment	1 set
	3.2 Control equipment	1 set
	3.3 In-station power equipment	1 set
	4. 13.8 kV distribution equipment	
	4.1 13.8kV overhead distribution line (Lelu Island)	1 set
	4.2 15kV underground cable (Okat Area)	1 set
Procurement	1. Power generation maintenance tools	1 set
	2. Replacement parts	1 set
	3. Emergency spare parts	1 set
Construction	1. Diesel generator house (floor area: approx. 588 m^2)	1 set
	2. Diesel generator and auxiliary unit foundations	1 set

(4) Project construction Schedule and Cost Estimation

In the case where the Project is implemented under the grant aid scheme of the Government of Japan, the rough cost burden on the Federated States of Micronesia side is estimated to be approximately 9 million yen.

The main items to be borne by the Federated States of Micronesia side will be the renewal of low-voltage lines of the Lelu Island distribution line (approximately 5.3 million yen), removal of obstructions from the scheduled construction site and installation of the gate and perimeter fence for the new power station (approximately 700,000 yen). The Project work schedule including the implementation design will be approximately 22.5 months.

(5) Project Evaluation

1) Relevance

Since the Project will contribute to the realization of the Federated States of Micronesia development plans and energy policy and impart benefits to all 6,600 residents of Kosrae State, it is deemed to have a high degree of relevance.

2) Effectiveness

a) Quantitative Effects

Indicator	Reference Value (2014)	Target Value (Following project completion in March 2021)
Power generating equipment capacity installed in the Project (kW)	0	1,200
Tofol Power Station Total generating capacity (MWh) *1	5,463	7,450
Power supply interruptions (times/year) *2	48	24
Fuel consumption per unit of generated power (g/kWh) *3	234	229

[Notes] *1: Total generating capacity obtained by adding the Project to the existing G-8 unit (1,000kW) and the diesel generator G9 unit scheduled for assistance by the WB (planned as 600kW). This does not include solar power generating equipment.
*2: Number of power interruptions per year (unscheduled and scheduled interruptions)
*3: Fuel consumption regarding the total generating capacity of the Project plus the existing G-8 unit and the diesel generator G9 unit scheduled for assistance by the WB

b) Qualitative Effects

Current Conditions and Problems	Project Measures (Grant Aid Project)	Degree of Projects Effects and Improvement
1. Two out of three generators in operation at Tofol Power Station in Kosrae State have been operating for 31 and 25 years respectively, and troubles and unscheduled power interruptions are frequently caused by the equipment deterioration. This triggers problems such as deterioration of the living environment and decline of public services for residents, and damage to tourism in Kosrae State. Moreover, it is urgently necessary to respond to scheduled increase in demand of approximately 460 kW.	Construct a new power station, renew the deteriorated generators, and thereby improve fuel consumption and secure backup capacity.	Through renewing the generating equipment, troubles and power interruptions caused by deteriorated equipment will be reduced and stable power supply will be achieved, thereby leading to improvement in the living environment and public services for residents, and tourism in Kosrae State. This will improve the living standard of residents and public service and make it possible to respond to the planned increase in demand.
2. Power supply to Lelu Island is distributed along overhead lines composed of wooden poles and bare wire lines. This distribution line was constructed in 1975 and has been operating for almost 40 years; moreover, due to harsh natural conditions (salt damage, heavy rain, insect damage, etc.) and deterioration over time, the poles and lines are badly deteriorated and unable to provide stable power supply.	Conduct renewal of the distribution line to Lelu Island, and thereby reduce unscheduled power interruptions.	Through renewing the distribution line, it will become possible to supply power to Lelu Island, which has high population concentration, and this will lead to improvement in the living environment and public services for residents.
3. Power supply to the airport island (Okat) is conducted through two 2,065m underground cable lines that were constructed along the causeway in 1986. However, one of the lines has been disconnected, while the remaining line, which is deteriorated, supplies power to the airport facilities (the physical distribution gateway to Kosrae State), large-scale fuel storage facilities, landing facilities and so on. Therefore, in addition to urgently replacing the disconnected cable, it is necessary to replace the other deteriorated cable that has been in use for approximately 29 years and thereby secure stable electricity supply.	Through replacing two power distribution lines, power supply to the airport island will be made more secure.	Through replacing the two power distribution lines, it will be possible to conduct stable power supply, thereby vitalizing activities at the airport facilities, large-scale fuel storage facilities, landing facilities and so on. Operation of these facilities will lead to improvement in the living environment and public services for residents of Kosrae State.

Since implementation of the Project can be expected to impart immense effects as described above, it is deemed to have a high degree of relevance for implementation under the grant aid scheme of the Government of Japan. Moreover, the Micronesia side is deemed to possess sufficient personnel and funding to ensure there is no problem concerning implementation of the Project and operation and maintenance following implementation.

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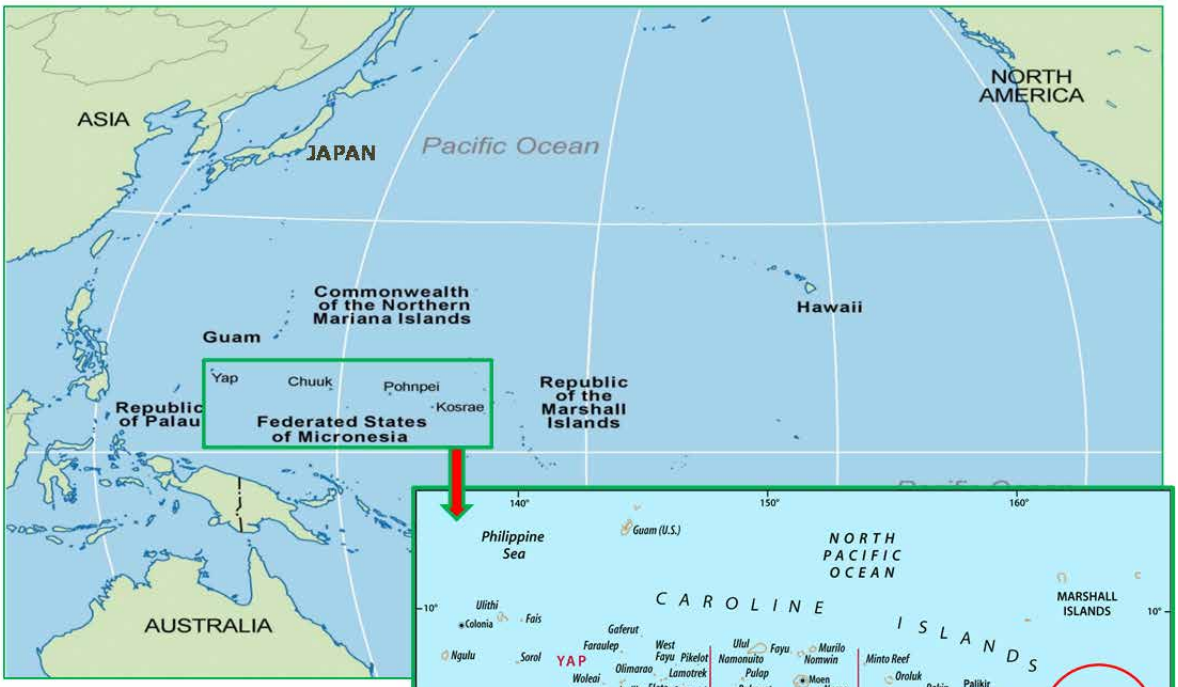
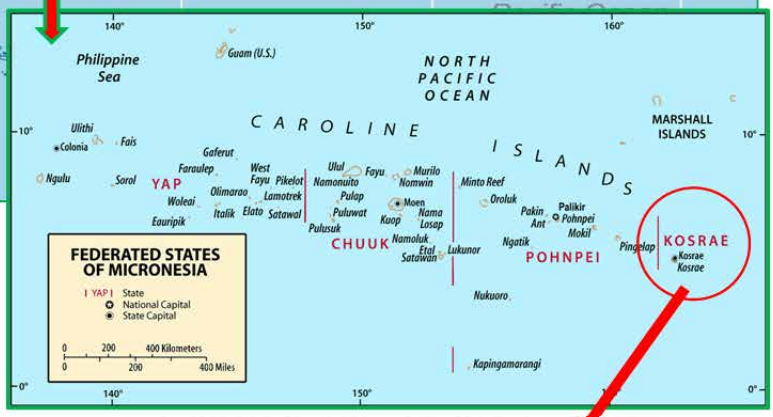
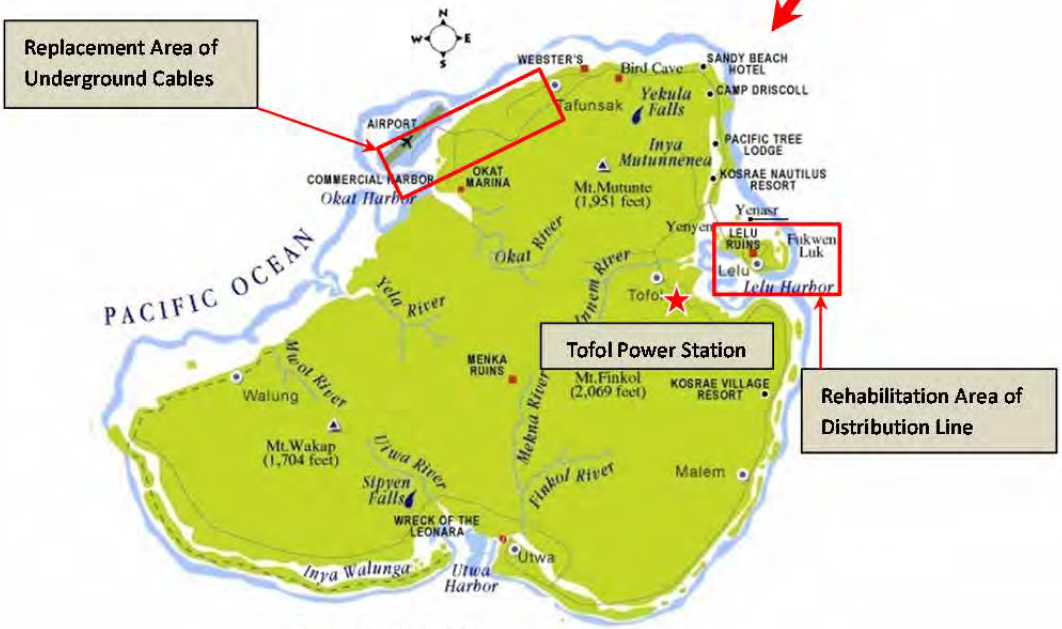


Location of the
Federated States of Micronesia



Location of the States of Kosrae



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LOCATION OF PROJECT SITE

PERSPECTIVE

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ABBREVIATIONS

ADB	Asian Development Bank
AIJ	Architectural Institute of Japan
ANSI	American National Standards Institute
ASEAN	Association of Southeast Asian Nations
ASTM	American Society for Testing and Materials
COM	College of Micronesia
DAC	Development Assistance Committee
DESD	Division of Environment and Sustainable Development
DPS	Division of Public Safety
E/N	Exchange of Notes
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EU	European Union
IEEE	The Institute of Electrical and Electronics Engineers
FRP	Fiber-Glass Reinforced Plastic
FSM	Federated States of Micronesia
G/A	Grant Agreement
GDP	Gross Domestic Product
GNI	Gross National Income
IEC	International Electrotechnical Commission
IEE	Initial Environmental Examination
IOM	International Organization for Migration
IP	International Protection
ISO	International Organization for Standards
JCS	Japanese Electrical Wire and Cable Maker's Association Standards
JEC	Japanese Electrotechnical Committee
JEM	Standards of Japan Electrical Manufacturer's Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
KEMA	Keuring Elektrotechnische Materialen Arnhem
KIRMA	Kosrae Island Resource Management Authority
KSDP	Kosrae State Strategic Development Plan
KUA	Kosrae Utilities Authority
KSG	Kosrae State Government
NEMA	National Electrical Manufacturers Association
NGO	Non-Governmental Organization
NOx	Nitrogen Oxides
O & M	Operation and Maintenance
OEEM	Office of Environment and Emergency Management
OJT	On the Job Training
PEC	Pacific Environment Community

PMU	Project Management Unit
PV	Photovoltaic
SEA	Strategic Environmental Assessment
SI	The International System of Units
SOx	Sulfur Oxides
TOR	Terms Of Reference
WB	World Bank
WCPFC	Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
WHO	World Health Organization

CHAPTER 1 BACKGROUND OF THE PROJECT

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1-1 Background of the Grant Aid and Outline of the Request

The Federated States of Micronesia (with population of approximately 110,000 and area of approximately 702 km^2) is an island nation situated in the northern Pacific Ocean. In terms of economy, the Federated States of Micronesia has no major industries other than fisheries, agriculture and tourism, and it depends on imports to provide almost all daily necessities. In each state, diesel generators are mainly used to supply electric power, however, due to equipment deterioration, declining generating efficiency, and the effects of inflation on fuel prices up to the middle of 2014, the power tariff is expensive (US$0.59/kWh in 2014, US$0.52/kWh in 2015) and this is placing a heavy economic burden on citizens.

In these circumstances, the central government of the Federated States of Micronesia has compiled the FSM National Energy Policy 2010 in which it aims to achieve the provision and utilization of cost-effective, safe, reliable and sustainable electric power services geared to national social and economic development, and within this the improvement of deteriorated generation, transmission and distribution facilities is an issue that demands urgent attention.

In the Project site of Kosrae State (population approximately 6,600, area approximately 110 km^2), the power utility is operated by the Kosrae Utilities Authority (KUA), which operates three diesel generators with combined capacity of 2,615 kW (as of October 2015) with respect to a peak power demand of 1,140 kW (October 2015). Out of these three generators (G-4 unit: introduced in 1984 with maximum output of 400 kW, G-6 unit: started operation in 1990, 1,200 kW, and G-8 unit: started operation in 2008, 1,000 kW), the G-4 and G-6 units have already exceeded their intended service lives and are experiencing declining generating efficiency and reliability. Moreover, the associated power transformation equipment (1983), underground cables (1975), and power distribution equipment (1986) are also badly deteriorated as a result of long-term exposure to the local harsh natural conditions (salt damage, heavy rain, pest damage, etc.). Meanwhile, since there are plans to construct new private sector storage facilities, etc. and the demand for power from the industrial sector is expected to grow from now on, it is urgently necessary for Kosrae State to achieve the efficient and stable supply of power in order to support people's lives.

Against such a background, the Government of the Federated States of Micronesia made a request to the Government of Japan for the provision of grant aid renew primary diesel generating facilities and associated transformation, transmission and distribution facilities in Kosrae State.

1-2 Current Conditions and Issues

(1) Current Conditions of Power Generation Equipment

The power utility in Kosrae State is operated by Kosrae Utilities Authority (KUA), which conducts power generation through to power supply to consumers. KUA mainly uses diesel generators to generate power, however, it also operates 300 kWp of photovoltaic (solar power) generating equipment, comprising a 200 kWp unit since April 2015 (constructed under assistance from the Pacific Environment Community (PEC)) and a 100 kWp unit (constructed under assistance from the European Union (EU)) since December 2015. However, due to failures caused by the deterioration of diesel generators, and frequent stoppages and scheduled interruptions of generation due to poor maintenance of distribution equipment, there were a total of 48 power outages in fiscal 2014.

Moreover, since Kosrae State only has a population of around 6,600, far less than in other states[1], its power system, 1.1 MW, is also small. Also, due to inflation in the price of fuel for power generation (diesel oil) (peaking in 2014), KUA's operating balance had displayed a deficit in recent years (US$86,000 in fiscal 2014), although it showed signs of improvement by recording a surplus of approximately US$40,000 in fiscal 2015 thanks to the start of a decline in the price of fuel oil.

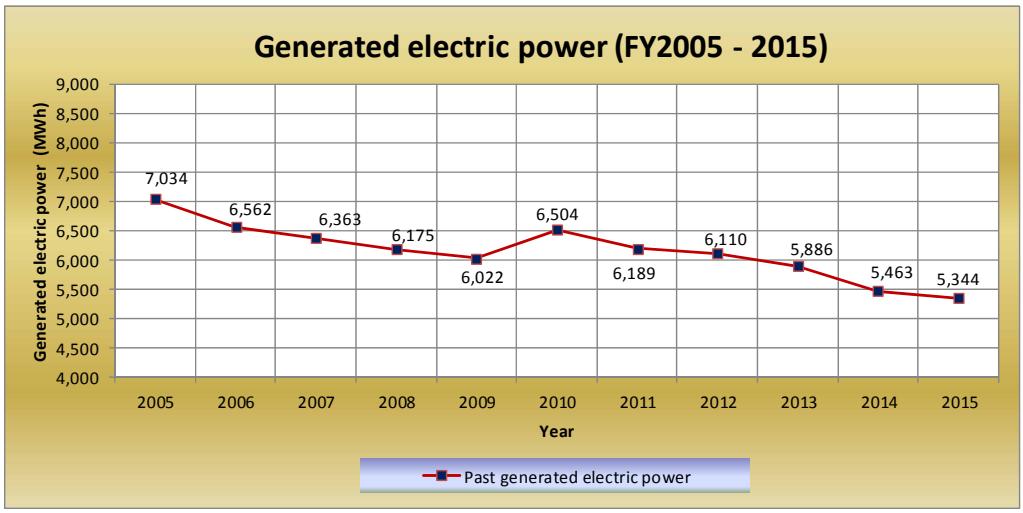
Kosrae State compiled Kosrae State Energy Action Plans 2013 based on the FSM National Energy Policy of 2010, and it aims to increase the ratio of renewable energy in power generation to 30%. Moreover, due to the inflation in KUA's generating fuel expenses that continued until mid-2014, it plans to reduce diesel generation fuel costs. Table 1-2.1 shows the current conditions of diesel generating equipment at KUA's Tofol Power Station (as of January 2016); Figure 1-2.1 shows movements in the annual amount of generated power (including solar power power) between fiscal 2005 and fiscal 2015 (in the Federated States of Micronesia the fiscal year is counted from October to the following September); and Figure 1-2.2 shows the arrangement of diesel generators.

Table 1-2.1 Diesel Generating Equipment in Kosrae State

No.	Rated capacity (kW)	Potential generating capacity (kW)	Rotating speed (rpm)	Manufactured year	Current condition	Remarks
G-2	750	400	-	1980	Stopped	Scrapped
G-3	750	400	-	1984	Stopped	Scrapped
G-4	740	400	1,200	1984	Can be operated	Standby unit
G-6	1,500	1,200	900	1990	Can be operated	Operating
G-7	1,650	1,300	900	1996	Stopped	Scrapped
G-8	1,050	1,000	1200	2007	Can be operated	Operating

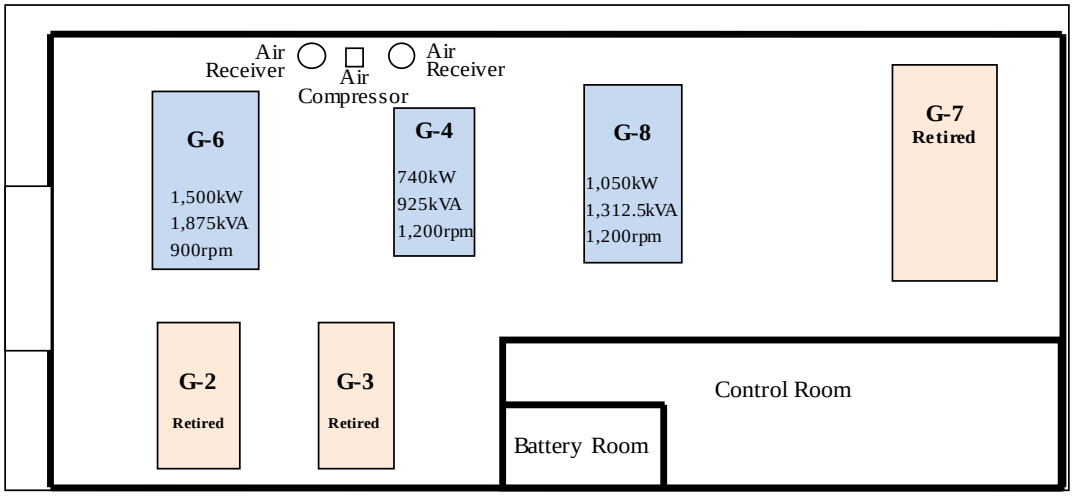
[Source] Kosrae Utilities Authority (KUA)

[1] 36,000 in Pohnpei, 48,600 in Chuuk, and 11,300 in Yap. [Source] The Japanese Embassy in the Federated States of Micronesia, 2013



[Source] Kosrae Utilities Authority (KUA)
(Note) Including 118 MWh of solar power in 2015

Figure 1-2.1 Changes in the Annual Amount of Generated Power by KUA (2005–2015)



[Source] Findings by Kosrae Utilities Authority (KUA) and the JICA Survey Team
(Scrapped equipment)

Figure 1-2.2 Layout of Existing Diesel Generators

As is shown in Figure 1-2.1, the annual generating volume by diesel generators of Tofol Power Station is steadily declining (between 2005 and 2015 it fell by 26% per year from 7,034 MWh to 5,226 MWh), and one of the reasons is thought to be the decline in the population of Kosrae State as shown in Table 1-2.2. Also, KUA mainly adopts the prepaid tariff system, which is adopted over 83% of Kosrae State overall (as of January 2016). Adoption of the prepaid system is thought to be one of the causes for the decline in demand.

Table 1-2.2 Changes in the Population of Kosrae State

Year	Population	Reduction Rate
2000	7,686	
2010	6,616	13.6% decline from 2000

[Source] Kosrae Utilities Authority (KUA)

As of January 2016, Tofol Power Station can only operate three diesel generators, i.e. the G-4, G-6 and G-8 units; however, G-4 has already reached 31 years of operation, while G-6 has reached 25 years. Therefore, in view of the declining generation capability and the service life of the equipment, it is urgently necessary to renew the generating equipment. The G-8 generator was manufactured in 2007 and started operation in 2008. Its operation was suspended for prolonged periods due to failure two times in 2012 and 2014, however, it resumed operation in June 2015 and is currently the main generator in use at Tofol Power Station. The operating condition and main breakdowns of each diesel generator are as follows.

- The G-4 generator currently only has maximum output of around 400 kW due to problems in the engine cooling system. The cause of the problems in the engine cooling system is water leakage triggered by rust, which means that the necessary cooling capacity cannot be realized. In recent years, this unit has been used as backup during breakdown and periodic inspection of the G-6 generator, however, since the G-8 generator started operating again from June 2015, it is now entirely used for backup purposes. When the new generator supplied under World Bank assistance starts operating in 2016, it is scheduled to scrap this unit.

- Concerning the G-6 generator, because the exhaust valve of the No. 6 cylinder is in poor condition, although the KUA data indicates potential output of 1,200 kW, the maximum output currently stands at around 800-900 kW. Raising output any further than this causes the No. 6 cylinder to display abnormal exhaust temperature, so it cannot be done. Since the G-8 generator has started operating again, KUA intends to repair the exhaust valve at an appropriate time. Moreover, once the new generators planned for supply in the Project commence operation, it is scheduled to scrap the G-6 generator or use it entirely for backup purposes.

- The G-8 generator ceased operation when the stator was burned in February 2012, however, a new Chinese stator was fitted and the generator resumed operation within the same year. In September 2014, the generator ceased operation due to a broken cylinder exhaust valve, however, repairs were finished and it resumed operation in June 2015. Since the G-8 generator was manufactured in 2007 and started operation in 2008 and this thus relatively new, KUA intends to use it as the main unit in dual operation with G-6, and this dual operation will continue for the immediate future. According to KUA data, the combined possible output of the G-6 and G-8 generators is 2,200 kW.

Table 1-2.3 shows the existing solar power equipment as of January 2016.

Table 1-2.3 Solar Power Generating Equipment in Kosrae State

No.	Installed location	Rated capacity (kWp)	Installed year	Grid connection method	Aid agency
Solar-1	Parking area of Kosrae state government offices	9.4	2008	Low-voltage connection	EU
Solar-2	KUA car park roof	4.8	2008	Low-voltage connection	EU
Solar-3	Roof of entrance to Kosrae International Airport	6.5	2008	Low-voltage connection	EU
Solar-4	Hospital	15.7	2008	Low-voltage connection	EU
Solar-5	State government assembly building	9.0	2008	Low-voltage connection	EU
Solar-6	Tofol Power Station premises	200.0	April 2015	13.8kV grid connection	PEC
Solar-7	Parking area of Kosrae state government offices	100.0	December 2015	13.8kV grid connection	EU
Total		345.4			

[Source] Findings by Kosrae Utilities Authority (KUA) and the JICA Survey Team

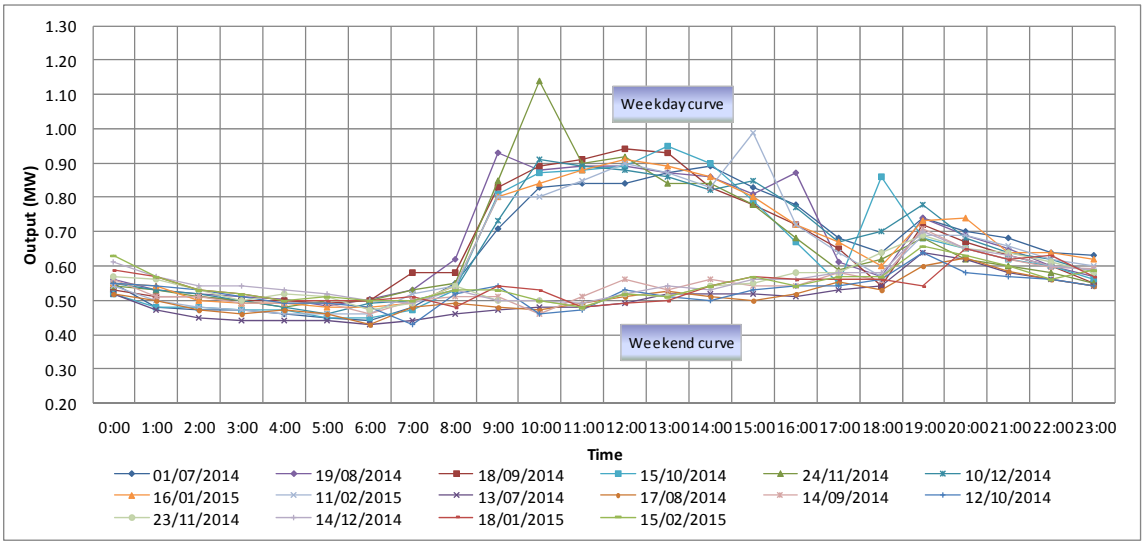
The units Solar-1 to 5 were installed under European Union (EU) assistance in 2008, however, since each of these cater to individual consumers via low-voltage connections and they have small output, they do not exert a great impact on KUA's power generating capability and power quality. Solar-6, which has been installed on the premises of KUA under the Pacific Environment Community Fund (PEC fund), is a solar power system with maximum output of 200 kWp. KUA completed all the installation works by the end of March 2015, after which test adjustments were conducted by the Mitsubishi Electric Corporation of Singapore (the equipment procurement operator), the system was handed over to KUA and it started operation in April that year. As of January 2016, the system is operating smoothly and it is connected to the Malem system. Solar-7, which is a 100 kWp solar power system that was installed in the car park of Kosrae government offices under assistance from the European Union (EU), started operating in December 2015. This unit is connected to Tafunsak system.

Meanwhile, according to Kosrae State Energy Action Plans 2013, it is intended to increase the ratio of renewable energy out of total power generation to 30% by 2020. As is shown in Table 1-2.3, completion of the Solar-7 solar power system has brought the total capacity of solar power systems up to 345.4 kWp, and since the peak power demand of Kosrae State currently stands at 1,320 kW (as of January 2016), comprising the peak power demand of 1,140 kW in 2014 and the load of 180 kW of the trans-shipment facilities that commenced operation in November 2015, this does not exceed the figure of 396.0 kWp that is 30% of the peak demand (1,320kW x 30%). However, the 345.4 kWp total output of solar power systems is approximately 44% of the minimum demand of 780 kW (minimum daytime demand of approximately 670 kW in October 2015 plus the constant load of approximately 110 kW of the trans-shipment facilities) during daytime on weekdays when the solar power systems operate. Even if it is assumed that the solar power systems have power generating efficiency of 70%, their share still comes to approximately

31%. Therefore, if it is assumed that solar power systems are connected to the grid as they are, since it is forecast that the impact on power supply quality will increase, it is necessary to consider the rated capacity and operating modes of generating equipment when selecting the capacity and number of diesel generators to procure in the Project.

At present, it is possible to respond to conditions by controlling the operating mode of diesel generators on weekdays, however, at weekends, because the load falls to half of that on weekdays as shown in Figure 1-2.3, it is not possible to cope simply by controlling the operating mode of diesel generators. Accordingly, the JICA Survey Team proposed to KUA that, on weekends, the solar power system that was constructed under Pacific Environment Community Fund (PEC fund) assistance be closed by 50% (equivalent to roughly 100 kWp) and that an automatic breaker panel that uses a schedule timer be installed in the Project.

Moreover, as more renewable energy generating units come to be installed in Kosrae State from now on, the stability of power supply quality will become an increasingly important issue. Therefore, it is necessary for Kosrae State and KUA to consider the additional installation of quality stabilization equipment (system stabilization equipment, capacitors, storage batteries, etc.) in order to ensure that frequency fluctuations and voltage fluctuations are held to prescribed levels. In this respect, as of January 2016, KUA has submitted a request for storage battery equipment to the EU.



[Source] Kosrae Utilities Authority (KUA)

Figure 1-2.3 Daily Load Curve (July 2014~February 2015)

(2) Current Conditions and Problems of Substations

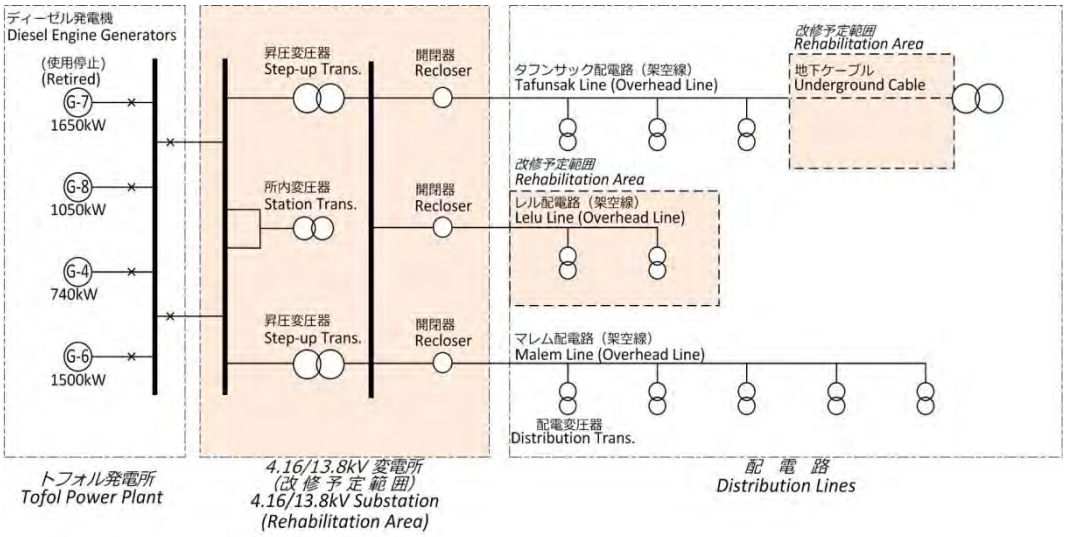
Since the voltage of power generated in existing generators is 4,160 V, KUA steps it up to 13,800V, and it operates an outdoor substation for distributing power to consumers, next to the generator house. The substation is composed of two step-up transformers (2,500 kVA, 4.16/13.8 kV, 60Hz) and three 13.8 kV distribution circuit breakers. It started operation in 1983 and has been in service for over 30 years (the step-up transformers were renewed 10 years ago).

However, due to the harsh natural conditions on Kosrae Island and deterioration over time, the iron frames at the substation have become rusty and many of the relays and instruments are no longer functional, so it is urgently necessary to conduct a full-scale rehabilitation. Considering the harsh natural conditions on Kosrae Island, the related equipment will be installed inside the generator house to be constructed in the Project. Concerning the two step-up transformers, since these have been in service for approximately 10 years, they have no defective parts and they possess large capacity of 2.5 MW, considering that the current peak power is roughly 1.1 MW, they are deemed to be fit for continued use.

(3) Current Conditions and Problems of Lelu Island Distribution Line

Power distribution equipment in the Federated States of Micronesia is designed and constructed according to the American standard. At the substation inside the power station premises, step-up transformers raise the voltage of generated power (3 phase, 4160 V, 60 Hz) to 13.8 kV, after which the power is distributed at 13.8 kV via 3 phase 4 wire lines, and then it is stepped down to 240/120 V via pole transformers for connection to consumers' households. Protective equipment on the side of users consists of fuses on the primary side having the objective of protecting the pole transformers. (Figure 1-2.4 shows the power distribution system diagram on Kosrae Island).

Power supply to Lelu Island is distributed along overhead lines composed of wooden poles and bare wire lines (3 phase, 13.8 kV, 60 Hz) constructed on the causeway, and the power is then stepped down to 240/120 V via pole transformers for connection to consumers' households. Since this distribution line was constructed in 1975 and has been operating for almost 40 years, the poles and lines have become badly deteriorated and are unable to provide stable power supply to approximately 300 households on the island due to harsh natural conditions (salt damage, heavy rain, insect damage, etc.) and deterioration over time. Therefore, in the Project, it is intended to conduct full renewal of the 13.8 kV distribution line from the entrance to the causeway that connects to Lelu Island. Moreover, it has been agreed that KUA will implement the renewal and rehabilitation of the low-voltage distribution lines.



[Source] Taken by the JICA Study Team

Figure 1-2.4 Power Distribution System Diagram on Kosrae Island

(4) Current Conditions and Problems of the Distribution Cable to the Airport Island

Power supply to the airport island (Okat) is conducted through two approximately 2.1km underground cables (13.8kV, AWG1/0, XLPE aluminum cable) that were constructed along the causeway in 1986. However, one of the cables has been disconnected, while the remaining cable, which is deteriorated, supplies power to the airport facilities, large-scale fuel storage facilities, port facilities and so on. Therefore, since the cable still being used has been in service for 28 years, beyond its scheduled service life, and could fail at any moment, it has been decided to replace both cables in the Project.

As is shown in Figure 1-2.4, the power distribution network on Kosrae Island currently comprises three distribution lines: Tafunsak, Lelu and Malem; the power system is based on 13.8kV, 3 phase, 4 wire, 60 Hz supply, and this is stepped down to 240/120 V via pole transformers for distribution to consumer households. Upon checking with KUA, the JICA Survey Team found that the sections intended for renewal in the Project are the entire Lelu distribution line, and the underground cable of the Tafunsak line leading to the Airport Island (Okat).

(5) Power Loss

One type of loss is non-load loss (core loss) in step-up transformers. Judging from the peak power in Kosrae State at present, even though the required capacity of step-up transformers is between 1,200~1,500 kVA, the two existing step-up transformers have capacity of 2,500 kVA, and this is thought to be one cause of the power loss. Therefore, in the Project, it is planned to reduce the power loss through adopting a system that generates power at the distribution voltage of 13.8 kV, thereby making the step-up transformers unnecessary.

As specific records of power loss, Table 1-2.4 shows the results of the power loss calculations

indicated in the report on power loss restoration that was prepared in 2010 by the Dutch energy consultant KEMA Co. at the request of PPA. According to this report, the power loss in Kosrae State in 2010 was approximately 12%, of which 6% was technical loss. The KEMA Co. report, targeting KUA in Kosrae State, shows the results of survey of utility companies in 10 islands in the North Pacific. According to this report, currently two generators with rated output of more than 1,000 kW supply power to the Kosrae power system, where the peak demand is approximately 1,100 kW (850~900 kW on weekdays) and minimum demand is 400 kW or less, and it points out that high fuel consumption of 10~15% is one of the factors behind the poor profitability of KUA.

Table 1-2.4 Power Loss Calculated in the KEMA Report

	MWh	% of Generation	% of System Consumption	KEMA Comments
Annual Generation	6,022			
Annual Station Auxiliary	300	5.00%		Reasonable
Annual System Consumption	5,722	95.00%		
Annual Energy Sold w/o Street Lights	5,014	83.00%		
System Loss	708	11.76%	12.38%	
Unbilled Usage	156	2.58%	2.72%	Need better control
Technical Loss	352	5.85%	6.16%	Some better control
Non Technical Loss	201	3.33%	3.51%	Reasonable

[Source] KEMA Report ("Quantification of Energy Efficiency in the Utilities of the U.S. Affiliate States") June 2010

(6) Records of Power Outages

Table 1-2.5, and Table 1-2.6 shows the number of power outages, outage time and causes of power outages in Kosrae State in 2013 and 2014. The number of power outages increased by 1.6 times in 2014, although the total outage time and mean outage time were down by 66% and 41% respectively compared to 2013.

According to hearings with KUA, concerning the causes of power outages, cases arising from ① generators increased a lot from five to 12 in 2014. The reason for the increased number of outages was stoppage of operation caused by breakdown of the G-8 cylinder exhaust valve until August. Outages arising from ② distribution lines are more common than generator outages (14 times and 12 times), and these arise from shorting failures caused by the deterioration of distribution lines and the harsh natural conditions (salt damage, heavy rain, insect damage, etc.). Outages of unknown causes (③) and outages caused by poor weather (④) amount to 24 times per year. The outages caused by poor weather are thought to consist of shorting failures caused by contact by trees with distribution lines. The duration of outages was approximately 1 hour in 2014, so assuming there are four outages per month, there is approximately 45 hours of outage time per year. Incidentally, the annual outage time recorded by Tokyo Electric Power in 2013 in general houses was 5 minutes.

Table 1-2.5 Power Outage Records for 2013

(G-6 operation at normal times, G-4 standby operation)

Period	Number of outages	Total outage time	Average time per outage	Causes of outage			
				Generator	Distribution line	Unknown	Poor weather
2012 October ~ December	10	1,629 min	163min (2h 43min)	2	4	1	3
2013 January ~ March	4	485 min	121min (2h 1min)	1	3	-	-
2013 April ~ June	7	652 min	93 min (1h 33min)	1	3	1	2
2013 July ~ September	9	1,318 min	146 min (2h 26min)	1	4	1	3
Total	30	4,084 min	136 min (2h 16min)	5	14	3	8

[Source] Kosrae Utilities Authority (KUA)

Table 1-2.6 Power Outage Records for 2014

(G-6 and G-8 operation at normal times, G-4 standby operation)

Period	Number of outages	Total outage time	Average time per outage	Causes of outage			
				Generator	Distribution line	Unknown	Poor weather
2013 October ~ December	4	138min	34.5min (0.58 h)	-	2	-	2
2014 January ~ March	20	1,272min	63.6min (1h 4min)	5	4	5	6
2014 April ~ June	6	211min	35.2min (0.59h)	2	2	-	2
2014 July ~ September	18	1,062min	59min (0.98h)	5	4	5	4
Total	48	2,685min	56 min (0.93h)	12	12	10	14

[Source] Kosrae Utilities Authority (KUA)

(7) Projected Power Demand

1) Power Demand as confirmed in the second field survey

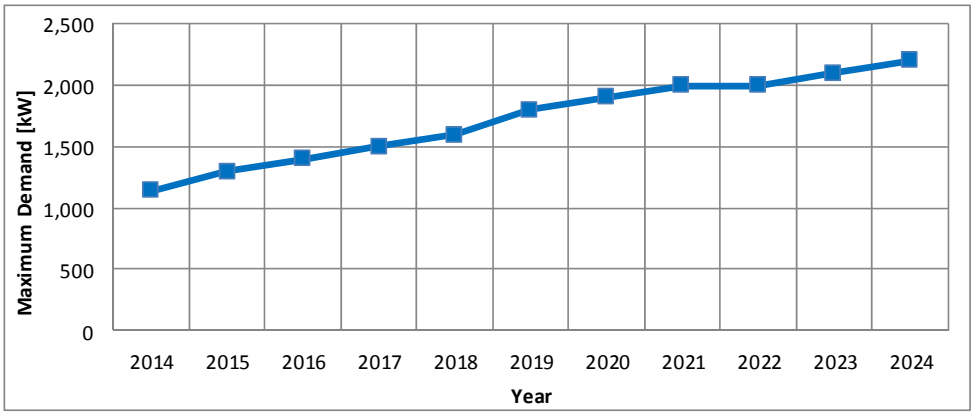
As was indicated in Figure 1-2.1 (Changes in the Annual Amount of Generated Power by KUA), power generation by KUA has declined continuously over the past 10 years (2005~2015).

Concerning peak power demand, in the first survey (January 2015), KUA projected the peak demand shown in Figure 1-2.5 over the next 10 years (up to 2024). It assumed that new demand would occur at ① the hospital (200kW), ② a school (100kW) and ③ a fish trans-shipment container facility at the port (500 kW) that were scheduled for construction.

However, in the detailed discussions and investigation in the second survey (March 2015), no concrete basis for this increase in demand was confirmed. Therefore, at the end of the second survey, the JICA Survey Team determined that the power demand and number of consumers in Kosrae State in the near future will remain more or less consistent with levels in 2014 and secured consent from the Federated States of Micronesia side.

* Peak power demand :1,140 kW
* Minimum power demand (weekdays: a.m.9:00 – p.m.4:00) :670 kW
* Minimum power demand (weekends: a.m.9:00 – p.m.4:00) :460 kW

At the same time, the JICA Survey Team secured consent from the Federated States of Micronesia side to take these conditions into account when calculating the capacity and number of units of diesel generators in the Project.



[Source] Kosrae Utilities Authority (KUA)

Figure 1-2.5 Demand Forecast prepared by KUA

As is shown in the daily load curve for the past year (Figure 1-2.3) for the period from July 2014 to February 15, 2015, concerning the daily load pattern, it was confirmed that there is little difference between weekdays and weekends for the hours between 18:00 and 08:00 the next day, however, a major disparity arises for the hours between 08:00 and 18:00. Moreover, the load pattern is almost the same on both weekdays and weekends.

2) Power Demand Projection

With respect to the power demand that was calculated based on the aforementioned transitions in power demand, from June 2015 onwards, Kosrae State Government and KUA submitted information on the construction plans of the four facilities shown in Table 1-2.7 to the JICA Survey Team and requested that these facilities be reflected in the power demand projections.

In response, the JICA Survey Team implemented the third field survey in October 2015 in order to confirm the contents of the new plans. The JICA Survey Team concluded that it is appropriate to take these new loads into account in the future demand for power.

In addition, Figure 1-2.6 shows the peak power demand forecast for Kosrae State for three years after completion of the Project works. This was compiled upon once more confirming the construction status of new facilities when conducting explanations of the Preparatory Survey Report (draft) in January 2016. The peak demand at the start of 2019 (scheduled year of completion of the four new facilities) is 1,601 kW (peak demand in October 2015 1,140 kW +

new peak power demand 461 kW), and this is forecast to continue rising until 2021.

[Source] Findings by Kosrae Utilities Authority (KUA) and the JICA Survey Team

Figure 1-2.6 Changes in and Projection of Peak Power Demand

Also, Table 1-2.7 shows the facilities that have been requested by Kosrae State Government and KUA as new demand sources from June 2015. The table shows the peak load and regular load of each facility.

Table 1-2.7 New Construction Plans and Power Demand (as of October 2015)

	Peak Load (kW)	Regular Load (kW)	Notes
a. Fish Transshipment Facilities	180 kW	110 kW	15 Containers, One (1) container' load is Max. 12 kW and Regular 7.3 kW.
b. Water Bottling Facility	180 kW	126 kW	Peak load = Incoming transformer's capacity. Regular load is 70% of peak load.
c. Dr.A.P.Sigrah Memorial Hospital	101 kW	71 kW	Existing peak load is 240 kW; New peak load is 341 kW. Regular load is 70% of peak load.
d. Malem Elementary School	-	-	No additional demand was confirmed. (New school is same as existing one).
Total additional load	461 kW	307 kW	

[Source] Survey findings by Kosrae Utilities Authority (KUA) and the JICA Survey Team as of October 2015

The following Table 1-2.7 describes the scheduled timing of the start of operations and gives an outline of the above facilities.

a. The fish transshipment facilities (frozen container facilities), which are located in Kosrae Port, were completed in November 2015 and are already operating. They are operated by a Chinese enterprise.

b. The water bottling facility is scheduled to resume operations following purchase of facilities and equipment that were used until a few years ago by an Australian company. The facility previously used two 300 kW generators, however, due to the high cost of fuel, it plans to newly draw electricity from KUA. KUA has already installed the pole transformer for leading in the power, however, construction of approximately 1.5 km of distribution line (13.8 kV 60Hz) is not yet finished. As soon as the distribution line is completed, the facility will be able to conduct test operation. It is envisaged that test operation will begin by the beginning of April 2016 at the latest.

c. Dr. A. P. Sigrah Memorial Hospital, which entails the rebuilding of an existing hospital, is being constructed by the Federated States of Micronesia PMU (Project Management Unit) under support from the United States. The project tender and evaluation is scheduled to be started in 2016, and the hospital is scheduled to be completed by the end of 2018. The peak power demand following the rebuilding work is estimated by PMU and KUA to be 341 kW, which is 101 kW higher than in the previous hospital (240 kW).

d. Malem Elementary School is scheduled for rebuilding due to deterioration, however, it has been confirmed that this will not entail any major changes in the size of the school building or power demand, etc.

The projected peak power demand in 2021 (three years following completion of the Project) with the inclusion of the aforementioned new demand in addition to the current power demand described in the previous section is as follows. The peak power at the beginning of 2019 (year in which the four new facilities will be completed) will be 1,601 kW (current peak power of 1,140kW + new peak power of 461 kW).

* Peak power demand: :1,601 kW
  (current peak power of 1,140kW + new peak power of 461 kW)
* Minimum power demand (weekdays: a.m.9:00 – p.m.4:00) :977 kW
  (current peak power of 670 kW + new peak power of 307 kW)
* Minimum power demand (weekends: a.m.9:00 – p.m.4:00) :510 kW
  (current peak power of 460 kW + new peak power of 50 kW)

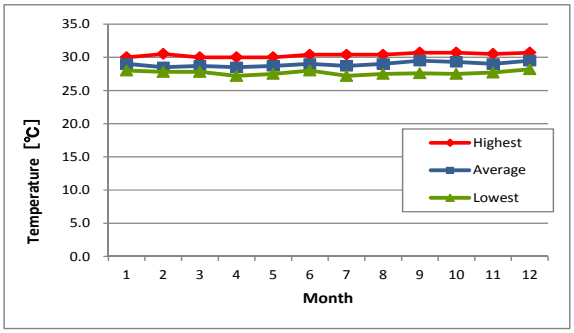
(8) Electrification Situation and Electrification Rate

According to hearings with KUA, the electrification rate of Kosrae State is currently approximately 95%. Electrification has been slow in the district of Walung (roughly 150 households), which doesn't have road access, although a road construction project is currently being implemented using machinery procured under Japanese non-project aid.

1-3 Natural Conditions

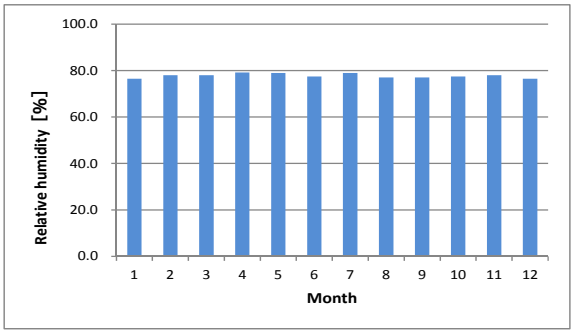
(1) Temperature, Precipitation and Relative Humidity

Figure 1-3.1 through Figure 1-3.4 show the temperature, relative humidity, rainfall and rainy day graphs for Kosrae State. For temperature and relative humidity, monthly mean values for the period from 2012 to 2014 are shown. The average maximum temperature throughout the year is around 30°C, and humidity is high. For precipitation and the number of rainy days, average monthly totals are shown. Rain falls all year round and reaches 5,000 mm or more. There are no marked rainy seasons and dry seasons.



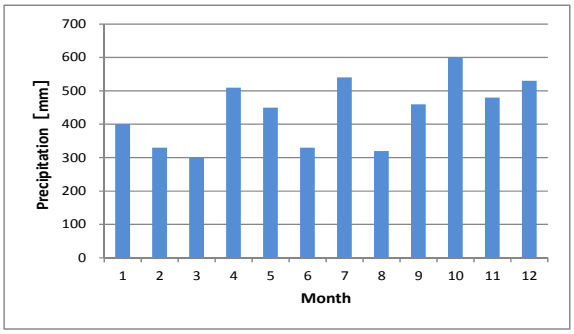
[Source] Kosrae Port Authority

Figure 1-3.1 Monthly Temperature



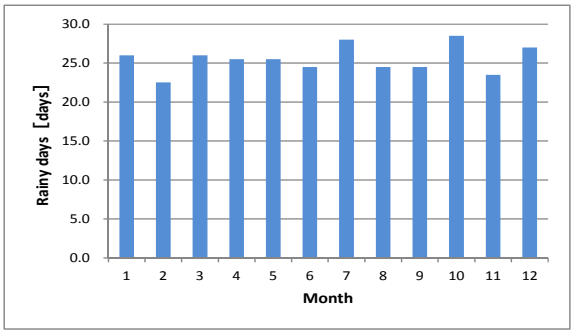
[Source] Kosrae Port Authority

Figure 1-3.2 Monthly Relative Humidity



[Source] Kosrae Port Authority

Figure 1-3.3 Monthly Precipitation

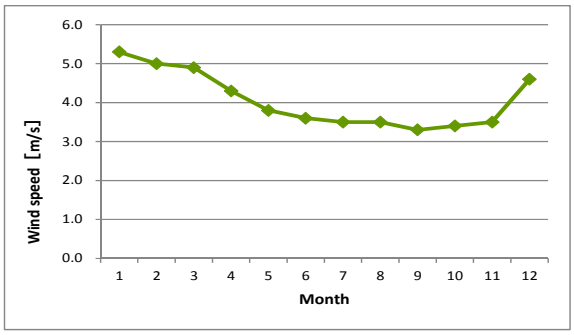


[Source] Kosrae Port Authority

Figure 1-3.4 Monthly Rainy Days

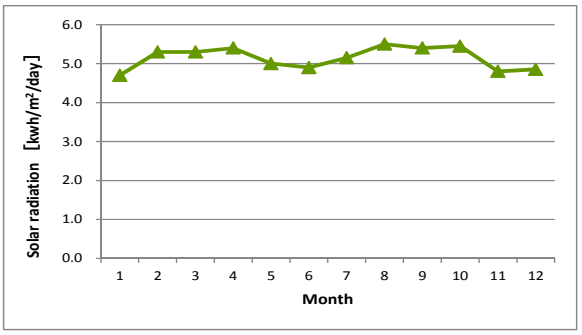
(2) Wind Speed and Solar Radiation

Figure 1-3.5 shows average wind speeds in Kosrae State. Mean wind speeds are shown by month for the period from 2012 to 2014. The average wind speed for the year is 4.1 [m/s]. According to KUA, winds are rarely strong enough to have an impact on power facilities, etc., and no typhoon has approached the islands in decades. Figure 1-3.6 shows the monthly average solar radiation. The average solar radiation for the year is 5.16 [kWh/m^2/day].



[Source] Kosrae Port Authority

Figure 1-3.5 Monthly Wind Speed



[Source] Federated States of Micronesia, Energy Policy

Figure 1-3.6 Monthly Solar Radiation

1-4 Environmental and Social Consideration

(1) Outline of Project Components that Impart Environmental and Social Impacts

The Project components comprise renewal of the diesel generators, other equipment and substation at Tofol Power Station in Kosrae State, renewal of power distribution equipment on Lelu Island, and renewal of power distribution cables to the airport island (Okat District). Environmental and social consideration will be implemented for (1) renewal of Tofol Power Station (including renewal of substation equipment), (2) renewal of power distribution line to Lelu Island, and (3) renewal of underground cable to the airport island (Okat District) (see Table 1-4.1)

Table 1-4.1 Project Components and Sites

	Project Component	Project Site
(1)	**Renewal of Tofol Power Station** * Installation of diesel generator Installation of generator auxiliary unit and electrical equipment	Tofol Power Station
(2)	**Renewal of distribution cable (Lelu Island)** * Renewal of distribution line (set of overhead distribution line equipment and materials)	Existing distribution line on Lelu Island
(3)	**Renewal of underground cables** * Renewal of spare underground line (overhead polyethylene cable)	Existing buried distribution line between Kosrae and Okat

(2) Base Environmental and Social Conditions

1) Conditions of the Project Sites

a) Tofol Power Station

Tofol Power Station, where it is intended to conduct renewal of the diesel generators and transformation equipment, is located on the main road of Tofol, the state capital of Kosrae Island, in the area where administrative agencies such as the police station, law courts and state government offices are concentrated. The station grounds covering approximately 2,200 mm^3 contain the generator house and main facilities comprising a substation, workshop, garage, five fuel tanks, three waste oil tanks, and KUA Headquarters (offices). On the south side of the station grounds, a solar power generating facility (200 kWp) is in operation.

The Project target site and surrounding land, except for the utilized parts, is covered in vegetation. The state high school and junior college are situated approximately 200 m northwest of the station, and the state hospital is approximately 300 m to the west.

The nearest residential land is located approximately 400 m northwest of the site.

Table 1-4.2 gives an overview of the land use situation.

Table 1-4.2 Land Use around Tofol Power Station

North side	Kosrae State government building and the police station are situated across the site perimeter and trunk road.
East side	The gas station used by state government vehicles is adjacent. East of that, across the trunk rod, there is a state government-designated waste landfill site at the bottom of the slope. There are also a garage and workshop that belong to the state government.
West side	There are private sector facilities leased by the state government, as well as barren land and natural forest. On the west side are hills that reach around 50m in height.
South side	The land is barren and covered in shrubs. There are no buildings.

Target site north side
(Kosrae State government building)

Target site east side (waste landfill)

Target site west side (barren land)

Target site south side
(barren land on a higher level)

[Source] Taken by the JICA Study Team

Photograph 1-4.1 Area around Tofol Power Station

b) Lelu Island distribution line

Power supply to Lelu Island, which is situated roughly 2 km from Tofol, is conducted along a distribution line constructed along a causeway approximately 250 m long that branches from Kosrae Island. On the island, the distribution line (not including the section on the causeway) is approximately 3,600 m long and is connected to approximately 300 households. Lelu Island has the highest population concentration within Kosrae State. This is where the Lelu Dynasty prospered from the 11th Century to around the 15th Century, and it is now an important historical and cultural site.

The distribution line mainly stretches along roads, and the wooden poles are erected alongside roads, within roadside forests, or in the yards of private homes. The trees situated around the distribution line reach around the same height as the poles, and there are even places where leaves and branches come into contact with the distribution line.

(Utility pole beside the road in front of a house)　　(Utility poles on private property)

[Source] Taken by the JICA Study Team

Photograph 1-4.2 Area around Existing Distribution Line on Lelu Island

c) Existing underground distribution line between Kosrae Island~Okat

Power to Okat, which contains the airport, port loading/unloading docks, fuel storage tanks and air rescue facilities, is supplied through underground cable that stretches for approximately 2,065 m. The underground distribution line branches underground via a conduit tube that starts from the utility pole near the entrance to Okat district and leads to Okat via manholes and pipes buried under the road. All buried pipes are situated under roads, and wire threading and other words can all be performed from manholes. Moreover, since this component only entails the replacement of existing cable, it will not require any excavation or other civil engineering works.

At the entrance to Okat district, the area around the road over the distribution line comprises trees on the Kosrae Island side and mangroves on the ocean side. Moreover, the bridge leading to Okat is currently being expanded under aid from China.

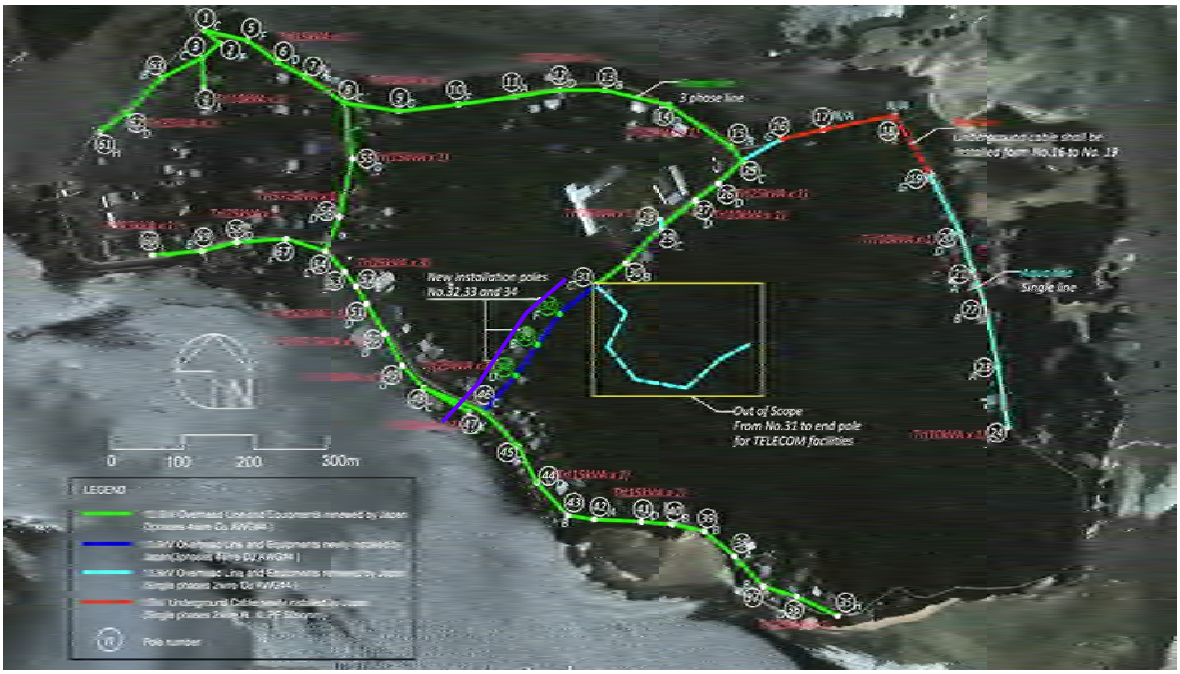
(3) Necessity for Land Acquisition and Resettlement of Residents

The underground distribution line to Tofol Power Station is located on land owned by the state government, and there are no residents here. During the 1980~1990s, the state government signed a long-term lease agreement (roughly 99 years) with landowners concerning the land for the existing distribution line, road and other infrastructure on Lelu Island. In the Project too, basically it is scheduled to utilize the existing distribution line land. Therefore, there will be no need to acquire land or resettle residents in the Project.

However, concerning the Lelu Island distribution line, it is planned to transfer and newly install the line over the following two sections (Figure 1-4.1). Since almost all land on Lelu Island is owned by individuals, it will be necessary to confirm the land ownership situation and reach agreement with landowners for the areas that are intended for installation.

1) Pole No. 31~Pole No. 46: This section currently has no connections. It is planned to newly install distribution line in order to build a loop in the distribution network.

2) Pole No. 16~Pole No. 19: Utility poles are currently erected on a concrete base (foundation) in the ocean, but it is planned to install line along the road.



[Source] Prepared by the JICA Study Team

Figure 1-4.1 Distribution Line Sections Planned for Transfer and New Installation

(4) Natural Environment

1) Overview of the Natural Environment

Kosrae Island, where the state capital Tofol is located, has land area of 109.61 km^2, most of which is covered in forest. The inland area has steep hills that reach heights of 600 m, while the coastal part comprises beaches and mangroves, and there are coral reefs (fringing reefs[2]) offshore.

2) Ecosystems

the Federated States of Micronesia has forests and coral reefs that contain some of the most abundant biodiversity in the world. The closely grouped islands in the Pacific Ocean provide a relay point for migratory birds and marine animals migrating between Eastern Asia and Australia, and each island has a unique ecosystem.

Kosrae Island is composed of the following two types of forest ecosystems.

- Highland cloud forest: This type of dense forest is enveloped in clouds and mist and has high humidity. It contains numerous endemic species.
- Lowland swamp forest: This forest mainly comprises the endemic tree variety "Ka" (*Terminalia carolinensis*). Yela Watershed on the west side of Kosrae Island is the largest forest group.

Also, 14% of Kosrae Island comprises mangrove forests, although the area of mangroves is diminishing. One reason for this is thought to be excessive cutting of trees by local residents.

3) Nature Reserves

There are no state-designated nature reserves in and around the Project target area. However, much of the coastline on Lelu Island comprises mangrove forest. Also, plans are being discussed for designating Awane Marine Park and Awane-Weok Reef as a nature reserve with the aim of protecting the mangroves and coral reefs (see Figure 1-4.2).

[2] Fringing reef: coral reef that has developed around a volcanic island.

[Source] Prepared by the JICA Study Team

Figure 1-4.2 Nature Reserve and Historical Sites

(5) Social Environment

1) Economic Overview

Kosrae State has a population of approximately 6,600, with two-thirds of the population living in Lelu Island and Tafunsak. Communities in Kosrae Island are concentrated along the coastline and half of the island is accessible by paved roads, however, the village of Walung on the northwest side of the island can only be reached by boat. The main industries of Kosrae State are agriculture and fisheries, but there are hardly any commercial or industrial activities.

2) Minorities and Indigenous Peoples

There are no minorities or indigenous peoples that require special consideration in the Project target area and environs. Incidentally, almost all residents in the Federated States of Micronesia are indigenous people who have inherited land from their forefathers, and their rights are recognized under both customary law and legislation under the Constitution of the Federated States of Micronesia.

3) Cultural Heritage

There is no cultural heritage or historical remains inside Tofol Power Station and its environs. On Lelu Island, there are remains of the Lelu Dynasty that prospered in the 1400s, and also buildings from WWII that have been designated as state historical remains.

(6) Environmental and Social Consideration Systems and Organizations in the Federated States of Micronesia

1) Administrative Organization for Environmental and Social Consideration

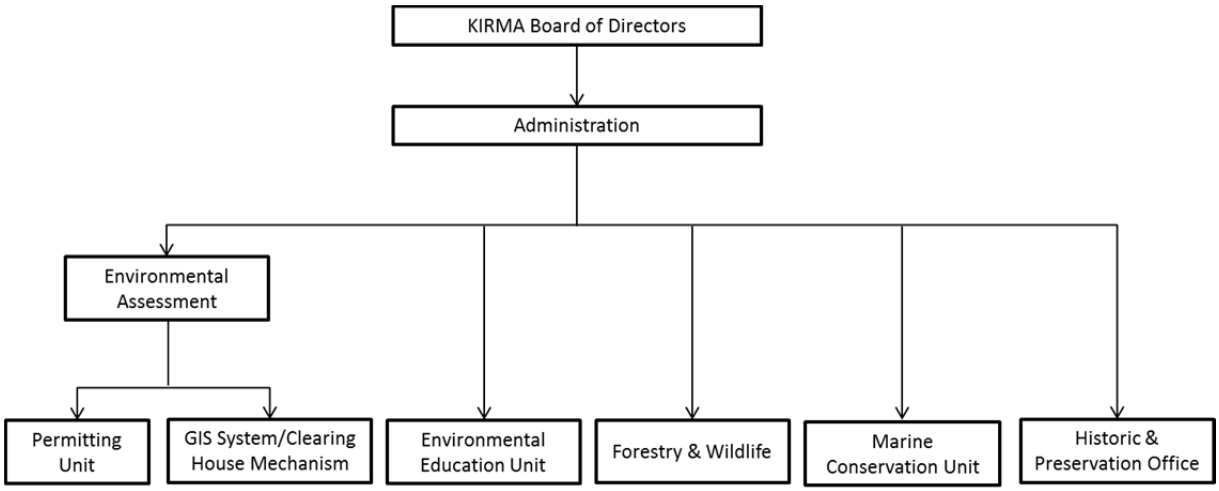
a) Office of Environment and Emergency Management (OEEM)

The Division of Environment and Sustainable Development (DESD), which belongs to the Division of Environment & Emergency, is responsible for formulating environmental policies and regulations on the national level. In the Federated States of Micronesia, each state has de facto right of self-government, and concerning environmental management too, the environmental protection agencies in each state are responsible for implementing environmental impact assessment and other environmental legislation.

b) Kosrae Island Resource Management Authority (KIRMA)

KIRMA acts as the environmental protection authority for Kosrae State. Based on Kosrae State Regulation Article 19, KIRMA is mandated to "Protect the environment, human health and welfare, and safety, and prevent, improve or manage air, soil and water pollution through introducing controls for facilitating sustainable development while balancing economic and social development with the necessity for environmental preservation."

Figure 1-4.3 shows the organization chart of KIRMA. The project development permit system of Kosrae State includes the EIA process, and permit reviews are implemented via the Permitting Unit. In addition to project development permit, KIRMA is also in charge of civil engineering works permits (and issue of permits for land development), and permits concerning air and solid waste management, watershed management and so on.



[Source] Prepared by the JICA Study Team

Figure 1-4.3 KIRMA Organization Chart

2) Legal Systems concerning Environmental and Social Consideration

a) The Constitution of the Federated States of Micronesia

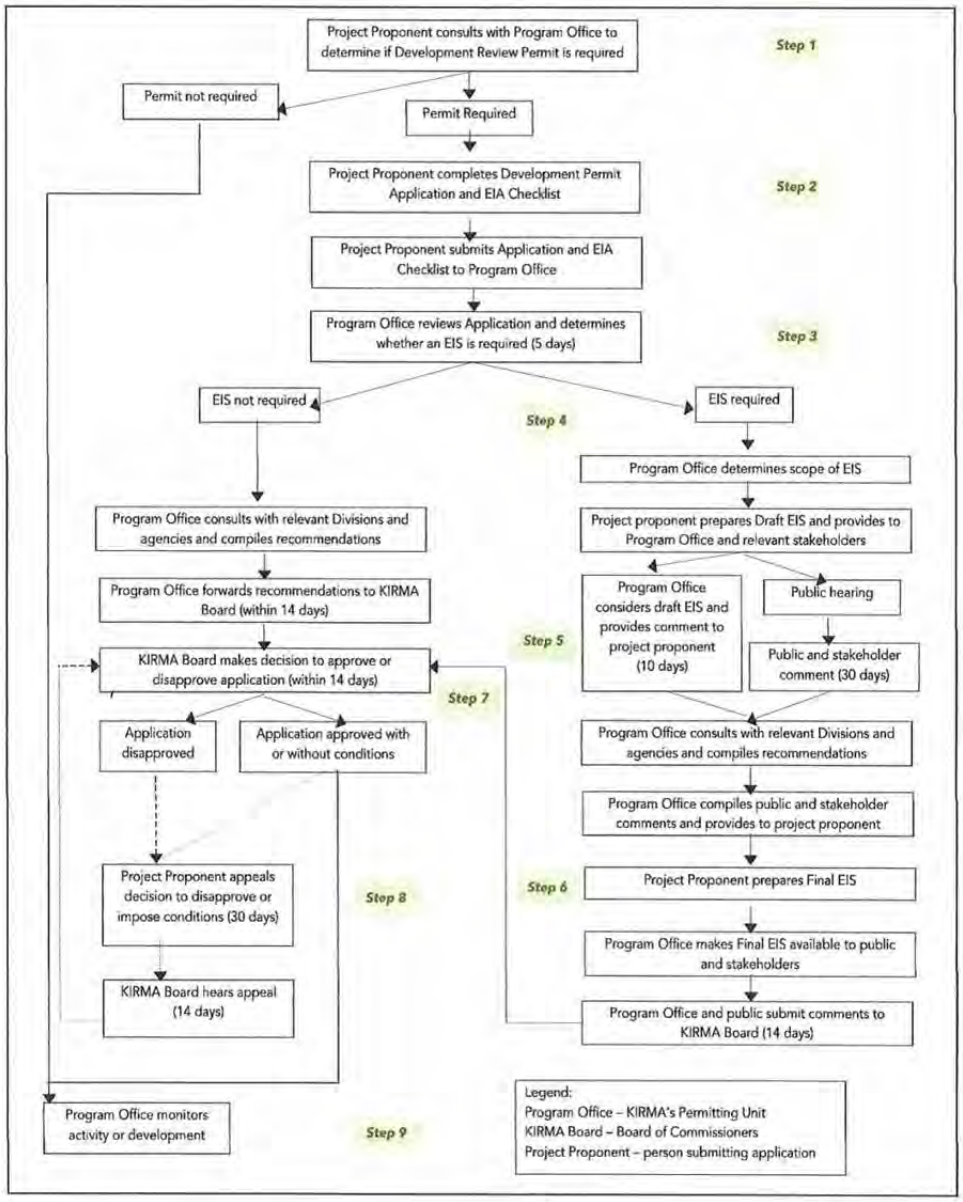
Based on the Constitution of the Federated States of Micronesia, the state governments are responsible for enacting legislation and conducting management for environmental protection. However, the federal government has jurisdiction over development and utilization of ocean areas far removed from the coast, prohibition of use of radioactive materials, handling of international conventions and other matters that cannot be handled on the state level. Moreover, since the Federated States of Micronesia places great importance on the traditions that have been passed down through the generations, customary law is recognized under the Constitution.

b) Kosrae State Constitution

Kosrae State Constitution recognizes the right of state citizens to live in a healthy, clean and stable environment, and it states the general principle of state development as follows: “For appropriate development and utilization of natural resources, the state government shall conduct protection based on law that contributes to the public benefit and prevents harm to the state’s environment, nature and natural resources.”

c) Kosrae State Development Projects Law

EIA procedures in Kosrae State are stipulated in the Regulations for Development Projects (revised in January 2014). KIRMA compiled Kosrae State Environmental Impact Assessment Guidelines in 2014, in which it summarized the state’s EIA process and thinking. Figure 1-4.4 gives an outline of the EIA process.



[Source] KIRMA, Environmental Impact Assessment in Kosrae State, FSM

Figure 1-4.4 EIA Process in Kosrae State

d) Stages in the EIA process

Step 1 Consultation with KIRMA

Consultations are held with KIRMA to determine whether or not permit (EIA permit) is required for the development project. Basically, it is necessary to acquire development project permit (EIA permit) for the following projects:

(a) Projects that entail civil engineering works

(b) Projects that are implemented in "Coastal development risk areas"[3]

[3] The development project ordinance has an attached table which shows that almost all the coastline of Kosrae Island is in this category.

(c) Projects that cost 5,000USD or more
(d) Projects that entail land use different from the surrounding area
(e) Projects that entail generation or disposal of excavated or dredged soil (including sand extraction)
(f) Projects that entail use, management and disposal of harmful substances, agricultural chemicals, petroleum and oil
(g) Projects that include the commercial extraction of marine and/or forest resources
(h) Concerning projects that are expected to entail environmental impacts other than those mentioned above, it is necessary to notify KIRMA (the permitting agency). Incidentally, small-scale agricultural and house reform projects are not targeted.

Step 2 Application for permit

If it is deemed necessary to acquire development project permit, the project proponent completes the Development Permit Application and initial EIA Checklist using the KIRMA designated format.

Step 3 Review by KIRMA

The KIRMA Permitting Unit implements review of the Application. If it is deemed from the Application contents that the project will exert a major impact on the environment, it will be necessary to prepare an environmental impact assessment report (Environmental Impact Statement: EIS).

The types of projects that require EIS are not defined, however, the “major impacts” exerted on the environment are indicated. Negative impacts exerted on people and the natural environment are judged based on the following criteria:

(a) Numbers of affected people
(b) Duration of impact (short-term ~ long-term)
(c) Ratio of impacted natural environment
(d) Position of the project implemented in vulnerable areas (historical sites, coastal area, nature reserve, etc.)
(e) Relation to other project components and other projects implemented in other areas
(f) Intensity of impacts (irreversible, cumulative)

In the case of projects that require EIS, the Permitting Unit gives notification of the scoping plan and EIS preparation. If EIS preparation isn’t required, the Permitting Unit collects internal comments in KIRMA and submits its written opinions to the KIRMA Board of Commission.

Step 4 EIS preparation

For projects that require EIS, the EIS is prepared with the following items included:

(a) EIS summary
(b) Outline of project
(c) Environmental overview
(d) Environmental impacts
(e) Project alternative plans
(f) Persons and agencies that conducted consultations

Step 5 Draft EIS and consultation

KIRMA determines the necessity for public hearings and consultations as required. The project proponent submits the draft EIS to KIRMA and the main stakeholders (administrative agencies, communities, etc.) in order to assist information disclosure and consultation. The Permitting Unit gathers all the comments and notifies them to the project proponent.

Step 6 Final EIS

The project proponent prepares the final EIS reflecting the collected comments. It makes the final EIS available to the public and collects any final comments.

Step 7 Final decision

The Permitting Unit gathers the comments regarding the EIS final version and submits its final opinion to the Board of Commission. The Board of Commission examines whether or not to grant permission and considers the incidental conditions before making its final decision.

Step 8 Appeal, etc.

The project proponent can appeal the final decision of the Board of Commission over a certain period. Moreover, based on the Administrative Procedures Act, any individual who is unhappy with the decision can lodge an appeal with Kosrae State Court of Law, etc.

Step 9 Monitoring and execution

The Permitting Unit monitors the project permission and incidental conditions. If any violations of the permission, etc. are recognized, administrative sanctions and a fine of 10,000USD per day are imposed.

e) Land ownership system

The land ownership system in the Federated States of Micronesia differs between the states. Although it is institutionally possible for land to be forcibly expropriated in the Federated States of Micronesia, such cases are extremely rare due to the value placed on customary

culture, and it is common for state governments to bind long-term lease arrangements with landowners. As a rule, it is not possible for anyone other than the Federated States of Micronesia citizens to own land.

In Kosrae State, except for a strip of inland mountainous land known as the Japanese line and an area of the ocean that are placed under state government jurisdiction, almost all land is privately owned. Under the land ownership system in Kosrae State, based on the Land Court Act, 2000, the Land Court manages land survey, land setting and registration of land rights, and it also holds trials to settle land disputes.

3) Comparison with the JICA Environmental and Social Consideration Guidelines (April 2010)

a) Compatibility with the JICA Environmental and Social Consideration Guidelines

Comparison of the JICA Environmental and Social Consideration Guidelines (April 2010) with the Federated States of Micronesia environmental legislation shows that, although there are some differences in terms of the minor survey items and so on, the major items are the same and there are no major differences. Moreover, since Kosrae State Development Project Law has provisions covering public participation, information disclosure and so on, it has been confirmed that the local situation is roughly compatible with the JICA Environmental and Social Consideration Guidelines. Incidentally, there are no provisions concerning SEA in Kosrae State.

b) EIA permission in the Project

Since the Project entails renewal of generators in an existing power station and renewal of existing distribution line, and both of these components have little possibility of exerting major environmental impact, KIRMA indicated that there is no need to prepare an EIS based on the Development Project Law in the preliminary consultations with KUA, however, KUA has voluntarily compiled an EIS report and submitted it to KIRMA. KIRMA provisionally approved the Project on July 8, 2013. Based on the preparatory survey draft report, it has been confirmed that there were no major differences with the approved contents of 2013 when the decision to implement the Project was made. After confirmation and approval were conducted in the KIRMA Board Meeting at the end of January 2016, confirmation and approval were conducted by Lelu Municipality Meeting at the start of February, and final approval was granted on February 25, 2016.

The final approval given by KIRMA includes the following incidental conditions.

(a) Project implementation

- The works and renovation shall be implemented in compliance with the approval. Permission shall be obtained from KIRMA if any major changes are made to the

Project contents.

- Negotiations over easements shall be implemented and the ROW shall be secured before the start of the Project.
- The following measures shall be taken:
  - Noise: Noise during construction shall be monitored and measures shall be taken to ensure that no impacts are imparted to nearby residential areas, schools or citizens' lives.
  - Safety: Signs, temporary enclosures and lights shall be installed around the construction sites to prevent unauthorized access and ensure the safety of workers.
  - Traffic management: Signs shall be placed as necessary around the construction sites and traffic management shall be conducted to prevent accidents.
  - Dust: Water sprinkling on transport roads and other dust prevention measures will be taken.

(b) Waste management

- Wastes shall be appropriately managed in compliance with the laws of Kosrae State.
- General wastes shall be stored in closed containers, regularly collected and disposed at Tofol disposal site as needed.
- Hazardous wastes shall be stored in authorized containers and managed with appropriate labels affixed.
- Pollution Regulations 2013 shall be complied with (including reporting to KIRMA and implementation of countermeasures when there is leakage of pollutants).
- Vehicle maintenance will be appropriately implemented in order to prevent leaks of gasoline and other hazardous substances.

(c) Air quality: Exhaust gas countermeasures will be implemented as much as possible.

(d) Water quality: Fuel and waste oil shall be appropriately managed and stored in order to prevent water pollution.

(e) Soil pollution: Measures shall be implemented to enable the early discovery of soil and groundwater pollution. If leaks and so on do occur, measures will be promptly taken to prevent dispersion.

(f) Ecosystem: The current ecosystem will be preserved and managed at its current level.

(g) Livelihoods: Landowners shall be clarified and agreement for land use shall be obtained

before the start of works.

(h) Cultural assets: Effort shall be made to protect cultural assets. If new historical sites, etc. are discovered, Kosrae Historic Preservation Office shall be contacted and all activities shall be suspended until its instructions are received.

(i) Working environment: Regulations of Kosrae State and KUA shall be complied with.

(j) Impacts during construction: Contractors shall be instructed to take steps to prevent runoff of muddy water and traffic congestion.

(k) Monitoring: Monitoring shall be appropriately implemented based on a monitoring plan.

(l) Effective term, injunction and cancellation: This authorization shall remain effective from the start of the Project to its completion. KIRMA may cancel implementation under the following conditions:

- Non-fulfillment of the above conditions
- Non-compliance with laws and systems
- Cases where, prior to injunction and cancellation by KIRMA, guidance and countermeasures are implemented regarding non-compliant items but no improvement is observed.

(7) Examination of Alternative Plans

1) Renewal of Tofol Power Station

As alternative plans to the renewal of Tofol Power Station, examination was carried out on the plan to supply the entire design electrical capacity through solar power generation (Alternative Plan 1) and the plan to not implement the Project (Alternative Plan 2) (Table 1-4.3). As a result, in the case of the zero option in Alternative Plan 2, since the power shortages facing the residents of Kosrae Island would not be alleviated and the deterioration of equipment and facilities would likely lead to increased exhaust gases and noise from now on, this plan is not recommended. Also, in the case where all power supply is replaced with solar power generation as proposed in Alternative Plan 1, although CO_2 emissions would be reduced and environmental impacts would be kept to a minimum, implementation would be difficult due to the need for large-scale land expropriation. Therefore, the Project is deemed to be the optimum effective plan. Incidentally, the comparative examination with alternative plans also included assumption of generators procured under assistance from the World Bank.

Table 1-4.3 Examination of Alternative Plans (Renewal of Tofol Power Station)

Item	Project Plan (Medium speed diesel generation)	Alternative Plan 1 (Solar power generation)	Alternative Plan 2 (Zero option)
Outline	Renew the existing diesel generators.	Supply the entire electrical energy capacity planned in the Study through solar power generation.	Continue using the existing facilities.
Generation capacity	600kW×3 units	1,800kW	-
Technical aspects	The generated electrical energy is stable, and stable supply as a base power source is possible.	The amount of generated electrical energy is greatly affected by the weather, and it is difficult to realize a stable power supply.	Because equipment is old, there are frequent breakdowns and procuring parts is difficult.
Assessment	A	B	C
Land use	Because equipment is installed inside the KUA site, there is no need to expropriate land.	Area of roughly 18,000m^2 is needed in order to generate 1,800kW, so large-scale land expropriation is needed.	Because equipment is installed inside the KUA site, there is no need to expropriate land.
Assessment	A	C	A
Cost estimation	Approximately 1 billion yen	Approximately 1.2 billion yen	0 yen
Assessment	B	C	A
Fuel reduction effect (compared to the present situation)	10~15%	100% (fuel isn't needed)	0% (status quo)
Assessment	B	A	C
Environmental aspect	Although CO_2, exhaust gases and noise are generated, quantities will be less than from the existing facilities. Moreover, the impacts can be reduced through taking mitigation measures.	It is clean energy that generates no CO_2 or noise.	Since the equipment is obsolete, emissions of CO_2, exhaust gases and noise are greater than in new equipment.
Assessment	B	A	C
Social aspect	Thanks to the stable supply of power, the living standard of residents can be expected to be improved.	Since the quality of power will be unstable and it won't be possible to generate power at night and during poor weather, power supply will be unstable and there is concern over the impact on the living standard of residents	Due to increasingly frequent power interruptions and long-term interruptions due to the deterioration of equipment, serious impacts will be imparted to social and economic activities.
Assessment	A	C	C
Overall assessment	Although the initial cost is expensive, this plan is the best in terms of social impact. Moreover, environmental impacts can be alleviated through implementing mitigation measures.	This plan has the smallest environmental impacts, however, due to the land expropriation and other social impacts, it is not feasible.	Due to concern over technical, environmental and social impacts, this plan cannot be recommended.
Assessment	A	C	C

A: Optimum, B: Superior to the other plans, C: Inferior to the other plans

2) Renewal of Distribution line

Alternative plans to the renewal of Lelu Island distribution line and underground cable are the plan to renew distribution line upon acquiring a new Right of Way (ROW) (Alternative Plan 1) and the plan to not implement the Project (Alternative Plan 2) (see Table 1-4.4). As a result, in the case of the zero option in Alternative Plan 2, since power interruptions would become more frequent due to the deterioration of equipment, this plan is not recommended. In the case of Alternative Plan 1, the environmental and social impacts would be large due to the need to expropriate new land, cut trees and level ground along the new ROW. Therefore, the Project plan, which entails using the existing ROW, is deemed to be the optimum alternative.

Table 1-4.4 Examination of Alternative Plans Alternative Plan (Renewal of Distribution line)

Item	Project Plan (Renewal in the existing ROW)	Alternative Plan 1 (Renewal in new ROW)	Alternative Plan 2 (Zero option)
Outline	Renew distribution line using the existing ROW.	Renew distribution line using new ROW.	Continue using the existing facilities.
Technical aspects	Temporary scheduled power interruptions arise during the works, however, due to the renewal, power interruptions are reduced and the maintenance burden is mitigated.	Distribution line can be renewed without causing any scheduled power interruptions.	It is possible that deterioration of lines will lead to more accidents and management difficulties.
Assessment	B	A	C
Land use	Since work is implemented in the existing ROW, there is no need to expropriate land.	There is need to expropriate land for the new ROW.	There is no need to expropriate land.
Assessment	A	C	A
Cost estimation	Since the existing ROW is utilized, only the cost of renewal work is incurred.	Since new ROW needs to be secured, in addition to the cost of the Project plan, costs will be incurred in land expropriation, ground leveling and other civil engineering works.	0 yen
Assessment	B	C	A
Environmental aspect	Since work is implemented in the existing ROW, it is forecast that tree cutting, ground leveling and soil runoff will be minor.	Tree felling and ground leveling and needed for the new ROW, and there is concern over soil runoff.	Because existing facilities are utilized, there are no environmental impacts.
Assessment	B	C	A
Social aspect	Due to renewal of distribution line, power supply can be stabilized.	Due to renewal of distribution line, power supply can be stabilized.	There is risk that equipment deterioration will lead to increased power interruptions, long-term power interruptions and collapse or falling of equipment.
Assessment	A	A	C
Overall assessment	This is the optimum plan because there is no need to expropriate land and stable power supply can be secured.	This is not recommended because it is necessary to expropriate land, there are large negative environmental impacts, and it is costly.	This is not recommended because of concern over increasing technical and social impacts due to the deterioration of facilities.
Assessment	A	C	C

A: Optimum, B: Superior to the other plans, C: Inferior to the other plans

(8) Scoping

Since the Project will be implemented on the sites of existing facilities, its impacts will be limited to those sites, and there will be few irreversible impacts, it is grouped under Category B according to the JICA Environmental and Social Consideration Guidelines (April 2010). Accordingly, environmental and social consideration survey was implemented on the level of Initial Environmental Examination (IEE) in the Study. The following sections describe scoping that was implemented regarding the renewal of Tofol Power Station and distribution line based on the Environmental and Social Consideration Guidelines using existing information and findings of the site survey. The assessment categories are as follows:

A±: Items where dramatic positive or negative impacts are foreseen
B±: Items where a certain degree of positive or negative impacts are foreseen
C±: Items where the degree of positive or negative impacts is unknown
D: Items where no impacts are forecast

As a result, it was confirmed that Project implementation will not impart any irreversible or major negative environmental impacts. Meanwhile, it was confirmed that consideration will need to be exercised regarding air pollution, water pollution, solid wastes, soil pollution (only the power station), noise and vibration, ecosystem, resettlement and land acquisition (only the distribution line), existing infrastructure and social services, cultural heritage (only the distribution line), HIV/AIDS and other infections, work environment, accidents, and cross-border impacts.

Table 1-4.5 Scoping (Renewal of Tofol Power Station)

Target	No.	Impact Item	Assessment		Reasons for Assessment
			During works	In service	
Pollution countermeasures	1	Air pollution	B-	B-	During works: It is forecast that air quality will temporarily deteriorate due to exhaust gases from construction machinery and heavy machinery and dust generated by the coming and going of heavy machinery. In service: There is concern over the impact on air quality caused by the generation of exhaust gases from the diesel generating facilities. However, judging from the scale and installed situation of the power station, it is forecast that the impact will be limited.
	2	Water pollution	B-	D	During works: There is concern over the generation of turbid water in line with the excavation and other civil engineering works. In service: Cooling water will be required in the generating facilities, however, since this will be circulated in a closed system, there will be no generation of waste cooling water.
	3	Solid wastes	B-	D-	During works: It is forecast that construction wastes, residual earth from excavation, used equipment and harmful wastes will be discharged in the works. It will be necessary to implement the appropriate treatment of these solid wastes. In service: It will be necessary to implement the appropriate treatment of waste oil and sludge from the diesel generating facilities, however, since waste oil treatment equipment will be installed in the Project, it is forecast that the impact will be limited.
	4	Soil pollution	D	B-	During works: Implementation of the works is not expected to generate soil pollution. In service: It will be necessary to implement the appropriate treatment of waste oil and sludge from the diesel generating facilities, however, since waste oil treatment equipment will be installed in the Project, it is forecast that the impact will be limited.
	5	Noise and vibration	B-	B-	During works: It is forecast that noise and vibration will be temporarily generated in line with the operation of construction machinery, etc. In service: Since it is expected that the generators will generate noise, it will be necessary to take appropriate noise prevention measures.
	6	Ground settlement	D	D	There are not expected to be any works or facilities that entail large-scale pumping of groundwater or ground settlement.
	7	Odor	D	D	There are not expected to be any works or facilities that cause odor.
	8	Bottom sediment	D	D	There are not expected to be any works or facilities that cause deterioration of bottom sediment.
Natural environment	9	Nature preserves	D	D	There are no national parks or reserves designed to protect ecosystems in and around the Project target area.
	10	Ecosystem	B-	D	During works: The Project target area is occupied by existing generating facilities and there are not expected to be any impacts on rare flora and fauna, however, there is concern that soil runoff during the works could impact coastal ecosystems such as mangroves and coral reefs. In service: Operation of the facilities is not expected to impart any impacts on ecosystems.
	11	Water conditions	D	D	During works: No works are planned on such a scale that will transform rivers, lakes, marshes, groundwater or seawater, so there are not expected to be any impacts on water conditions. In service: Since no major drainage of wastewater is planned from the facilities, there are not expected to be any impacts on water conditions.
	12	Topography and geology	D	D	Since no large-scale earth cutting and banking works are planned, there are not expected to be any impacts on topography and geology.

Target	No.	Impact Item	Assessment		Reasons for Assessment
			During works	In service	
Social environment	13	Resettlement and land acquisition	D	D	Since the Project target area is located on land owned by Kosrae State that contains no residences and so on, there will be no need to conduct resettlement and land acquisition.
	14	People in poverty	D	D	The implementation of works and operation of facilities are not expected to exert impacts on people in poverty.
	15	Minorities and indigenous people	D	D	There are no minorities and indigenous people that require any special consideration in and around the Project target area.
	16	Local economy (employment and means of livelihood, etc.)	B+	A+	During works: Since local residents will be employed in the works, there is expected to be a positive impact. In service: Due to the stable supply of power, it is expected that the quality of living will improve, industry will be vitalized, and the local economy will be boosted.
	17	Land use and utilization of local resources	D	D	Since the Project will be implemented on existing facilities, there will be no changes in land use.
	18	Water use	D	D	The Project will not entail large-scale water use, nor impart any impacts on water use in the local area.
	19	Existing infrastructure and social services	B-	A+	During works: It is planned to land the heavy machinery and equipment and materials at port and transport them overland to the target area. Since the road is also used by residents for everyday activities, there is concern over the impact on road traffic. In service: It is expected that the stable supply of electricity will make it possible to provide more stable services at medical facilities, schools and other education facilities.
	20	Social infrastructure and social organizations such as community decision-making bodies, etc.	D	D	Since the Project entails the renewal of existing facilities, there will be no impacts on infrastructure and social organizations.
	21	Uneven distribution of impacts and benefits	D	D	Since the Project entails the renewal of existing facilities, there will be no impact in terms of uneven distribution of impacts and benefits.
	22	Conflict of interests in the local area	D	D	Since the Project entails the renewal of existing facilities, there will be no impact in terms of conflict of interests.
	23	Cultural heritage	D	D	There are no cultural heritage or historical sites in and around the target area.
	24	Landscape	D	D	Since the Project entails the renewal of existing facilities, there will be no impact on the landscape.
	25	Gender	D	D	Since the Project entails the renewal of existing facilities, there will be no impact in terms of gender disparity.
	26	Children’s rights	D	D	Since the Project entails the renewal of existing facilities, there will be no impact on children’s rights.
	27	HIV/AIDS and other infections	B-	D	During works: Major works are not anticipated, however, due to the influx of workers, it is possible that infections will spread unless appropriate health education is implemented.
	28	Work environment (including work safety)	B-	B-	During works: It will be necessary to pay attention to the work environment when implementing the works. In service: It will be necessary to conduct ample industrial health and safety education for workers engaged in maintenance work.
Others	29	Accidents	B-	B-	It will be necessary to take steps to prevent accidents during the works and in service.
	30	Cross-border impacts and climate change	C	B+	During works: If solid wastes are treated across borders, it will be necessary to implement appropriate procedures, transportation and treatment. In service: Thanks to the renovations, it is expected that unit emissions of CO_2 can be reduced and higher efficiency can be achieved.

Table 1-4.6 Scoping (Renewal of Distribution line)

Target	No.	Impact Item	Assessment		Reasons for Assessment
			During works	In service	
Pollution countermeasures	1	Air pollution	B-	D	During works: It is forecast that air quality will temporarily deteriorate due to exhaust gases from construction machinery and heavy machinery and dust generated by the coming and going of heavy machinery. In service: There is not expected to be any air pollution.
	2	Water pollution	B-	D	During works: There is concern over the generation of turbid water in line with the excavation and other civil engineering works. In service: There is not expected to be any water pollution.
	3	Solid wastes	B-	D	During works: It is forecast that residual earth from excavation, used equipment and harmful wastes will be discharged in the works. It will be necessary to implement the appropriate treatment of these solid wastes. In service: There is not expected to be any generation of solid wastes.
	4	Soil pollution	D	D	There is not expected to be any soil pollution.
	5	Noise and vibration	B-	D	During works: It is forecast that noise and vibration will be tenmporarily generated in line with the operation of construction machinery, etc. In service: There is not expected to be any generation of noise.
	6	Ground settlement	D	D	There are not expected to be any works or facilities that entail large-scale pumping of groundwater or ground settlement.
	7	Odor	D	D	There are not expected to be any works or facilities that cause odor.
	8	Bottom sediment	D	D	There are not expected to be any works or facilities that cause deterioration of bottom sediment.
Natural environment	9	Nature preserves	D	D	There are no national parks or reserves designed to protect ecosystems in and around the Project target area.
	10	Ecosystem	B-	D	During works: Around the project target area, there are mangroves and coral reefs that are candidates for designation as nature reserves. There is concern that soil runoff during the works could impact these coastal ecosystems. In service: Operation of the facilities is not expected to impart any impacts on ecosystems.
	11	Water conditions	D	D	During works: No works are planned on such a scale that will transform rivers, lakes, marshes, groundwater or seawater, so there are not expected to be any impacts on water conditions. In service: There are not expected to be any impacts on water conditions.
	12	Topography and geology	D	D	Since no large-scale earth cutting and banking works are planned, there are not expected to be any impacts on topography and geology.

Target	No.	Impact Item	Assessment		Reasons for Assessment
			During works	In service	
Social environment	13	Resettlement	B-	D	During works: The Project is scheduled to be implemented on existing ROW where KUA has signed a long-term lease agreement. Therefore, there will be no need to conduct resettlement and land acquisition. However, on sections where it is necessary to transfer or build utility poles, it will be necessary to reach agreement with the landowners, etc.
	14	People in poverty	D	D	The implementation of works and operation of facilities are not expected to exert impacts on people in poverty.
	15	Minorities and indigenous people	D	D	There are no minorities and indigenous people that require any special consideration in and around the Project target area.
	16	Local economy (employment and means of livelihood, etc.)	B+	A+	During works: Since local residents will be employed in the works, there is expected to be a positive impact. In service: Due to the stable supply of power, it is expected that the industry will be vitalized and the local economy will be boosted.
	17	Land use and utilization of local resources	D	D	Since the Project will be implemented on existing facilities, there will be no changes in land use.
	18	Water use	D	D	The Project will not entail large-scale water use, nor impart any impacts on water use in the local area.
	19	Existing infrastructure and social services	B-	A+	During works: It is planned to land the heavy machinery and equipment and materials at port and transport them overland to the target area. Since the road is also used by residents for everyday activities, there is concern over the impact on road traffic. In service: It is expected that the stable supply of electricity will make it possible to provide more stable services at medical facilities, schools and other education facilities.
	20	Social infrastructure and social organizations such as community decision-making bodies, etc.	D	D	Since the Project entails the renewal of existing facilities, there will be no impacts on infrastructure and social organizations.
	21	Uneven distribution of impacts and benefits	D	D	Since the Project entails the renewal of existing facilities, there will be no impact in terms of uneven distribution of impacts and benefits.
	22	Conflict of interests in the local area	D	D	Since the Project entails the renewal of existing facilities, there will be no impact in terms of conflict of interests.
	23	Cultural heritage	C	D	During works: Since historical sites designated by KIRMA exist on Lelu Island, depending on the positions of utility poles, it is possible that impacts will arise.
	24	Landscape	D	D	Since the Project entails the renewal of existing facilities, there will be no impact on the landscape.
	25	Gender	D	D	Since the Project entails the renewal of existing facilities, there will be no impact in terms of gender disparity.
	26	Children's rights	D	D	Since the Project entails the renewal of existing facilities, there will be no impact on children's rights.
	27	HIV/AIDS and other infections	B-	D	During works: Major works are not anticipated, however, due to the influx of workers, it is possible that infections will spread unless appropriate health education is implemented.
	28	Work environment (including work safety)	B-	B-	During works: It will be necessary to pay attention to the work environment when implementing the works. In service: It will be necessary to conduct ample industrial health and safety education for workers engaged in maintenance work.
Others	29	Accidents	B-	B-	It will be necessary to take steps to prevent accidents during the works and in service.
	30	Cross-border impacts and climate change	C	D	During works: If solid wastes are treated across borders, it will be necessary to implement appropriate procedures, transportation and treatment. In service: There are not expected to be any cross-border impacts or climate change impacts..

(9) TOR for the Environmental and Social Consideration Survey

Based on the results of scoping, the TOR for the environmental and social consideration survey were examined as shown below (Table 1-4.7).

Table 1-4.7 TOR of Environmental and Social Consideration Survey

No.	Impact Item	Assessment	Survey Item	Survey Method
1	Air pollution	During works B- In operation B- (generation)	・Confirmation of environmental standards, etc. ・Grasping of current conditions of air quality ・Existence of houses, schools, hospitals, etc. around the Project target area ・Impact on air quality (during works and in service)	・Site reconnaissance and hearings ・Survey of existing materials
2	Water pollution	During works B-	・Confirmation of environmental standards, etc. ・Grasping of current conditions of environmental water quality ・Impact of turbid water generated during works	・Site reconnaissance and hearings ・Survey of existing materials
3	Solid wastes	During works B- In operation B- (generation)	・Confirmation of the current methods of solid waste management ・Methods for treating construction wastes, residual earth and harmful wastes that arise during works ・Methods for treating wastes during service	・Site reconnaissance and hearings ・Survey of existing materials
4	Soil pollution	In operation B- (generation)	・Measures for addressing oil leaks during service	・Site reconnaissance and hearings ・Survey of existing materials
5	Noise and vibration	During works B- In operation B- (generation)	・Confirmation of environmental standards, etc. ・Grasping of current conditions of noise and vibration ・Noise and vibration impacts (during works and in service)	・Site reconnaissance and hearings ・Survey of existing materials
10	Ecosystem	During works B-	・Grasping of current conditions of local ecosystems ・Impacts on ecosystems due to the implementation of works	・Site reconnaissance and hearings ・Survey of existing materials
13	Resettlement and land acquisition	During works C (distribution)	・Need for transfer of utility poles	・Site reconnaissance and hearings ・Survey of existing materials
19	Existing infrastructure and social services	During works B-	・Impacts on road traffic in line with transportation of equipment and materials	・Site reconnaissance and hearings ・Survey of existing materials
23	Cultural heritage	During works C (distribution)	・Impacts on historical sites due to the implementation of works	・Site reconnaissance and hearings ・Survey of existing materials
27	HIV/AIDS and other infections	During works B-	・Situation regarding diseases around the Project target area	・hearings ・Survey of existing materials
28	Work environment (including work safety)	During works B- In operation B-	・Industrial safety countermeasures during works	・hearings ・Survey of existing materials
29	Accidents	During works B- In operation B-	・Situation regarding work accidents	・hearings ・Survey of existing materials
30	Cross-border impacts and climate change	During works C	・Necessity for cross-border transfer of solid wastes	・Site reconnaissance and hearings ・Survey of existing materials

(10) Results of Environmental and Social Consideration Survey

1) Air pollution

Except for the existing Tofol Power Station, there are no other major sources of air pollution in and around the Project target area. Kosrae State does not conduct periodic monitoring and measurement of air quality, neither has it established any environmental standards or emission standards. According to hearings with KIRMA, although the Federated States of Micronesia is considering establishing its own environmental standards, it currently refers to international standards and Japanese standards. Therefore, international standards and Japanese standards will be applied in the Project too.

[During the works]

During works, since multiple construction machines will operate simultaneously, albeit for a limited spell, there is concern over the impact that this will impart in terms of air pollution in the local area. Also, there is concern over the impact on the local air quality due to particulates generated by the construction and demolition works. Concerning the air pollution impact caused by particulates generated by the operation of construction machinery, the following environmental preservation measures will be planned:

- Through levelling the works processes, avoid the concentrated operated of construction machinery.
- When operating construction machinery inside the Project target area, strive to stop idling as much as possible.
- Strive to use construction machinery of the low-emissions type as much as possible.
- In areas where dust is likely to be caused, prevent dust by conducting appropriate water sprinkling, and also consider the erection of dust prevention netting where necessary.

When conducting renewal works at Tofol Power Station, even though the closest school and hospital are around 200 m away and there are no houses in the immediate area, impacts may spread to these facilities depending on the wind direction, etc. Moreover, since the Lelu Island distribution line renewal works will be implemented in residential areas, the environmental preservation measures described above will be implemented while checking wind direction, etc. with a view to limiting impacts on air pollution caused by the operation of construction machinery.

[In service]

In service, there is concern over the impact on air quality caused by the generation of exhaust gases (SO_2, NOx, particulates) from the diesel generators. Upon checking the KUA record of complaints received between January 2009 and January 2015, there were no complaints about air

pollution from the power station. In the Project, it is planned to adopt diesel generators that are small in size and satisfy Japanese air pollution standards. Moreover, via the OJT and soft component in the Project, it is intended to conduct technology transfer concerning equipment inspections and continuous maintenance that will contribute to environmental preservation. Therefore, the impacts on air pollution caused by the operation of facilities and equipment will be minor, in fact less than the impacts caused by the existing generators that were introduced 25~30 years ago.

2) Water pollution

Kosrae State does not implement periodic monitoring and measurement of water quality conditions in rivers, lakes, marshes and ocean. Also, as in the case of air pollution, it does it establish any environmental standards or emission standards concerning water quality.

[During the works]

Since it is planned to conduct soil excavation during works in both the renewal of Tofol Power Station (foundation works for the generator house, generators and auxiliary units) and renewal of Lelu Island distribution line (renewal of utility poles, etc.), there is concern over the impacts on sea water quality caused by runoff of turbid water and sediment from works sites, albeit on a minor and temporary scale. KUA has compiled the Erosion and Sedimentation Control Plan within the EIS, and KIRMA requires implementation of this in its EIA permit. Therefore, through implementing the following preservation measures according to the Erosion and Sedimentation Control Plan, it is forecast that the impact in terms of water pollution can be minimized during the works.

- Mitigate the impacts of sediment runoff through avoiding civil engineering and excavation works at times when major rainfall is forecast.
- Minimize site preparation works and excavation works through positioning the generator house as far as possible on land that has already been prepared within the grounds of the existing power station.
- In cases where there is concern over large-scale runoff of sediment into the ocean, prevent the direct runoff of high-concentration turbid water through installing treatment equipment (sand basin, etc.) and silt fences. Particular care will be needed in the case of Lelu Island distribution line because the works will be implemented alongside the coastal road.

3) Solid wastes

[During the works]

During works, it is forecast that residual earth from excavation and used equipment (waste construction materials, transformers, cables, utility poles, etc.) will be discharged.

Concerning the residual earth, it is scheduled to backfill it inside the works site or reuse it within the power station grounds as much as possible. As for the earth and waste equipment and materials that cannot be reused, it is intended to dispose it in a landfill based on Kosrae State regulations or to have a metals recycling operator that has been licensed by Kosrae State conduct appropriate treatment. Therefore, it is expected that the impact of solid waste treatment during the works will be minor.

[In service]

In service, waste oil and sludge will be generated from the power station. Incineration and recycling of waste oil is not implemented in Kosrae State, however, according to hearings with the state government and related agencies, it is examining plans to treat waste oil in the state together with the secretariat of the Pacific Regional Environment Programme (SPREP). The waste oil and sludge that have been discharged until now in KUA have been stored inside a waste oil tank inside the power station grounds, however, this is expected to become full in the next few years. In the Project, in consideration of these conditions, it is planned to install a small waste oil incinerator so that the waste oil generated within KUA (including the waste oil that has been stored until now) can be incinerated and appropriately treated. Therefore, it is expected that the environmental and social impact of solid waste treatment after facilities go into service will be minor.

4) Soil pollution

[In service]

When equipment and facilities go into service, it will be necessary to take measures to prevent soil and groundwater pollution caused by oil leaks from the generating facilities, waste oil tanks and pipes. Oil fences are fitted to the waste oil tanks and fuel tanks currently in use, and fuel is supplied to the generators through aboveground pipes. Meanwhile, due to the rapid growth of vegetation in the local area, there are areas of poor visibility and it is possible that the discovery of oil leaks could be delayed.

In the Project, the following measures will be thoroughly enforced in order to prevent soil pollution and ensure the rapid discovery of leaks.

- Prevent breakage of facilities through conducting appropriate maintenance.
- Periodically implement grass cutting in order to enable the early discovery of leaking areas and areas of soil pollution.
- Appropriately implement visual checks and monitoring of odor.
- Gauge residual levels inside waste oil and fuel tanks in order to check for leaks.

5) Noise and vibration

Kosrae State does not implement periodic monitoring and measurement of noise and vibration, neither has it established any environmental standards for them.

In the Project target area and environs, except for the existing Tofol Power Station, there are no other major sources of noise and vibration. At the time of the site survey, the shutters of the generator house were left open to allow the discharge of heat, and the noise from generators was equivalent to 100 dB(A) outside of the generator building and 70 dB(A) on the perimeter of the power station. Meanwhile, only once complaint was received about generator noise (in 2009), but there have been no complaints since.

[During the works]

During works, since multiple construction machines will operate simultaneously, albeit for a limited spell, there is concern over the noise and vibration impact that this will impart in the local area. Concerning the noise and vibration impact caused by construction machinery, the following environmental preservation measures will be planned:

- Use construction machinery with low-noise and low-vibration specifications as much as possible.
- Fully examine construction methods and procedures with a view to minimizing noise and vibration.
- When operating construction machinery inside the Project target area, strive to stop idling as much as possible.
- In compiling the works schedule, limit work on weekdays to the daytime only, and try to avoid conducting work on holidays as much as possible.

In addition to the above preservation measures, since the nearest residences to the Project target area are roughly 400 m away, it is expected that the noise and vibration impacts will be minor.

[In service]

In line with the operation of generating facilities, there is concern over the impact in the local area caused by noise and vibration generated by the diesel generators, etc. Glass wool will be used to improve the sound proofing effect in the generator house to be constructed in the Project, and a blower system that takes the engine waste heat and combustion air into consideration will be installed. Through fitting shutters at the entrances to the generator house and closing the facility as much as possible, it is intended to minimize the external noise impact as much as possible.

Upon conducting hearings at the local school, nearby houses and hospital regarding current noise levels, it was found that noise from the power station is not a problem in daily life. Since the nearest residences are around 400 m away from the power station, there is a buffer zone of vegetation around the station, the generator house planned in the Project has a high shielding performance, and environmental preservation measures such as equipment maintenance and inspections will be thoroughly implemented, it is expected that the noise and vibration impacts from the operation of facilities can be mitigated.

6) Ecosystems

Renewal of the power station will be implemented within the KUA grounds next to the existing facilities, while renewal of the distribution line will be implemented within the existing ROW alongside the road. Therefore, no rare flora or fauna are expected inside the work areas. However, there is concern that soil runoff during the works could impact coastal ecosystems such as mangroves and coral reefs. It is planned to mitigate the effects on the habitat of wildlife as much as possible through implementing the abovementioned water pollution countermeasures.

According to hearings with KIRMA, the following endemic species (plants) are confirmed to exist on the plain Kosrae Island (Table 1-4.8), and care should be exercised not to cut these species.

Table 1-4.8 Endemic Species in the Plain of Kosrae Island (plants)

	Scientific Name	Local Name
1	Hermandia Sonora	Pingping
2	Calophyllum inophyllum	Itu
3	Barringtonia asiatica	Puspus
4	Barringtonia racemosa	Kwengul
5	Intsia bujuga	-
6	Guettarda speciose	Pahnu
7	Heritiera littoralis	-
8	Lumnitzera littoralis	Oi
9	Premna obtusifolia	-
10	Tourneforia argentae	-
11	Vitex parviflora	-
12	Xylocarpus granatum	Tui
13	Fagraea benteriana	-
14	Ficus tentoria	-
15	Pemphis acidula	Kacngi

[Source] KIRMA

Based on the EIA permit system of KIRMA, and according to hearings, it is expected that impacts on ecosystems can be minimized through taking the following countermeasures in the Project.

- When removing vegetation in civil engineering works, conduct replanting using local and endemic species. If it is necessary to cut or remove rare and valuable species, promptly contact KIRMA and follow instructions.

- If foreign invasive species are found on works sites, take appropriate measures to eliminate them or minimize their spread (for example, visual checking when using and transferring works machinery, and removal and disposal of seeds, roots, etc. attached to machinery).

7) Resettlement and land acquisition

[During the works]

It is planned to implement the renewal of Lelu Island distribution line on the existing ROW, for which the state government has signed a long-term lease agreement. Through utilizing the existing utility poles, it is expected that no social impacts such as resettlement and expropriation of land will arise. However, since it is planned to transfer and newly erect utility poles along part of the distribution line, it will be necessary to reach agreement with the landowners in such cases.

Based on Kosrae State Land Court Act, 2000, the Land Court conducts land survey, manages perimeter settings and registers land rights. Almost all land in Kosrae State is privately owned, and on Lelu Island too, landowners are clearly specified in cadastral maps that indicate boundaries. KUA has signed land use agreements and conducts the proper procedures with all existing ROW landowners in Kosrae Island. Therefore, concerning land where it is necessary to transfer or erect new utility poles in the Project, it will be necessary for KUA to confirm the landowners from the cadastral maps, hold discussions with them and sign land use agreements before the start of the tender announcement.

8) Existing infrastructure and social services

[During the works]

It is planned to land the heavy machinery and construction equipment and materials at the international trading port at Okat, and from there transport them overland to the target area. Since the road is also used by residents for everyday activities, there is a possibility that the safety of residents will be partially affected.

In the Project, the transportation of generators, heavy machinery and construction equipment and materials will be limited to a few days during works, however, in order to minimize the impact on the normal life of local residents, safety will be secured through informing residents in advance about the works vehicles operating routes, transportation times and so on.

9) Cultural heritage

[During the works]

There are some historical sites dotted around Lelu Island, and there is concern over the impact that will be caused by the distribution line renewal works, in particular the re-installation of

utility poles in the Project. According to the KIRMA map of historical sites, there is a possibility that the following historical sites will be impacted by the works:

Historical site 1: Lelu Ruins (site of the Lelu Dynasty that prospered in the 1400s)
Historical site 2: Yat Step (structure from the Pacific War)
Historical site 3: Fukul Blockhouse (structure from the Pacific War)
Historical site 4: Mutunsrem Hospital Site (structure from the Pacific War)
Historical site 5: Fukul School Area (structure from the Pacific War)

As a result of the site reconnaissance, it was confirmed that all these historical sites are situated sufficiently far away from the utility poles. Therefore, there are not expected to be any impacts on historical sites as a result of Project implementation. In cases where there is discovered to be possibility of historical sites during the works, the works will be immediately suspended and notification given to KIRMA based on the EIA permit incidental conditions.

10) HIV/AIDS and other infections

[During the works]

Major works are not anticipated in the Project, however, due to the influx of workers from outside of the island, it is possible that infections will spread unless appropriate health education is implemented.

According to hearings at Dr. A.P. Sigrah Memorial Hospital, there has been an outbreak of tuberculosis in the past, however, such infections are extremely unusual in the Federated States of Micronesia. In the Project, since appropriate health and safety education will be thoroughly implemented for the foreign workers recruited by the Japanese contractor, it is expected that the impact of infections caused by the influx of workers will be minor.

11) Work environment (including work safety)

[During the works]

Major works are not anticipated in the Project, however, it will be necessary to pay attention to the work environment for workers when implementing the works. The works plan will be compiled while giving ample consideration to safety; safety managers will be appointed and assigned during the works; health and safety education will be provided for workers; and regular safety meetings will be held in order to ensure safety during the works and in the work environment. At the same time, compliance with labor legislation (including issues of child labor, etc.) in the Federated States of Micronesia will be confirmed, and other steps will be taken to ensure that safety is improved in the work environment.

[In service]

As in the case of during the works, safety managers will be appointed and assigned by KUA when the facilities and equipment go into service. It will also be necessary to conduct health and safety education for workers, implement regular safety meetings, and compile operation and maintenance plans while giving ample consideration to safety. Regarding the workers who will be engaged in operation and maintenance work, it will be necessary to conduct ample education on health, safety and environment regarding measures for preventing poisoning caused by harmful gases and oxygen deficiency and so on. At the same time, KUA will need to check compliance with labor legislation (including issues of child labor, etc.) in the Federated States of Micronesia, and take other steps to ensure that safety is improved in the work environment.

12) Accidents

Upon conducting a hearing with KUA concerning industrial disasters and accidents, there have been no accidents since an incident in 1995 when a work vehicle toppled over during maintenance work on distribution line. Meanwhile, there is concern that common minor accidents could escalate into major accidents.

[During the works]

The following measures will be taken during the generator and distribution line renewal works:

- Upon compiling the safety management plan, health and safety managers will be appointed.
- In addition to conducting safety education of workers, safety meetings will be periodically held.
- Works plans will be compiled with consideration given to safety.
- Prevention of accidents will be sought through implementing periodic inspections of construction machinery and works vehicles.
- In addition, the EIA permit requires that the following steps be taken for managing harmful substances (fuel, waste oil, lubricating oil and other harmful wastes) and preventing accidents at times of typhoons, and these shall be complied with in the Project too.
- Control of harmful substances
    - ✧ Harmful substances shall be stored and appropriately controlled inside the KUA site.
    - ✧ Any leaked fluids shall be repacked and stored in a site where countermeasures have been taken (use of impermeable materials such as concrete, installation of oil fences, etc.), and labels indicating hazardous toxicity shall be applied in English and the local Kosrae language.

- ✧ Each year by September 30, a report detailing the types and quantities of harmful substances that have been used or are in storage on the Project site shall be submitted to KIRMA.
- ✧ In the case where harmful substances (unexploded bombs, etc.) are discovered during Project implementation, the works shall be promptly suspended and notification given to the state government (Division of Public Safety: DPS). KUA shall erect fences to prevent entry and prohibit trespassers, and the works must not be resumed until the DPS has confirmed safety.

- Typhoon countermeasures
  - ✧ During typhoons, the weather information will be monitored and preparations will be made for accidents.
  - ✧ In cases where wind speed of more than 30 knots is forecast, steps will be taken to prevent the fly-off of equipment and materials, and conditions will be monitored with a view to keeping damage to a minimum.

Through implementing the above countermeasure, it is thought that the occurrence of accidents can be kept to a minimum during the works.

[In service]

When in service, it will be necessary to take precautions regarding accidents arising in line with the operation of generating facilities. Moreover, prevention of accidents will be strived for through having the contractor conduct initial operation guidance on installation and the consultant implement the soft component in order to impart correct handling methods. Moreover, through implementing the measures that are required in the EIA permit in the same way as during the works, occurrence of accidents in service will be reduced.

13) Cross-border impacts and climate change

[During the works]

According to the hearing with KUA, there is not expected to be any cross-border movement of solid wastes from the Project. If it does become necessary to move wastes across borders, the appropriate procedures and measures will be taken based on the laws and regulations of the Federated States of Micronesia and Kosrae State and international conventions (Basel Convention, etc.).

(11) Impact Assessment

Based on the results of the environmental and social consideration survey, Table 1-4.9 and Table 1-4.10 show the results of the assessment of environmental and social impacts in the Project.

Table 1-4.9 Results of Environmental and Social Assessment Survey (Renewal of Tofol Power Station)

Target	No.	Impact Item	Impact Assessment during Scoping		Impact Assessment based on Survey Results		Reasons for Assessment
			During works	In service	During works	In service	
Pollution countermeasures	1	Air pollution	B-	B-	B-	B-	[During the works] It is expected that the impacts arising from operation of construction machinery can be kept small through taking environmental preservation measures such as levelling the works processes, stopping idle operation, using construction machinery of the low-emissions type, preventing dust fly-off and so on. [In service] Since the diesel generators planned for introduction are small, it is planned to use equipment that satisfies strict Japanese air pollution standards, and environmental preservation measures such as ensuring normal operation through implementing maintenance and so on will be taken, it is expected that the air pollution impact will be minor.
	2	Water pollution	B-	D	B-	N/A	[During the works] KUA has compiled the Erosion and Sedimentation Control Plan for the Project. Therefore, through implementing the following preservation measures according to the Erosion and Sedimentation Control Plan, it is forecast that the impact in terms of water pollution can be kept small: ① Avoid conducting civil engineering and excavation works at times when major rainfall is forecast, ② Build the generator house on the grounds of the existing power station, and ③ In cases where there is concern over large-scale runoff of sediment into the ocean, install equipment to treat turbid water, and so on.
	3	Solid wastes	B-	B-	B-	B-	[During the works] Concerning the residual earth, it is scheduled to backfill it within the works site or reuse it within the power station grounds as much as possible. As for the earth and waste equipment and materials that cannot be reused, it is intended to dispose it in a landfill based on Kosrae State regulations or to have a metals recycling operator that has been licensed by Kosrae State conduct appropriate treatment. Therefore, it is expected that the impact of solid waste treatment during the works will be minor. [In service] Waste oil and sludge will be generated from the power station. In the Project, it is planned to install a small waste oil incinerator so that waste oil can be appropriately treated. Therefore, it is expected that the environmental and social impact of solid waste treatment after facilities go into service will be minor.
	4	Soil pollution	D	B-	N/A	B-	[In service] Oil fences are fitted to the waste oil tanks and fuel tanks currently in use, and fuel is supplied to the generators through aboveground pipes. In the Project, it is planned to prevent soil pollution and ensure the rapid discovery of leaks through conducting the appropriate maintenance of facilities, conducting visual checks and monitoring of odor, grasping residual levels inside tanks and so on.

Target	No.	Impact Item	Impact Assessment during Scoping		Impact Assessment based on Survey Results		Reasons for Assessment
			During works	In service	During works	In service	
	5	Noise and vibration	B-	B-	B-	B-	[During the works] The noise and vibration impact caused by construction machinery can be kept small by using construction machinery with low-noise and low-vibration specifications, stopping unnecessary idling, limiting works to daytime and taking other environmental preservation measures. [In service] Since the nearest residences are around 400 m away from the power station, there is a buffer zone of vegetation around the station, the generator house planned in the Project has a high shielding performance, and environmental preservation measures such as equipment maintenance and inspections will be thoroughly implemented, it is expected that the noise and vibration impacts from the operation of facilities will be minor.
	6	Ground settlement	D	D	N/A	N/A	-
	7	Odor	D	D	N/A	N/A	-
	8	Bottom sediment	D	D	N/A	N/A	-
Natural environment	9	Nature reserves	D	D	N/A	N/A	-
	10	Ecosystem	B-	D	B-	N/A	[During the works] Impacts on coastal ecosystems such as mangroves and coral reefs can be kept small by implementing the abovementioned water pollution countermeasures, conducting replanting using local and endemic species, notifying KIRMA if it is necessary to cut or remove rare and valuable species, taking steps to prevent invasion by foreign species and so on.
	11	Water conditions	D	D	N/A	N/A	-
	12	Topography and geology	D	D	N/A	N/A	-
Social environment	13	Resettlement and land acquisition	D	D	N/A	N/A	-
	14	People in poverty	D	D	N/A	N/A	-
	15	Minorities and indigenous people	D	D	N/A	N/A	-
	16	Local economy (employment and means of livelihood, etc.)	B+	A+	B+	A+	-
	17	Land use	D	D	N/A	N/A	-
	18	Water use	D	D	N/A	N/A	-
	19	Existing infrastructure and social services	B-	A+	B-	A+	[During the works] The heavy machinery and construction equipment and materials will be transported to the Project site along a road that is also used by residents for everyday activities, however, because the transportation will be limited to a few days only during the works period, residents will be informed about the routes and operating times of works vehicles and other steps will be taken, it is thought that the impact will be minor
	20	Social infrastructure and social organizations such as community decision-making bodies, etc.	D	D	N/A	N/A	-

Target	No.	Impact Item	Impact Assessment during Scoping		Impact Assessment based on Survey Results		Reasons for Assessment
			During works	In service	During works	In service	
	21	Uneven distribution of impacts and benefits	D	D	N/A	N/A	-
	22	Conflict of interests	D	D	N/A	N/A	-
	23	Cultural heritage	D	D	N/A	N/A	-
	24	Landscape	D	D	N/A	N/A	-
	25	Gender	D	D	N/A	N/A	-
	26	Children's rights	D	D	N/A	N/A	-
	27	HIV/AIDS and other infections	B-	D	B-	N/A	[During the works] Since appropriate health and safety education will be thoroughly implemented for workers during the works, it is expected that the impact in terms of spread of infections caused by the influx of workers will be minor.
	28	Work environment (including work safety)	B-	B-	B-	B-	[During the works] During works, through appointing safety managers and ① conducting health and safety education for workers, ② holding regular safety meetings, ③ compiling operation and maintenance plans while giving ample consideration to safety, and so on, it will be possible to minimize negative impacts on the work environment during the works. [In service] As in the case of during the works, since KUA will appoint safety managers, conduct health and safety education for workers, hold regular safety meetings, compile operation and maintenance plans while giving ample consideration to safety, and so on, it will be possible to make the work environment safer and minimize negative impacts.
Others	29	Accidents	B-	B-	B-	B-	[During the works] During works, through ① appointing safety managers, ②conducting health and safety education for workers, ③holding regular safety meetings, ④ compiling works plans while giving ample consideration to safety, ⑤ implementing periodic inspections of construction machinery and works vehicles, and so on, it will be possible to minimize the occurrence of accidents. Also, based on the incidental conditions of the EIA permit, management of harmful substances and measures to counter accidents during typhoons will be taken. [In service] Prevention of accidents will be strived for through having the contractor conduct initial operation guidance on installation and the consultant implement the soft component in order to impart correct handling methods. Moreover, through implementing the measures that are required in the EIA permit in the same way as during the works, occurrence of accidents in service will be reduced.
	30	Cross-border impacts and climate change	C	B+	D	B+	[During the works] As a result of the hearing with KUA and site reconnaissance, there is not expected to be any cross-border movement of solid wastes from the Project.

A±: Items where dramatic positive or negative impacts are foreseen
B±: Items where a certain degree of positive or negative impacts are foreseen
C±: Items where the degree of positive or negative impacts is unknown
D: Items where no impacts are forecast

Table 1-4.10 Results of Environmental and Social Assessment (Renewal of Distribution Line)

Target	No.	Impact Item	Impact Assessment during Scoping		Impact Assessment based on Survey Results		Reasons for Assessment
			During works	In service	During works	In service	
Pollution countermeasures	1	Air pollution	B-	D	B-	N/A	[During the works] It is expected that the impacts arising from operation of construction machinery can be kept small through taking environmental preservation measures such as levelling the works processes, stopping idle operation, using construction machinery of the low-emissions type, preventing dust fly-off and so on.
	2	Water pollution	B-	D	B-	N/A	[During the works] KUA has compiled the Erosion and Sedimentation Control Plan for the Project. Therefore, through taking preservation measures according to the Erosion and Sedimentation Control Plan such as not conducting civil engineering and excavation works at times when major rainfall is forecast, installing equipment to treat turbid water, and so on, it is forecast that the impact can be kept small.
	3	Solid wastes	B-	D	B-	N/A	[During the works] Concerning the residual earth, it is scheduled to backfill it within the works site or reuse it within the power station grounds as much as possible. As for the earth and waste equipment and materials that cannot be reused, it is intended to dispose it in a landfill based on Kosrae State regulations or to have a metals recycling operator that has been licensed by Kosrae State conduct appropriate treatment. Therefore, it is expected that the impact of solid waste treatment during the works will be minor.
	4	Soil pollution	D	D	N/A	N/A	-
	5	Noise and vibration	B-	D	B-	N/A	[During the works] The noise and vibration impact caused by construction machinery can be kept small by using construction machinery with low-noise and low-vibration specifications, stopping unnecessary idling, limiting works to daytime and taking other environmental preservation measures.
	6	Ground settlement	D	D	N/A	N/A	-
	7	Odor	D	D	N/A	N/A	-
	8	Bottom sediment	D	D	N/A	N/A	-
Natural environment	9	Nature reserves	D	D	N/A	N/A	-
	10	Ecosystem	B-	D	B-	N/A	[During the works] Impacts on coastal ecosystems such as mangroves and coral reefs can be kept small by implementing the abovementioned water pollution countermeasures, conducting replanting using local and endemic species, notifying KIRMA if it is necessary to cut or remove rare and valuable species, taking steps to prevent invasion by foreign species and so on.
	11	Water conditions	D	D	N/A	N/A	-
	12	Topography and geology	D	D	N/A	N/A	-

Target	No.	Impact Item	Impact Assessment during Scoping		Impact Assessment based on Survey Results		Reasons for Assessment
			During works	In service	During works	In service	
Social environment	13	Resettlement and land acquisition	B-	D	B-	N/A	[During the works] It is planned to implement the renewal of Lelu Island distribution line on the existing ROW, for which the state government has signed a long-term lease agreement, however, since it is planned to transfer and newly erect utility poles along part of the distribution line, it will be necessary to reach agreement with the landowners in such cases. If KUA can confirm the landowners from cadastral maps, hold discussions with them and sign land use agreements before the start of the works, it will be possible to limit the impact on residents to a minimum.
	14	People in poverty	D	D	N/A	N/A	-
	15	Minorities and indigenous people	D	D	N/A	N/A	-
	16	Local economy (employment and means of livelihood, etc.)	B+	A+	B+	A+	-
	17	Land use	D	D	N/A	N/A	-
	18	Water use	D	D	N/A	N/A	-
	19	Existing infrastructure and social services	B-	A+	B-	A+	[During the works] The heavy machinery and construction equipment and materials will be transported to the Project site along a road that is also used by residents for everyday activities, however, because the transportation will be limited to a few days only during the works period, residents will be informed about the routes and operating times of works vehicles and other steps will be taken, it is thought that the impact will be minor.
	20	Social infrastructure and social organizations such as community decision -making bodies, etc.	D	D	N/A	N/A	-
	21	Uneven distribution of impacts and benefits	D	D	N/A	N/A	-
	22	Conflict of interests	D	D	N/A	N/A	-
	23	Cultural heritage	C	D	D	N/A	[During the works] There are some historical sites dotted around Lelu Island, however, it was confirmed that all these historical sites are situated sufficiently far away from the utility poles. Therefore, there are not expected to be any impacts on historical sites as a result of Project implementation.
	24	Landscape	D	D	N/A	N/A	-
	25	Gender	D	D	N/A	N/A	-
	26	Children’s rights	D	D	N/A	N/A	-

Target	No.	Impact Item	Impact Assessment during Scoping		Impact Assessment based on Survey Results		Reasons for Assessment
			During works	In service	During works	In service	
	27	HIV/AIDS and other infections	B-	D	B-	N/A	[During the works] Since appropriate health and safety education will be thoroughly implemented for workers during the works, it is expected that the impact in terms of spread of infections caused by the influx of workers will be minor.
	28	Work environment (including work safety)	B-	B-	B-	B-	[During the works] During works, through appointing safety managers, conducting health and safety education for workers, holding regular safety meetings, compiling operation and maintenance plans while giving ample consideration to safety, and so on, impacts can be reduced. [In service] As in the case of during the works, since KUA will appoint safety managers, conduct health and safety education for workers, hold regular safety meetings, and compile operation and maintenance plans while giving ample consideration to safety, it will be possible to minimize the impacts.
Others	29	Accidents	B-	B-	B-	B-	[During the works] During works, through appointing safety managers, conducting health and safety education for workers, holding regular safety meetings, compiling works plans with ample consideration given to safety, and implementing periodic inspections of construction machinery and works vehicles, it will be possible to minimize the occurrence of accidents. Also, based on the incidental conditions of the EIA permit, management of harmful substances and measures to counter accidents during typhoons will be taken. [In service] Prevention of accidents will be strived for through having the contractor conduct initial operation guidance on installation and the consultant implement the soft component in order to enforce measures to prevent accidents when facilities and equipment are in service. Moreover, through implementing the measures that are required in the EIA permit in the same way as during the works, occurrence of accidents in service will be reduced
	30	Cross-border impacts and climate change	C	D	D	N/A	[During the works] As a result of the hearing with KUA and site reconnaissance, there is not expected to be any cross-border movement of solid wastes from the Project.

A±: Items where dramatic positive or negative impacts are foreseen
B±: Items where a certain degree of positive or negative impacts are foreseen
C±: Items where the degree of positive or negative impacts is unknown
D: Items where no impacts are forecast

(12) Environmental Management Plan and Monitoring Plan

While considering the implementation capacity and financial standing of KUA and the level of measurement instruments for environmental monitoring in the Federated States of Micronesia and Kosrae State, the environmental management plan and monitoring plan were compiled according to the works phase and in-service stage based on the abovementioned environmental mitigation measures (see Table 1-4.11 and Table 1-4.12).

Table 1-4.11 Environmental Management Plan and Monitoring Plan (During Works)

No.	Impact Item	Item	Management & Monitoring Method	Location	Frequency	Responsible Agency
1	Air pollution	Airborne dust situation	Visual confirmation (is there any conspicuous fly-off of particulates, or any intermittent or long-term fly-off, etc.)?	Inside and around the Project target area	As appropriate	KUA Contractor
2	Water pollution	Water turbidity	Visual confirmation (is there any large-scale or long-term run-off of muddy water, etc.)?	Inside and around the Project target area	As appropriate (see the "Ecosystem" item)	KUA Contractor
3	Solid wastes	Generated quantities of solid wastes	Visual confirmation (number of containers, etc.)	Inside the Project target area	Once/month	KUA Contractor
		Reporting of harmful substances (including waste oil) to KIRMA	Visual confirmation (storage and transportation situation, etc.) and weighing	Inside the Project target area	Once/month (until September 30)	KUA Contractor
5	Noise and vibration	Complaints from nearby residents	Hearings with residents	Around the Project target area	As appropriate	KUA Contractor
10	Ecosystem	Water turbidity	Visual confirmation (outflow to waters around Lelu Island)	Around the Project target area	As appropriate	KUA Contractor
			Visual confirmation (outflow to outside of the KUA grounds)	Around the Project target area	As appropriate	KUA Contractor
13	Resettlement and land acquisition	Complaints from landowners	Receipt of complaints, hearings with residents, etc.	Project target area and environs	As appropriate	KUA Contractor
19	Existing infrastructure and social services	Situation regarding transportation of materials	Confirmation of monthly works progress reports	Project target area	Once/month	KUA Contractor
23	Cultural heritage	Discovery of new historical sites				
27	HIV/AIDS and other infections	Implementation of health and safety education				
28	Work environment					
29	Accidents					

Table 1-4.12 Environmental Management Plan and Monitoring Plan (In service)

No.	Impact Item	Item	Management & Monitoring Method	Location	Frequency	Responsible Agency
1	Air pollution	Complaints from nearby residents	Hearings with residents	Around the Project target area	6 months after the generators go into operation	KUA
		Measurement of combustion exhaust gases (NOx, SO_2)	Measurement by combustion exhaust gas analyzer (Note 1)	Generator smokestack outlet (or measurement hole)	Once every 6 months	KUA
2	Water pollution	Existence of oil leaks (oil film)	Visual confirmation (any oil film, continuous generation of oil film, increase in amount of oil film, etc.)?	Inside and around the Project target area	As appropriate	KUA
3	Solid wastes	Generated quantities of solid wastes	Visual confirmation (number of containers, etc.)	Inside the Project target area	Once/month	KUA
		Operating condition of waste oil incinerator	Confirmation of implementation records	Inside the Project target area	Once/month	KUA
		Reporting of harmful substances (including waste oil) to KIRMA	Visual confirmation (storage and transportation situation, etc.) and weighing	Inside the Project target area	Once/month (until September 30)	KUA
4	Soil pollution	Leaks from waste oil and fuel tanks	Visual confirmation (any leaking areas, conditions inside oil fences, checking of tank degradation, etc.)	Inside the Project target area	Once/week	KUA
		Grass cutting around waste oil tanks	-	Inside the Project target area	As appropriate	KUA
5	Noise and vibration	Complaints from nearby residents	Hearings with residents	Around the Project target area	6 months after the generators go into operation	KUA
		Measurement of noise level	Measurement by noise meter (Note 1)	Power station site perimeter and optional points (inhabited houses, etc. where there is concern over noise)	・ 6 months after the generators go into operation ・ As appropriate	KUA
28	Work environment	Implementation of safety meetings	Recording of implementation	Inside the Project target area	As appropriate	KUA
29	Accidents	Accident occurrence situation	Recording of accidents			

(Note 1) Since neither KUA nor KIRMA own any measurement devices, these will be procured within the Project.

Moreover, if management and monitoring are implemented based on visual checking, there is a possibility that judgments will differ between checkers, leading to uncertain assessments and hindering appropriate countermeasures being taken. One solution is to appoint a monitor for each item and have the same person conduct the visual inspections. Doing this will make it possible to detect changes based on periodic monitoring and thereby mitigate the uncertainty.

CHAPTER 2 CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

2-1-1 Higher Plans and Project Goals

The FSM National Energy Policy 2010, which is the supreme plan for the electric power sector has the following objective: “To supply economical, reliable and environmentally friendly energy and improve the lives of all people in Kosrae State.” Moreover, based on this higher plan, Kosrae State Energy Action Plan 2013 raises the following as important goals: 1) improvement of generating efficiency, 2) reduction of fuel consumption, and 3) reduction of distribution loss, and the Project here will contribute to the realization of this policy.

2-1-2 Basic Concept of the Project

Through renewing diesel generator and associated facilities in Kosrae State, the Project aims to secure supply of stable and efficient power supply, and thereby contribute to improvement of lifestyle for the citizens, economic development and environmental and climate change countermeasures in the Federated States of Micronesia. The Project entails constructing a diesel generator house and installing diesel generator equipment and distribution equipment.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

The Project aims to procure and install normal use power generating equipment and distribution equipment that can meet the current peak load and demand that is scheduled in future plans, with the objective of improving power generating efficiency and distribution equipment in Kosrae State. The installation site for the generating equipment will be inside the existing Tofol Power Station, however, because the current generator house is deteriorated and space is restricted due to the existence of unused, obsolete generating equipment, a new generator house will be constructed near to the existing one. Since Kosrae State is surrounded by ocean and prone to the effects of salt damage, the generating equipment will be installed indoors as much as possible. Concerning the policy for distribution equipment, basically the badly deteriorated overhead distribution line to Lelu Island and two 15 kV underground cables that supply power to Tafunsak district, which contains airport and port facilities, will be replaced with new equipment.

The target year for the Project is 2021, which is three years after the start of supply of the expected power demand in the Project target area.

Moreover, the Project is scheduled to be implemented in cooperation with the World Bank (WB). The diesel generators that are offered under assistance from the WB are expected to be

high-speed machines of 1,200~1,800 rpm, while the Project generators are scheduled as medium-speed machines with ordinary specifications of 900 rpm or less. Since the medium-speed machines with ordinary specifications can provide stable power supply over the long term, the Project diesel generators will be intended for base load use, while the WB generators will be operated during periods when one (1) Project generator is not operating due to maintenance and so on, and peak load period.

(2) Policy regarding Natural Conditions

1) Policy regarding Temperature and Humidity

Temperature and humidity in the Project target area remain fairly constant throughout the year at on average 30°C and 77.3% respectively. Since the engine and generator to be procured will be installed indoors, there will be no need to take any particular countermeasures regarding outside temperature, however, in designing the engine combustion air and engine room ventilation, care will be taken to keep the design temperature to 40°C and the electricity room temperature to no higher than 35°C, and to ensure that outdoor equipment can function at temperatures of no higher than 40°C. Moreover, the equipment for procurement will be selected in consideration of the local heat and humidity.

2) Salt Damage

Since the facilities and generator equipment to be constructed and installed in the Project will be situated close to the coast, equipment will be installed indoors as much as possible. Concerning the equipment that has to be installed outdoors and the exterior walls of buildings, salt-resistant coating will be applied to counter salt damage. Moreover, since the distribution equipment and materials such as bushing, etc. for insulators, switches, transformers, etc. will also be used under the same conditions as the generators; salt-resistant products will again be adopted.

(3) Concept regarding Social and Economic Conditions

Since most of the citizens of Kosrae State are Christians, Sunday is a day of rest and ordinary shops and restaurants and so on remain closed. Apart from that, there are no particular limitations or conditions that will impact the construction schedule. Having said that, at the start of the power station construction and power distribution works, KUA will need to notify the local residents of the works schedule and seek understanding for the Project in advance.

The Project target areas will be the site of the KUA power station, the overhead distribution line to Lelu Island and the underground cable routes to and around the airport. Since Lelu, which is a scheduled site for renewal of the overhead distribution line, is located close to residential land, care will need to be taken to ensure that the local residents are not inconvenienced and no harm is caused to existing structures and buried objects.

(4) Concept regarding Procurement Conditions and Construction Conditions

Kosrae State has no industries of note apart from agriculture, fisheries and tourism, so it relies almost completely on imports to provide daily necessities, building materials and equipment, etc. Accordingly, there is no equipment or materials that can be procured locally, and it is also difficult to secure local workers. Therefore, it will be necessary to consider the overseas procurement of construction equipment and materials and recruitment of foreign workers for the Project works. Roads around the Project target area are narrow but comparatively well paved, so there won't be a major problem regarding the transportation of equipment and materials. The local port has no large-scale cranes and so on, however, it should be possible to transport and unload the procured equipment on derricks, etc.

(5) Concept regarding Utilization of Local Contractors and Local Equipment and Materials

1) Utilization of Local Contractors

The Project target area of Kosrae State previously had one or two construction companies financed out of Guam, however, the head offices in Guam have decided to pull these operations out due to the absence of any new construction projects. There are not many vehicles capable of transporting equipment and materials, and few construction machines capable of normal operation on the island, and none of the local workers possess the skills required to execute works on the scale of those in the Project. In reality, it is necessary to rely on third country workers from the Philippines, etc.

There are a number of construction companies in the Federated States of Micronesia, in particular Pohnpei State, and it is deemed possible to procure construction materials transportation vehicles and works machinery, however, even in Pohnpei State, concerning workers, it is necessary to rely on third country workers from the Philippines, etc. as is the case in Kosrae State. It is also necessary to bring in large-scale construction machinery from overseas.

In the Project, generating equipment and distribution equipment installation works and facilities construction works, since high-level engineers will be required, it will be necessary to dispatch engineers from Japan in order to conduct quality control, schedule management, safety management, testing and adjustment.

2) Utilization of Local Equipment and Materials

The aggregate, cement and other materials required for concrete works and foundation works can be procured in the Federated States of Micronesia, however, since quantities are insufficient, it is necessary to depend on imported materials. Reinforcing bars, architectural steel frame, steel frame structure roof and wall materials, equipment materials, generating equipment piping and cables, and other equipment and materials for mechanical and electrical works cannot be

procured locally, so will need to be procured from third countries.

3) Procurement of Third Country Products

The Federated States of Micronesia imports almost all power generating, substation and distribution equipment and materials from the United States. When procuring equipment from third countries, ample examination will be conducted regarding prices, quality, delivery, ease of procuring spare parts after the start of service, post-sales service structure, and compatibility with existing equipment and so on.

4) Buildings

In the Federated States of Micronesia, it is relatively easy to locally procure simple laborers, transportation vehicles, construction equipment, etc. for construction of houses and other small structures, however, because laborers, transportation vehicles, construction equipment, etc. for construction of a power station and foundations like in the Project are not available, procurement from Japan or third countries will be considered.

Also, high-level engineers will be required in order to install the generating equipment and construct the large-scale steel structure generator house in the Project. Apart from simple laborers, since local contractors cannot be utilized for these works, it will be necessary to dispatch engineers from Japan or third countries in order to conduct quality control, offer technical guidance and supervise the works.

(6) Concept regarding Maintenance Capacity of the Executing Agency

As it does with existing equipment, KUA will conduct operation and maintenance of the Project generating equipment after it goes into service. Since KUA has operated diesel generator equipment for many years, it is deemed to possess the practical ability to conduct operation and maintenance.

However, because almost all employees have never received specialized mechanical or electrical training, it is likely that they lack the systematic and theoretical knowledge required to conduct preventive maintenance including routine inspections, etc. As part of the guidance on operation and maintenance technology in the Project, short-term intensive classroom training and practical training using actual machinery will be implemented by Japanese engineers via the soft component during the construction period. This training will educate the KUA operators and maintenance staff in basic theory and practical operation management methods concerning generating equipment from both the mechanical and electrical aspects. Moreover, proposals will be made concerning the approach to preventive maintenance following the start of operation, and care will be exercised to ensure that the equipment is operated more effectively and efficiently.

(7) Concept regarding the Scope and Grade of Facilities and Equipment, etc.

In order to design the Project facilities and equipment with appropriate technical and economic levels, standard equipment and materials that comply with international standards (ASTM, ISO, etc.) will be adopted as much as possible. Through selecting the minimum necessary types and quantities of equipment and materials, greater compatibility will be sought.

(8) Concept regarding Construction Method, Procurement Method and Works Schedule

Since the Project will be implemented based on the Japan's Grant Aid scheme, it will be necessary to complete the procurement and installation works within 24 months after signing of the grant agreement (G/A). In order to finish the works and realize the anticipated effects during this period, it will be necessary to coordinate the respective works schedules between the Japanese and the Federated States of Micronesia sides and to compile a schedule that takes transportation routes, methods, lead-times, procedures, etc. into account.

Equipment procured in Japan and other third countries will primarily be transported to Kosrae State by sea. The road from Kosrae Port to Tofol Power Station (approximately 15 km) is in relatively good condition, however, because the road is narrow and is crossed by distribution lines, it is thought that equipment and materials will be transported in the presence of KUA employees and under guard by the local police.

Since a high level of skill will be required to construct the generator house, which will be a steel frame structure with relatively high eaves, it will be necessary to dispatch engineers from Japan or third countries in order to offer technical guidance and manage the schedule.

2-2-2 Basic Plan

(1) Design Conditions

In designing the Project facilities and equipment, specifications will be planned based on the following conditions.

1) Climate and Natural Conditions

a) Mean ambient temperature (maximum) : 30.3 °C
b) Mean ambient temperature (minimum) : 26.8 °C
c) Relative humidity (maximum) : 99 %
d) Mean wind speed : 4.1 m/s
e) Mean annual precipitation : 5,235 mm

2) Applicable Standards

a) Japan Industrial Standard (JIS):
Applicable to industrial products in general.

b) Japanese Electro-technical Committee Standard (JEC):
Applicable to electrical products in general.

c) Japan Electrical Manufactures' Association Standard (JEM):
Applicable to electrical products in general.

d) Japanese Cable Makers' Association Standard (JCS):
Applicable to power lines and cables

e) Technical Standards for Electrical Equipment:
Applicable to electrical works in general.

f) International Electro-technical Commission Standard (IEC):
Applicable to electrical products in general.

g) International Organization for Standardization (ISO):
Applicable to electrical and mechanical products in general.

h) Building Standards Act (AIJ):
Applicable to building structural design and calculation.

i) American National Standards Institute (ANSI):
Applicable to industrial products in general.

j) American Society for Testing and Materials (ASTM):
Test methods for materials

k) Institute of Electrical and Electronics Engineers (IEEE):
Applicable to electrical products in general.

l) National Electrical Manufacturers Association Standard (NEMA):
Applicable to electrical products in general.

m) Rural Electrification Administration Standard (United States Department of Agriculture, Rural Electrification Administration, Specifications and Drawings for 12.5 / 7.2 kV Line Construction):
Applicable to distribution line pole assembly

n) National Electrical Safety Code:
Applicable to electrical works in general

3) Used Units

As a rule, the international system of units (SI units) will be used in the Project. Also, concerning mechanical equipment in general and equipment and materials for distribution lines, yard and pound units will be used as needed.

4) Electrical System

The electrical system applied to the Project plans will be as shown in Table 2-2.1 with a view to securing compatibility with existing equipment.

Table 2-2.1 Electrical System

Item	Medium Voltage	Low Voltage	In-station Power Source	
			AC	DC
Nominal voltage	13.8 kV	240/120 V	415-240 V	110 V
Maximum voltage	15 kV	264/132 V	457-264 V	121 V
Frequency	60 Hz			-
Maximum short circuit capacity	12.5 kA (1 sec.)	-	-	
Lightning impulse withstand voltage	95 kV (Note 4)	-	-	
Grounding system	Direct grounding system, generator neutral point direct grounding	-	-	
Minimum surface leakage distance	229 mm	-	-	
Minimum separation of conductors	(Note 1)	-	-	
With earth	647 mm	266 mm	-	
Between phases	1,120 mm	460 mm	-	
Wiring system	3 phase 4 wire			2 wire
Distance from structures	(Note 2)			
General areas	5.6 m	-		
Roads	5.6 m	-		
Water/ navigation channels	5.2 m	-		
Occupied scope of distribution line	6.1 m	-		
Housing	3.0 m	-		
Protection class (IP)	(Note 3)			

[Source] Investigation by the JICA Study Team

(Note)
1. Minimum separation of distribution line conductor is based on the Rural Electrification Administration Standard (United States Department of Agriculture, Rural Electrification Administration, Specifications and Drawings for 12.5 / 7.2 kV Line Construction) that is applied by KUA. However, conductor separation inside 13.8 kV distribution boards shall be based on manufacturer's standards.
2. The separation of distribution line conductor and distance of support structures distribution line is based on the US National Electrical Safety Code that is applied by KUA.
3. Standard specifications of protection classes for 13.8 kV distribution boards, low voltage panels, control and protection panels, and equipment operating panels shall be as follows.
   Outdoor: IP 53, Indoor: IP 21
4. 110kV shall be applied to all overhead distribution lines

5) Environmental Protection Standards

In the Federated States of Micronesia, when constructing new generating equipment, since there are no established environmental standards, the following standard values will be set as design conditions in consideration of Japanese standards and the local conditions.

a) NOx emission standard : 950 ppm or less (when residual oxygen concentration is 13%)
b) SOx emission standard : 500 ppm or less (when the sulfur content of fuel is 2%)
c) Oil emission standard : 50 ppm or less
d) Dust emission standard : 100 mg/Nm^3 or less
e) Noise standard : Only when the Project generating equipment is operating, 110 dB (A) or less (1m from the machine side)
f) Vibration standard : Only when the Project generating equipment is operating, 65dB or less on the site perimeter

6) Facilities Layout Plan

The Project generating equipment will be installed inside a new generator house that will be constructed near to the existing generator house inside the grounds of Tofol Power Station.

The diesel engine generator and auxiliary unit will be installed inside the new generator house; the circuit breaker panel, generator control and monitoring panel, and low voltage power control panel will be put in the electricity room and monitoring and control room; the air supply blower will be put inside the blower room; and the waste oil disposal equipment and radiators will be installed outside. The facilities and equipment will be arranged in such a manner that makes it easy to conduct operation and maintenance.

Also, it is planned to supply engine fuel (diesel oil) in the Project from the existing diesel oil storage tanks, so there will be no construction of fuel oil storage tanks in the Project.

In addition to the operation and maintenance of the generating equipment, the following conditions will be considered in designing the layout plan:

a) Minimization of the impacts of noise and vibration on nearby residents, and
b) Securing of connection with existing equipment

(2) Outline of the Basic Plan

Table 2-2.2 shows an outline of the basic plan of the Project.

Table 2-2.2 Outline of the Basic Plan

Planning Category	Contents of Plan
Project target area (district)	・Renewal of generating equipment: Existing Tofol Power Station ・Renewal of distribution equipment: Lelu Island (power distribution system) and Okat Area (underground distribution cables)
Construction of generator house	・Number of building : Generator house 1 building ・Foundation : Footing ・Structure : Steel structure, two story, atrium in the diesel engine generator Room on ground floor ・Maximum eaves height : 12.45 m ・Floor area : Ground floor/440.84 m^2, first floor/147.36 m^2, total/588.20 m^2 ・External finish : - Roofing/fluorine resin painted and galvanized steel ribbed sheet, Cover concrete for protection of waterproofing - Wall/ fluorine resin painted and galvanized steel ribbed sheet - Spandrel wall/emulsion paint on mortal ・Internal finish : - Diesel engine generator room (Flooring/ dust proof paint, Wall/ emulsion paint, Ceiling/exposed steel structure and steel ribbed sheet) - Entrance hall (Ditto) - Electrical room (Flooring/ dust proof paint, Wall/ emulsion paint, Ceiling/ exposed deck plate) - Office (Flooring/ vinyl tile, Wall/emulsion paint, Ceiling/ makeup plasterboard) - Control room (Ditto) - Blower room (Flooring/ mortal steel trowel, Wall/ emulsion paint, Ceiling makeup plasterboard)

Planning Category	Contents of Plan
	・ Building service : Electrical system, air conditioning and ventilation systems, Intercom system, fire alarm system and lightning protection system ・ Others : Foundations for the generator, auxiliary unit, etc., access road for generator house
Procurement and installation of generating equipment (including electrical equipment)	・ Procurement and installation of diesel generator equipment (Rating 600kW x 2 units) ・ Procurement and installation of incidental mechanical equipment for the generating equipment - Fuel equipment - Lubricating oil equipment - Cooling water equipment - Compressed air equipment - Ventilation equipment - Waste oil disposal equipment ・ Procurement and installation of incidental electrical equipment for the generating equipment - 13.8 kV circuit breaker panel - In-station transformer board - In-station power control panel, low-voltage distribution board - DC power supply board, protective board, control panel - Wiring and grounding materials - Laying of cables between the existing power station and new power station ・ Procurement of spare parts and maintenance tools for the generating equipment and auxiliary unit ・ Procurement of operation and maintenance manual (including OJT teaching materials) for generating equipment and implementation of OJT
Procurement and installation of distribution equipment	・ Procurement and installation of the following equipment necessary for construction of the 13.8 kV power distribution system: - Utility poles, wire, insulators, and other necessary incidental items - Pole transformer - 15 kV distribution underground cables and necessary accessories
Procurement of spare parts and maintenance tools	・ Spare parts (quantity needed up until the first overhaul) and general and specialized tools necessary for maintenance of generating equipment and distribution equipment

[Source] Investigation by the JICA Study Team

(3) Basic Items

The equipment to be procured in the Project will be selected so as not greatly exceed the current technical levels of KUA, and emphasis will also be placed on the ease and economy of operation and maintenance following completion.

Because the generating equipment will be installed inside the existing Tofol Power Station, where available site land is limited, care will be taken to avoid obstructing the layout and routes of existing generating equipment and the equipment, pipes, wires, etc. scheduled for provision by the World Bank when selecting the layout of the major equipment and routing of pipes and wires. Moreover, since the construction site is expected to be prone to corrosion due to the rainy climate and salt damage and so on, it is planned to install equipment inside the new generator house as much as possible. Also, in selecting the control system for the power generating equipment, it will be necessary to take into account the systems of the generating equipment that will be inter-connected, i.e. the existing equipment and the diesel generators scheduled for supply under World Bank assistance.

As for the renewal of 13.8 kV distribution equipment on Lelu Island, since it will be necessary to interrupt power to some of the existing equipment and block traffic and so on when executing the

works, it will be necessary for KUA to advertise the works plans that are prepared by the contractor and confirmed by KUA, and for the contractor to hold discussions with KUA, to ensure that the impacts on residents during the works period are kept to a minimum.

(4) Generating Equipment Plan

1) Basic Items and Contents of Plan

a) Basic Items

The equipment required for constructing the generating system will be selected based on the following basic items and plan contents.

i. Power generating system

Considering that existing equipment is based on diesel power, and taking into account the technical capability of KUA's operation and maintenance personnel and the ease of operation and maintenance, diesel generator equipment will be adopted in the Project.

ii. Control system

Concerning the operation and control system of generating equipment, both remote and manual operations will be adopted in consideration of the ease of operation and maintenance and the systems of existing equipment and diesel generators scheduled for supply by the World Bank.

Remote operations will be conducted from the monitoring and control room in the new generator house, however, in consideration of safety, manual operation (machine side) will also be considered for starting and stopping of the diesel engine. Also, it will be possible to monitor the existing equipment and diesel generators scheduled for supply by the World Bank from the monitoring and control room in the new generator house.

iii. Fuel

The existing diesel generator equipment uses diesel oil procured from Singapore. It is expected that the Project generating equipment will also use the same fuel currently used by Tofol Power Station. Table 2-2.3 shows the fuel properties.

Table 2-2.3 Fuel Properties

Item	Unit	Properties
Color	--	Pale yellow
Ignition point	°C	82
Kinematic viscosity (40°C)	cst	3.29
Specific gravity (15°C)	kg/m^3	0.832
Pour point	°C	-9
Total sulfur content	mg/kg	7
Water content	Vol%	0.01

[Source] Kosrae Utility Authority (KUA) (Xson Mobile)

iv. Lubricating oil

The recommended composition of lubricating oil differs between manufacturers of generating equipment. In the Project, it is planned to use the same lubricating oil 15W-40 (TOTAL: RUBIA TIR 7900) that is used in the existing equipment in order to ensure compatibility with existing equipment and keep storage space to a minimum.

v. Cooling water

In the Project, as with the existing equipment, it is planned to use city water for cooling the new generating equipment. The city water will undergo treatment to make it compatible for use with the diesel engine.

b) Contents of Plan

i. Conditions for selection of diesel generator capacity (single units and total)

Based on Clause 1-3 in Chapter 1, examination of the necessary number of diesel generator units and capacity to satisfy the forecast demand in the third year after Project completion (2021) is conducted.

i) Conditions of Peak and Lowest Demand

Peak demand: 1,140kW + 461kW (assumed additional load) = 1,601 kW
(refer to Clause 1-3 (2) in Chapter 1, concerning the additional demand).

Low demands of Weekend: 460kW + 50kW (assumed additional load) = 510 kW
(Assumed additional load of weekend is assumed 50% of the peak load of the memorial hospital (101kW). For the other facilities such as fish transhipment facilities and the water bottling facility, JICA study team assumed the cases their operation would stop on the weekend).

ii) Conditions of other power source

Solar Power Generation: 300 kWp (Weekend generating capacity: PEC 200kWp x 50% + EU 100kWp = 200 kWp)

(Note): In Kosrae State, there are two (2) solar power generation systems. One (1) project with 200kWp output capacity installed under support from the Pacific Environment Community (PEC) which was completed at within Tofol power station premises. It started operation on last April. The other solar power project assisted by the European Union (EU) with 100 kWp capacity at the parking area of Kosrae State office has been constructed and started operation from December 2015.
The power demand of weekend is low compared with the one of weekday. The solar power solar power generation ratio of Kosrae State is high against total

power demand. Therefore, JICA team requested KUA to stop 50% of output from the solar power system installed under the Pacific Environment Community (PEC) assistance on the weekend, in order to keep the power quality (such as frequency and voltage) and KUA agreed to JICA's request. KUA has currently manually stopped one of two power conditioners and cut output by 50%, but in the project it was decided to install a start/stop panel based on program timer.

On the other hand, necessity to stop 50% of solar power system output of PEC fund on the weekday is not confirmed, since solar power output affects small on system frequency due to the large enough amount of diesel generators output of the weekday's daytime, even in the case when solar power output suddenly decreases due to weather conditions.

iii) Operating conditions of diesel generators

- Minimum Operation Load: Recommended as more than 40% of rated unit capacity, in order to protect cylinders from soot caused by incomplete combustion.
- Limited of Load Change Ratio: The total rated output of solar power generation will be set at no higher than than 25% of total rated capacity of diesel generators, as a safeguard against sudden changes in solar power output caused by weather conditions.
- Minimum unit capacity of diesel generator: Recommended at least equal to minimum system load during weekend.

iv) Load capacity of diesel generators

Peak load : 1,601kW = 1,601kW

Low load of Weekend : 510kW – (solar power: 200kWp x 50% + 100kWp (EU fund) = 310kW

v) Calculation of Suitable Total and Unit Capacity of Diesel Generator

[Suitable total capacity for generators]

The minimum total capacity of diesel generators considered from the viewpoint of "Limit of Load Change Ratio (25%)" caused by solar power generation, based on item iii) above, is calculated as follows;

Minimum total capacity: 300kW ÷ 25% = 1,200kW

Hereby,

300 kWp : Rating of solar power generating equipment

25% : Instantaneous load fluctuation rate

Result: Suitable total capacity of diesel generators should be 1,200kW or more from the view point of the total solar power generation capacity (300kW)

[Suitable unit capacity for generators]

Suitable unit capacity of diesel generator considered from the view point of "minimum weekend load" (clause iii) above), is calculated as follows;
(Minimum operation load of diesel generator is recommended more than 40% of rated capacity).

Unit maximum diesel generator capacity: 310kW ÷ 40% = 775kW

Hereby,

310kW : Minimum demand of diesel generator
40% : Low load operating rate

Result: Suitable unit capacity of diesel generator should be less than 775 kW.

From the results of the above, the unit capacity of generator is recommended between 310 kW (Low load of weekend covered by diesel generator) and 775 kW.

ii. Appropriate unit generator capacity and total capacity for assistant

Through the whole study of JICA study team, appropriate units and size for assistant components for KUA funded by World Bank and JICA are presented as three (3) sets of 600kW diesel generators (continuous rating) hereto. All stakeholders will make the best effort that KUA is going to procure recommended unit capacity of diesel engine generator as close to and not less than 600 kW (continuous rating).

The correlation among the total available capacity of all generators including proposed assistant units and existing units, the firm capacity (defined as "Total generation capacity of Tofol power station – the largest unit generator capacity"), and the peak demand determined in (refer to Clause 1-2 (2) in Chapter 1.) is shown Figure 2-2.1.

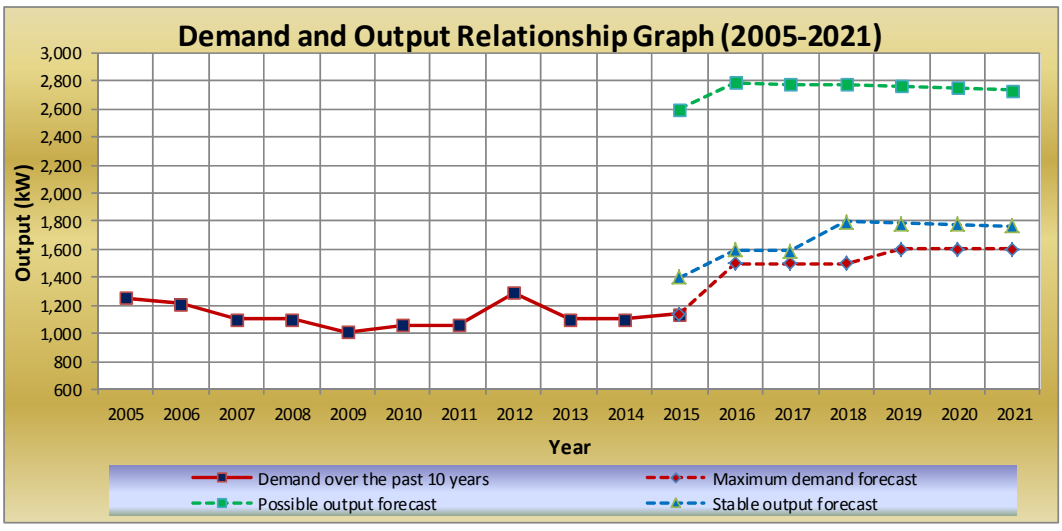


Figure 2-2.1 Demand and Output Relationship Graph

"Total generation capacity of Tofol power station" in Figure 2-2.1 is determined based on the KUA's operation schedule of all related generators shown in Table 2-2.4.

Table 2-2.4 Diesel Generators Operating Plan

Equipment No.	Item	Generating capacity (kW)	Year						
			2015	2016	2017	2018	2019	2020	2021
G-4	Existing equipment	400		Decom mission					
G-6	Existing equipment	1,200				Decom mission			
G-8	Existing equipment	1,000							
G-9	Scheduled for WB assistance	600							
G-10	Scheduled for Govt. of Japan assistance	600							
G-11	Scheduled for Govt. of Japan assistance	600							
Total		4,400							

The concept behind the selected components is described below.

i) Total generation capacity of Tofol power station including newly installed three units of 600 kW covers enough for the peak demands from the year 2016 to the year 2021 as shown in the Figure 2-2.1.

ii) Any kind of diesel generators should be conducted periodical maintenance works at every six months and its maintenance period is two weeks to three months. In order to consider these maintenance cycles for Tofol power station, the firm capacity was taken account for the study. The firm capacity shown in Figure 2-2.1 was made sure that there are some margin capacities against the peak demand from the year 2016 to the year 2021.

iii) In the examination of single unit capacity of the generators, generators of 600 kW and 750 kW will be selected. Comparison of both types was conducted from the viewpoints of versatility, fuel consumption rate and low load operation time, and the results are shown in Table 2-2.5.

- Versatility

  Both the 750kW diesel generator and 600kW diesel generator have good versatility. The 750kW generator often uses the same engine as the 600kW generator, however, because it has little allowance regarding output, the 600kW generator has slightly better versatility.

➢ Fuel consumption efficiency

Both generators display little difference in fuel consumption when output is 50% or more, however, at less than 50% the 600kW diesel generator is more advantageous. Since demand is low in Kosrae State, the 600kW diesel generator is more suitable.

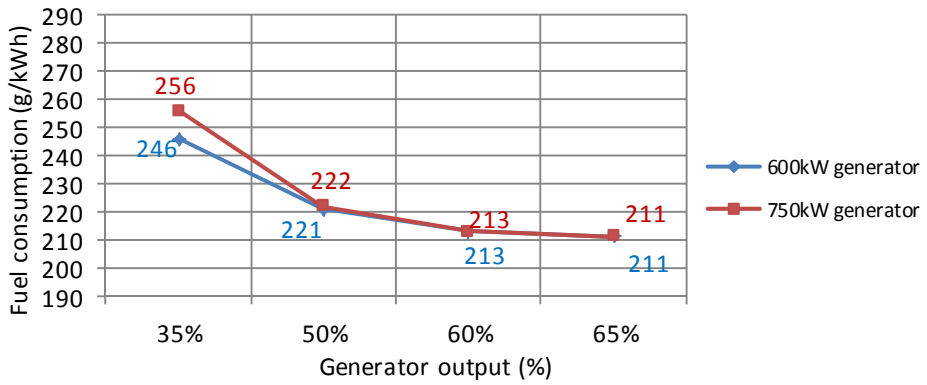
➢ Low-load operation time

Low-load operation (40% or less of rated output) will not arise for the 600 kW and 750 kW diesel generators.

As a result of the above examination, the 600kW diesel generator is best suited to Kosrae State.

Table 2-2.5 Comparison of 600kW and 750kW Diesel Generators

①	Versatility of diesel generators	
1	600kW generator	Versatility is good
2	750kW generator	Versatility is slightly inferior to that of the 600kW
②	Fuel consumption efficiency of diesel generators	(Unit: g/kWh)



③	Diesel generator estimated low-load operating time (40% or less of rated capacity)	
1	600kW generator	No low-load operation
2	750kW generator	No low-load operation

[Source] Survey by the JICA Study Team

c) Operation plan

It is planned to operate four diesel generators at Tofol Power Station, namely the existing Unit No. 8 (rating 1,050 kW), the one diesel generator scheduled to be supplied under WB assistance (rating 600 kW), and the two diesel generators to be supplied and installed in the Project (each with rating of 600 kW).

Since the two diesel generators to be supplied in the Project are medium-speed units, they will generally have better fuel consumption efficiency than the high-speed WB diesel generator and the existing No. 8 diesel generator. Therefore, the Project diesel generators will be used for normal operation, while the WB generator will also be operated (three units in operation) when demand increases (when demand is at the maximum level of 1,600 kW

or it is 1,200 kW or more).

Based on the generating record of KUA since 2014, the peak demand time (more than 1,200 kW) is between 09:00 and 15:00, and this adds up to around 20 hours on average per month. Moreover, in cases where one of the diesel generators to be supplied in the Project is stopped for maintenance, failure, etc., the other Project generator will be operated in combination with the WB generator as the base load, while the existing generator (No. 8) will be operated for responding to higher demand.

Figure 2-2.2 shows the predicted operation plan.

Item	Month												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Project generator (No.11)													Rating: 600kW
Operating months	2.00				3.00					3.00		0.25	8.25 months/year
Operating hours	1,440				2,160					2,160		180	5,940 hours/year
Operating rate													67.81 %
Project generator (No.10)													Rating: 600kW
Operating months		3.00				3.00				3.00			9.00 months/year
Operating hours		2,160				2,160				2,160			6,480 hours/year
Operating rate													73.97 %
WB scheduled assistance generator (No.9)													Rating: 600kW
Operating months	0.03		1.00	1.00	0.03		1.00	1.00	0.03		1.00	0.50	5.59 months/year
Operating hours	20		720	720	20		720	720	20		720	360	4,020 hours/year
Operating rate													45.89 %
Existing generator (No.8)													Rating: 1050kW
Operating months		0.03	0.03	0.27	0.25	0.03	0.03	0.27	0.25	0.03	0.03	0.26	1.48 months/year
Operating hours		20	20	195	180	20	20	195	180	20	20	185	1,055 hours/year
Operating rate													12.04 %

: Bay load operation
: Peak response operation (based on the KUA operating record, high-load operation is planned as 20 hours per month: 5 hours/week x 4 weeks = 20 hours)
: Maintenance period

[Source] Survey by the JICA Study Team

Figure 2-2.2 Operation Plan

2) Mechanical Equipment Plan

The 600 kW generator end engine output (PS) and generator rated capacity (kVA) in the Project are calculated as shown below.

Incidentally, because engine specifications, etc. differ somewhat between manufacturers, the following figures are given as a rough guide.

- Engine output

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

Pe : Engine output (PS, meter horsepower)
P : generator output (600 kW)
η : generator efficiency (assumed as 90%)

- Generator capacity

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

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

Table 2-2.6 Engine Output and Generator Capacity

Item	Capacity
Engine output Pe (PS)	906
Generator capacity P_G (kVA)	750

[Source] Investigation by the JICA Study Team

- Rotation speed

To ensure economic operation and maintenance, power companies in Japan generally adopt medium speed generators of 900 rpm or less as base load generators having single unit capacity 600 kW. Such generators have an extensive operating record. Accordingly, medium speed machines with engine speed of 900 rpm or less will be adopted in the Project too.

- Mechanical incidental equipment plan

In consideration of the ease of operation and maintenance, energy conservation and the procurement cost of equipment, common equipment methods will be adopted in incidental equipment as far as possible. The outline plan is described below.

a) Fuel supply equipment

The existing fuel storage tanks are as follows. Since these can also be utilized in the Project, the existing equipment will be used.

Number of fuel storage tanks : 5 tanks (cylindrical, horizontal tanks)
Fuel storage tank capacity
No.1 and No.2 : 14,594 gallons/ tank
No.3 and No.4 : 8,774 gallons/ tank
No.5 : 20,564 gallons
Condition of fuel storage tanks : Good

Concerning fuel supply, a new fuel pipe will branch from the outlet pipe of the existing fuel storage tank and deliver fuel to the fuel service tank installed on the generator house roof via the fuel transfer pump. From the fuel service tank, the fuel will flow to the fuel supply pump by force of gravity, and from there be pumped to the engines.

b) Lubricating oil equipment

The lubricating oil tank will be installed inside the diesel engine main body. The lubricating oil replacement interval will be 8,000 hours and, in order to reduce maintenance costs, a

centrifuge or filter type lubricating oil cleaner will be installed. The lubricating oil cleaner system will be made independent of the power generating system. The lubricating oil will be supplied to the engine tank by the lubricating oil transfer pump.

c) Cooling water equipment

As the engine cooling system, as in the existing equipment, a radiator closed circulation system, which is commonly used, will be adopted. The cooling water will be supplied from the treated water tank to the rooftop hot/cold cooling water expansion tanks by transfer pump. Moreover, as the cooling water, the city water supply to Tofol Power Station will be treated and stored in tanks for use in diesel engines.

d) Starting equipment

A large starting torque is required to start engines, and the pneumatic starting method based on compressed air will be adopted in the Project (the same method is used in the existing equipment too). The compressed air equipment will be installed in a dual system comprising electric motor drive and engine drive, making it possible to respond to emergencies and power failures. The air tank will have enough capacity to start the diesel engine three times or more. Moreover, since the atmospheric humidity is high and water is apt to accumulate in the compressed air tank, an automatic water drainage valve will be attached to the compressed air tank in order to periodically remove water.

d) Air supply, exhaust and ventilation equipment

In order to reduce the impact of noise from the engines during operation of the generating equipment on nearby facilities and residents, entrances to the generator house will be closed during operation. Therefore, ventilation equipment (blowers) will be installed in the ventilation machine room in order to supply the necessary air for engine combustion, dissipate heat from the engines, and provide the necessary air supply to the generator room. The necessary filter at the air inlet will be selected with a view to minimizing pressure loss, and a panel-type unit that allows for easy replacement and repeated use through washing will be adopted. Wind speed at the air inlet will basically be 3.0m/s or less. Moreover, the structure will be designed to prevent infiltration of rain during blower operation, and nets will be fitted to stop insects from getting into the generator room.

Moreover, exhaust gases from the diesel engine will be discharged via the silencer installed on the roof of the generator house.

e) Waste oil disposal equipment

In the Project, a gravity-type oil-water separation tank and final separation unit will be installed on the generator house roof to ensure that no environmental contamination is

caused by waste diesel oil, lubricating oil, etc. from the diesel engines. Following two-stage separation of oil and water, the treated water will be discharged into the drainage ditch, while the oil will be incinerated to prevent any environmental pollution.

f) Piping routes

The Project will entail installation of fuel pipes, lubricating oil pipes, compressed air pipes, cooling water pipes, and drainage pipes. In order to ensure easy maintenance of piping systems, pipes will be installed inside trenches or on supports inside the generator house, while aboveground or directly buried pipes will be adopted outdoors. Directly buried pipes will be given protection from corrosion and so on using anti-corrosive jute, etc. Also, pipes will be color-differentiated in order to prevent wrong operation of valves, etc. and ensure easy maintenance.

3) Electrical Equipment Plan

The existing power generating system adopts 4.16 kV generating voltage, but 13.8 kV will be adopted for the new system to avoid the need for installing outdoor transformation equipment. Moreover, even after the Project is finished, since the power station will still use the existing diesel generator (G-8) and the diesel generator and existing step-up transformer (2,500 kVA-4.16/13.8 kV) provided under World Bank assistance, the new system will be designed to operate in tandem with these systems. Therefore, it is scheduled to procure the converter panel for incorporating basic signals (frequency, current, voltage, operating state, etc.) from the WB and existing diesel generators

a) Generators

The generators will be the 3 phase 3 wire, synchronous type with horizontal axis and air cooling. Heaters for preventing condensation will be attached to the generators. The main specifications will be as follows.

i.	Rating	Continuous
ii.	Capacity	750kVA or more
iii.	Voltage	13.8 kV
iv.	Frequency	60Hz
v.	Power factor	0.8 (delayed)
vi.	Rotation speed	Same as the diesel engine (engine coupling)
vii.	Excitation method	Brushless, thyristor type
viii.	Neutral point grounding method	Direct grounding

b) 13.8 kV circuit breaker panel

A 13.8 kV circuit breaker panel will be installed inside the electricity room of the generator house for diesel generator synchronous inputting, distribution to the 13.8 kV distribution line (3 lines), and connecting with the existing generating equipment. Also, a protective relay board will be installed for the circuit breakers. In consideration of the ease of operation and maintenance, it will be possible to operate the circuit breaker panel and distribution board on the ground and from the monitoring and control room on the second floor.

c) Neutral point grounding panel

The generator neutral point will be grounded, the neutral point formed, and the disconnector and grounding panel will be installed inside the electricity room of the generator house. Since the generator neutral point will be operated based on single point grounding, only one of the neutral point grounding disconnectors will be closed. A protective relay panel will be separately installed for the generator neutral point grounding circuit.

d) In-station transformer board

As the power supply for the generator auxiliary unit equipment and power station building equipment, one dry type in-station transformer will be stored inside an indoor board inside the electricity room of the generator house. Having capacity of 300 kVA, this transformer will be connected via a 13.8 kV bus line and load switch and will output power of 480-277 V and 415-240 V. The 480-277 V power will be used as power supply for the existing generator building.

e) Main low-voltage distribution board

The main low-voltage distribution board for distributing power from the in-station transformer to the in-station power control panel (motor control center) and DC power supply board will be installed in the electricity room.

f) In-station power control panel (motor control center)

The in-station power control panel for supplying power to the generating equipment auxiliary unit and generator house equipment will be installed in the electricity room. This in-station power control panel will be equipped with the necessary operating and measurement devices and warning devices.

g) DC power supply board

As the power supply for starting, stopping, controlling and measuring the generating equipment and auxiliary unit and issuing alarms and so on, a DC power supply unit (battery, charger and DC distribution board) will be stored in the board and installed in the electricity

room. Voltage will be 110 V, a nickel-cadmium and aluminum battery or a sealed lead storage battery will be adopted, and there will be enough capacity to cope with power interruption of 0.5 hours or more.

h) Low-voltage distribution board

A low-voltage distribution board will be installed in the electricity room and control room to provide power supply to the generating equipment and power station building equipment (lighting, air conditioning, ventilation, etc.).

i) Common control panel

A disc-type common control panel for operating the 13.8 kV circuit breakers to each distribution line and monitoring and controlling the power transmission operation will be installed in the control room.

j) Synchronous control panel

A disc-type synchronous control panel for automatically and manually controlling synchronization of the generating equipment will be installed in the control room. The synchronous control panel will be equipped with a protective relay.

k) Generator control panel

A disc-type generator control panel for controlling and monitoring the generating equipment, generator circuit, 13.8 kV circuit breakers, etc. will be installed in the control room.

l) Generator protective board

A generator protective board for protecting the generating equipment (OC, OCG, UV, etc.) and conducting automatic voltage regulation (AVR) will be installed in the control room. The generator protective board will be equipped with a static protective relay.

m) Distribution lineprotection panel

A distribution line protection panel for protecting (OC, OCG, UV, OV, etc.) the 13.8 kV distribution line, etc. will be installed in the control room.

n) Converter panel

Because the Project generators will be operated in tandem with generators provided under WB assistance and existing generators, a converter panel will be installed inside the existing generator house. The converter panel will be equipped to handle failure signals, status signals (generator operating condition circuit breaker condition, current and voltage converter, pulse signals, etc.), and control signals (generator start and stop, emergency stop, etc.).

o) Power cable and accessories

The cables used for making connections inside the new generator house and connecting with the existing generator house will comprise the following: 15 kV, 6.6 kV and 600 V power cables and control cables.

Specifications of the 15 kV and 600 V power cables for wiring inside the new generator house: Cross-linked polyethylene insulated vinyl sheath (CV) and copper conductor will be adopted.

Specifications of the 15 kV and 6.6 kV power cable for connecting with the existing generator house: Cross-linked polyethylene insulated (XLPE), vinyl cladding (PVC) and copper conductor will be adopted. Since this will be buried, aluminum wire armor (AWA) for single core cable will be adopted.

Table 2-2.7 shows the main specifications of 15 kV and 6.6 kV cables.

Table 2-2.7 15 kV and 6.6 kV Cable Specifications

No.	Start Point	End Point	Specifications			Length (m)	Remarks
			Type	Number of Cores	Conductor Sectional Area (mm^2)		
1	Distribution line circuit breaker panel (FP1)	13.8 kV overhead distribution line launch utility poles (Tafunsak line)	8.7/15kV, XLPE/ AWA/ PVC	1x4	50	60x4	1 is for the neutral line
2	Distribution line circuit breaker panel (FP2)	13.8 kV overhead distribution line launch utility poles (Lelu line)	8.7/15kV, XLPE/ AWA/ PVC	1x 4	50	60x4	1 is for the neutral line
3	Distribution line circuit breaker panel (FP3)	13.8 kV overhead distribution line launch utility poles (Malem line)	8.7/15kV, XLPE/ AWA/ PVC	1x 4	50	60x4	1 is for the neutral line
4	Generator circuit breaker panel (G10)	Generator No.10	15kV, CVT	3	60	30	
5	Generator circuit breaker panel (G11)	Generator No.11	15kV, CVT	3	60	30	
6	Existing step-up transformer circuit breaker panel (EA)	Existing step-up transformer A	8.7/15kV, XLPE/ AWA/ PVC	1x 3	50	100x3	
7	Existing step-up transformer circuit breaker panel (EB)	Existing step-up transformer B	8.7/15kV, XLPE/AWA/PVC	1x 3	50	100x3	
8	Existing step-up transformer A	Existing step-up transformer neutral point grounding panel (ENPA)	8.7/15kV, XLPE/AWA/PVC	1	50	100	
9	Existing step-up transformer B	Existing step-up transformer neutral point grounding panel (ENPB)	8.7/15kV, XLPE/AWA/PVC	1	50	100	
10	Generator No.10	Neutral point grounding panel (GNP10)	15kV, CV	1	60	25	
11	Generator No.11	Neutral point grounding panel (GNP11)	15kV, CV	1	60	25	
12	In-station transformer distribution board (AXP)	In-station transformer board (STR)	15kV, CVT	3	60	15	
13	Existing step-up transformer A	Existing generator distribution line panel A	3.8/6.6kV, XLPE/AWA/PVC	1x3	400	40x3	
14	Existing step-up transformer B	Existing generator distribution line panel B	3.8/6.6kV, XLPE/AWA/PVC	1x3	400	40x3	

[Source] Investigation by the JICA Study Team

p) Replacement parts and maintenance tools

All the diesel generators currently operated by KUA are made by Caterpillar in the United States, however, since the Project is a grant aid undertaking by the Government of Japan, basically Japanese equipment will be procured. Therefore, since parts cannot be shared, enough parts to last until the first overhaul after 16,000 hours (approximately 2 years) will be procured, and it will be planned so that the Project equipment can be appropriately operated

At the same time, since the diesel generators currently operated by KUA are made by Caterpillar in the United States, the maintenance tools it owns are based on inch specifications, whereas the equipment to be procured in the Project will be based on metric specifications. Accordingly, because KUA doesn't own maintenance tools that are based on metric specifications, the maintenance tools necessary for conducting inspections and maintenance will also be procured.

4) Rough Specifications of Main Equipment

In light of the above-mentioned design conditions, facilities and equipment layout plan and so on, the specifications of the main generating equipment and electrical equipment to be constructed in the Project will be compiled as shown in Table 2-2.8.

Table 2-2.8 Rough Specifications of Main Generating Equipment

No.	Main Equipment	Rough Specifications
1.	Diesel engine	Operation rating: Continuous Output: 667kW or more (approximately 906ps) RPM: 900rpm or less Engine type: 4 cycle, series type diesel engine Cooling method: Radiator method Fuel: diesel oil Common frame and with vibration-proof device
2.	Generator	Operation rating: Continuous Rated output: 750kVA Phases: 3 phase 3 wire Rated voltage: 13,800V RPM: 900rpm or less Power factor: 0.8 (delay) Frequency: 60Hz Winding connection method: Y connection (neutral point direct grounding) Excitation method: Brushless, thyristor method
3.	Mechanical equipment	
3.1	Fuel supply equipment ① Fuel service tank ② Fuel transfer pump ③ Fuel flow meter ④ Fuel supply pump	 Square or round shape, rooftop installation, capacity 1.0m^3/tank Motor-drive gear type, outdoor installation, capacity 4m^3/hr Direct reading, integrated, tolerance 0.5% (full-scale) Electric motor or engine drive gear type
3.2	Lubricating oil equipment ① Lubricating oil transfer pump ② Lubricating oil cleaning device ③ Lubricating oil cooler	 Motor-drive gear type, outdoor installation Filter or centrifuge, 200ℓ/hr Plates or multiple tubes, increase capacity 10% over the required area

No.	Main Equipment	Rough Specifications
3.3	Cooling water equipment	
	① Radiator	2 layers for hot and cold, 2 layer type, outdoor installation
	② Water treatment equipment	Filter type
	③ Treated water tank	Square or round shape, outdoor installation, capacity 2.0m^3
	④ Cooling water supply pump	Centrifuge, outdoor installation, capacity1m^3/hr
	⑤ Hot water expansion tank	Square or round shape, rooftop installation, capacity 0.35m^3
	⑥ Cold water expansion tank	Square or round shape, rooftop installation, capacity 0.35m^3
	⑦ Hot water circulation pump	Centrifuge, outdoor or indoor installation
	⑧ Cold water circulation pump	Centrifuge, outdoor or indoor installation
3.4	Compressed air equipment	
	① Air compressor	Pressure 30kg/cm^2, electric motor and engine drive (1 unit each)
	② Air tank	Capacity 300ℓ/tank, enough capacity to start engines 3 times
	③ Pressure reducing valve	Self-actuated pressure reducing
3.5	Ventilation equipment	
	① Air supply blower	Horizontal axial fan
	② Exhaust silencer	Vertical, outdoor installation
3.6	Waste oil disposal equipment	
	① Oil-water separation tank	Steel square shape, 2m^3
	② Oil-water transfer pump	Screw type, capacity 1m^3/hr
	③ Oil-water separation device	Capacity 1m^3/hr, treatment to 30ppm or less
	④ Oil content checking tank	Steel, capacity 0.3m^3
	⑤ Waste oil discharge pump	Screw type, capacity 0.5m^3/hr
	⑥ Waste oil collection tank	Steel, capacity 0.5m^3
	⑦ Waste oil transfer pump	Screw type, capacity 0.5m^3/hr
	⑧ Waste oil tank	Steel, capacity 0.3m^3
	⑨ Incinerator	Capacity 30ℓ/hr
4.	Electrical equipment	
4.1	Generating equipment	
	a) Distribution circuit breaker panel (FP)	Type: Indoor, self-supporting closed type Bus line specifications: 13.8 kV, 600A or more, 12.5kA (1s) Breaker: Vacuum breaker or SF6 gas breaker (pull-out type), 15kV or more
	b) Generator circuit breaker panel (G)	Type: Indoor, self-supporting closed type Bus line specifications: 13.8 kV, 600A or more, 12.5kA (1s) Breaker: Vacuum breaker or SF6 gas breaker (pull-out type), 15kV or more
	c) Neutral point grounding panel (GNP)	Type: Indoor, self-supporting closed type Disconnecting switch specifications: Single phase, 15kV or more, 400A or more, 12.5kA (1s)
	d) In-station transformer distribution board (AXP)	Type: Indoor, self-supporting closed type Bus line specifications: 13.8 kV, 600A or more, 12.5kA (1s) Load switch specifications: 15kV or more, 600A, 50kA with fuse
	e) In-station transformer board (STR)	Type: Indoor, self-supporting closed type, protected structure, IP21 Rated capacity: 300kVA Rated primary voltage: 13.8 kV +/-2x2.5% (without voltage tap switching) Rated secondary voltage: 480-277V/415-240V Vector: Dyn11
	f) Existing step-up transformer circuit breaker panel (EA, EB)	Type: Indoor, self-supporting closed type Bus line specifications: 13.8 kV, 600A or more, 12.5kA (1s) Breaker: Vacuum breaker or SF6 gas breaker (pull-out type), 15kV or more
	g) Main low-voltage distribution board (ADP)	Type: Indoor self-supporting type Bus line specifications: 600V, 600A, 20kA (1s) Circuit breaker: Wiring circuit breaker (MCCB)
	h) DC power supply board (DC)	Type: Indoor self-supporting type Storage battery: Nickel alkali or closed lead battery Rated capacity: 50Ah/5hours or more
	i) In-station power control panel common MCC (CMCC)	Type: Indoor self-supporting type Bus line specifications: 600V, 600A, 12.5kA (1s) Circuit breaker: Wiring circuit breaker (ACB, MCCB)
	j) In-station power control panel (MCC: motor control center)	Type: Indoor self-supporting type Bus line specifications: 600V, 1250A, 25kA (1s) Circuit breaker: Wiring circuit breaker (ACB, MCCB)

No.	Main Equipment	Rough Specifications
	k) Building equipment distribution board (BAP)	Type: Indoor self-supporting type Bus line specifications: 600V, 600A, 12.5kA (1s) Circuit breaker: Wiring circuit breaker (MCCB)
	l) Common control panel (CCD)	Type: Indoor disc type Monitoring and control functions: Breaker operation, ammeter, voltmeter, power meter, etc.
	m) Synchronous control panel (SYCD)	Type: Indoor disc type Monitoring and control functions: Load switch operation, zero-phase voltmeter, voltmeter, frequency meter, synchrometer, ammeter (with changeover SW), voltmeter (with changeover SW), etc.
	n) Generator control panel (GCD)	Type: Indoor disc type Monitoring and control functions: Breaker operation, ammeter, voltmeter, power meter, reactive power meter, power factor indicator, frequency meter, operation time integrating meter, etc.
	o) Existing generator control panel (ECD)	Type: Indoor disc type Circuit breaker operation, ammeter (with changeover SW), voltmeter (with changeover SW), power meter, etc.
	p) Generator protective board (PRG)	Type: Indoor self-supporting type Automatic voltage regulator: Automatic voltage regulator (AVR) Protective relay: Overcurrent relay, deficient voltage relay, overvoltage relay, etc.
	q) Distribution line protection panel (PRC)	Type: Indoor self-supporting type Protective relay: Overcurrent relay, earth-fault overcurrent relay, deficient voltage relay, earth-fault overvoltage relay, etc.
	r) Existing step-up transformer protective board (PRE)	Type: Indoor self-supporting type Overcurrent relay, deficient voltage relay, etc.
	s) Converter panel	Type: Indoor self-supporting type (capable of remote monitoring via the Internet) Failure signals, status signals (generator operating condition circuit breaker condition, current and voltage converter, pulse signals, etc.), and control signals (generator start and stop, emergency stop, etc.)
	t) Power cable and accessories	15kV CVT, CV power cable 8.7/15kV XLPE/AWA/PVC power cable 3.8/6.6kV, XLPE/AWA/PVC power cable 600V CV and CVMAZV power cable 600V PVC control, equipment cable Other wiring materials (wire pipes, cable trays)
5.	Replacement parts and maintenance tools	Consumables Emergency replacement parts Maintenance tools

[Source] Investigation by the JICA Study Team

5) Generator House Plan

Generator house plan shall be shown in the followings;

a) Scale and Structure of the Generator House

The floor planning of the generator house shall be minimum necessary designed by considering with securing the maintenance space of two diesel engine generators and the installation workability of its. And also the section planning such as atrium of diesel engine generator room shall be minimum necessary designed to secure the vertical height for a traveling crane which used for the exchange of engine cylinders above the diesel engine generator. The structure of the generator house shall be steel structure to secure the wide span for the necessary space of the generating equipment, and the foundation shall be the footing type based on the result of the soil investigation.

b) Finishing of Generator the Generator House

The main external finish such as roofing and external wall shall be fluorine resin painted and galvanized steel ribbed sheet by considering with the simplicity of the installation to the steel structure and the measure for the salt damage.

(5) Distribution Equipment Plan

1) Renewal of 13.8 kV Distribution Line in Lelu Island and Around Substation

a) Basic Items

In consideration of compatibility with existing distribution line and ease of operation and maintenance, etc., equipment and materials will be procured and installed assuming a nominal voltage of 13.8 kV.

b) Contents of Plan

i. Distribution array

The distribution lines will basically comprise a horizontal array. Also, new utility poles will basically be constructed near to existing utility poles, however, in coastal parts and other areas where construction is difficult, underground cables will be installed.

ii. Supports

Wooden poles or fiber glass poles (FRP poles) are used in the existing13.8 kV distribution network, so FRP poles will be examined in the Project too. Since FRP poles are not manufactured in the Federated States of Micronesia, it is necessary to procure from third countries. The existing FRP poles already installed in Kosrae State were made in the United States.

iii. Wire

The length of 13.8 kV distribution line on Lelu Island will be approximately 3.8 km (approximately 3.5 km of overhead line and 0.3 km of underground cable). The distribution line specifications will comprise bare copper single line and size will be AWG4 according to the American wire gauge standard. The underground cable will be based on IEC standard and the cable size will be 50mm^2.

c) Rough specifications of main equipment shows the quantities of 13.8 kV distribution line, and Table 2-2.10 shows the equipment list.

Table 2-2.9 13.8 kV Distribution Line Quantities Sheet

Distribution Line Route	Lelu Island Distribution Line (overhead line)	Lelu Island Distribution Line (underground cable)	Distribution line (overhead line) to the No. 1 pole near the substation
Distribution line length	3,520m	270m	36m
Overhead line (underground cable) distance	13,220m	540m	144m
Sag (3%)	397m	0m	4m
Overhead line (underground cable) distance subtotal	13,617m	540m	148m
Replenishment (10%)	1,362m	54m	15m
Procured quantity	14,979m	594m	163m

[Source] Investigation by the JICA Study Team

Table 2-2.10 Outline of Main Equipment (13.8 kV Distribution Line)

No.	Equipment	Design Quantity	Procured Quantity	Unit	Outline Specifications of Main Equipment
1	75 kVA pole transformer	1	2	Unit	Outdoor, oil-filled, single phase High-voltage side: 13.8/√3 kV, LIWV more than 110kV Low-voltage side: 240-120 V, salt-resistant tank, salt-resistant bushing
2	37.5 kVA pole transformer	2	3	Unit	Outdoor, oil-filled, single phase High-voltage side: 13.8/√3 kV, LIWV more than 110kV Low-voltage side: 240-120 V, salt-resistant tank, salt-resistant bushing
3	25 kVA pole transformer	10	11	Unit	Outdoor, oil-filled, single phase High-voltage side: 13.8/√3 kV, LIWV more than 110kV Low-voltage side: 240-120 V, salt-resistant tank, salt-resistant bushing
4	15 kVA pole transformer	5	6	Unit	Outdoor, oil-filled, single phase High-voltage side: 13.8/√3 kV, LIWV more than 110kV Low-voltage side: 240-120 V, salt-resistant tank, salt-resistant bushing
5	10 kVA pole transformer	10	11	Unit	Outdoor, oil-filled, single phase High-voltage side: 13.8/√3 kV, LIWV more than 110kV Low-voltage side: 240-120 V, salt-resistant tank, salt-resistant bushing
6	Load break switch	12	13	Set	Outdoor, 3 phase Rated voltage: 15 kV, LIWV more than 110kV
7	Switch with fuse	112	125	Unit	Outdoor, single phase Rated voltage: 15 kV, LIWV more than 110kV
8	Lightning arrester	39	42	Unit	Outdoor, single phase Rated voltage: 10 kV
9	Overhead distribution line (AWG4)	13,765	15,142	m	Copper conductor, single line (solid copper wire) Size: AWG4
10	Underground cable (for Lelu Island distribution line)	540	594	m	Aluminum conductor, 8.7/15kV XLPE Size: 50mm^2
11	Intermediate pole (Type A)	4	5	Set	Angle: 0-5 degrees Material: Fiber glass Salt-resistant insulators (LIWV 110kV or more),, cross arm, grounding wire and other equipment and materials (1 set)
12	Intermediate pole (Type 1A) (Single phase two wire)	2	2	Set	
13	Dead-end pole (Type B)	10	11	Set	Angle: 5 degrees or more Material: Fiber glass

No.	Equipment	Design Quantity	Procured Quantity	Unit	Outline Specifications of Main Equipment
14	Dead-end pole (Type 1B) (Single phase two wire)	1	1	Set	Salt-resistant insulators (LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
15	T-off pole (Type C)	8	9	Set	Material: Fiber glass Salt-resistant insulators(LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
16	T-off pole (Type 1C) (Three wire/single wire)	1	1	Set	
17	Transformer pole (Type D)	18	19	Set	For 1 single phase transformer Material: Fiber glass Salt-resistant insulators(LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
18	Transformer pole (Type D) (Single phase two wire)	1	1	Set	
19	Transformer pole (Type E)	1	2	Set	For 3 single phase transformers Material: Fiber glass Salt-resistant insulators (LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
20	Load break switch pole (Type F)	7	8	Set	For pole load switch Material: Fiber glass Salt-resistant insulators (LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
21	Cable termination pole (Type G)	3	4	Set	For cable connection Material: Fiber glass Salt-resistant insulators(LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
22	Cable termination pole (Type 1G) (Single phase two wire)	2	2	Set	
23	Termination pole (Type H)	2	3	Set	Material: Fiber glass Salt-resistant insulators (LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
24	Transformer pole (Type J)	2	3	Set	Terminal pole for 1 single phase transformer Material: Fiber glass Salt-resistant insulators (LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)
25	Transformer pole (Type 1J) (Single phase two wire)	1	1	Set	
26	Transformer pole (Type K)	1	2	Set	Terminal pole for 3 single phase transformers Material: Fiber glass Salt-resistant insulators (LIWV 110kV or more), cross arm, grounding wire and other equipment and materials (1 set)

[Source] Investigation by the JICA Study Team

2) Renewal of the Okat Underground Cable Distribution Line

a) Basic Items

In consideration of compatibility with existing distribution line and ease of operation and maintenance, etc., equipment and materials will be procured and installed assuming a nominal voltage of 13.8 kV.

b) Contents of Plan

The 15 kV underground cable route to be renewed in the Project will be approximately 2.1 km. The underground cable will be based on IEC standard and the cable size will be 50 mm^2.

c) Rough specifications of main equipment

Table 2-2.11 shows the quantities of 15 kV underground cable distribution line, and Table 2-2.12 shows the equipment list.

Table 2-2.11 15 kV Underground Cable Distribution Line Quantities Sheet

Distribution Line Route	Okat Distribution Line (Underground cable)
Distribution line length	2,065m
Underground cable distance (3 phase x 2)	12,390m
Replenishment (10%)	1,239m
Procured quantity	13,629m

[Source] Investigation by the JICA Study Team

Table 2-2.12 Outline of Main Equipment

No.	Equipment	Design Quantity	Procured Quantity	Unit	Outline Specifications of Main Equipment
1	Underground cable (for around the airport)	12,390	13,629	m	Aluminum conductor, 8.7/15kV XLPE Size: 50mm^2

[Source] Investigation by the JICA Study Team

3) Examination of Grid Connection of Photovoltaic (solar power) Equipment

Analysis was implemented to examine the impact in the case where diesel generator equipment is strengthened under World Bank (WB) assistance and solar power (PV) equipment is connected to the grid following completion of the Project.

a) Objective of examination

The interconnection limit with solar power generation that doesn't deviate from the system frequency control target value (there is no storage battery equipment, etc.) will be examined through conducting simulation.

b) Examination conditions

The frequency control target value shall be ±2% (60±1.2Hz). The figure of ±2% is the frequency scope that permits continuous operation of rotating electrical machines (JIS C4034: Rotating electrical machines), and this was adopted as the permissible limit in discussions with KUA.

i. Diesel generator data

- Project target generators: 3 phase - 60Hz – 750kVA (600 kW) - Pf= 0.8 – 900rpm - 13.8 kV x 2 units
- WB aid generator: 3 phase- 60Hz - 750kVA (600 kW) - Pf= 0.8 - 1,800rpm - 4.16kV x 1

  (Step-up transformer 4.16/13.8 kV) x 1
  - The DG generator uses the data model of the existing generator

- DG operation upper and lower limit: Provisional setting based on past performance and load (upper limit: 90% of rating, lower limit: 16% of rating)

ii. Photovoltaic generating system data

- PEC aid solar power system: 3 phase- 60Hz – 200 kWp: Connection to Malem system (start of operation in April 2015)
- EU aid solar power system: phase- 60Hz – 100 kWp: Connection to Tafunsak system (start of operation in December 2015)

iii. System capacity

Capacity of Kosrae State distribution network power system (following completion of the Project) will be as shown in Figure 2-2.3.

iv. Analysis software

"MATLAB" made by The Math Works, Inc. was used as the analysis software.

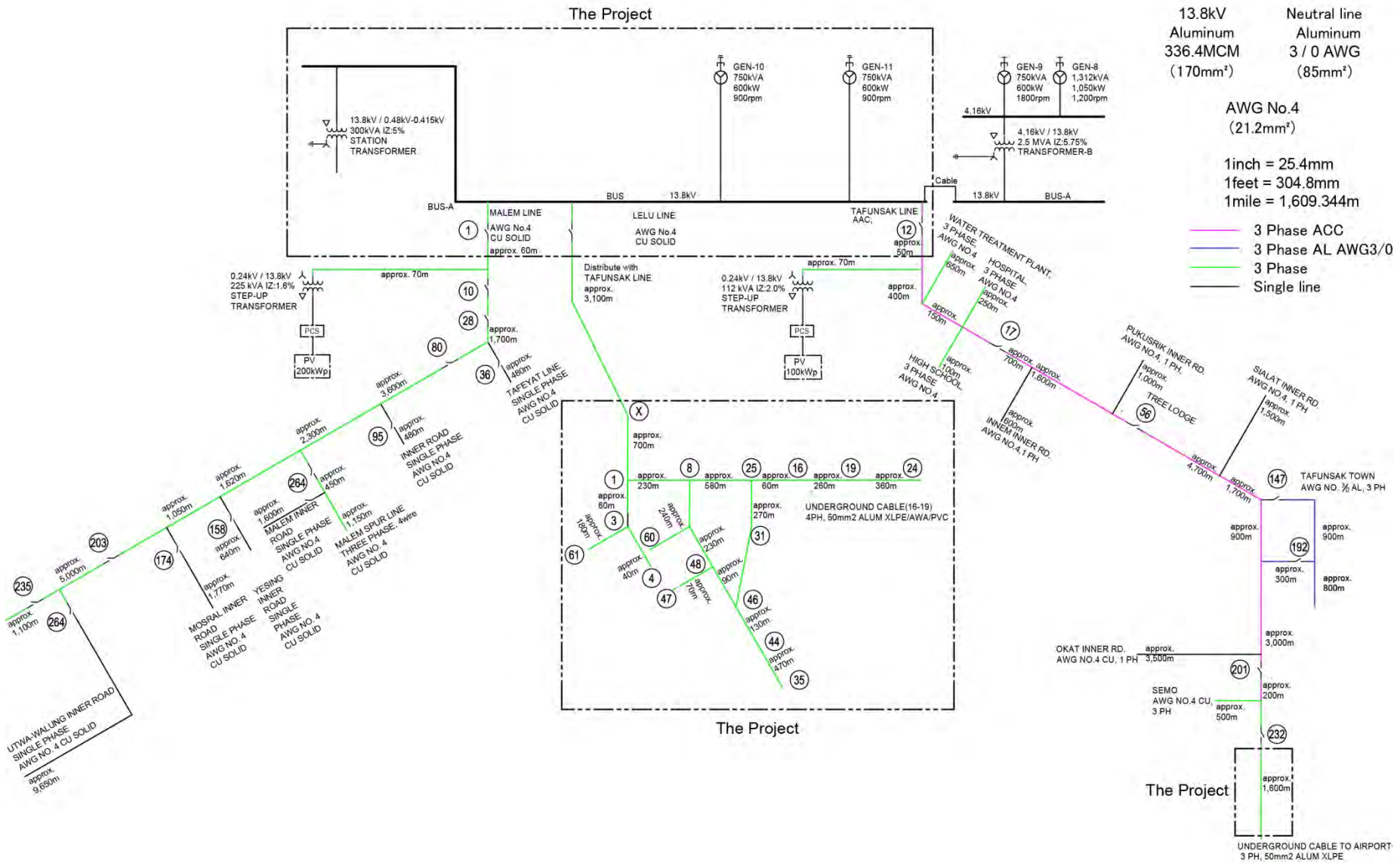


Figure 2-2.3 Kosrae State Distribution System Diagram

c) Calculations

i. Generator load conditions

The following three load cases will be simulated in order to gauge the solar power interconnection limit.

- Case 1: Simulation of weekday load 900 kW
- Case 2: Simulation of weekend load 510 kW (460 kW + future increase of 50 kW)
- Case 3: Simulation of weekday maximum 1,600 kW (1,140 kW + future increase 460 kW)

ii. Data used in calculation

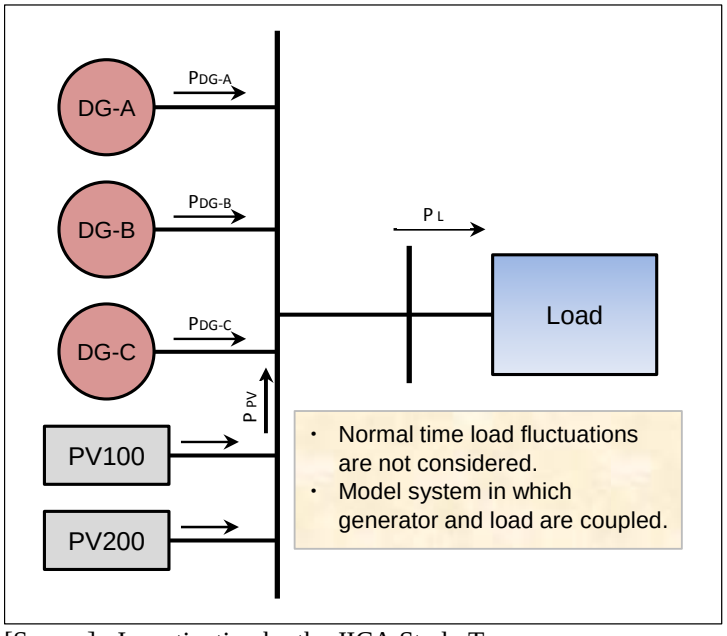
Since there are no detailed data on actual solar power generation in Kosrae State, per-second power generation data measured over 30 minutes in a domestic power company's solar power generating system (capacity 1,150 kWp) are converted to capacity and utilized.

- Calculation time: 0~1,800 seconds (30 minutes) (each case common)
- Calculation cycle (increment) Ts: 0.1 second (each case common)

Handling of solar power data: Ts = 0.1 second; since the solar power data storage interval is larger than Ts, interpolation is conducted.

iii. Frequency analysis model, analysis cases, analysis procedure

The frequency analysis model Figure 2-2.4, while the analysis cases are as shown in Table 2-2.13.



[Source] Investigation by the JICA Study Team

Figure 2-2.4 Frequency Analysis Model

Table 2-2.13 Analysis Cases

Generating equipment	Case 1	Case 2	Case 3
DG-A	○	○	○
DG-B	○		○
DG-C			○
Solar power100	○		
Solar power200	○		
Load	900 kW	510kW	1,600 kW

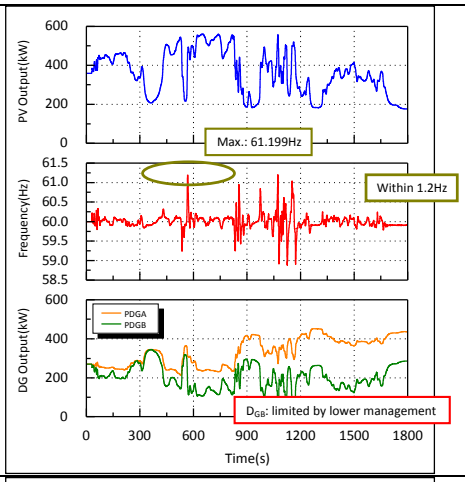
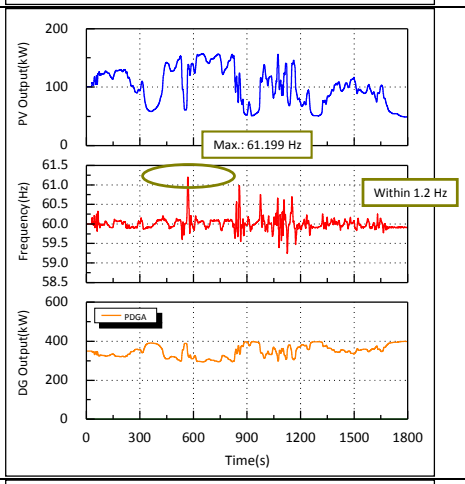
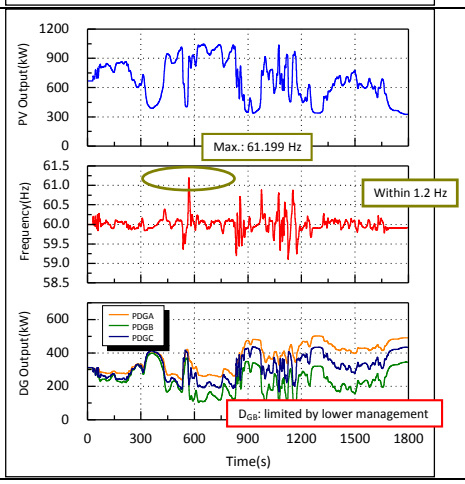
[Source] Investigation by the JICA Study Team
Note: ○ Operation generator, (generator (DG-A/B/C) capacity is assumed to be 600 kW)

The analysis procedure is as described below.

- Grasp the frequency fluctuation when the solar power is interconnected at initial capacity (each case common).
- Vary the solar power interconnected capacity from the above value to grasp the capacity where system frequency does not deviate from the target value (each case common).

d) Photovoltaic (solar power) system interconnection limit capacity examination results

In the Project operation plan, basically rotated operation will be conducted using a total of three new diesel generators (two Project generators and one generator provided through World Bank assistance), while the existing diesel generator (G-8) will be used for backup purposes. Accordingly, the results of analyzing the solar power system interconnection limit capacity (with no storage battery equipment) with the aim of keeping the frequency fluctuation within the control target (60 ± 1.2Hz) in the case of interconnection of the three new generators and the solar power systems are shown in Figure 2-2.5. Incidentally, because rated capacity of the existing generator (G-8) is larger than that of the new generators, meaning that the impact of solar power generation is smaller than on the new generators, it has been omitted from the analysis.

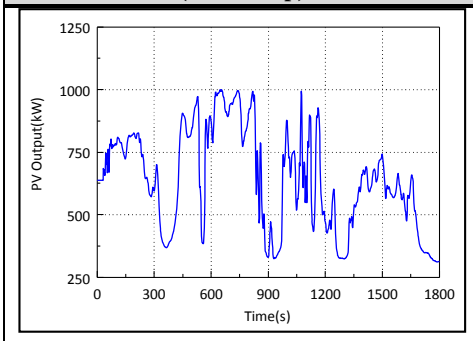
Case 1 Load: 900 kW, DG-A, DG-B operation, Interconnected solar power: 672 kWp	
Case 2 Load: 510 kW, DG-A operation, Interconnected solar power: 194 kWp	
Case 3 Load: 1,600 kW, DG-A,DG-B, DG-C operation, Interconnected solar power: 1,254 kWp	

[Source] Investigation by the JICA Study Team

Figure 2-2.5 Solar Power System Interconnection Limit Capacity (with no storage battery) Examination Results

The results of examination are summarized in Table 2-2.14.

Table 2-2.14 Solar Power System Interconnection Limit Capacity

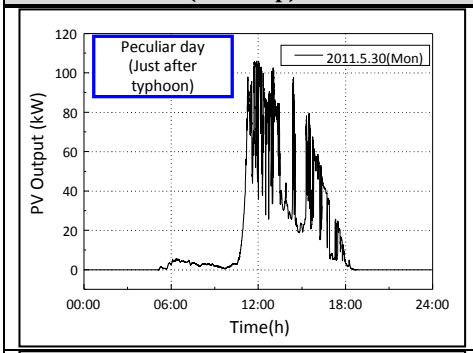
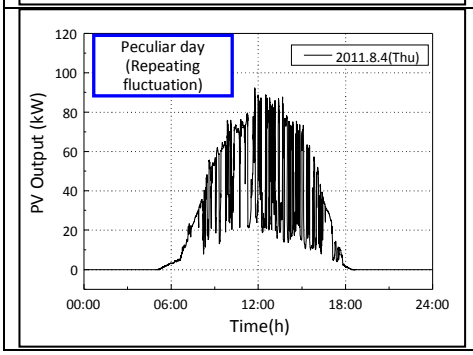
Solar power base data used in analysis (1,150 kWp)	Control target value	Solar power system limit output		
		Case 1	Case 2	Case 3
 Analysis Model	60±1.2Hz	672 kWp	194 kWp	1,254 kWp

[Source] Investigation by the JICA Study Team

Note: In the case where the multiple diesel generator units are combined in operation in the analysis model, the results will differ somewhat.

Also, for confirmation purposes, the results of analysis using data (6 second intervals, 1 day) from a 100 kWp solar power generating system owned by a corporation in Japan are shown in Table 2-2.15

Table 2-2.15 Solar Power System Interconnection Limit Capacity Based on Other Solar Power Generating Data

Solar power base data used in analysis (100 kWp)	Control target value	Solar power system limit output		
		Case 1	Case 2	Case 3
	60±1.2Hz	574kWp	241kWp	1,120kWp
	60±1.2Hz	629kWp	233kWp	1,241kWp

[Source] Investigation by the JICA Study Team

On comparing the interconnection limit capacity values indicated in Table 2-2.14 and Table 2-2.15, since values are more conservative in Table 2-2.14, where harsh data showing large fluctuation over 1-second increments were used, the Project was designed based on Table 2-2.14.

In the harshest scenario of Case 2 (during light load at weekends) in Table 2-2.14, in order to regulate the frequency to 60 ±1.2 Hz, the solar power generating system capacity that can be connected is 194 kWp.

The existing solar power system in Kosrae State has installed capacity of 300 kWp. If this capacity is connected to the grid, frequency would exceed the control target at times of light load and this would have an adverse impact on equipment that depends on frequency. Therefore, at times of low load at weekends, it is necessary to limit the solar power interconnection capacity to 194 kWp or less. For this purpose, it may be effective to use a wheelie timer, etc. in order to shut off part of the solar power generation from the grid.

Incidentally, in Case 1 (weekday load) and Case 3 (case of future load increase), it is possible to conduct operation without limiting the current solar power generating system capacity of 300 kWp.

e) Solar power start/stop control panel (PVC)

Since the examination of solar power system interconnection limit capacity showed that the maximum interconnection capacity at weekends is 194 kWp, it will be necessary to limit output of the 200 kWp solar power system that was installed with Pacific Environment Community (PEC) assistance to 50% at weekends.

Currently, KUA manually stops operation of one out of its two power conditioners (PCS: 100 kW x 2 units), however, to avoid risk of operation being forgotten, a PCS start/stop panel based on program timer will be installed in the Project.

The contents of the main equipment are as follows.

i.	Name	:	Solar power start/stop control panel (PVC)
ii.	Applicable standards	:	JIS, JEC, IEC or equivalent standards
iii.	Type	:	Indoor, wall-hanging type, protective structure IP21
iv.	Control functions	:	Remote start/stop function based on program timer, and manual start/stop function for the solar power system PCS (100 kW)
v.	Accessories	:	Automatic/Manual switch, PCS start/stop switch, auxiliary relays, etc.
vi.	Software	:	Program timer setting software (English)
vii.	Rough dimensions	:	W400 x D200 x H500 mm

viii. Replacement parts : Auxiliary relays (1 each) and control fuses (100% each)

Examination for Reduction of Power Loss

The results of conducting examination on reduction of power loss due to renewal of distribution lines in the Project are described below.

4) Examination for Reduction of Power Loss

a) Reduction of power loss based on replacement of pole transformers on Lelu Island

Power loss will be reduced through replacing the inefficient existing pole transformers with the latest high-efficiency pole transformers.

i. Examination conditions

- Since the existing distribution line was constructed in 1975, the existing pole transformer loss characteristics are equivalent to the values prescribed in JIS C4304 “Oil-filled transformers for distribution” (1977).
- The loss characteristics of the new pole transformers will be the values prescribed in the DOE (Department of Energy) Amended Energy Conservation Standards for Liquid-Immersed Distribution Transformers (2016).
- The load factor shall be 50% of the rated capacity.

ii. Results of examination

Table 2-2.16 Loss Reduction through Replacement of Pole Transformers

Transformer capacity (kVA)	Existing transformer loss (W) at 50% load	New transformer loss (W) at 50% load	Number of transformers	Total loss of existing transformers (W)	Total loss of new transformers (W)	Loss reduction (W)
10	112.9	32.9	10	1,129	329	800
15	153.0	44.8	5	765	224	541
25	224.3	66.3	10	2,243	663	1,580
37.5	314.2	89.9	2	628	180	449
75	588.1	153.1	1	588	153	435
Total	-	-	28	5,354	1,549	3,805

Based on the total loss reduction (W) shown in the table, the annual loss reduction (MWh) will be as follows:

3,805(W) x 24(h) x 365 (days)/1000=33.3(MWh)

b) Reduction of power loss based on intermittent operation of existing step-up transformers

Since the existing step-up transformers (2,500 kVA x 2 units) installed in the current substation of Tofol Power Station have large loss, the power loss will be reduced through switching the operation of these transformers from continuous to intermittent.

i. Examination conditions

- Judging from JIS C4304 “6 kV oil-filled transformers for distribution,” it is estimated that the existing step-up transformers (made in 1996) have the following loss characteristics: no-load loss 3,600W and load loss 29,300W (at 100% load).
- In the Project, one out of the two existing 2,500 kVA step-up transformers will be operated, only at times when the generator scheduled for provision by the WB (No. 9) or the existing generator (No. 8) is operating.
- The load pattern will be that obtained by combining the daily load curve shown in Figure 1-2.3 with the regular load indicated in Table 1-3.1 New Construction Plans and Power Demand. However, additional power demand at weekends will be limited to the 50 kW from the Memorial Hospital. Also, reduction in generator power generation due to solar power will not be considered.
- The generator operation plan based on the project will be as shown in Figure 2-2.2 Operation Plan.

ii. Results of examination

- Annual total loss when 2 existing step-up transformers are continuously operated under the current configuration Ⓐ: 77.0 MWh
- Annual total loss when 1 existing step-up transformer is operated only during operation of the No.8 or No.9 generator Ⓑ: 25.8 MWh

The total annual reduction in power loss due to the change in operation of transformers based on the Project (MWh) will be:Ⓐ-Ⓑ = 51.2 (MWh).

c) Reduction of power loss based on the Project

The total annual reduction in power loss based on the Project (MWh) will be: 33.3 MWh (item a) above) + 51.2 MWh (item b) above) = 84.5 (MWh).

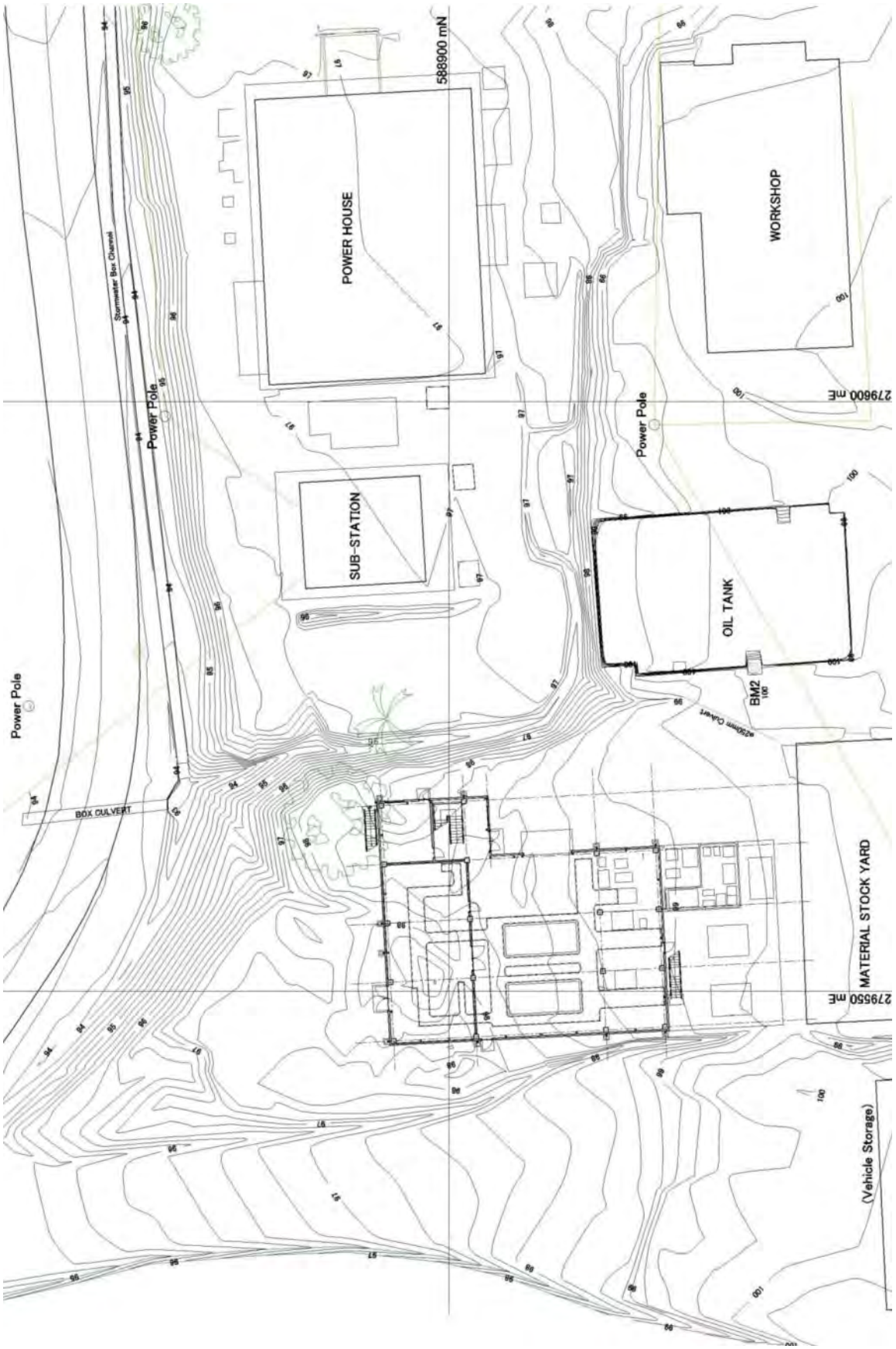
Therefore, the Project will make it possible to reduce the Technical Loss of 352 (MWh) in Table 1-2.4 (Power Loss Calculated in the KEMA Report) by 24% and the total system loss (1,008MWh) including in-station loss by 8.4%.

2-2-3 Outline Design Drawings

Table 2-2.17 shows the outline design drawings in the Project. The drawings are attached from the next page onwards.

Table 2-2.17 List of Outline Design Drawings

Drawing No.	Drawing Name
G-01	Overall Layout
G-02	Generator House Finishing Sheet
G-03	Generator House Plan View -01
G-04	Generator House Plan View -02
G-05	Generator House Elevation Plan -01
G-06	Generator House Elevation Plan -02
G-07	Generator House Cross Section
M-01	Basic System Diagram
M-02	Fuel System Diagram
M-03	Lubricating Oil System Diagram
M-04	Cooling Water System Diagram
M-05	Compressed Air System Diagram
M-06	Air Supply and Exhaust System Diagram
E-01	Power Station Single-line Diagram
E-02	Lelu Island Distribution Single-line Diagram
LL-R-01	Lelu Island Distribution Line Route Overall Diagram
UG-R-01	Underground Cable Route Diagram
D-01~16	Pole Assembly Drawing



DWG No. G-01 Overall Layout

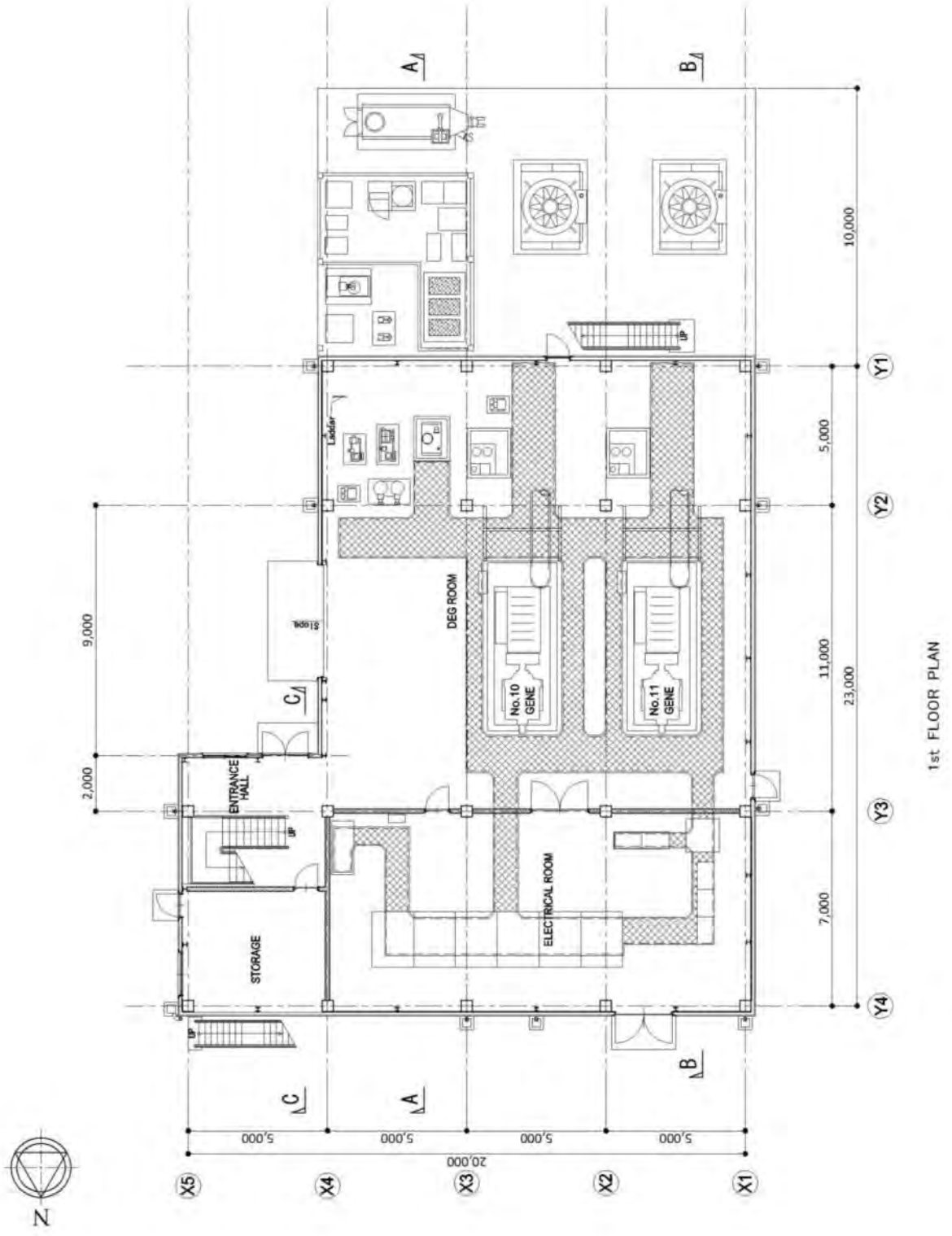
DWG No. G-02 Generator House Finishing Sheet

EXTERIOR FINISHING SCHEDULE

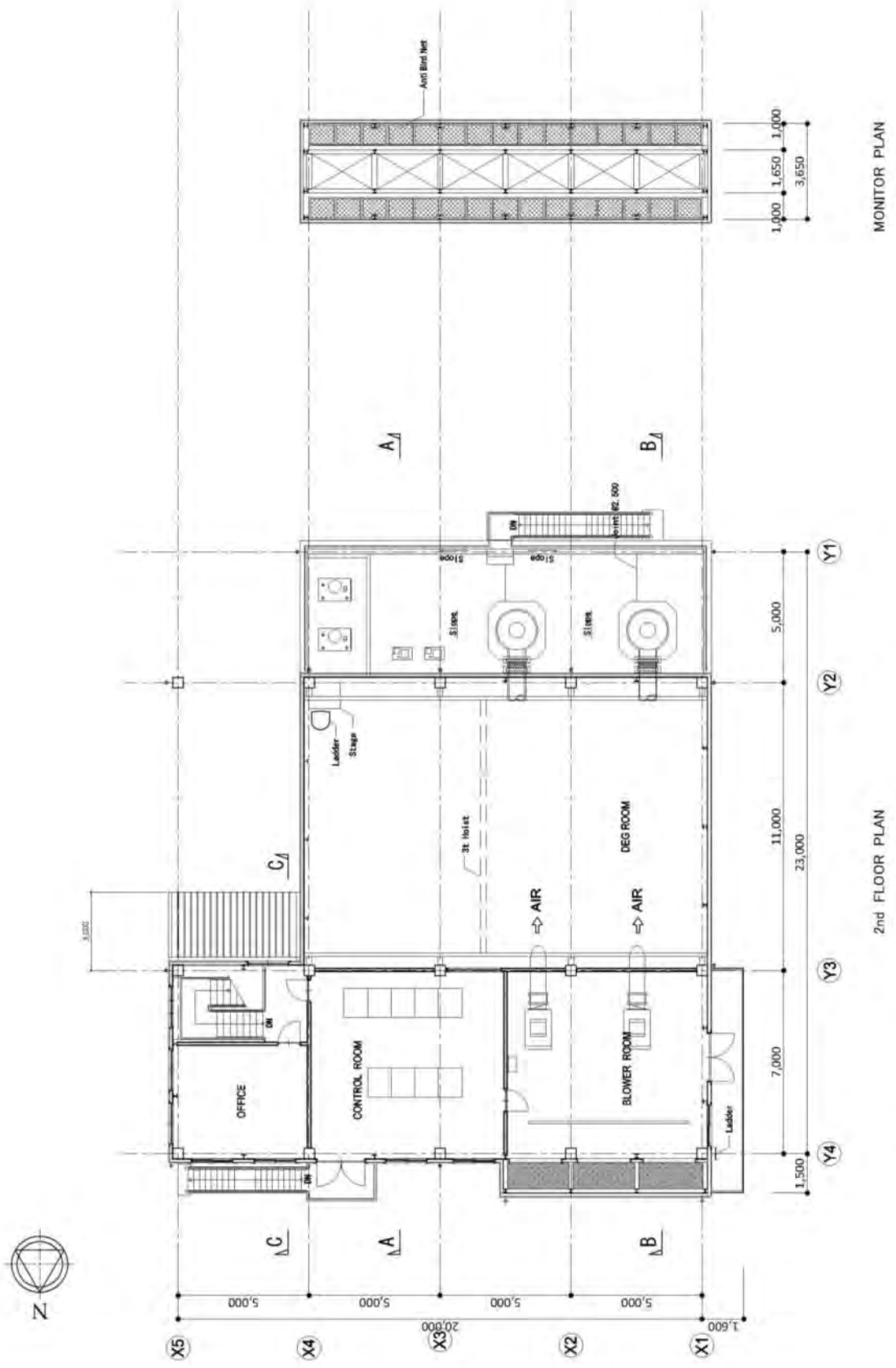
TOP ROOF	Felupride Resin Painting Galvalume Steel Ribed Sheet Metal Roofing H=170 t=0.8	EAVES GUTTER	Polyvinyl Chloride 200W x 150H, 150W 150H
LOWER ROOF	Waterproofing by Coating , Protection Concrete t=80-120 Slope Joint : @2,500	DOWNSPOURT	Polyvinyl Chloride Pipe Φ100
WALL	Felupride Resin Painting Galvalume Steel Ribed Sheet Metal Siding H=38 t=0.6	HANDRAIL	Galvanized Steel Pipe
CRERSTOREY	Fiber Reinforced Plastic Translusent Seet D=38 t=1.5	STAIR	Galvanized Steel
WAINSCOT	Paint(A.E.P) Finish on Mortal Steel Trowel on Concrte Block t=100 H=1,000		
BASEBOARD	Mortal Steel Trowel Finish		

INTERIOR FINISHING SCHEDULE

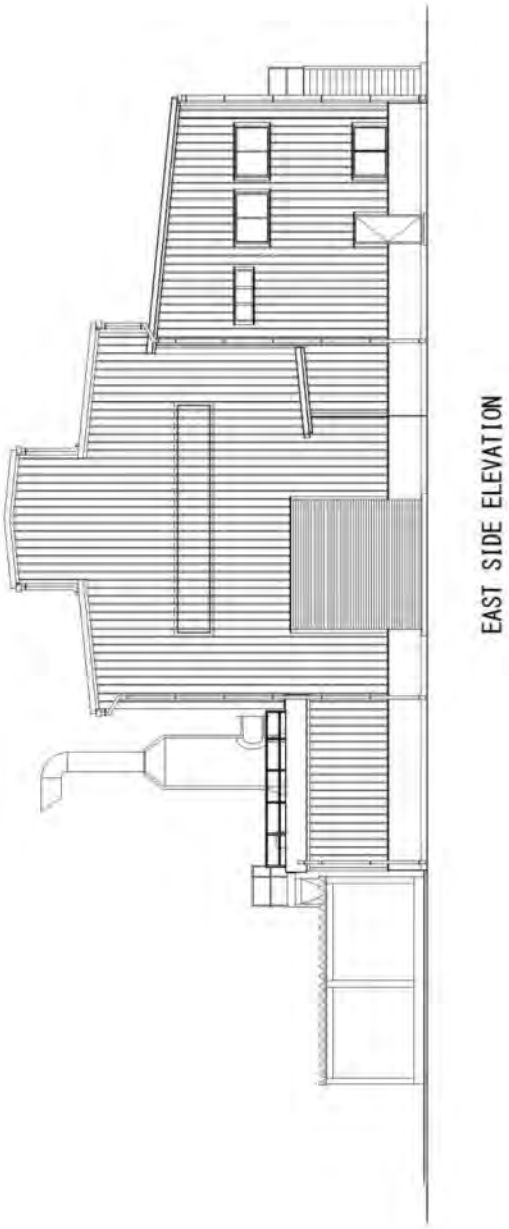
ROOM	FLOOR	BASEBOARD	WALL	CEILING	REMARKS
ENTRANCE HALL	Oil Paint Finish on Concrete Steel Trowel	Mortar Steel Trowel H=100	Emulsion Paint on Mortar Steel Trowel Exposed Steel Structure and Siding	Exposed Steel Structure and Roofing	
DEG ROOM	Oil Paint Finish on Concrete Steel Trowel	Mortar Steel Trowel H=100	Emulsion Paint on CiliconDioxide Calcium Board t=8 on Plaster Board t=12.5	Exposed Steel Structure and Roofing	3ton Hoist Crene ,Cable and Piping Pit
ELECTRICAL ROOM	Dustproof Paint Finish on Concrete Steel Trowel	Mortar Steel Trowel H=100	Emulsion Paint on Mortar Steel Trowel Emulsion Paint on Plaster Board	Exposed Steel Structure and Galvanize Steel Deck	Cable Pit
1F STORAGE	Concrete Steel Trowel	Mortar Steel Trowel H=100	Emulsion Paint on Mortar Steel Trowel Exposed Steel Structur and Steel Siding	Exposed Steel Structure and Galvanize Steel Deck	
OFFICE	Polyvinyl Tail t=2 on Mortar Steel Trowel	Vinyl Tail H=60	Emulsion Paint on CiliconDioxide Calcium Board t=8 on Plaster Board t=12.5 Glass Wool Grout t=100	Makeup Plasterboard t=9.5 on Light Iron Supended Ciling System Glass Wool Paiving t=100	
CONTROL ROOM	Polyvinyl Tail t=2 on Mortar Steel Trowel	Vinyl Tail H=60	Emulsion Paint on CiliconDioxide Calcium Board t=8 on Plaster Board t=12.5 Glass Wool Grout t=100	Makeup Plasterboard t=9.5 on Light Iron Supended Ciling System Glass Wool Paiving t=100	
BLOEWR ROOM	Mortar Steel Trowel	Vinyl Tail H=60	Emulsion Paint on CiliconDioxide Calcium Board t=8 on Plaster Board t=12.5 Glass Wool Grout t=100	Makeup Plasterboard t=9.5 on Light Iron Supended Ciling System Glass Wool Paiving t=100	

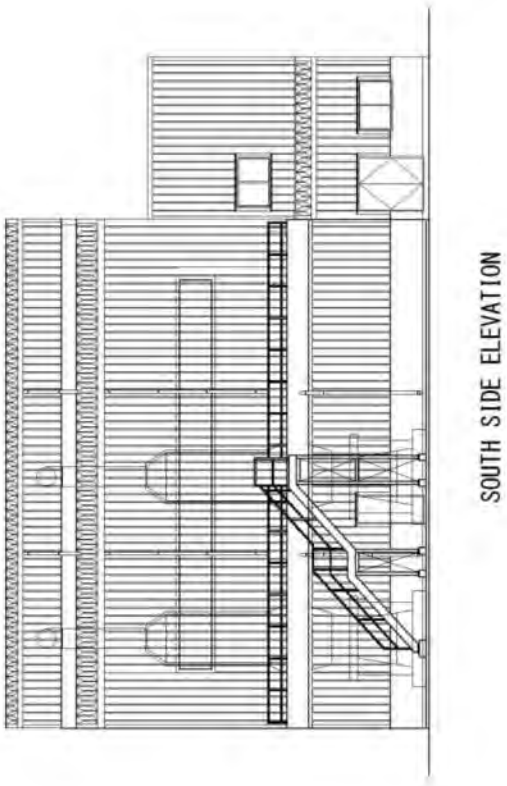


DWG No. G-03 Generator House Plan View -01

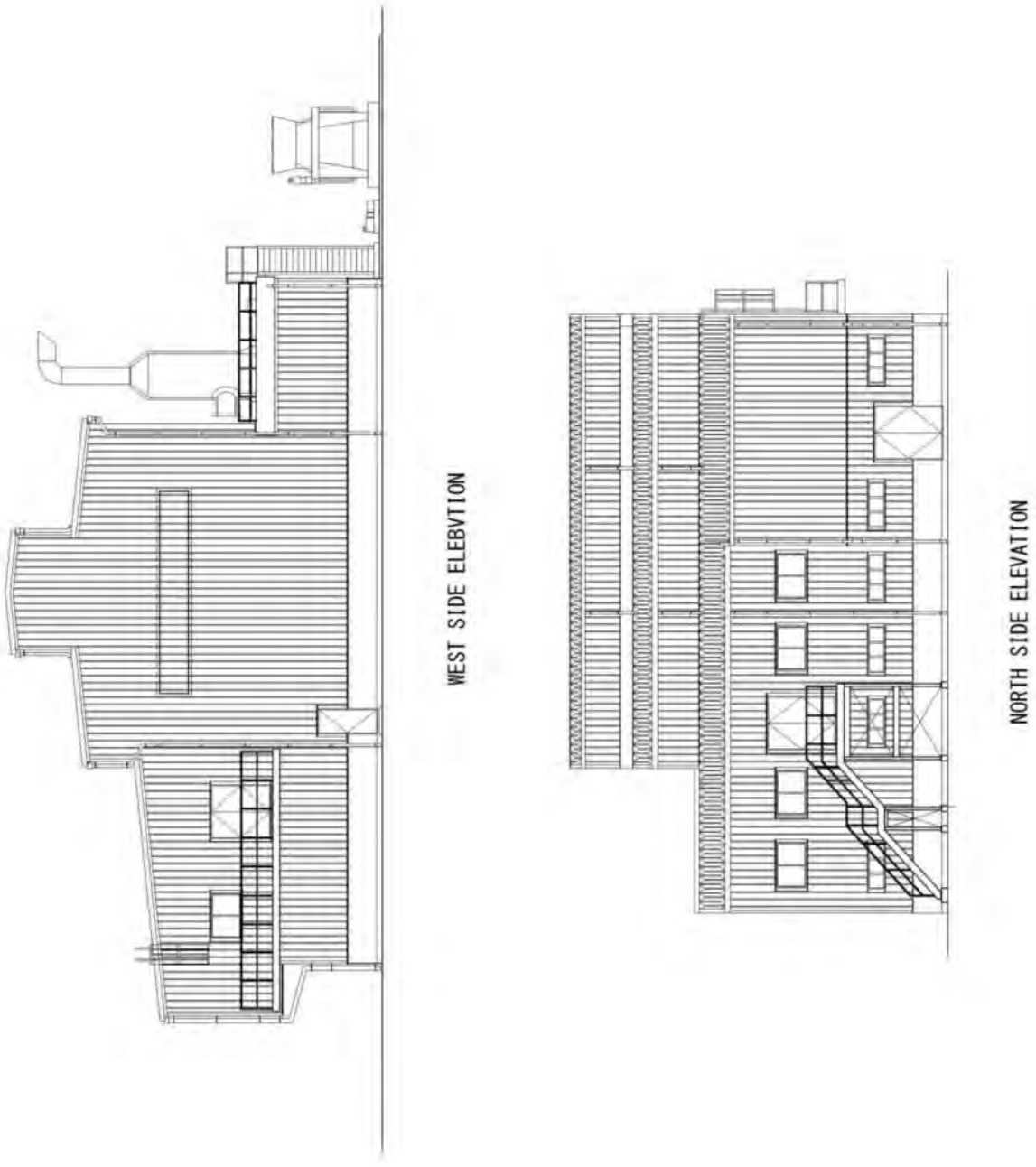


DWG No. G-04 Generator House Plan View -02

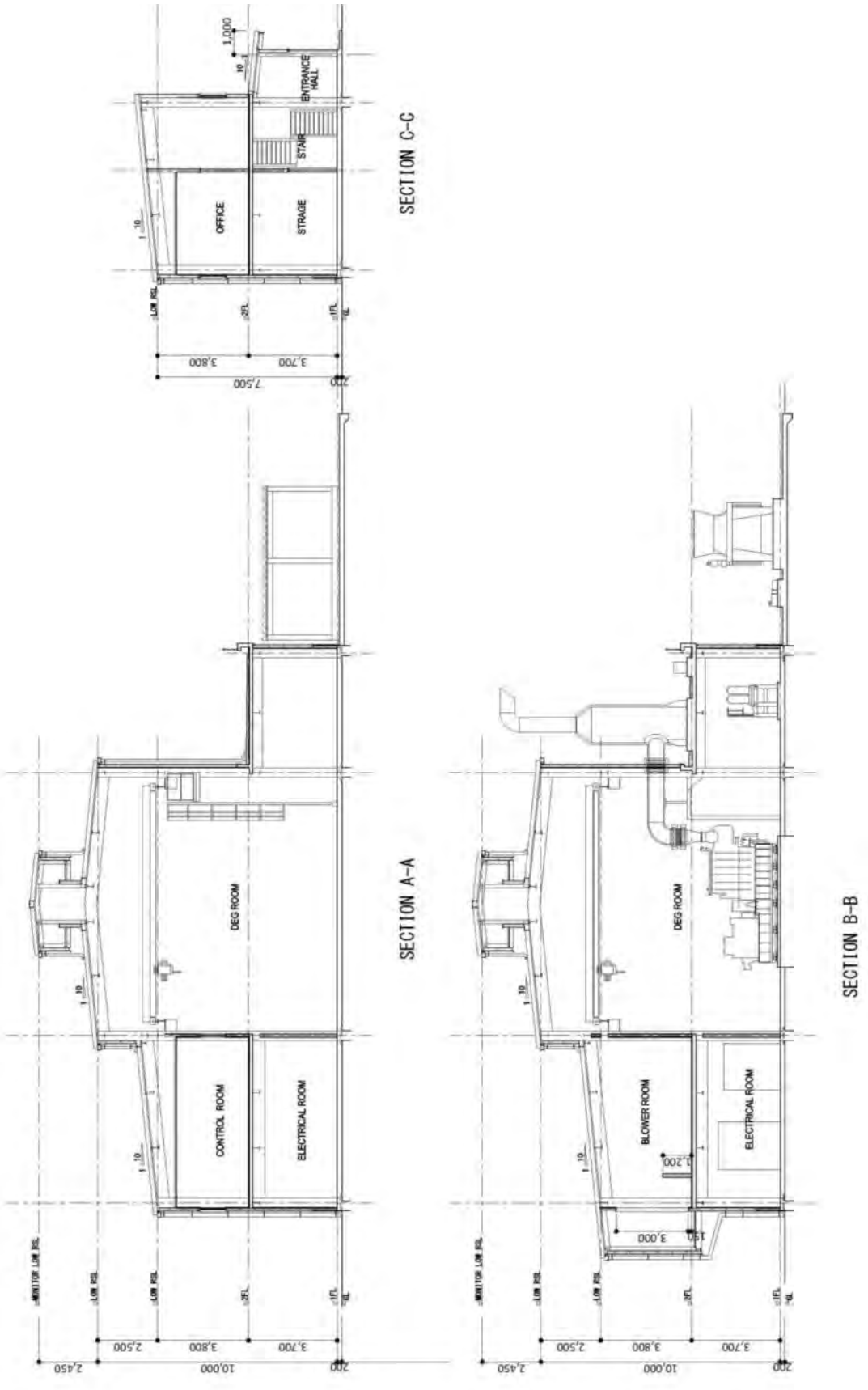




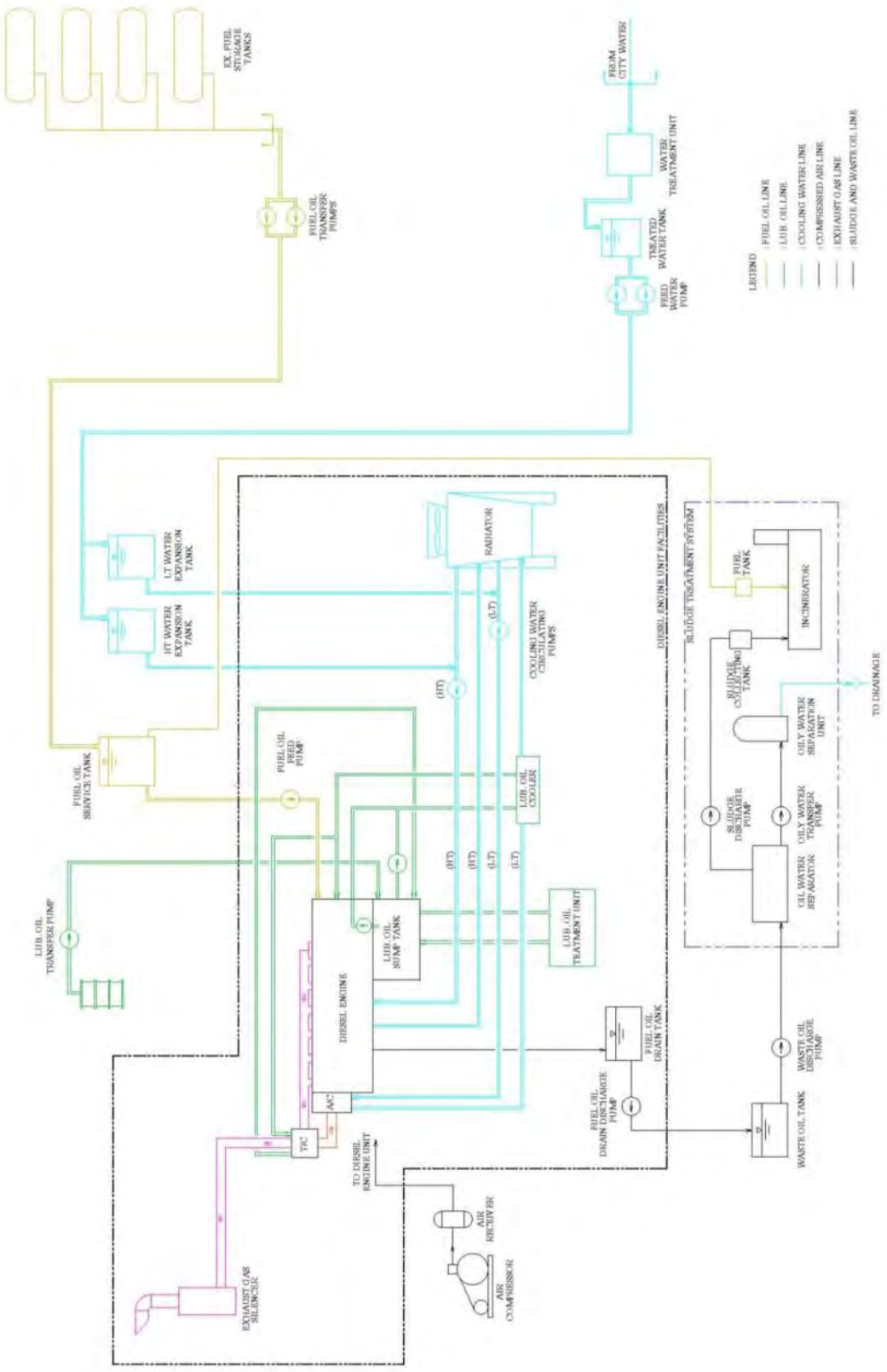
DWG No. G-05 Generator House Elevation Plan -01



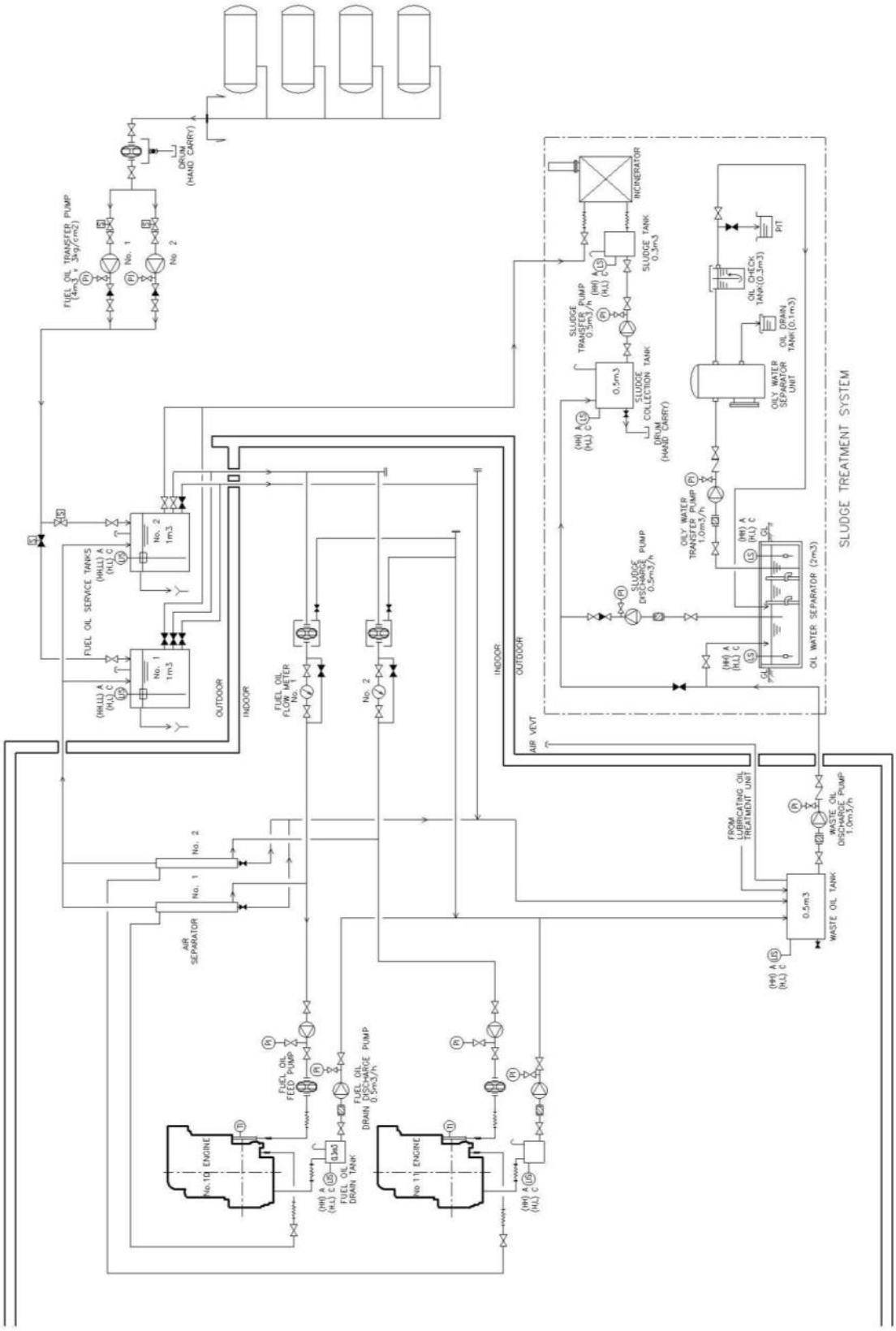
DWG No. G-06 Generator House Elevation Plan -02



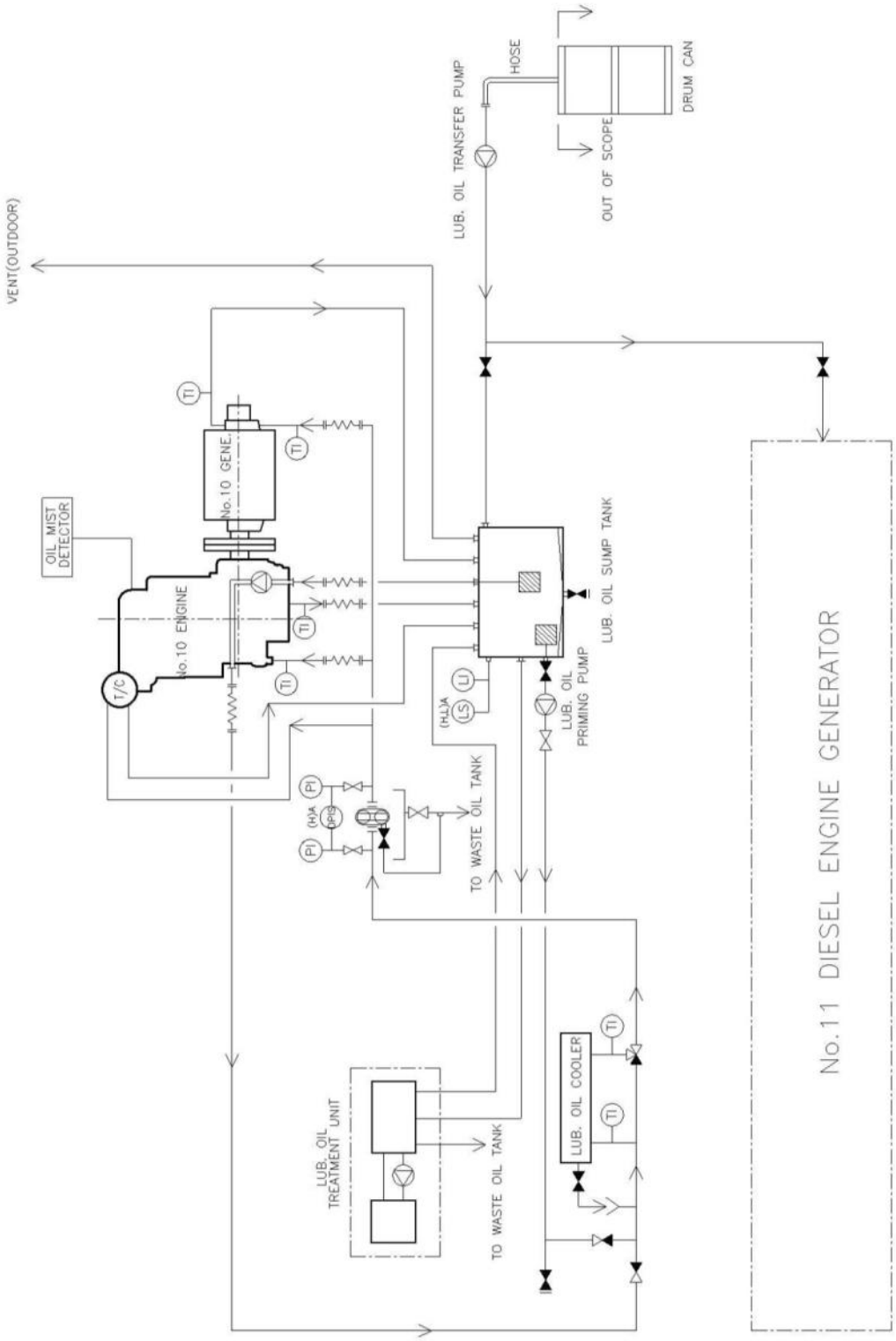
DWG No. G-07 Generator House Cross Section



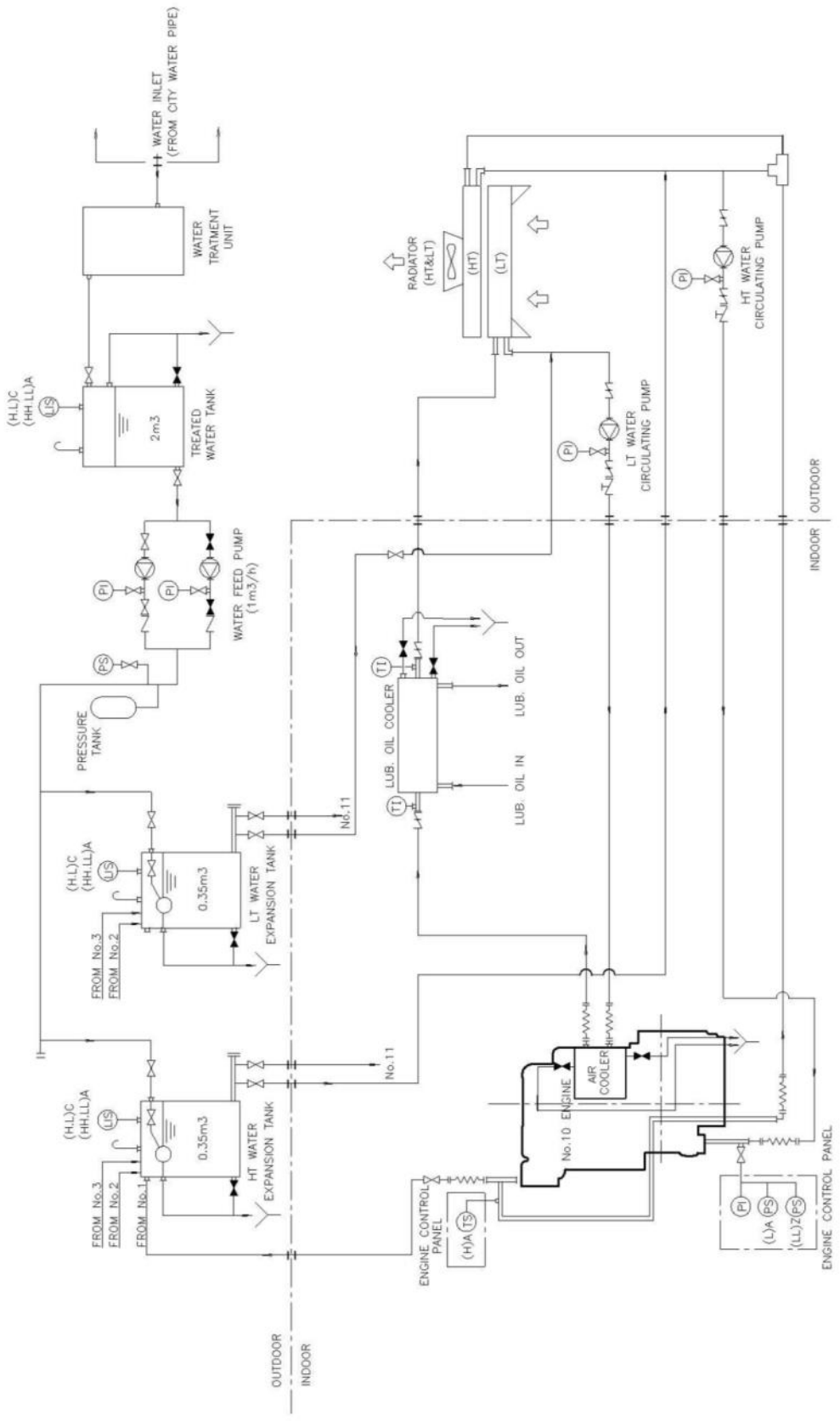
DWG No. M-01 Basic System Diagram



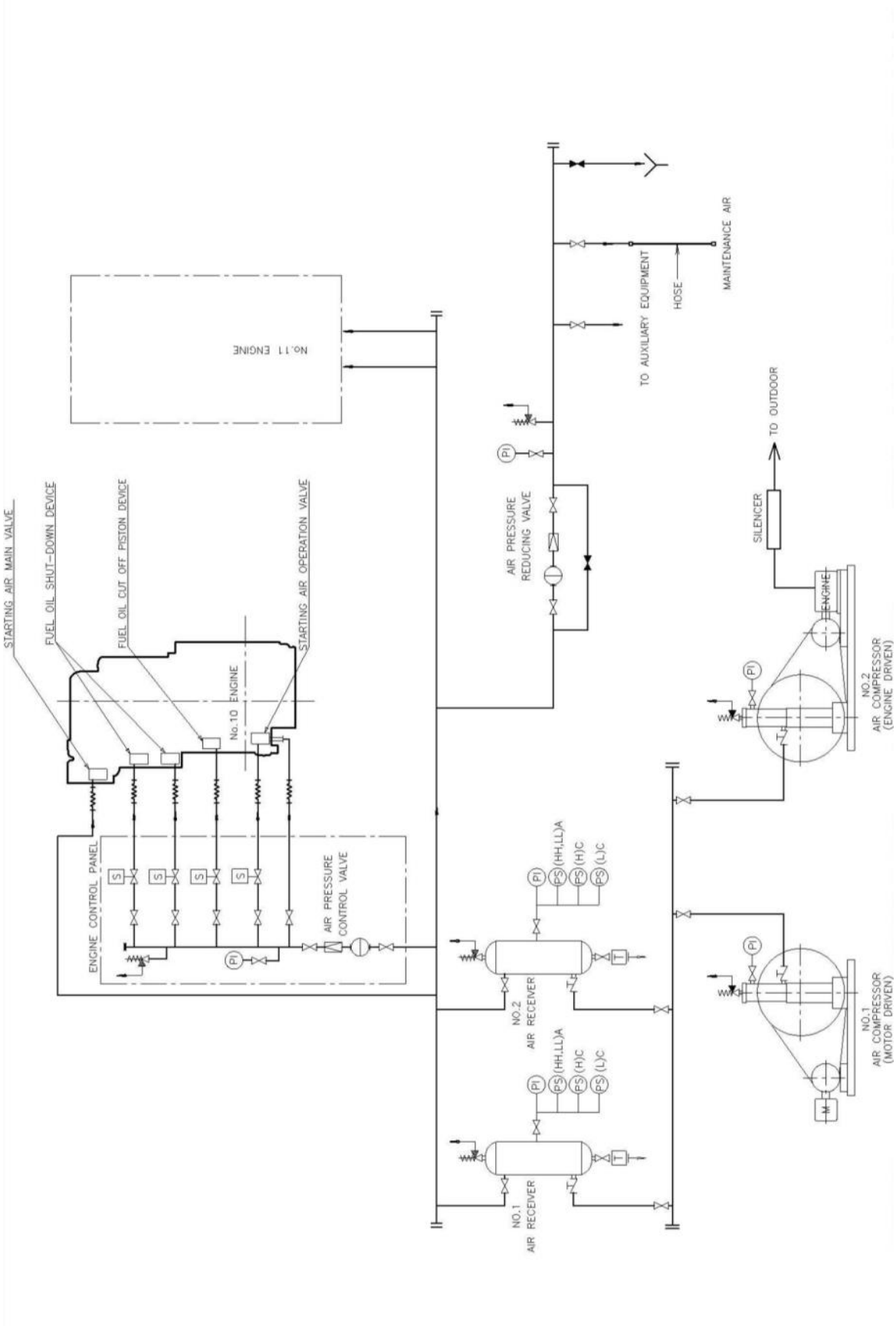
DWG No. M-02 Fuel System Diagram



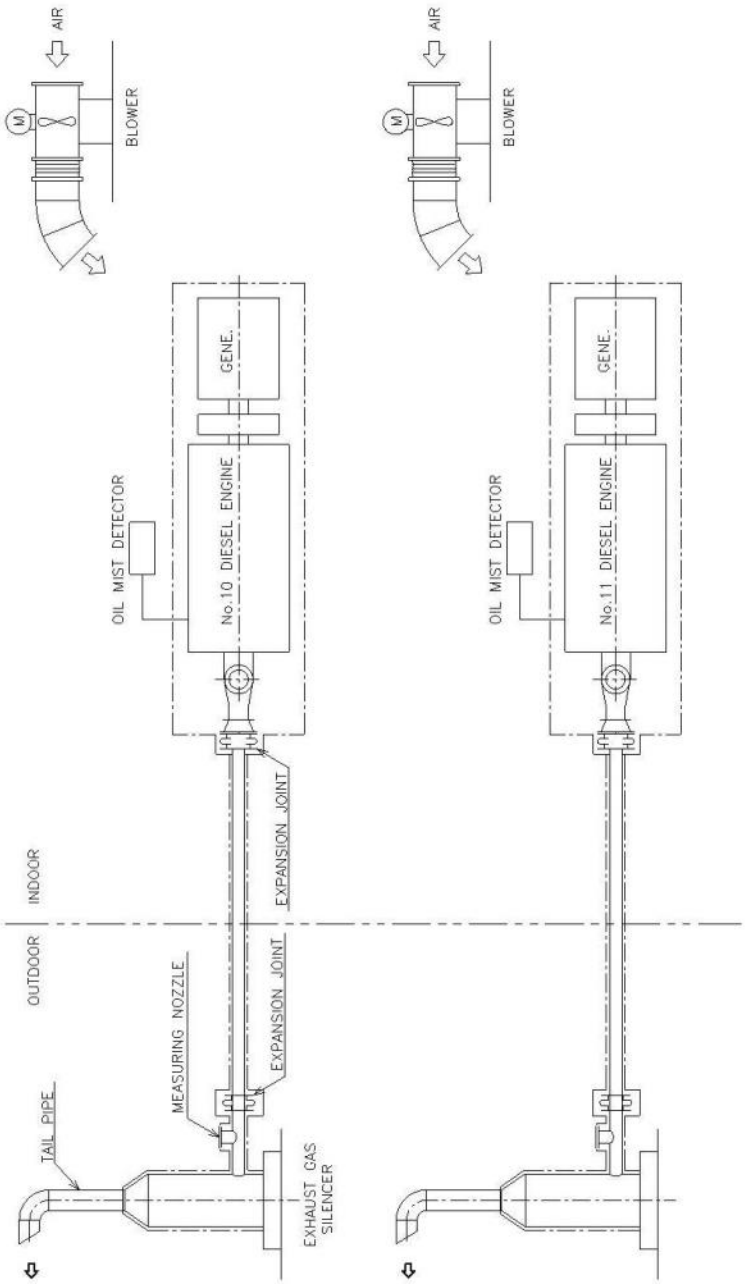
DWG No. M-03 Lubricating Oil System Diagram



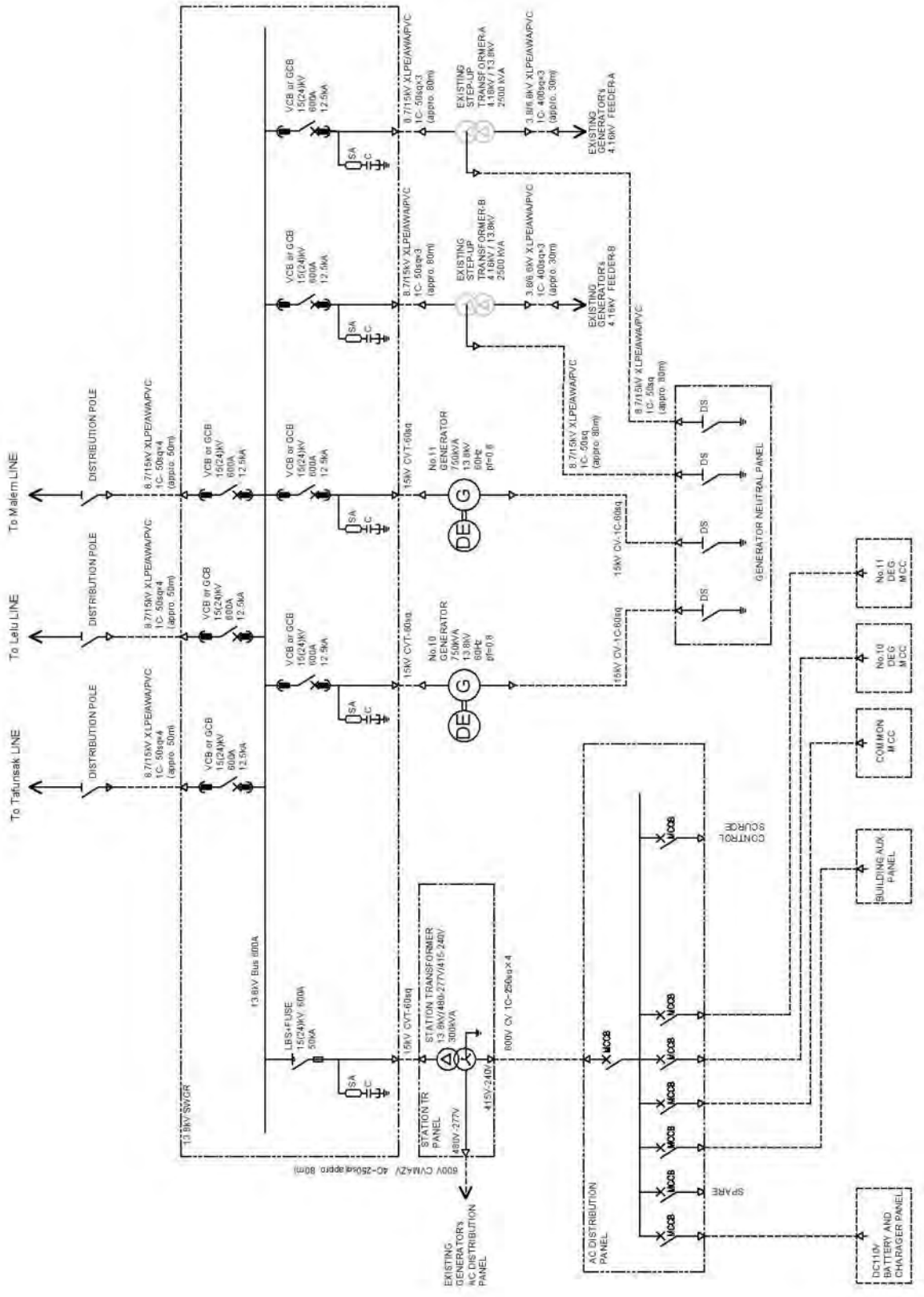
DWG No. M-04 Cooling Water System Diagram



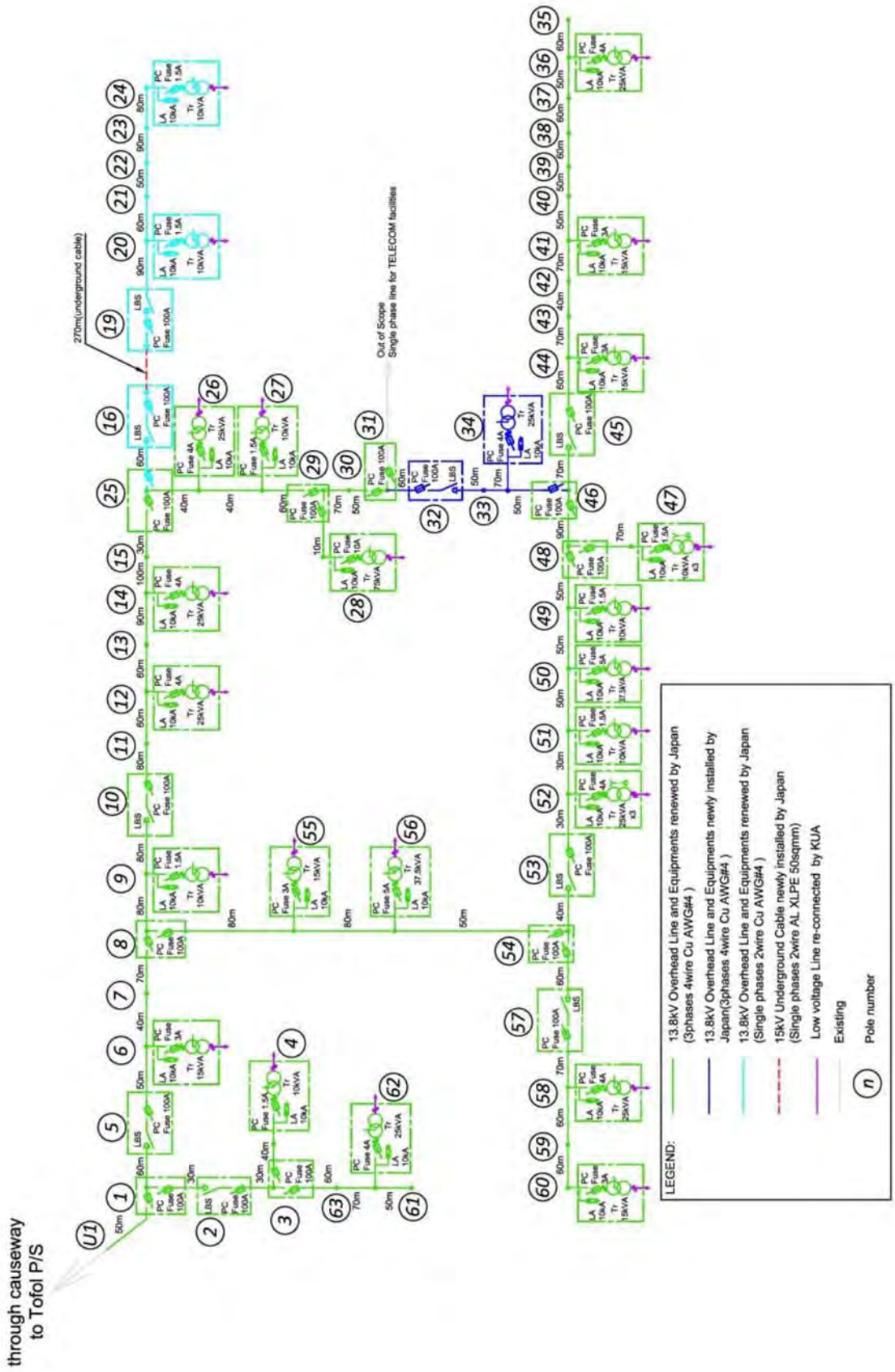
DWG No. M-05 Compressed Air System Diagram



DWG No. M-06 Air Supply and Exhaust System Diagram



DWG No. E-01 Power Station Single-line Diagram

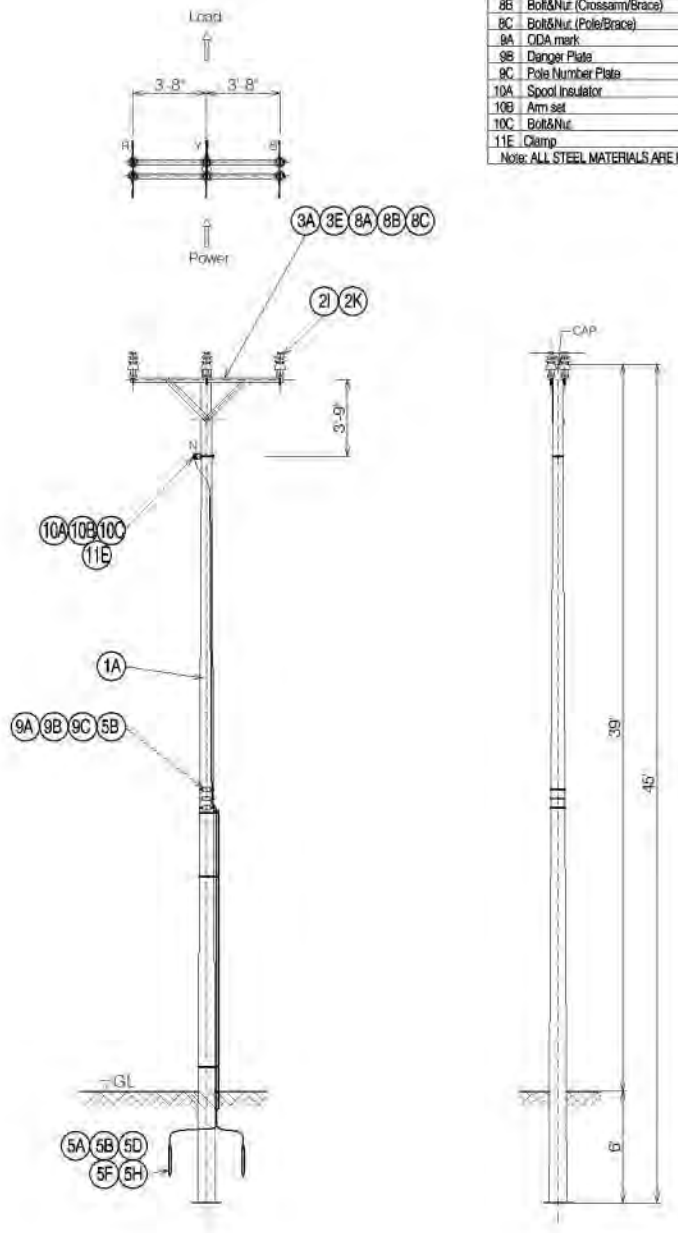


DWG No. E-02 Lelu Island Distribution Single-line Diagram

DWG No. LL-R-01 Lelu Island Distribution Line Route Overall Diagram

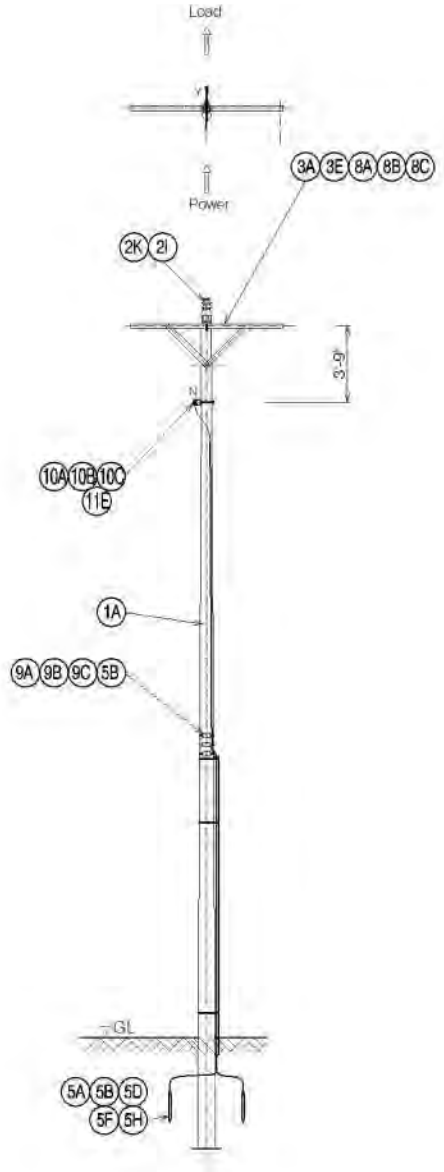
DWG No. UG-R-01 Underground Cable Route Diagram

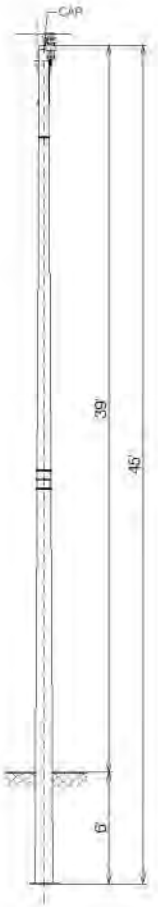
COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2I	Pin Insulator	ピン碍子	6	pcs
2K	Preformed Top Tie	頂部タイ	6	pcs
3A	Crossarm	腕金	2	pcs
3E	Crossarm Brace	腕金支持金物	4	pcs
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11E	Clamp	クランプ	1	pc
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				



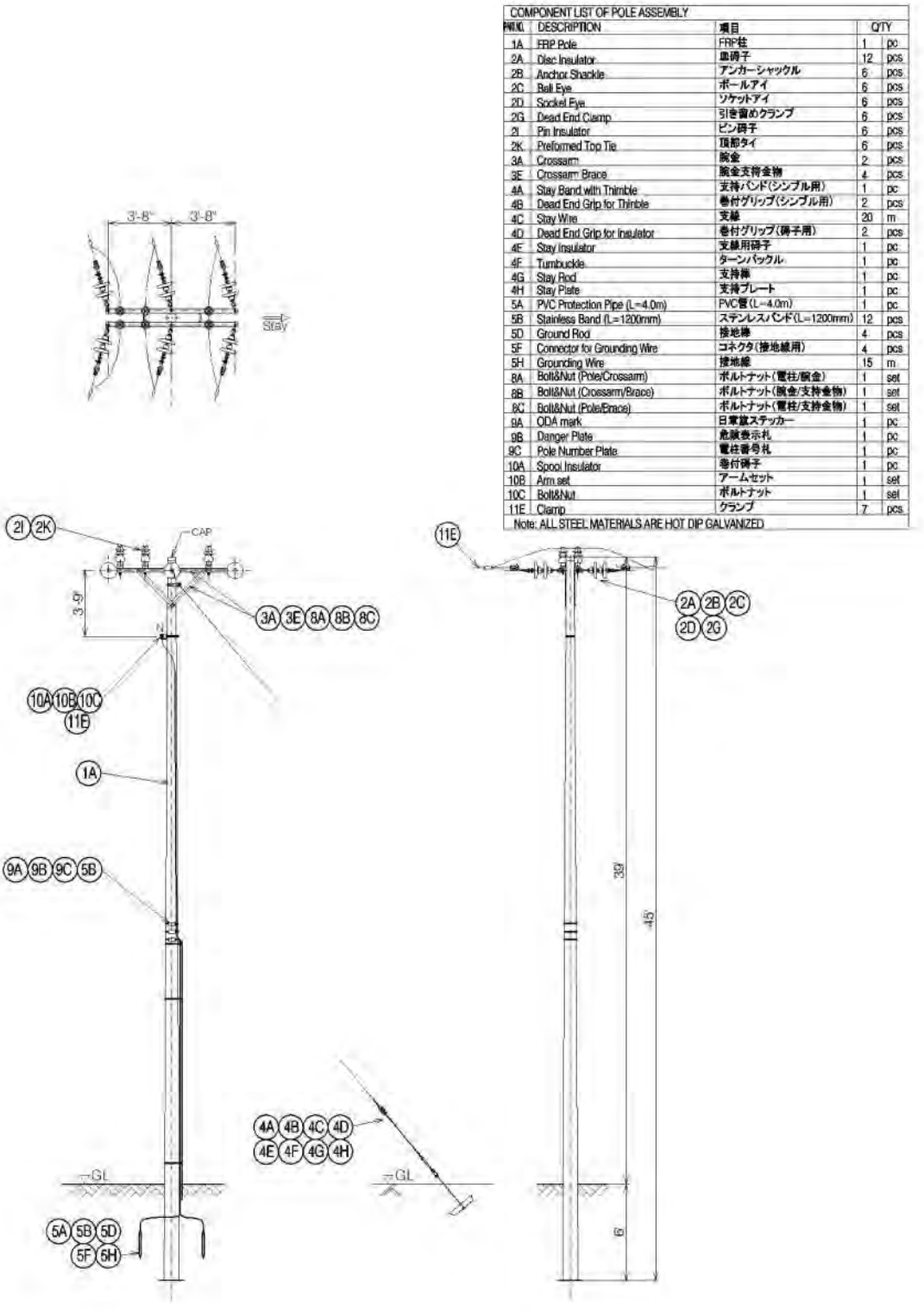
DWG No. D-01 Pole Assembly Drawing (Type A Intermediate Pole (Line Angle 0-5deg.))

COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2I	Pin Insulator	ピン碍子	1	pcs
2K	Preformed Top Tie	頂部タイ	1	pcs
3A	Crossarm	腕金	1	pcs
3E	Crossarm Brace	腕金支持金物	2	pcs
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11E	Clamp	クランプ	1	pc
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				





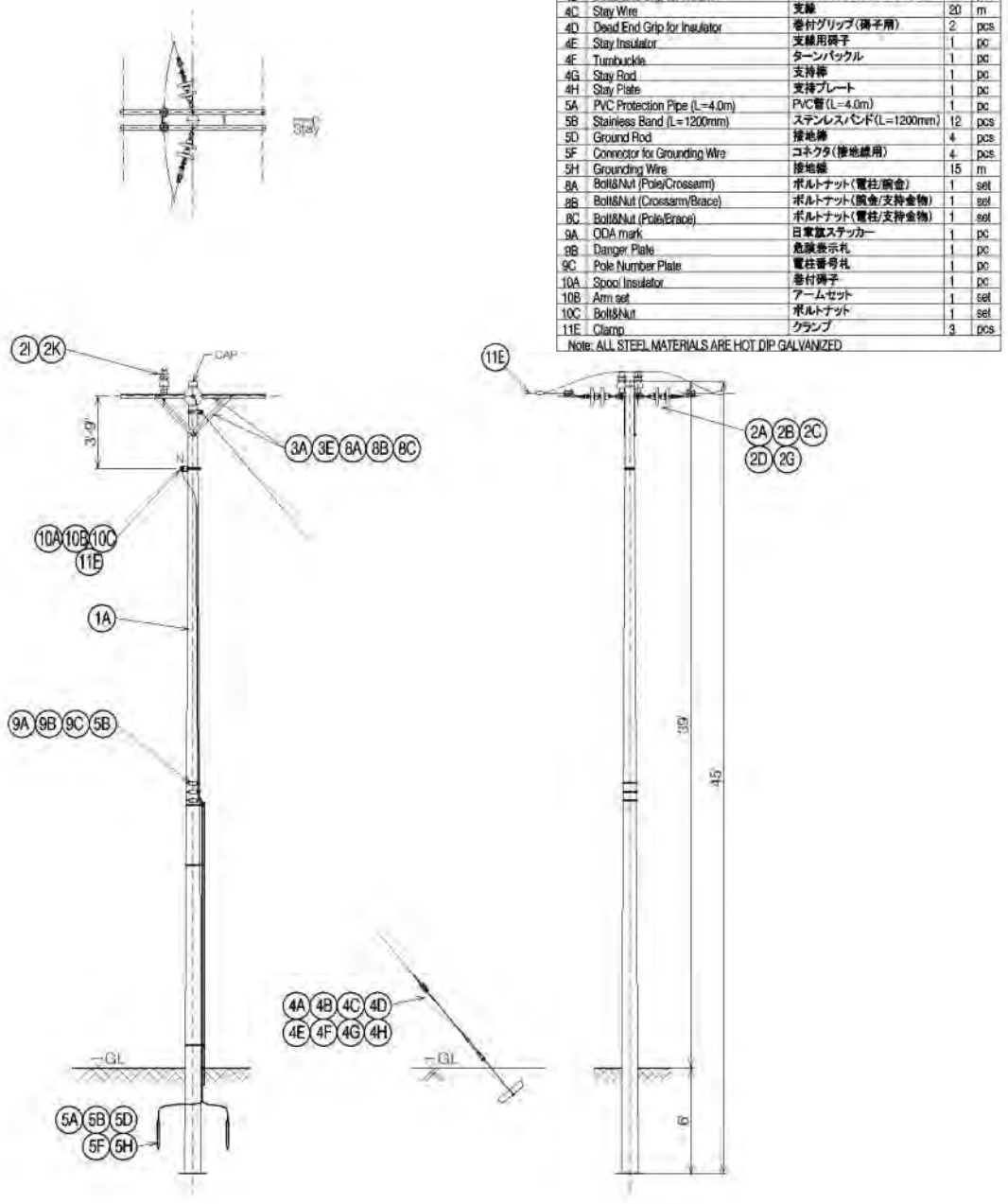
DWG No. D-02 Pole Assembly Drawing (Type 1A Intermediate Pole (Line Angle 0-5deg.))



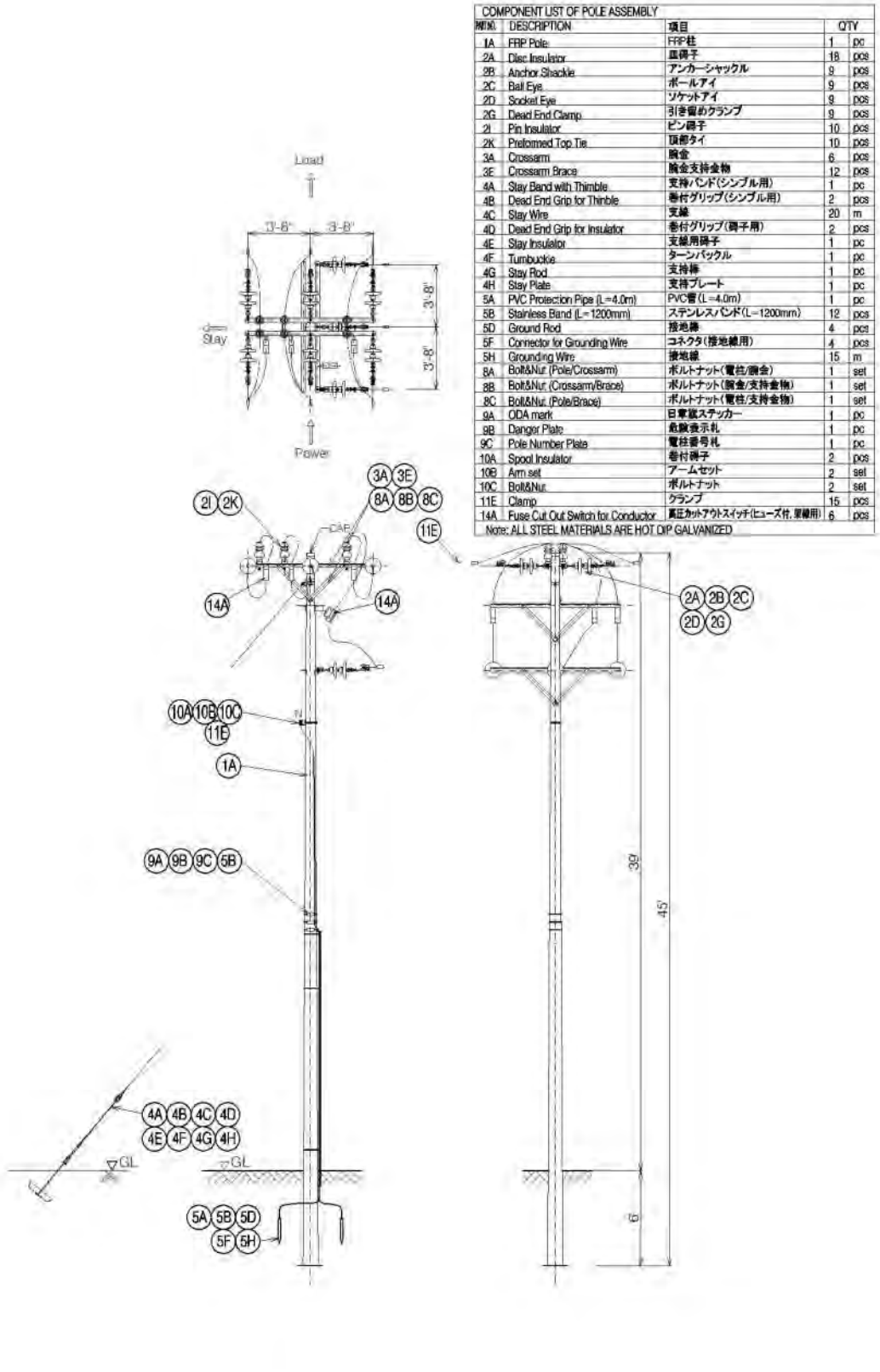
DWG No. D-03 Pole Assembly Drawing (Type B Angle and Section Pole)

COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	Q'TY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	4	pcs
2B	Anchor Shackle	アンカーシャックル	2	pcs
2C	Ball Eye	ボールアイ	2	pcs
2D	Socket Eye	ソケットアイ	2	pcs
2G	Dead End Clamp	引き留めクランプ	2	pcs
2I	Pin Insulator	ピン碍子	2	pcs
2K	Preformed Top Tie	頂部タイ	2	pcs
3A	Crossarm	腕金	2	pcs
3E	Crossarm Brace	腕金支持金物	4	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日東紡ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11E	Clamp	クランプ	3	pcs

Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED

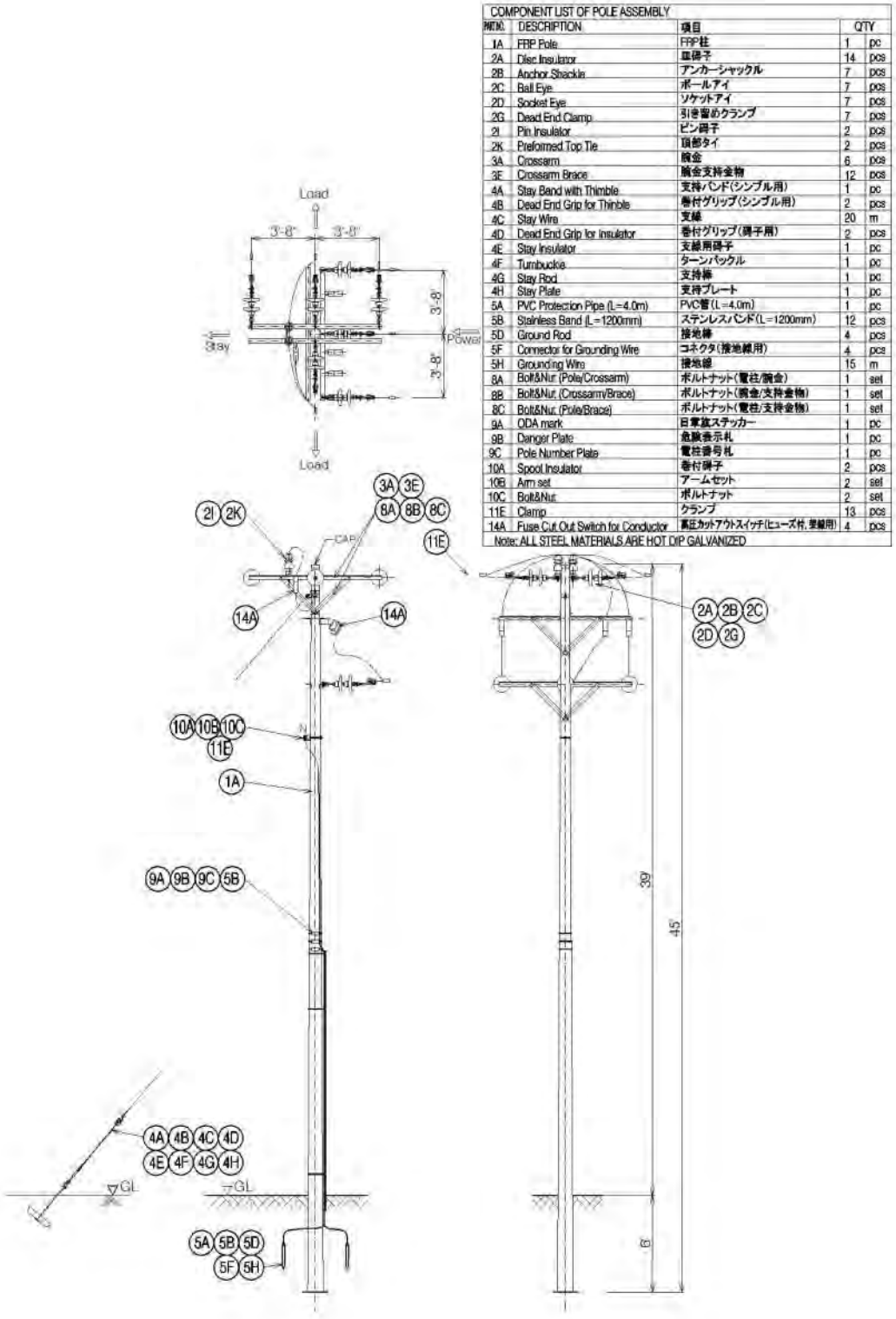


DWG No. D-04 Pole Assembly Drawing (Type 1B Angle and Section Pole)



COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	懸垂子	18	pcs
2B	Anchor Shackle	アンカーシャックル	9	pcs
2C	Ball Eye	ボールアイ	9	pcs
2D	Socket Eye	ソケットアイ	9	pcs
2G	Dead End Clamp	引き留めクランプ	9	pcs
2I	Pin Insulator	ピン碍子	10	pcs
2K	Preformed Top Tie	頂部タイ	10	pcs
3A	Crossarm	腕金	6	pcs
3E	Crossarm Brace	腕金支持金物	12	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	2	pcs
10B	Arm set	アームセット	2	set
10C	Bolt&Nut	ボルトナット	2	set
11E	Clamp	クランプ	15	pcs
14A	Fuse Cut Out Switch for Conductor	高圧カットアウトスイッチ(ヒューズ付, 架線用)	6	pcs
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				

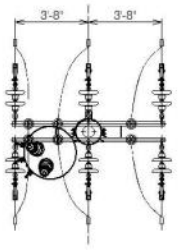
DWG No. D-05 Pole Assembly Drawing (Type C T-off Pole)

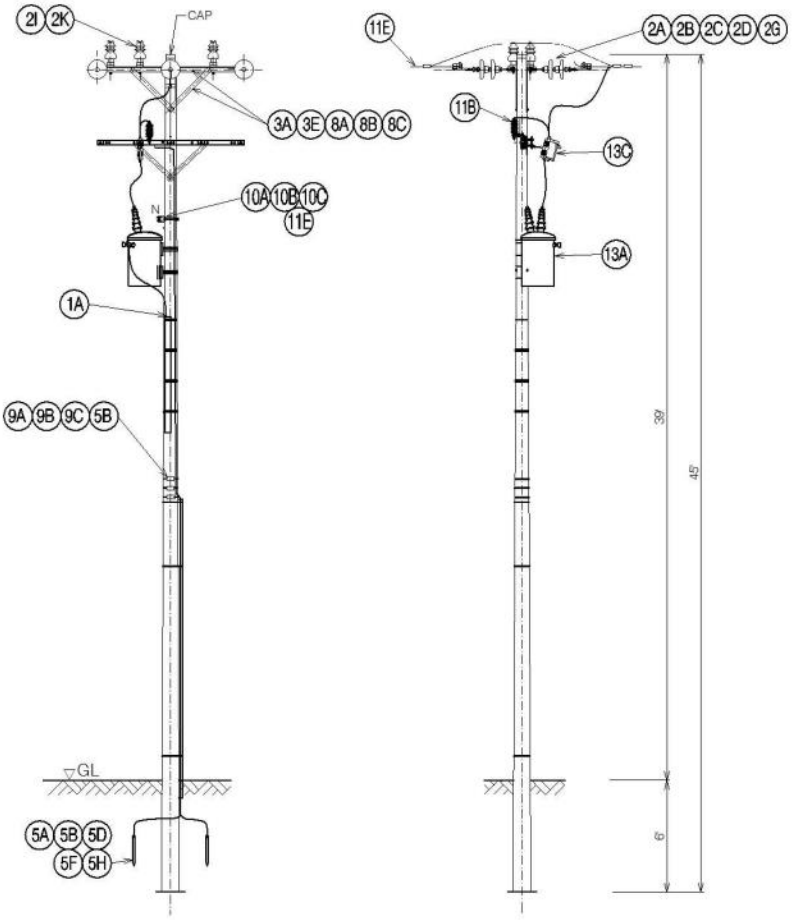


COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	懸碍子	14	pcs
2B	Anchor Shackle	アンカーシャックル	7	pcs
2C	Ball Eye	ボールアイ	7	pcs
2D	Socket Eye	ソケットアイ	7	pcs
2G	Dead End Clamp	引き留めクランプ	7	pcs
2I	Pin Insulator	ピン碍子	2	pcs
2K	Preformed Top Tie	頂部タイ	2	pcs
3A	Crossarm	腕金	6	pcs
3E	Crossarm Brace	腕金支持金物	12	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日電協ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	2	pcs
10B	Arm set	アームセット	2	set
10C	Bolt&Nut	ボルトナット	2	set
11E	Clamp	クランプ	13	pcs
14A	Fuse Cut Out Switch for Conductor	高圧カットアウトスイッチ(ヒューズ付, 架線用)	4	pcs
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				

DWG No. D-06 Pole Assembly Drawing (Type 1C T-off Pole)

COMPONENT LIST OF POLE ASSEMBLY				
PART NO.	DESCRIPTION	項目	Q'TY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	重碍子	12	pcs
2B	Anchor Shackle	アンカーシャックル	6	pcs
2C	Ball Eye	ボールアイ	6	pcs
2D	Socket Eye	ソケットアイ	6	pcs
2G	Dead End Clamp	引き留めクランプ	6	pcs
2I	Pin Insulator	ピン碍子	6	pcs
2K	Preformed Top Tie	頂部タイ	6	pcs
3A	Crossarm	腕金	4	pcs
3E	Crossarm Brace	腕金支持金物	8	pcs
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	1	pc
11E	Clamp	クランプ	10	pcs
13A	Single Phase Transformer	単相変圧器	1	pc
13C	Fuse Cut Out Switch for Transformer	高圧カットアウトスイッチ(ヒューズ付, 変圧器用)	1	pc
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				

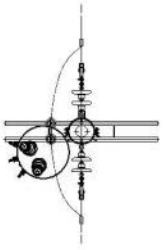


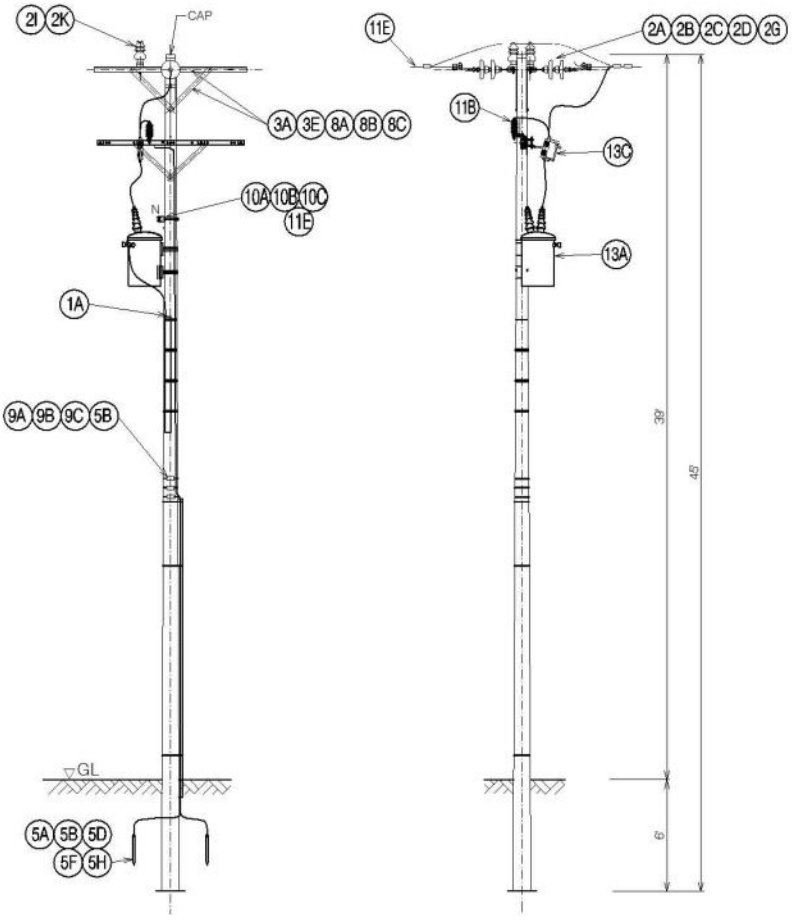


DWG No. D-07 Pole Assembly Drawing (Type D Transformer Pole (1 ph x 1))

COMPONENT LIST OF POLE ASSEMBLY				
MARK NO.	DESCRIPTION	項目	Q'TY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	重碍子	4	pcs
2B	Anchor Shackle	アンカーシャックル	2	pcs
2C	Ball Eye	ボールアイ	2	pcs
2D	Socket Eye	ソケットアイ	2	pcs
2G	Dead End Clamp	引き留めクランプ	2	pcs
2I	Pin Insulator	ピン碍子	2	pcs
2K	Preformed Top Tie	頂部タイ	2	pcs
3A	Crossarm	腕金	4	pcs
3E	Crossarm Brace	腕金支持金物	8	pcs
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	1	pc
11E	Clamp	クランプ	3	pcs
13A	Single Phase Transfomer	単相変圧器	1	pc
13C	Fuse Cut Out Switch for Transformer	高圧カットアウトスイッチ(ヒューズ付, 変圧器用)	1	pc

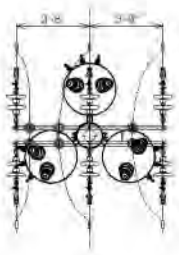
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED

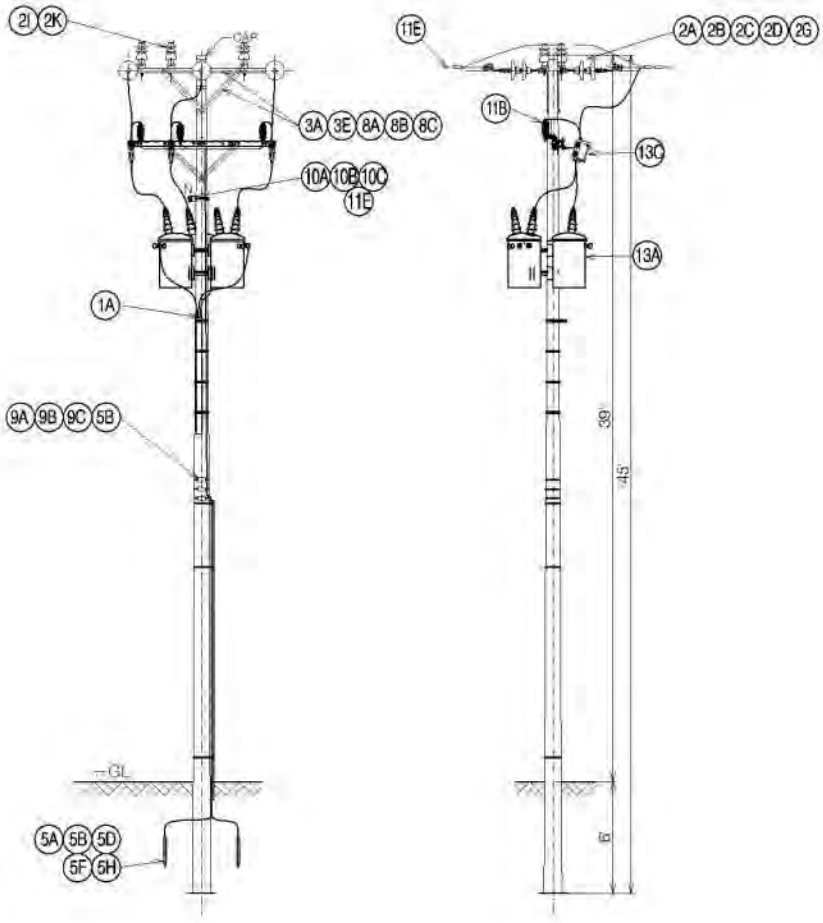




DWG No. D-08 Pole Assembly Drawing (Type 1D Transformer Pole (1 ph x 1))

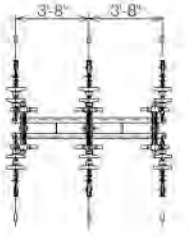
COMPONENT LIST OF POLE ASSEMBLY				
PART NO.	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	12	pcs
2B	Anchor Shackle	アンカーシャックル	6	pcs
2C	Ball Eye	ボールアイ	6	pcs
2D	Socket Eye	ソケットアイ	6	pcs
2G	Dead End Clamp	引き留めクランプ	6	pcs
2I	Pin Insulator	ピン碍子	6	pcs
2K	Preformed Top Tie	頂部タイ	6	pcs
3A	Crossarm	腕金	4	pcs
3E	Crossarm Brace	腕金支持金物	8	pcs
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	3	pcs
11E	Clamp	クランプ	16	pcs
13A	Single Phase Transformer	単相変圧器	3	pcs
13C	Fuse Cut Out Switch for Transformer	高圧カットアウトスイッチ(ヒューズ付, 変圧器用)	3	pcs
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				

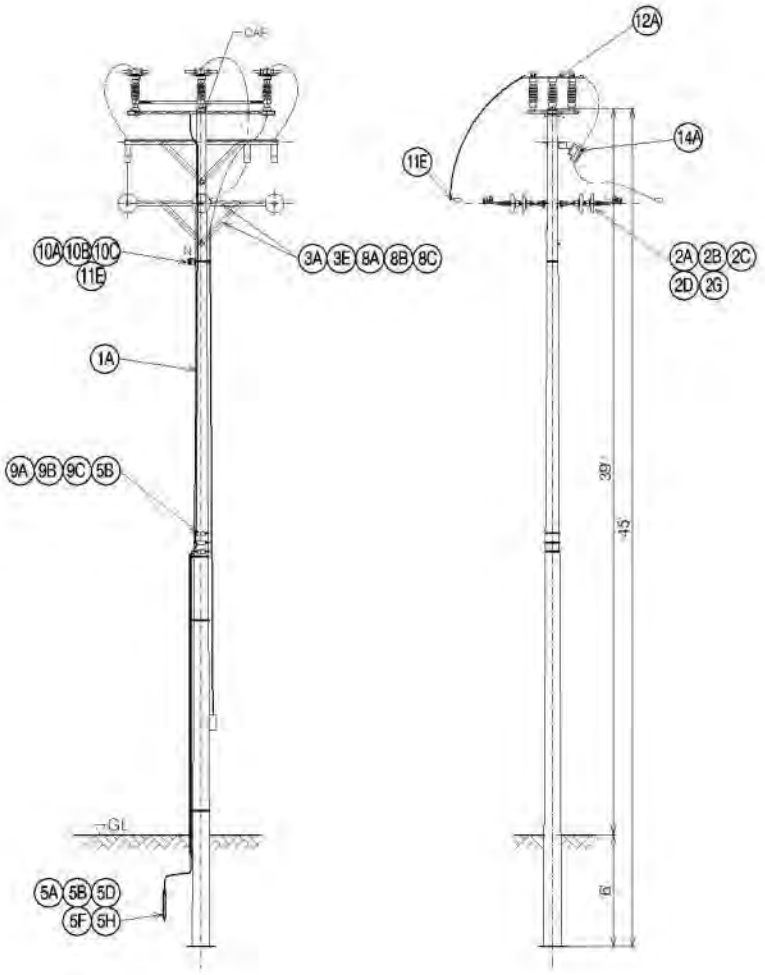




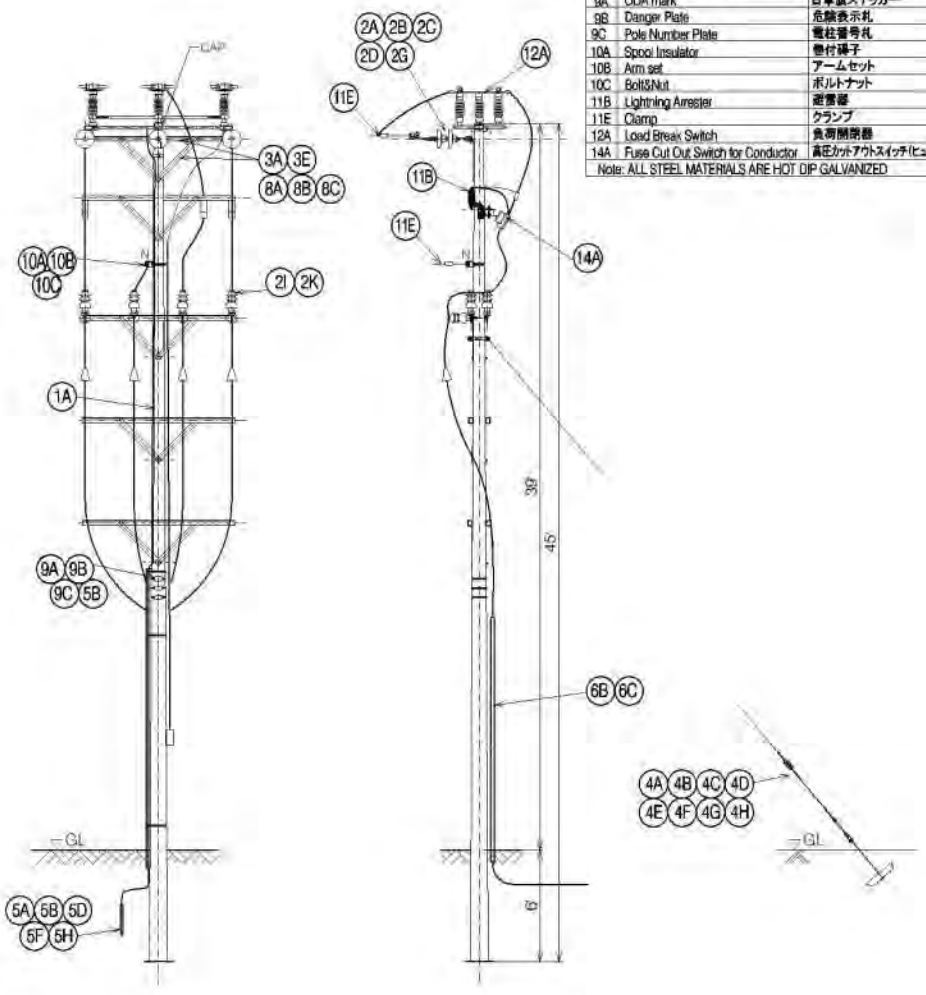
DWG No. D-09 Pole Assembly Drawing (Type E Transformer Pole (1 ph x 3))

COMPONENT LIST OF POLE ASSEMBLY				
PART NO.	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	12	pcs
2B	Anchor Shackle	アンカーシャックル	6	pcs
2C	Ball Eye	ボールアイ	6	pcs
2D	Socket Eye	ソケットアイ	6	pcs
2G	Dead End Clamp	引き留めクランプ	6	pcs
3A	Crossarm	腕金	6	pcs
3E	Crossarm Brace	腕金支持金物	12	pcs
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11E	Clamp	クランプ	7	pcs
12A	Load Break Switch	負荷開閉器	1	pc
14A	Fuse Cut Out Switch for Conductor	高圧カットアウトスイッチ(ヒューズ付, 架線用)	3	pcs
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				





DWG No. D-10 Pole Assembly Drawing (Type F Load Break Switch Pole)

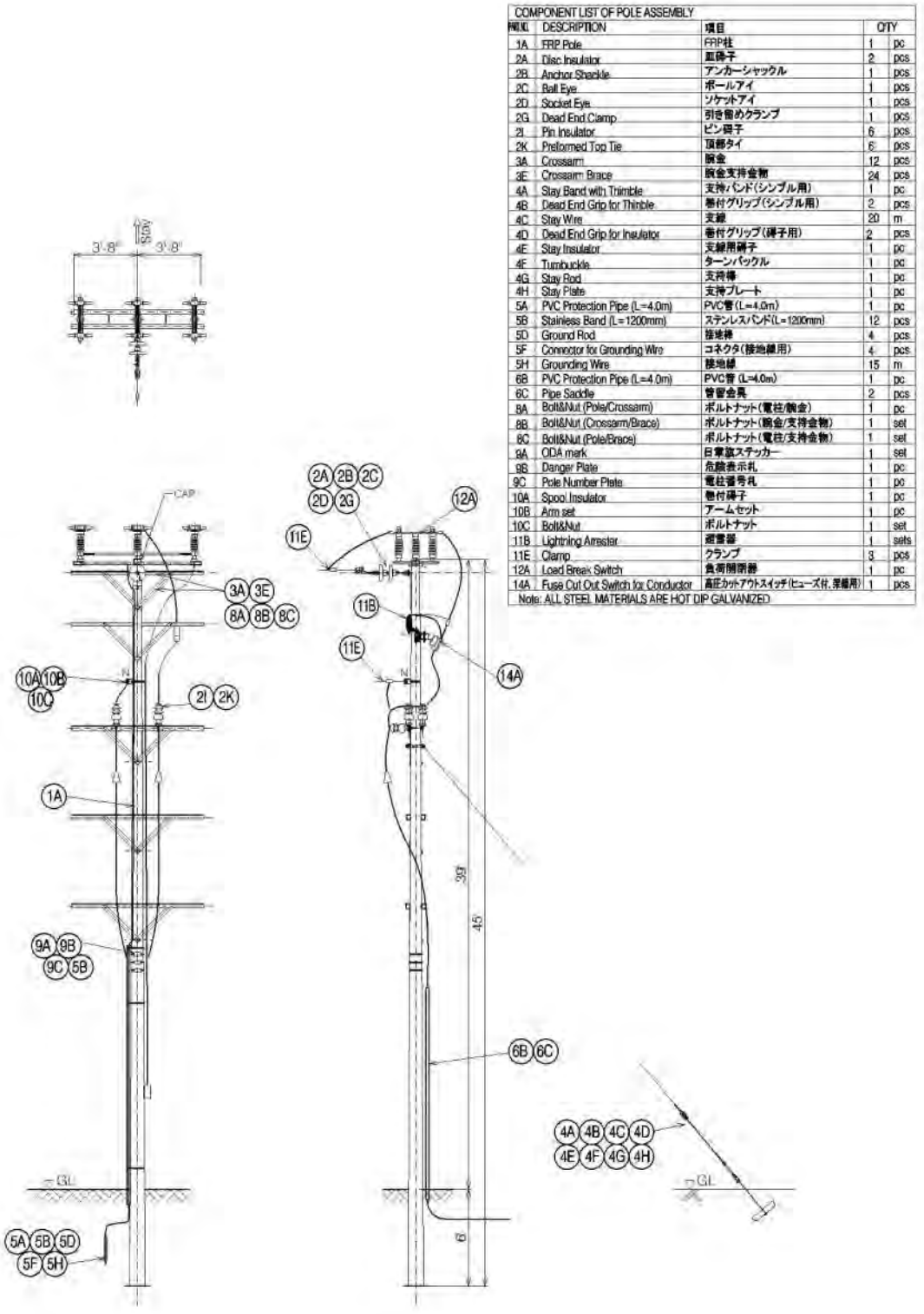


COMPONENT LIST OF POLE ASSEMBLY

ITEM NO.	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	6	pcs
2B	Anchor Shackle	アンカーシャックル	3	pcs
2C	Ball Eye	ボールアイ	3	pcs
2D	Socket Eye	ソケットアイ	3	pcs
2G	Dead End Clamp	引き留めクランプ	3	pcs
2I	Pin Insulator	ピン碍子	12	pcs
2K	Preformed Top Tie	頂部タイ	12	pcs
3A	Crossarm	腕金	12	pcs
3E	Crossarm Brace	腕金支持金物	24	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
6B	PVC Protection Pipe (L=4.0m)	PVC管 (L=4.0m)	1	pc
6C	Pipe Saddle	管留金具	2	pcs
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	pc
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支得金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	set
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	pc
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	3	sets
11E	Clamp	クランプ	7	pcs
12A	Load Break Switch	負荷開閉器	1	pc
14A	Fuse Cut Out Switch for Conductor	高圧カットアウトスイッチ(ヒューズ付, 架線用)	3	pcs

Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED

DWG No. D-11 Pole Assembly Drawing (Type G Cable Termination Pole)



COMPONENT LIST OF POLE ASSEMBLY

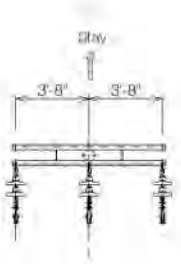
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	2	pcs
2B	Anchor Shackle	アンカーシャックル	1	pcs
2C	Ball Eye	ボールアイ	1	pcs
2D	Socket Eye	ソケットアイ	1	pcs
2G	Dead End Clamp	引き留めクランプ	1	pcs
2I	Pin Insulator	ピン碍子	6	pcs
2K	Preformed Top Tie	頂部タイ	6	pcs
3A	Crossarm	腕金	12	pcs
3E	Crossarm Brace	腕金支持金物	24	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
6B	PVC Protection Pipe (L=4.0m)	PVC管 (L=4.0m)	1	pc
6C	Pipe Saddle	管留金具	2	pcs
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	pc
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	set
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	pc
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	1	sets
11E	Clamp	クランプ	3	pcs
12A	Load Break Switch	負荷開閉器	1	pc
14A	Fuse Cut Out Switch for Conductor	高圧カットアウトスイッチ(ヒューズ付, 架線用)	1	pcs

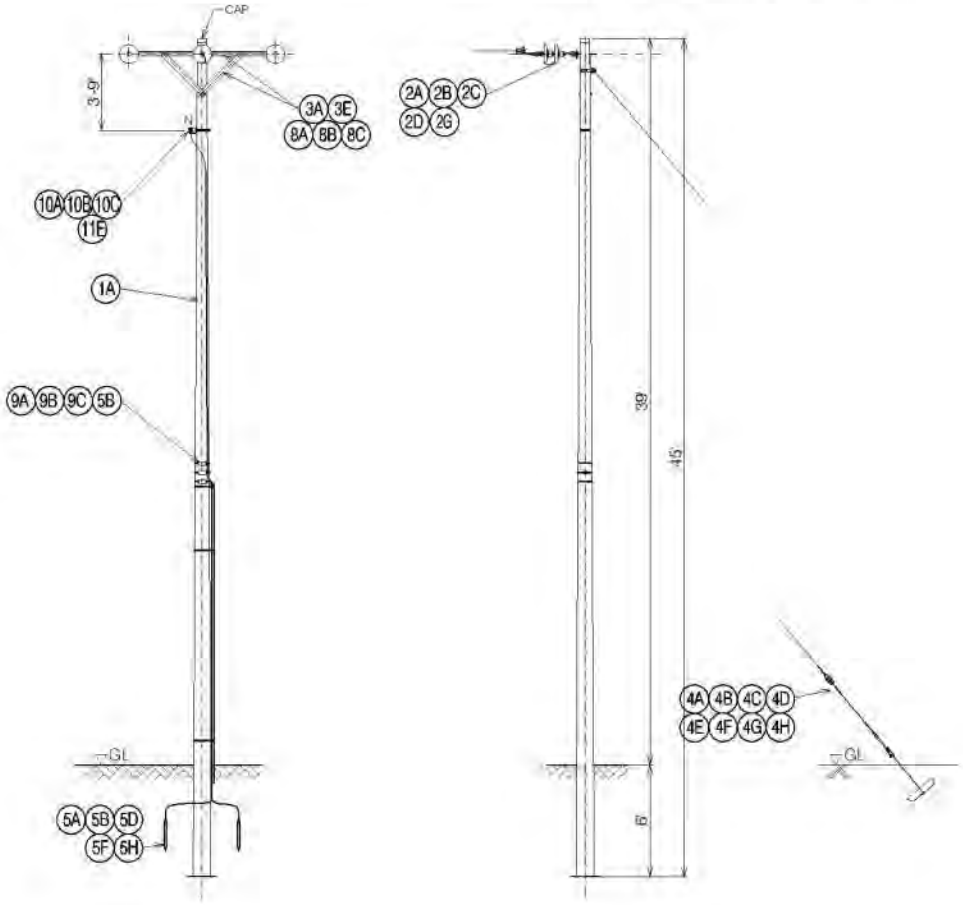
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED

DWG No. D-12 Pole Assembly Drawing (Type 1G Cable Termination Pole)

COMPONENT LIST OF POLE ASSEMBLY				
PART NO.	DESCRIPTION	項目	Q'TY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	6	pcs
2B	Anchor Shackle	アンカーシャックル	3	pcs
2C	Ball Eye	ボールアイ	3	pcs
2D	Socket Eye	ソケットアイ	3	pcs
2G	Dead End Clamp	引き留めクランプ	3	pcs
3A	Crossarm	腕金	2	pcs
3E	Crossarm Brace	腕金支持金物	4	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11E	Clamp	クランプ	1	pc

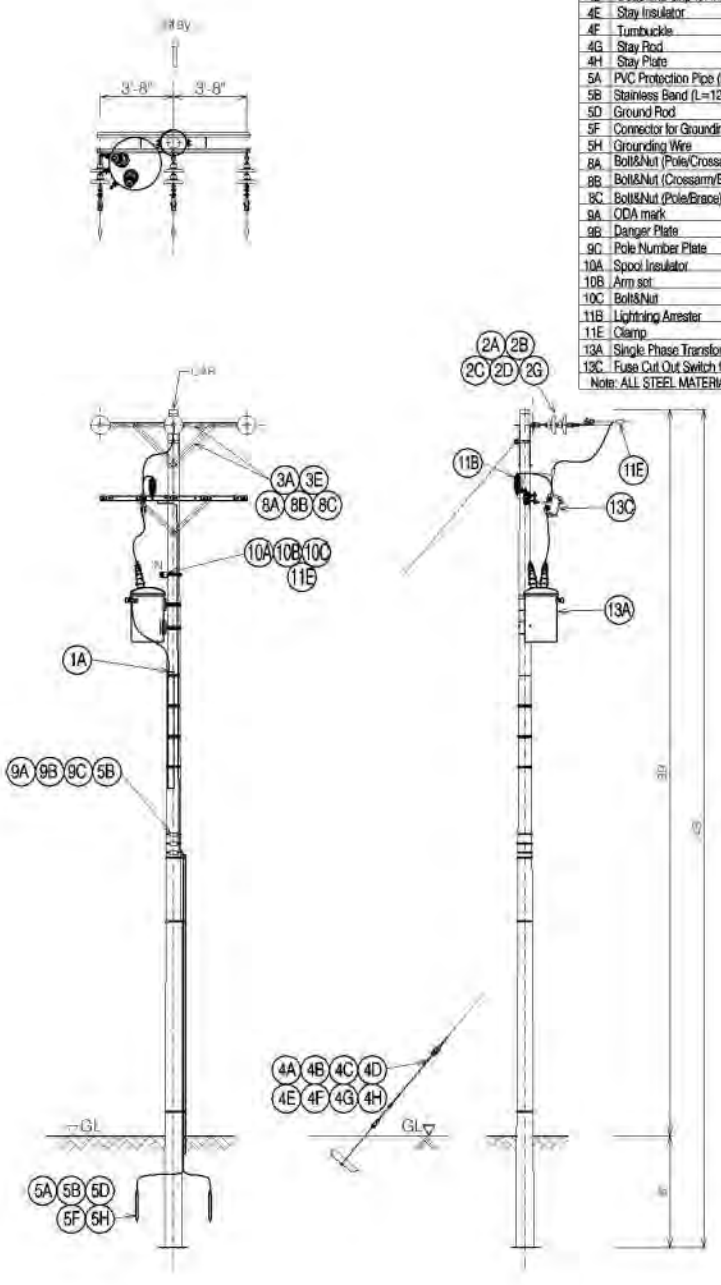
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED



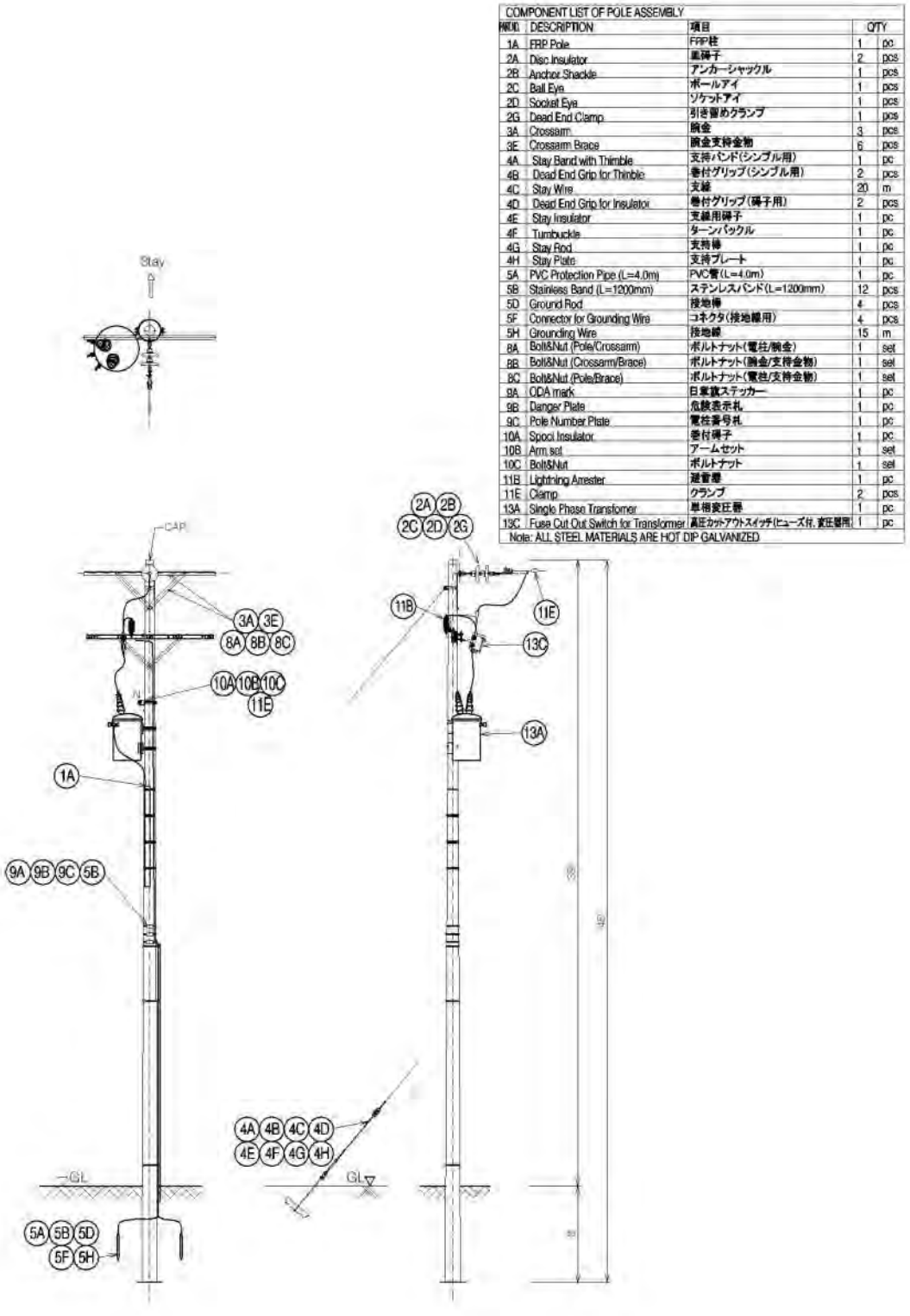


DWG No. D-13 Pole Assembly Drawing (Type H Termination Pole)

COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	皿碍子	6	pcs
2B	Anchor Shackle	アンカーシャックル	3	pcs
2C	Ball Eye	ボールアイ	3	pcs
2D	Socket Eye	ソケットアイ	3	pcs
2G	Dead End Clamp	引き留めクランプ	3	pcs
3A	Crossarm	腕金	4	pcs
3E	Crossarm Brace	腕金支持金物	8	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	1	pc
11E	Clamp	クランプ	4	pcs
13A	Single Phase Transformer	単相変圧器	1	pc
13C	Fuse Cut Out Switch for Transformer	高圧カットアウトスイッチ(ヒューズ付, 変圧器用)	1	pc
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				

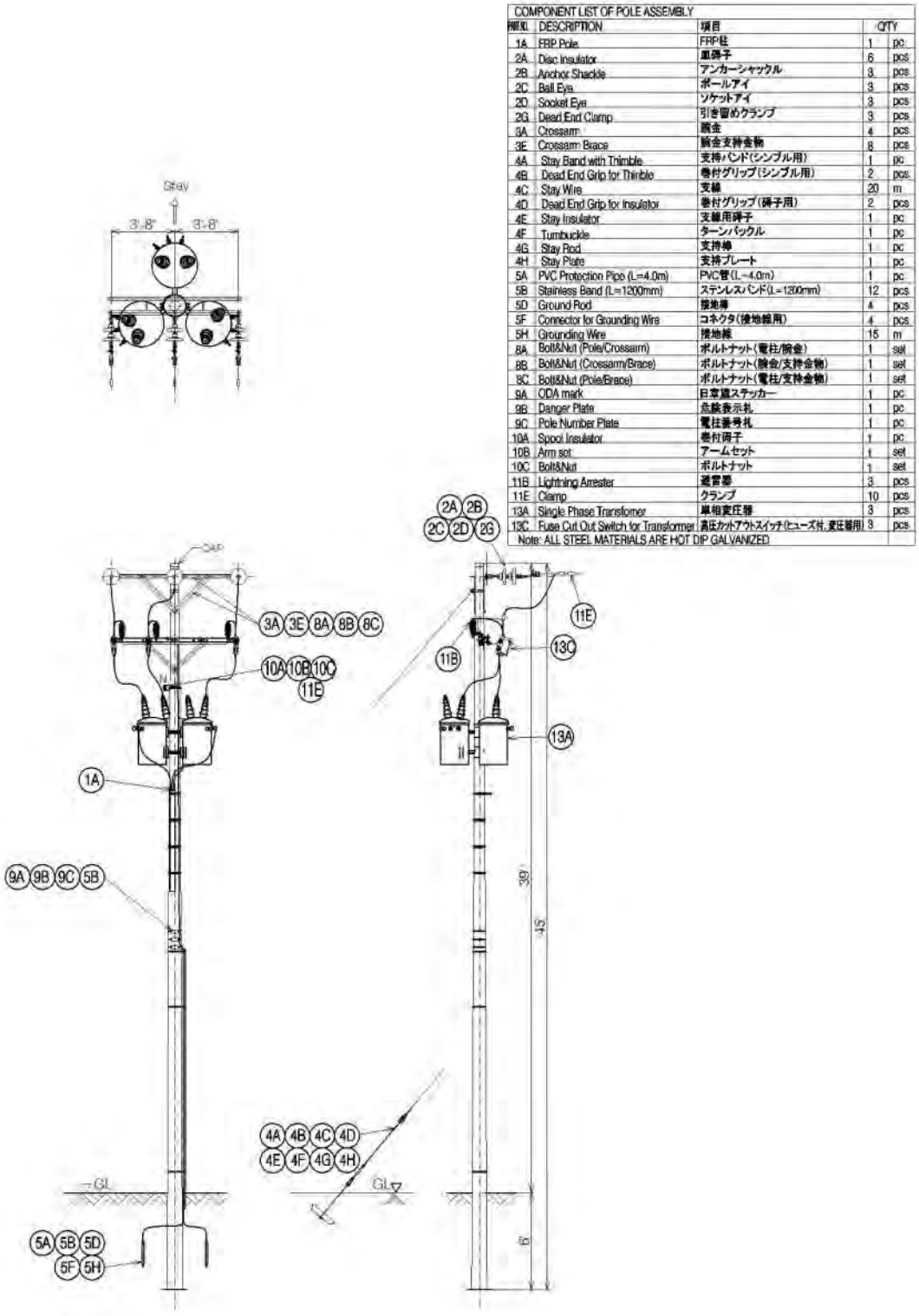


DWG No. D-14 Pole Assembly Drawing (Type J Transformer Pole (Terminal Pole))



COMPONENT LIST OF POLE ASSEMBLY				
MARK	DESCRIPTION	項目	QTY	
1A	FRP Pole	FRP柱	1	pc
2A	Disc Insulator	懸垂碍子	2	pcs
2B	Anchor Shackle	アンカーシャックル	1	pcs
2C	Ball Eye	ボールアイ	1	pcs
2D	Socket Eye	ソケットアイ	1	pcs
2G	Dead End Clamp	引き留めクランプ	1	pcs
3A	Crossarm	腕金	3	pcs
3E	Crossarm Brace	腕金支持金物	6	pcs
4A	Stay Band with Thimble	支持バンド(シンブル用)	1	pc
4B	Dead End Grip for Thimble	巻付グリップ(シンブル用)	2	pcs
4C	Stay Wire	支線	20	m
4D	Dead End Grip for Insulator	巻付グリップ(碍子用)	2	pcs
4E	Stay Insulator	支線用碍子	1	pc
4F	Turnbuckle	ターンバックル	1	pc
4G	Stay Rod	支持棒	1	pc
4H	Stay Plate	支持プレート	1	pc
5A	PVC Protection Pipe (L=4.0m)	PVC管(L=4.0m)	1	pc
5B	Stainless Band (L=1200mm)	ステンレスバンド(L=1200mm)	12	pcs
5D	Ground Rod	接地棒	4	pcs
5F	Connector for Grounding Wire	コネクタ(接地線用)	4	pcs
5H	Grounding Wire	接地線	15	m
8A	Bolt&Nut (Pole/Crossarm)	ボルトナット(電柱/腕金)	1	set
8B	Bolt&Nut (Crossarm/Brace)	ボルトナット(腕金/支持金物)	1	set
8C	Bolt&Nut (Pole/Brace)	ボルトナット(電柱/支持金物)	1	set
9A	ODA mark	日章旗ステッカー	1	pc
9B	Danger Plate	危険表示札	1	pc
9C	Pole Number Plate	電柱番号札	1	pc
10A	Spool Insulator	巻付碍子	1	pc
10B	Arm set	アームセット	1	set
10C	Bolt&Nut	ボルトナット	1	set
11B	Lightning Arrester	避雷器	1	pc
11E	Clamp	クランプ	2	pcs
13A	Single Phase Transformer	単相変圧器	1	pc
13C	Fuse Cut Out Switch for Transformer	高圧カットアウトスイッチ(ヒューズ付, 変圧器用)	1	pc
Note: ALL STEEL MATERIALS ARE HOT DIP GALVANIZED				

DWG No. D-15 Pole Assembly Drawing (Type 1J Transformer Pole (Terminal Pole))



DWG No. D-16 Pole Assembly Drawing (Type K Transformer Pole (Terminal Pole))

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project will be implemented based on the Government of Japan's Grant Aid scheme. Therefore, after the Government of Japan has given approval for Project implementation and the Exchange of Notes (E/N) has been conducted between the Government of Japan and Government of the Federated States of Micronesia, the Grant Agreement (G/A) will be concluded between the Japan International Cooperation Agency (JICA) and the Federated States of Micronesia side and the Project will be implemented. The following paragraphs describe the basic items and points requiring particular consideration in the event where the Project is implemented.

(1) Project Executing Agency

The Executing agency on the Federated States of Micronesia side is KUA. The implementing department in KUA will need to execute the Project and undertake the operation and maintenance of the Project facilities and equipment after they have been completed. In order to smoothly advance the Project, it will be necessary for KUA to conduct close communications and discussions with the Japanese Consultant and contractor, and appoint a manager who is responsible for the Project.

The Project manager that is appointed by KUA will need to fully explain the contents of the Project to related employees, concerned agencies and affected local residents in order to secure their understanding and cooperation for implementation.

(2) Consultant

In order to implement the procurement and installation of equipment in the Project, the Japanese Consultant that is recommended to the Federated States of Micronesia side by JICA will conclude a design and supervision contract with KUA and implement the implementation design and supervision of procurement and installation work. Also, the Consultant will prepare tender documents and conduct the tender on behalf of KUA (the Project Executing agency).

(3) Contractor

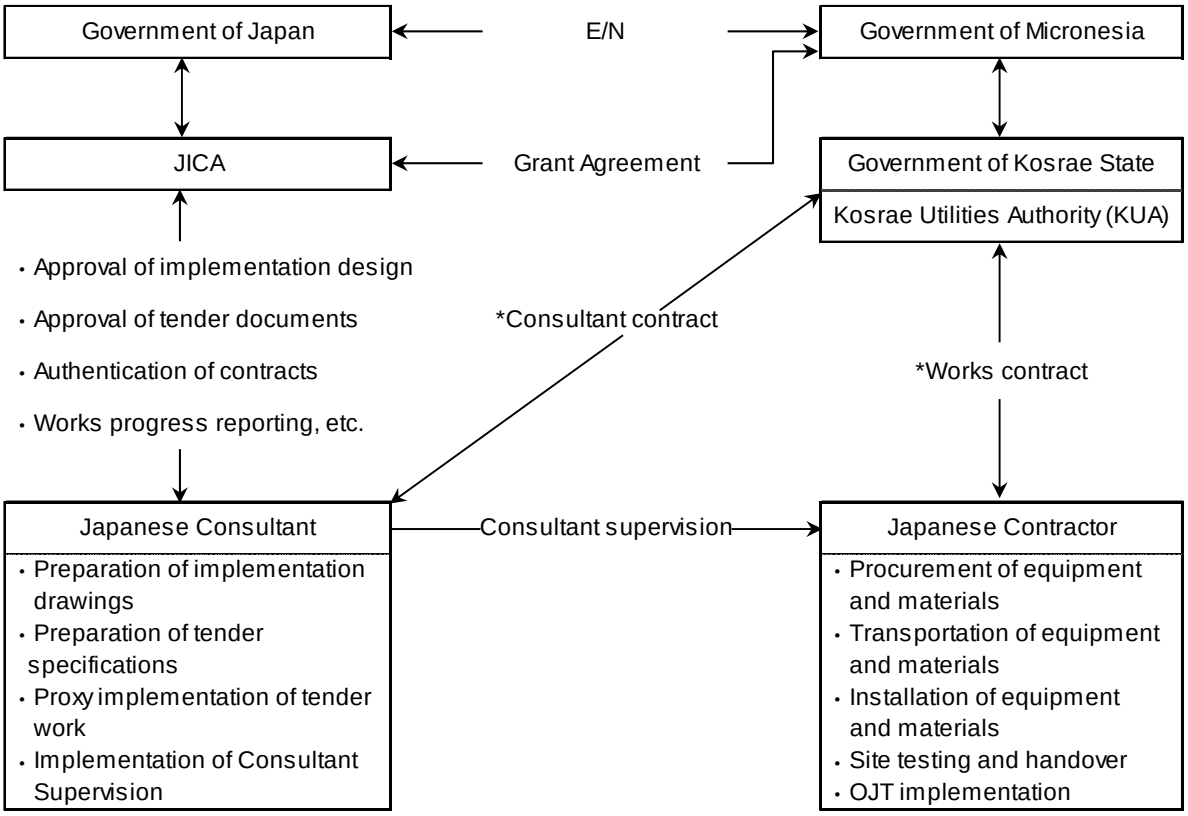
In accordance with the framework of the Government of Japan's Grant Aid scheme, the Japanese contractor that has been selected by the Federated States of Micronesia side in competitive tender will implement the equipment and materials procurement and installation works in the Project. Following completion of the Project, since it will be necessary to continue supplying spare parts and conducting post-installation service to address breakdowns and so on, it will be necessary to establish a liaison setup and display ample caution after the handover of the equipment and materials.

(4) Necessity for Dispatch of Engineers

Comprising the procurement and installation of two diesel generators with equipment capacity of 600 kW, distribution equipment, and other equipment and materials and the construction of facilities including a power station building, the Project will need to be executed by multiple work teams, and the teams will need to mutually coordinate their activities. With these works mostly being conducted simultaneously, it will be essential to dispatch a site chief from Japan who can conduct consistent management and guidance throughout the works period in order to ensure schedule control, quality control, performance control and safety control.

2-2-4-2 Overall Relationships in Project Implementation

Figure 2-2.6 shows the interrelationships between Project officials including during the Consultant supervision.



Note:*The Consultant contract and works contract require JICA authentication.

[Source] Investigation by the JICA Study Team

Figure 2-2.6 Project Implementation Relationships

2-2-4-3 Implementation Conditions

(1) Countries of Equipment and Materials Procurement

None of the Project equipment and materials, including distribution lines, pipes and other auxiliary materials, are produced in the Federated States of Micronesia; hence it is necessary to depend totally on imported products. Accordingly, the Project equipment and materials will in principle entirely be procured from Japan or third countries.

(2) Safety Measures

The Project target area presents no problems in terms of public order, however, it will still be necessary to take precautions in order to prevent theft of equipment and materials and secure safety of works personnel during the Project. In addition to requesting the Federated States of Micronesia side to implement the necessary safety measures, the Japanese contractor should also consider taking steps such as erecting fences around equipment and materials storage yards and assigning security guards.

(3) Tax Exemption

Table 2-2.18 shows the tax exemption procedures pertaining to the Project.

In order to receive exemptions of customs and tariffs on the Project equipment and materials, it will be necessary for the contractor to submit copies of the bill of lading, invoice and grant agreement (G/A) and written request for tax exemption to the tax authorities (Division of Customs & Tax Administration, Department of Finance and Administration, FSM). The Division of Customs & Tax Administration, Department of Finance and Administration, FSM will issue a permission letter and send it to the Kosrae branch. And the branch will apply its seal to the letter and send it the Division of Ports and Harbors of Kosrae to effect the tax exemption. This will not be based on the rebate system; rather, there will be total exemption whereby the Executing agency in the Federated States of Micronesia does not incur any tax burden.

Concerning sales tax applied to locally purchased equipment and materials and local workers, the contractor needs to submit copies of the exchanged notes (E/N) and grant agreement (G/A) to Kosrae State Department of Finance and Administration to receive tax exemption.

Table 2-2.18 Tax Exemption Procedures

Type of Tax	Tax Exemption / Refund Method	Department in Charge	Documents to be Submitted	Procedure	Remarks
Tariffs (imported equipment and materials)	Exemption	1) Unified Revenue Authority, the Federated States of Micronesia Department of Finance and Administration 2) Kosrae Office of the Unified Revenue Authority, the Federated States of Micronesia Department of Finance and Administration	1) Bill of landing 2) Invoice 3) Copy of Grant Agreement (G/A)	1) The contractor submits the documents on the left together with a written request to the Unified Revenue Authority, the Federated States of Micronesia Department of Finance and Administration (in Pohnpei State). 2) The Unified Revenue Authority, the Federated States of Micronesia Department of Finance and Administration issues a permit to its office in Kosrae. 3) The Kosrae Office of the Unified Revenue Authority, the Federated States of Micronesia Department of Finance and Administration applies its seal to the permit and sends it to Kosrae Port Authority. 4) The above procedure enables tax exemption.	The tax rate is 4% of the cost of equipment and materials
Sales tax (locally purchased equipment and materials and labor)	Exemption	Kosrae State Department of Finance and Administration	1) Copy of Exchange of Notes (E/N) 2) Copy of Grant Agreement (G/A)	The contractor submits the preparatory documents on the left to Kosrae State Department of Finance and Administration	Based on the federal constitution of the Federated States of Micronesia

Notes:
(1) E/N: Exchange of Notes, G/A: Grant Agreement
(2) Income tax is not exempted for local workers and third country workers, however, it is for Japanese workers (no exemption procedure is required).

(4) Transportation

Concerning the equipment and materials that are transported to Kosrae State by sea, landing and customs clearance work will be conducted at Kosrae Port. Since this port has no crane equipment that is capable of lifting heavy objects, it will be necessary for the contractor to separately secure lifting equipment (crane-equipped vessel or mobile crane equipment, etc.). Equipment procured in Japan will be packed securely enough to withstand the long sea transportation from Japan, landing at port, inland transportation to the Project site and storage.

2-2-4-4 Scope of Works

For implementation of this General Project Grant Aid undertaking, the detailed scope of works on the Japanese and the Federated States of Micronesia sides will be as shown in Table 2-2.19.

Table 2-2.19 Scope of Works

No.	Item	Scope of Works		Remarks
		Japan	The Federated States of Micronesia	
1	Securing of the Project site		○	Including securing of the new power station and distribution line route in Lelu Island
	Ground leveling and removal of obstructions on the Project site	○	(○)	KUA will remove existing equipment and obstructions inside the Project site.
2	Installation of fences and gates			
	(1) Temporary fences and gates	○		
	(2) Fences and gates		○	
3	Road works			
	(1) Road inside the Project site	○		Access road to the new powerhouse
4	Incidental equipment works			
	(1) Electrical works			
	a) Indoor wiring in the new power station	○		Including lighting, etc.
	(2) Water supply works			
	a) Extension and connection works		○	
	b) Piping works on the secondary side from the connection points onwards	○		
	(3) Drainage works			
	a) Outside the new power station		○	
	b) Inside the new power station	○		
	(4) Firefighting equipment	○		Including fire extinguishers, fire alarms, etc.
	(5) Internet		○	
5	Handling of transport and customs clearance procedures and taxes			
	(1) Transportation to the port of unloading	○		
	(2) Tax exemption and customs clearance procedures in the Federated States of Micronesia		○	
	(3) Transportation from the port of unloading to the Project site	○		
	(4) Exemption or bearing of domestic value added tax on locally procured construction materials and equipment		○	

No.	Item	Scope of Works		Remarks
		Japan	The Federated States of Micronesia	
6	The necessary steps to acquire the following authorizations: - Authorization for building works - Authorization for installation works - Authorization for access to restricted areas - Acquisition of permission for installing underground cables - Approval of the environmental impact assessment		○	Acquire before Project implementation if necessary
7	Appropriate operation and maintenance of facilities and procured equipment and materials		○	Including purchase of replacement parts
8	Bearing of other costs not covered by the grant aid		○	
9	Payment of the following commissions based on a banking agreement:			
	(1) A/P (Authorization to Pay) commission		○	
	(2) Payment commission		○	
10	Implementation and monitoring of the environmental management plan necessary for implementation of the Project		○	
11	Installation of the On/Off switching panel for the solar power conditioner		○	
12	Securing of temporary materials storage yard and parking spaces during the works period		○	Materials storage yard site: Total inside the power station premises 30m×30m
13	Works office	○		For the Japanese Consultant and contractor
14	Securing of safety of works personnel	○	○	
15	Immigration and other cooperation for the Japanese engineers needed to implement the works		○	
16	Provision of disposal sites for residual earth and works wastewater		○	
17	Manufacture and procurement of equipment and materials	○		
18	Equipment and materials installation works, adjustment and testing	○		
19	Necessary procedures for power interruption, and explanations and compensation to residents		○	
20	Final connections with existing equipment			
	(1) Final connections with the power grid		○	To be implemented with the Japanese contractor in attendance.
	(2) Final connections with the existing fuel oil system		○	To be implemented with the Japanese contractor in attendance.
	(3) Final connections with the existing city water line		○	To be implemented with the Japanese contractor in attendance.
21	Procurement of materials necessary for the above final connection works	○		
22	Initial operation guidance and guidance on maintenance for the procured equipment and materials	○		
23	Furniture required for the new monitoring and control room		○	
24	Low-voltage distribution line removal and restoration work in line with the 13.8 kV distribution line works on Lelu Island		○	Including the telephone line switching and re-laying works
25	Securing of consent or permission from landowners on the 13.8 kV distribution line routes		○	

No.	Item	Scope of Works		Remarks
		Japan	The Federated States of Micronesia	
26	Cutting of trees for securing of Project site		○	Including distribution lines
27	Connections between the new underground cable for the Okat distribution line and the existing underground cable		○	The Japanese side will procure and install underground cable (2 lines) up to Manhole No. 16. The Federated States of Micronesia side will implement connections with the existing underground cable (cable to the airport and port equipment).
28	Procurement of fuel oil, lubricating oil, etc. necessary for testing and adjustment and operation		○	
29	Implementation of environmental monitoring following the start of new diesel power generation		○	
30	Internet equipment for online remote monitoring of the diesel generators		○	

○ Indicates the responsible side regarding each item.
[Source] Investigation by the JICA Study Team

2-2-4-5 Consultant Supervisor

Based on the works agreement signed with KUA, the contractor will conclude a contract with a subcontractor of the Federated States of Micronesia or a third country in order to employ engineers and laborers to implement the facilities construction works and equipment installation works. To ensure that the subcontractor also thoroughly complies with schedule control, quality control and safety control during the construction period, the contractor will dispatch Japanese engineers who have experience of similar work in overseas countries to the site to conduct supervision.

2-2-4-6 Consultant Supervision

Based on the scheme of the Government of Japan's Grant Aid, the Consultant will organize a consistent project team to smoothly conduct the implementation design and construction supervision work according to the principles of the rough design compiled from the Preparatory Survey. 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 and safety control. Furthermore, according to necessity, personnel will attend plant inspections and pre-shipping inspections of equipment and materials manufactured in Japan with a view to ensuring that no troubles occur following delivery of materials and equipment to the Federated States of Micronesia.

(1) Basic Concept of Construction Supervision

The basic concept of Consultant supervision will be as follows: to supervise the progress of works to ensure completion 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 consider in Consultant supervision are described below.

1) 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 and materials 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.

a) Confirmation of works performance (including manufacture of equipment and materials in plant)
b) Confirmation of equipment and materials delivery
c) Confirmation of temporary installation works and construction machinery preparations
d) Confirmation of yield and actual numbers of engineers, skilled workers and laborers, etc.

2) Safety Control

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

a) Establishment of safety control regulations and appointment of manager
b) Holding of regular safety control meetings
c) Prevention of accidents through implementation of periodic inspections of construction machinery
d) Planning of the works vehicles and construction machinery operating routes and thorough enforcement of slow driving
e) Encouragement of laborers to utilize welfare measures and vacations

(2) Quality Control

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 Project equipment and materials and the execution and installation performance stipulated in the contract documents (technical specifications and implementation design drawings, etc.). In cases where doubts arise over quality and performance, the construction supervisor will immediately demand that the contractor make amendments, revisions or corrections.

a) Checking of shop drawings and specifications of equipment and materials
b) Attendance of plant inspections of equipment and materials and checking of plant inspection results reports
c) Checking of packing, transportation and on-site temporary storage methods

d) Checking of shop drawings and installation guidelines of equipment and materials

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

f) Supervision of site installation works of equipment and materials and attendance of trial operations, adjustments, tests and inspections

g) Checking of facilities shop drawings against work performance on site

h) Checking of completion drawings

2-2-4-7 Procurement Plan

The equipment and materials to be procured and installed in the Project, and the equipment and materials for construction of the Project facilities, are not manufactured in the Federated States of Micronesia; hence they will need to be procured from Japan or third countries. However, local products will be considered for sand, gravel and cement used in concrete. Table 2-2.20 shows the procurement sources of equipment and materials.

Table 2-2.20 Procurement Sources of Equipment and Materials

Equipment and Materials	Procurement Source		
	The Federated States of Micronesia	Japan	Third Country (See Reference)
(Equipment and materials for construction works)			
① Sand, gravel	○	○	○
② Cement	○	○	○
③ Steel	-	○	○
④ Steel frame	-	○	-
⑤ Building equipment, finishing materials	-	○	-
(Construction machinery / Transportation vehicles)			
① General construction machinery	○	○	○
(Diesel generator equipment)			
① Diesel engines, synchronous generators	-	○	-
② Ditto - auxiliary units (fuel supply equipment, cooling water equipment, compressed air equipment, etc.)	-	○	-
③ Ditto – piping materials and accessories	-	○	-
④ Electrical equipment for generating system (circuit breaker panels, generator boards, power control panels, etc.)	-	○	-
⑤ Electrical installation materials (low-voltage cable, wire pipes, accessories, etc.)	-	○	○
⑥ Electrical installation materials (medium voltage cable)	-	○	○
⑦ Diesel generator equipment spare parts and maintenance tools	-	○	-
(Distribution equipment)			
① Utility poles, and necessary accessories	-	○	○
② Pole transformers	-	○	○
③ 15 kV power distribution underground cables	-	○	○

[Source] Investigation by the JICA Study Team

Reference: Third countries will be DAC or ASEAN member countries.

(1) Generating equipment

Countries that can supply generating equipment that satisfies the specifications required in the Project are Japan and Western nations that belong to DAC. However, since the Project is a grant aid undertaking of the Government of Japan, the major equipment will basically be procured from Japan. Moreover, from the viewpoints of delivery performance that can meet the schedule requirements of the Government of Japan's Grant Aid as well as issues of post-installation service, the diesel generators and auxiliary equipment in the Project shall be selected from Japanese products.

(2) Power distribution equipment

Existing power distribution equipment in the Federated States of Micronesia is procured from Western nations and Japan. Accordingly, when selecting procurement sources for power distribution equipment and materials in the Project, 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.

The existing power distribution equipment and materials are procured and installed based on American standards. Considering the ease of operation and maintenance, procurement of spare parts, the method of addressing failures and the strong wishes of the Federated States of Micronesia side, it is necessary to select DAC countries and ASEAN countries as procurement sources for the power distribution equipment and materials.

2-2-4-8 Operational Guidance Plan

Since KUA's existing generating equipment is beset by numerous breakdowns, in order to ensure the smooth operation following the start of operation, it is proposed that a Japanese contractor conduct the necessary initial operation guidance and operation guidance via on-the-job training (OJT) during the works and trial operation period.

(1) OJT Plan during the Installation Works and Trial Operation Period

The operation and maintenance technologies for the equipment and materials to be procured and installed in the Project will be transferred to the Federated States of Micronesia counterpart during the installation works and trial operation period.

The specifications and grades of the Project generating equipment will be selected upon taking into account the existing technical level of the KUA employees who are engaged in the operation and maintenance of existing equipment. However, because the existing generating equipment is beset by numerous breakdowns, engineers who are dispatched from the manufacturers will implement operation and maintenance OJT to the engineers on the Federated States of Micronesia side during the installation works and trial operation period.

(2) OJT Implementation Period and Locations

- Classroom learning: Approximately 1 week (to be implemented in the Federated States of Micronesia during the works period)
- On-the-job training: Approximately 4 weeks (to be implemented in the Federated States of Micronesia during the works period)

(3) Instructors

Equipment installation, trial operation and adjustment engineers who are dispatched from the manufacturers of the generating equipment supplied by the Japanese contractor will act as the instructors.

(4) Trainees

Following the start of generating equipment operation, the KUA operators and maintenance personnel who directly handle the operation and maintenance work will be selected or appointed to receive OJT. Accordingly, the Executing agency in the Federated States of Micronesia, i.e. KUA, will appoint the specific trainees by the start of the generating equipment installation works.

(5) Training Contents

Classroom learning

The following basic education focusing on generating equipment will be conducted using operation and maintenance manuals.

- Characteristics, structure, etc. of the generating equipment
- Basics of operation and maintenance (basic thinking on schedule control and preventive maintenance, basics of equipment functions, countermeasures for accidents and failures, management of spare parts and tools, management of drawings and documents)
- Waste oil disposal equipment system and management method, etc.

On-the-job training

During the installation works and trial operation period, the Japanese contractor will conduct OJT on maintenance and inspections focusing on start and stop of generators, engine disassembly and servicing.

2-2-4-9 Soft Component Plan

KUA has 23 employees that conduct power supply in Kosrae State, and around seven of these are involved in the technical operation and maintenance. Two diesel generators are currently in working order and KUA is able to conduct routine maintenance of the generating equipment, however, in the case where new equipment is introduced, it will be necessary to build an organized maintenance structure and implement maintenance capacity building (implementation, recording, sorting, analysis and archiving of routine inspections) in order for the equipment to be operated and maintained appropriately.

Except for low-voltage connected systems, grid-connected systems have so far not been installed in Kosrae State, however, in April 2015 a new solar power generating system (200 kWp) was installed under support from the Pacific Environment Community (PEC), while another 100 kWp solar power generating system was introduced based on aid from the European Union (EU) in December 2015. Accordingly, a total of 300 kWp has been connected to the 13.8 kV distribution system. As a result, the total power from solar power systems of 300 kWp now accounts for 32.6% of recent demand Kosrae State (maximum daytime mean approximately 920 kW). However, KUA has no system stabilizing equipment, etc., and it will need to firmly establish the concept and methodology for operating and maintaining the Project diesel generators in consideration of the impact on power quality from the solar power systems that are connected to the 13.8 kV distribution system.

Diesel generation equipment maintenance is broadly divided into preventive maintenance and follow-up maintenance. The maintenance activities of KUA largely consist of unplanned emergency follow-up maintenance. Such follow-up maintenance is regarded as a problem for the following reasons: (1) major damage is imparted to equipment and massive costs are incurred in repairs, and (2) equipment operation needs to be stopped for long periods in order to implement repairs.

The technical education that is currently implemented by KUA mainly consists of OJT inside the power station and on the solar power systems. In the Project, OJT (on the job training) for KUA maintenance personnel focusing on operation and maintenance using the procured diesel generation equipment will be implemented by the equipment suppliers during the works period, trial operation and commissioning, however, since OJT focusing on operation and maintenance training alone is not enough to ensure the general operation and maintenance of generating equipment, in the Soft Component, it is planned to conduct a comprehensive package of technical guidance ranging from classroom study on equipment operating principles, structures and systems to preventive maintenance comprising maintenance, patrol inspections and record keeping for the KUA maintenance personnel. Since it will be essential to conduct interconnected operation between diesel generating equipment and solar power systems, technical guidance will be conducted on interlinked operation with the diesel generating equipment.

(1) Objectives of the Soft Component

In the Soft Component, the Consultant will conduct technical guidance on the operation and maintenance of the Project diesel generator equipment (two 600kW generators) to KUA (the Executing agency). In Kosrae State, since interconnected operation will be conducted with the solar power systems that have been constructed under assistance from the Pacific Environment Community (PEC) and European Union (EU), technical guidance will also be conducted on ways of minimizing the impact of the solar power systems on the diesel generating equipment in such operation. The Consultant will disseminate maintenance (preventive maintenance) via classroom learning of generator operating principles, structure, etc. of diesel engines and generators, and guidance on practical knowledge and technology using actual equipment. The goals of the Soft Component are indicated below.

a) Transfer of systematic knowledge concerning the structure, functions and theory of internal combustion engines (diesel engines)

b) Transfer of systematic knowledge concerning the structure, functions, systems, etc. of generators

c) Transfer of systematic knowledge concerning the structure, functions and composition of mechanical equipment systems (lubricating oil systems, cooling water systems, and electrical equipment systems)

d) Guidance in systematic knowledge concerning the preventive maintenance of diesel engines, generators, mechanical and electrical equipment systems

e) Formulation of plans for the preventive maintenance of diesel engines, generators, mechanical and electrical equipment

f) Formulation of operation plans and preventive maintenance plans for diesel engine generators in consideration of the effects imparted by grid-interconnected solar power systems

(2) Outputs of the Soft Component

Through introducing the Soft Component, the following outputs will be achieved in terms of preventive maintenance planning.

a) KUA will compile operation and maintenance plans of diesel engines, generators, and mechanical and electrical equipment systems in consideration of structures, functions and theory acquired via the classroom learning and practical training and grid-interconnected operation.
: Formulation of a standard values data sheet for operation management of systems

b) KUA will compile plans for preventive maintenance of diesel engines, generators, and mechanical and electrical equipment systems in light of structures, functions and theory acquired via the classroom learning and practical training.
: Establishment of a table showing periodic inspection intervals

(3) Soft Component Activities (Plan of Inputs)

1) Contents of Activities

In the Soft Component, in order to implement preventive maintenance activities, the following technical guidance including the necessary classroom learning will be conducted focusing on guidance in operation and maintenance knowledge using actual equipment. Moreover, tests, internal debate and so on will be conducted in order to grasp the degree to which knowledge is being absorbed.

a) Principles of 4-cycle diesel engines and generators
b) Structure of generators including coupling with engines
c) Outline of fuel oil systems, maintenance of thermal efficiency, exhaust gas control, management of fuel oil properties
d) Outline of lubricating oil systems, operating principles of lubricating oil cleaning devices, fluid lubrication, management of lubricating oil properties
e) Outline of cooling water systems, relationship between cooling performance and thermal efficiency, prevention of corrosion in cooling systems, management of cooling water properties
f) Outline of compressed air systems, and diesel engine starting method
g) Structure and connection method of cable connecting terminals on the secondary side of generators
h) Generator test methods and test apparatus
i) Outline of air supply and exhaust systems, and importance of exhaust temperature
j) Attachment of sensors and conditions of wiring
k) Outline of waste oil treatment systems, and important points from the perspective of environmental impact
l) Equipment failures and preventive maintenance (formulation of spare parts purchasing plans)
m) Important points in preventive maintenance of diesel engines
n) Important points in preventive maintenance of mechanical equipment systems
o) Formulation of a periodic inspection interval sheet for diesel engines
p) Formulation of a standard values data sheet for operation management of diesel engines
q) Formulation of a periodic inspection interval sheet for mechanical equipment systems
r) Formulation of a standard values data sheet for operation management of mechanical and electrical equipment systems
s) Diesel generator starting conditions and operation constraints on solar power systems arising from power load
t) Operation planning (weekday and holiday) of diesel generators interconnected with solar power systems

2) Plan of Inputs

In implementing the Soft Component, in the work in Japan, the Consultant will appoint ① a Japanese engineer who has been involved and is well-versed in design, operation and maintenance of diesel engines, and ② a Japanese person who has been involved in design of interconnected operation of diesel generators and solar power systems and is well-versed in operation and maintenance technologies. Their terms of activity in the Federated States of Micronesia will be 1.0 month and 0.5 months respectively between the end of the contractor's contract and completion of the handover of facilities and equipment, and staff planning will be conducted to ensure that the technical guidance is finished by the start of Project equipment operation.

a) Activities in Japan

In the work in Japan before being dispatched to the Federated States of Micronesia, the instructors will analyze the technical levels of KUA mechanical and electrical engineers based on the gathered KUA operation and maintenance materials, and compile the technical guidance materials (materials on structure, functions and theory of diesel engines, technical materials on mechanical equipment systems, features of generating equipment that conducts grid-interconnected operation, issues for examination, and test questions) (1.0 month and 0.5 months).

Table 2-2.21 shows the contents of activities of Soft Component personnel in Japan.

Table 2-2.21 Detailed Plan of Soft Component Activities (in Japan)

Category	Contents of Activities	Implementation Period
Theory of internal combustion engines	Preparation of texts, manuals and test questions concerning the following: ① "Principles of 4-cycle diesel engines" ② "Principles and structure of coupled generators"	0.25 months x 1 person
Theory of mechanical and electrical equipment systems	Preparation of texts, manuals and test questions concerning the following: ③ "Outline of fuel oil systems, maintenance of thermal efficiency, exhaust gas control, management of fuel oil properties" ④ "Outline of lubricating oil systems, operating principles of lubricating oil cleaning devices, fluid lubrication, management of lubricating oil properties" ⑤ "Outline of cooling water systems, relationship between cooling performance and thermal efficiency, prevention of corrosion in cooling systems, management of cooling water properties" ⑥ Structure and connection of terminals of cables on the secondary side of generator ⑦ "Generator test methods and test apparatus" ⑧ "Outline of air supply and exhaust systems, and importance of exhaust temperature" ⑨ "Outline of air supply and exhaust systems, and importance of air temperature management" ⑩ Attachment of sensors and conditions of wiring ⑪ "Outline of waste oil treatment systems, and important points from the perspective of environmental impact"	0.25 months x 1 person

Category	Contents of Activities	Implementation Period
Preventive maintenance	Preparation of texts, manuals and test questions concerning the following: ⑫ "Equipment failures and preventive maintenance" ⑬ "Important points in preventive maintenance of diesel engines" ⑭ "Important points in preventive maintenance of mechanical equipment systems"	0.25 months x 1 person
Formulation of preventive maintenance plan	Preparation of texts, manuals and test questions concerning the following: ⑮ "Formulation of a periodic inspection interval sheet for diesel engines" ⑯ "Formulation of a standard values data sheet for operation management of diesel engines" ⑰ "Formulation of a periodic inspection interval sheet for mechanical equipment systems" ⑱ "Formulation of a standard values data sheet for operation management of mechanical and electrical equipment systems"	0.25 months x 1 person
Features and issues of generating equipment that conducts grid-interconnected operation with solar power systems	Preparation of texts, manuals and test questions concerning the following: ① "Principles and basic knowledge of generating equipment that conducts grid-interconnected operation" ② "Features of generating equipment that conducts grid-interconnected operation" ③ "Issues for examination when introducing generating equipment that conducts grid-interconnected operation" ④ "Output fluctuations in generating equipment that conducts grid-interconnected operation"	0.5 months x 1 person
Total		**1.5 months x 1 person**

[Source] Investigation by the JICA Study Team

b) Activities in the Federated States of Micronesia

Guidance to local staff members concerning the contents of the soft component will be conducted onsite. Since practical training will also be conducted, this guidance will be schedule to coincide with the trial operation and commissioning.

The activities in the Federated States of Micronesia, comprising the contents shown in Table 2-2.22, will last for 1.5 months.

Table 2-2.22 Detailed Plan of Soft Component Activities
(in the Federated States of Micronesia)

Category	Contents of Activities	Implementation Period
Theory of internal combustion engines	① Principles of 4-cycle diesel engines, auxiliary units, generators and electrical equipment	0.20 months x 1 person
Theory of mechanical and electrical equipment systems	② Start and stop training using actual diesel engines and generators (including compressed air systems) ③ Outline of fuel oil systems, maintenance of thermal efficiency, exhaust gas control, management of fuel oil properties ④ Outline of lubricating oil systems, operating principles of lubricating oil cleaning devices, fluid lubrication, management of lubricating oil properties ⑤ Outline of cooling water systems, relationship between cooling performance and thermal efficiency, prevention of corrosion in cooling systems, management of cooling water properties ⑥ Outline of air supply and exhaust systems, importance of exhaust temperature ⑦ Outline of waste oil treatment systems, important points from the perspective of environmental impact	0.40 months x 1 person
Preventive maintenance	⑧ Equipment failures and preventive maintenance ⑨ Important points in preventive maintenance of diesel engines ⑩ Preventive maintenance of generators and electrical equipment systems ⑪ Important points in preventive maintenance of mechanical equipment systems	0.20 months x 1 person
Formulation of preventive maintenance plan	⑫ Formulation of a periodic inspection interval sheet for diesel engines ⑬ Formulation of a periodic inspection interval sheet for generators and electrical equipment ⑭ Formulation of a standard values data sheet for operation management of diesel engines ⑮ Formulation of a periodic inspection interval sheet for mechanical equipment systems ⑯ Formulation of a standard values data sheet for operation management of mechanical equipment systems	0.20 months x 1 person
Theory and practical training on generating equipment that conducts interconnected operation with solar power systems	⑰ Explanation and lecture concerning “Principles and basic knowledge of generating equipment that conducts grid-interconnected operation” ⑱ Grasping of “Features of generating equipment that conducts grid-interconnected operation” ⑲ Guidance on preparation of materials concerning “Output fluctuations in generating equipment that conducts grid-interconnected operation” ⑳ Guidance concerning “Preparation of operation manual on interconnected operation of diesel generator equipment and solar power systems”	0.5 months x 1 person
Total		**1.5 months x 1 person**

[Source] Investigation by the JICA Study Team

c) Soft Component Implementation schedule

Table 2-2.23 shows the implementation schedule of the Project Soft Component.

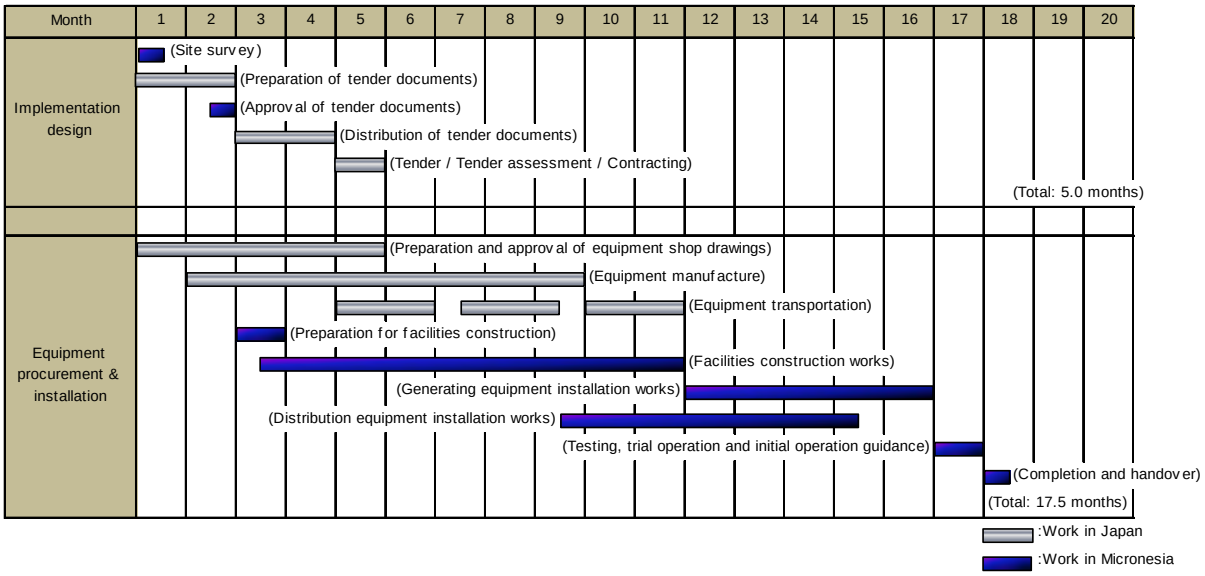
Table 2-2.23 Soft Component Implementation Schedule

Number of Months	1	2
1. Theory of internal combustion engines and generators	■	
2. Theory and practical training for mechanical and electrical equipment systems	■	
3. Necessity of preventive maintenance, and practical training	■	
4. Formulation of preventive maintenance plan	■	
5. Interconnected operation of diesel generator equipment and solar power systems		■

[Source] Investigation by the JICA Study Team

2-2-4-10 Implementation Schedule

After the Government of Japan has granted approval for implementation of the Project, the two governments will conduct the exchange of notes (E/N), and the Project will be commenced based on the Government of Japan's Grant Aid scheme. The Project will broadly be divided into three stages: i. Implementation design, ii. Selection of contractor (preparation of tender documents, announcement of tender, staging of tender, assessment of bids, signing of contract), and iii. Procurement and installation of the equipment and materials. Figure 2-2.7 shows the Project implementation schedule.



[Source] Investigation by the JICA Study Team

Figure 2-2.7 Project Implementation Schedule

2-3 Obligations of Recipient Country

When it comes to implementing the Project, in addition to the scope of works on the Federated States of Micronesia side indicated in (4) Scope of Works of 2-2-2.4 Implementation Plan, items to be implemented or borne by the Federated States of Micronesia side are as follows.

Common Items

a) To provide information and materials necessary for the Project

b) To secure tax exemption and customs clearance and the speedy unloading of equipment and materials for the Project at the port of unloading in the Federated States of Micronesia

c) To provide tax exemptions and conveniences for the necessary equipment and materials and dispatched Japanese nationals in the Project

d) To grant permission for Japanese nationals to enter and stay in the Federated States of Micronesia in relation to the equipment and materials and services necessary for the Project

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

f) To bear all items not covered under Japan's Grant Aid when implementing the Project

g) To appoint specialist engineers to transfer operation and maintenance technology for the Project, and to attend works checks and quality inspections of equipment and materials during the works

h) To properly and effectively use and maintain the facilities and equipment that are constructed and procured under Japan's Grant Aid

i) To implement environmental monitoring

j) To plan and implement procedures for the necessary power interruptions during the equipment and materials installation works

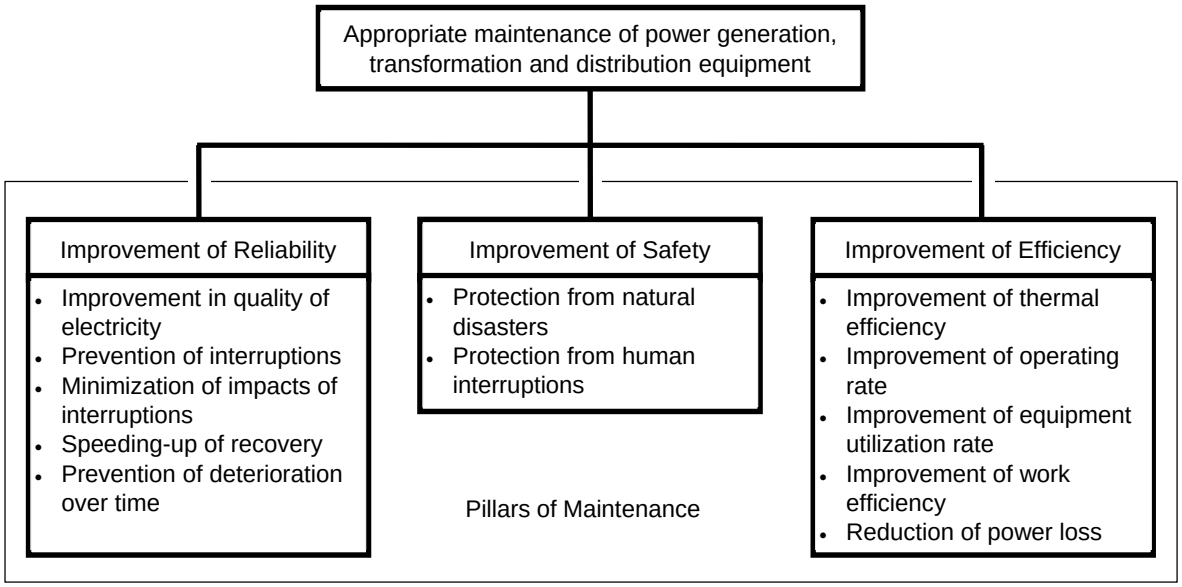
k) To secure a disposal site for excavated earth, sewage, waste oil and recovered equipment and materials during the works period

2-4 Project Operation Plan

2-4-1 Basic Policy

In the Project, the most important equipment requiring maintenance will be the generating equipment. In conducting maintenance, it is essential to conduct equipment operation and maintenance (O&M) and maintenance of the equipment environment in order to secure stable power supply commensurate with everyday changes in demand.

In order to sustain the performance and functions of the generating equipment and conduct continuous power supply, it is desirable to conduct appropriate preventive maintenance and ordinary maintenance based on improving the reliability, safety and efficiency of the generating equipment.



[Source] Investigation by the JICA Study Team

Figure 2-4.1 Basic Thinking on Maintenance of Generation, Transformation and Distribution Equipment

In the Project, the Federated States of Micronesia side will need to bear the above points in mind as it implements operation and maintenance following the Project in accordance with the O&M manuals and technologies that are passed on in the OJT implemented by the Japanese engineers dispatched during the works period.

2-4-2 Periodic Inspection Items

(1) Generating Equipment

Officials on the Federated States of Micronesia side will need to compile an operation and maintenance plan for the generating equipment based on the standard periodic inspection items shown in Table 2-4.1 and the operation and maintenance manual(s) provided by the equipment manufacturers. They will also need to compile an economical operation plan that is commensurate to the power demand.

Table 2-4.1 Standard Periodic Inspection Items for Generating Equipment

	Inspection Category	Main Work Items
Diesel engine	Routine (daily) inspection	- Fuel oil level, lubricating oil sump tank oil level - Checking of jacket water level - Checking of pressure in the starting air tank - Exterior appearance inspection of each part
	1,000 hour inspection	- Checking of tightened state of bolts and nuts - Cleaning of fuel and lubricating oil filters
	2,500~3,000 hour inspection	- Checking of operation, oil leaks, etc. in air supply and exhaust valves, starting valves, fuel valves, fuel pumps, pistons, liners, etc., and analysis of oil in the lubricating oil sump tank
	7,500~8,000 hour inspection	- Checking of operation, oil leaks, etc. in pistons and cylinder liners, and replacement of gaskets - Replacement of piston rings, oil scraping rings, and O-rings - Cylinder head disassembly and replacement of gaskets and O-rings - Inspection of air supply and exhaust valves and replacement of exhaust valve O-rings - Inspection of fuel injection valves and replacement of nozzles - Inspection and necessary replacement of crank pin bearings - Supercharger disassembly and inspection and replacement of bearings, etc. - Analysis of oil in the lubricating oil sump tank, and replacement of lubricating oil as needed
	16,000 hour inspection	- The above 7,500~8,000 hour inspection - Inspection and necessary replacement of main bearings - Inspection and necessary replacement of exhaust valve rotator - Disassembly inspection and necessary replacement of engine-fitted lubricating oil pumps
Generator	Routine (every day during operation) inspection	- Visual inspections and checking of strange noises and temperature in each part
	Monthly inspection	- Abnormal vibrations - Checking of lubricating oil flow conditions and oil leaks around bearings - Necessary cleaning of parts
	Annual inspection	- Measurement of insulation resistance and inspection of lead wires and terminals - Visual inspection of space heaters and other accessories - Visual inspections and necessary cleaning of bearings

[Source] Investigation by the JICA Study Team

The number of days required for the above standard periodic inspections are roughly as follows:

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

(2) Electrical Equipment

Table 2-4.2 shows the standard periodic inspection items for the electrical equipment to be procured and installed in the Project. As is shown in the table, electrical equipment inspections can be grouped into the following three categories:

- "Patrol inspections" where the five human senses are used to check for strange noises, etc. in equipment every day
- "Ordinary inspections" where charged parts that cannot be covered in routine patrol inspections are inspected, for example, heating, tightened state of bolts, etc., surface staining of insulated parts and so on
- "Detailed inspections" that entail functional inspection of interlock mechanisms, etc. and accuracy or measuring gauges

Normally, ordinary inspections are implemented once every 1~2 years, and detailed inspections once every 4 years. Also, when implementing ordinary inspections and detailed inspections, it is desirable to appropriately replace parts that are subject to performance degradation, insulation performance degradation, contact abrasion and deterioration of characteristics, for example, fuses, instruments, relays, etc. installed inside circuit breaker panels, distribution boards, etc. upon confirming the characteristics and frequency of use of such parts.

Table 2-4.2 Standard Periodic Inspection Items for Electrical Equipment

Inspection Item	Inspection Contents (Method)	Patrol Inspection	Ordinary Inspection	Detailed Inspection
Equipment exterior appearance	Display contents of switch indicators and indicator lamps	○	○	
	Any strange noises and odors	○	○	
	Heating discoloration of terminals	○	○	
	Cracks, damage or staining in bushing and insulation tubes	○	○	
	Rust on installation cases, frames, etc.	○	○	
	Abnormal temperature (thermometer)	○	○	
	Tightened state of bushing terminals (mechanical check)	○	○	
Operating devices and control panels	Display condition of instruments	○	○	○
	Indications of operation counters		○	○
	Moisture, rust or staining inside operation boxes and panels		○	○
	Conditions of lubrication and cleaning		○	○
	Tightened state of wiring terminals	○	○	○
	Checking of switch displays		○	○
	Air leaks and oil leaks		○	○
	Checking of pressure before and after operation (air pressure, etc.)		○	○
	Check of operation gauges		○	○
	Rust, deformation, damage of springs (care)	○	○	○
	Abnormalities in tightened pins		○	○
	Inspection (care) of auxiliary switches and relays		○	○
	Inspection of DC control power supply	○		
Measurement and testing	Measurement of insulation resistance		○	○
	Measurement of contact resistance			○
	Heater disconnections		○	○
	Relay operation test		○	○

[Source] Investigation by the JICA Study Team

2-4-3 Spare Parts Purchase Plan

Spare parts for generating and electrical equipment are divided into standard accessories, which are replaced according to the operation time, and replacement parts, which are required when failures and accidents occur. Accordingly, the Federated States of Micronesia side will need to purchase such parts in accordance with the cycle of periodic inspections.

In the Project, it is planned to procure the minimum necessary spare parts for the first full-scale periodic inspection implemented after 16,000 hours of operation (approximately 2 years) and the periodic inspections prior to that. The main items are as indicated in the periodic inspection items in Table 2-4.3. Therefore, the Federated States of Micronesia side will need to prepare sufficient funds to purchase standard accessories (approximately 3% of the generating and electrical equipment costs) and emergency replacement parts for roughly two years. Table 2-4.4 shows the maintenance tools that are scheduled for procurement in the Project.

Table 2-4.3 Spare Parts to be Procured in the Project

No.	Item	Quantity
1.	Diesel engine main body	
	① Cylinder head O-rings	2 sets x number of cylinders x 2 units
	② Cylinder head gasket packing	2 sets x number of cylinders x 2 units
	③ Cylinder head packing (air supply pipes)	2 sets x number of cylinders x 2 units
	④ Cylinder head full installation (including air supply and exhaust valves)	2 sets
	⑤ Air supply valve stem seals	2 sets x number of cylinders x 2 units
	⑥ For air supply valves (single units)	2 sets x number of cylinders x 2 units
	⑦ Air supply valves (including valve rotators, springs, cocks)	2 sets
	⑧ Air supply valve seats	2 sets x number of cylinders x 2 units
	⑨ Exhaust valves (single units)	2 sets x number of cylinders x 2 units
	⑩ Exhaust valve seats	2 sets x number of cylinders x 2 units
	⑪ Exhaust valve stem seals	2 sets x number of cylinders x 2 units
	⑫ Exhaust valve (including valve rotators, springs, cocks)	2 sets
	⑬ Fuel injection valve nozzle tips	2 sets x number of cylinders x 2 units
	⑭ Fuel injection valve O-rings	2 sets x number of cylinders x 2 units
	⑮ Fuel injection pump full installation	2 sets
	⑯ Piston rings	2 sets x number of cylinders x 2 units
	⑰ Oil rings	2 sets x number of cylinders x 2 units
	⑱ Piston pin bushes	2 sets x number of cylinders x 2 units
	⑲ Crank pin metal	2 sets x number of cylinders x 2 units
	⑳ Crank pin bolt full installation	2 sets x number of cylinders x 2 units
	㉑ Main metal	1 set x number of cylinders x 1 unit
	㉒ Thrust metal	2 sets × 2 units
	㉓ Cylinder liner	2 sets
	㉔ Fuel injection pump plunger full installation	2 sets x number of cylinders x 2 units
	㉕ Fuel injection pump deflectors	2 sets x number of cylinders x 2 units
	㉖ Fuel injection pump O-rings	2 sets x number of cylinders x 2 units
	㉗ Air cooler packing	2 sets × 2 units
	㉘ Start valve packing	2 sets x number of cylinders x 2 units
	㉙ Finger pressing device safety valve packing	2 sets x number of cylinders x 2 units
	㉚ Finger pressing device safety valves	2 sets x number of cylinders x 2 units
	㉛ Exhaust extension tubes	2 sets x number of cylinders x 2 units
	㉜ Fuel injection pump high-pressure tubes	2 sets x number of cylinders x 2 units
	㉝ Supercharger bearings	2 sets × 2 units
	㉞ Supercharger filters	2 sets × 2 units
	Emergency Spare Parts	
	① Fuel injection pump discharge valve full installation	1 set x number of cylinders x 2 units
	② Fuel injection pump full installation	2 sets
	③ Cylinder safety valve full installation	2 sets
	④ Start valve full installation	2 sets
	⑤ Piston full installation	1 set
2.	Fuel supply equipment	
	① Fuel oil transfer pump	1
	② Fuel oil supply pump	1
	③ Fuel oil drainage pump	1
	④ Waste oil discharge pump	1
	⑤ Pressure gauges	1 each
3.	Lubricating oil equipment	
	① Lubricating oil supply pump	1
	② Pressure gauges	1 each
4.	Cooling water supply equipment	
	① Low-temperature circulating pump (LT)	1
	② High-temperature circulating pump (HT)	1
	③ Pressure gauges	1 each
5.	Distribution line circuit breaker panel	
	① High-voltage circuit breaker	1
	② Control circuit fuses	Various types 100%
	③ Display lamps	Various types 100%
	④ VT fuses	Various types 100%

No.	Item	Quantity
6.	Generator circuit breaker panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ VT fuses	Various types 100%
7.	Neutral point grounding panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
8.	In-station transformer distribution board	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ VT fuses	Various types 100%
9.	Existing step-up transformer circuit breaker panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ VT fuses	Various types 100%
10.	Main low-voltage distribution board	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Thermal relays	1 set each
	④ VT fuses	Various types 100%
	⑤ Control circuit fuses	Various types 100%
	⑥ Display lamps (not including LED)	Various types 100%
	⑦ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%
11.	DC power supply board	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Control circuit fuses	Various types 100%
	④ Display lamps	Various types 100%
	⑤ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%
12.	In-station power control panel common MCC	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Thermal relays	1 set each
	④ VT fuses	Various types 100%
	⑤ Control circuit fuses	Various types 100%
	⑥ Display lamps (not including LED)	Various types 100%
	⑦ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%
13.	In-station power control panel	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Thermal relays	1 set each
	④ VT fuses	Various types 100%
	⑤ Control circuit fuses	Various types 100%
	⑥ Display lamps (not including LED)	Various types 100%
	⑦ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%
14.	Distribution board for building equipment	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Thermal relays	1 set each
	④ VT fuses	Various types 100%
	⑤ Control circuit fuses	Various types 100%
	⑥ Display lamps (not including LED)	Various types 100%
	⑦ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%
15.	Electricity room low-voltage distribution board	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Thermal relays	1 set each
	④ Display lamps (not including LED)	Various types 100%
	⑤ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%

No.	Item	Quantity
16.	Common control panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
17.	Synchronous control panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ Protective relays, auxiliary relays and timers	1 unit of each type
18.	Generator control panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ Auxiliary relays and timers	1 unit of each type
19.	Existing generator control panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ Protective relays, auxiliary relays and timers	1 unit of each type
20.	Generator protection panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ Protective relays, auxiliary relays and timers	1 unit of each type
21.	Distribution line circuit breaker protection panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ Protective relays, auxiliary relays and timers	1 unit of each type
22.	Existing step-up transformer protection panel	
	① Control circuit fuses	Various types 100%
	② Display lamps	Various types 100%
	③ Protective relays and timers	1 unit of each type
23.	Control room low-voltage distribution board	
	① Auxiliary relays	1 set each
	② MCCB	1 set each
	③ Thermal relays	1 set each
	④ Display lamps (not including LED)	Various types 100%
	⑤ Fluorescent lamps and glow lamps for in-board lighting	Various types 100%

[Source] Investigation by the JICA Study Team

Table 2-4.4 Maintenance Tools to be Procured in the Project

No	Item	Quantity
1.	Tools for mechanical equipment	
	Standard/ special engine tools	1 set each
	Grinding machine for aligning air supply valves and exhaust valves	1
	Grinding machine for aligning air supply valve seats and exhaust valve seats	1
	Lubricating oil analyzer	1 set
	Water analyzer	1 set
	Tool box	1 set
	Caliper	1 set
	Micro meter	1 set
	Hand pallet	1
	Ladder (2-stage)	1
	1.0ton/2.5ton chain blocks	1 set each
	Lifting wires	1 set each
2.	Tools for electrical equipment	
	Electric circuit tester	2
	DC voltmeter	2
	Battery operated insulation resistance meter (500V)	2
	Battery operated insulation resistance meter (2500V)	2
	Ground resistance meter	2
	Low-voltage phase rotation meter	2
	Relay tester	1 set
	Low-voltage electroscope	2
	13.8 kV electroscope	2
	Digital multi meter	2
	AC/DC clamp meter	2
	Grounding tools for maintenance	1 set
	Withstand voltage tester	1 set
	Tool set	2 sets
	Circuit breaker pull-out tools	1 set
3	Environmental monitoring devices	
	Noise meter	1
	Combustion exhaust gas analyzer	1

[Source] Investigation by the JICA Study Team

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

In the case of the actual implementation of the Project under the grant aid scheme of the Government of Japan, the Federated States of Micronesia Side is expected to pay the costs of its undertakings listed below.

(1) Costs to be borne by the Federated States of Micronesia Side

The total cost to be borne by the Federated States of Micronesia Side is approximately 71,000 USD (8.51 million JPY)

Item	Amount (US$)	Amount (1,000 yen)
1. Removal of obstructions, trees, weeds, etc. from the scheduled construction site for the new power station	US$ 1,000	120 k-yen
2. Construction of the following facilities on the scheduled construction site for the new power station (1) Gate and perimeter fence for the new power station (2) Guardroom	US$ 5,000-	600 k-yen
3. Connection of underground cable and overhead lines (3 lines) from the station 13.8 kV distribution board to the first pole under supervision by engineers of the Japanese contractor	US$ 2,000-	240 k-yen
4. Renewal of low-voltage lines of the Lelu Island distribution line to be renewed in the Project	US$ 44,000-	527 k-yen
5. Re-installation of water supply pipes for the new power station	US$ 2,000-	240 k-yen
6. PR activities concerning the scheduled power interruption plan in line with Project implementation (radio, newspapers, etc.)	US$ 2,000-	240 k-yen
7. Others (including opening of bank account and payment commission)	US$ 15,000-	1,800 k-yen
Total	US$ 71,000-	8,510 k-yen

(2) Estimation criteria

a) Estimation point : March 2015

b) Exchange rate : 1 US$=119.79 JPY
(TTS mean value from December 2014 to February 2015)

c) Works and procurement period:
The detailed design and equipment procurement and installation period is as shown in the implementation schedule

d) Other points : The Project will be implemented according to the Grant Aid scheme of the Government of Japan.

2-5-2 Operation and Maintenance Cost

Kosrae Utilities Authority (KUA) is in charge of services from generation to distribution to consumers, in Kosrae State. Main power source is Diesel engine generation. However, blackouts are recorded 48 times in total in 2014. This is because frequent occurrence of breakdown of generation facilities caused by aging and trip or planned outage of generation caused by insufficient maintenance of distribution facilities.

The maintenance cost (replacement parts and expendables procurement cost) of diesel engine generators to be procured in the Project will be around 3% per year of the equipment cost (based on the rough Project cost) and will amount to approximately US$154,000 per year. Moreover, since the statutory service life of diesel engine generators is prescribed as 15 years (according to Japan's Electricity Business Act), it will be necessary to save funds (depreciation cost) in order to renew the equipment after 15 years. Calculating residual value of 10% from the equipment procurement and installation cost, the depreciation cost is approximately US$308,000 per year, and since KUA currently has depreciation costs of approximately US$ 375,027 per year, it will need to appropriate a total of approximately US$683,000 per year.

Demand in Kosrae State in fiscal 2021 following completion of the project is forecast to be approximately 7,758 MWh, which is equivalent to approximately 40% of the equipment utilization rate, rising some 2,500 MWh from the present 5,200 MWh. Moreover, the existing power station was incurring high repair and maintenance costs due to deterioration, however, these maintenance costs can be reduced as a result of the Project. Even taking the above expenditure into account, as is shown in Table 2-5.1, the annual balance of KUA will show revenue of US$705,000.

In conclusion, it is deemed possible to implement maintenance of the diesel generators and related facilities based on the KUA budget.

Table 2-5.1 Projected Operating Balance of Generating Equipment Procured in the Project

Item			Unit	Annual equipment utilization rate (%)							
				20	25	30	40	50	60	70	80
I Revenue											
1. Equipment capacity	①		[kW]	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850
2. Annual operating time	②		[hr]	1,752	2,190	2,628	3,504	4,380	5,256	6,132	7,008
3. Generating end electrical power	③		[kWh]	4,993,200	6,241,500	7,489,800	9,986,400	12,483,000	14,979,600	17,476,200	19,972,800
4. In-station power consumption	④	(③ x 5%)	[kWh]	249,660	312,075	374,490	499,320	624,150	748,980	873,810	998,640
5. Transmission and distribution power loss	⑤	(③ x 15%)	[kWh]	748,980	936,225	1,123,470	1,497,960	1,872,450	2,246,940	2,621,430	2,995,920
6. Sold electrical energy	⑥	(③-④-⑤)	[kWh]	3,994,560	4,993,200	5,991,840	7,989,120	9,986,400	11,983,680	13,980,960	15,978,240
7. Mean unit rate of sold electricity	⑦		[US$/kWh]	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Total revenue	⑧	(⑥ x ⑦)		$2,356,790	$2,945,988	$3,535,186	$4,713,581	$5,891,976	$7,070,371	$8,248,766	$9,427,162
II Expenditure											
1.Fuel cost	⑨	(③x(2)x(4))	[US$]	1,168,726	1,460,907	1,753,089	2,337,452	2,921,815	3,506,178	4,090,541	4,674,904
2. Lubricating oil cost	⑩	(③x(3)x(5))	[US$]	25,699	32,123	38,548	51,397	64,247	77,096	89,945	102,794
3. Personnel expenses	⑪	(6) x 23	[US$]	422,763	422,763	422,763	422,763	422,763	422,763	422,763	422,763
4. Maintenance cost	⑫	(7) x 3%	[US$]	154,137	154,137	154,137	154,137	154,137	154,137	154,137	154,137
5. Indirect expenses	⑬	(9)	[US$]	360,000	360,000	360,000	360,000	360,000	360,000	360,000	360,000
6. Cost depreciation	⑭	(8)	[US$]	683,301	683,301	683,301	683,301	683,301	683,301	683,301	683,301
Total expenditure	⑮		[US$]	2,814,626	3,113,232	3,411,838	4,009,051	4,606,263	5,203,475	5,800,687	6,397,900
III Operating balance			[US$]	-$457,836	-$167,244	$123,347	$704,530	$1,285,713	$1,866,896	$2,448,079	$3,029,262

Examination preconditions:

(1) Mean unit rate of sold electricity	0.59	US$/kWh	
(2) Fuel oil unit price	0.850	US$/ℓ	KUA materials: 3.2191US$/Gallon
(3) Lubricating oil unit price	3.217	US$/ℓ	669.0736US$/Drum
(4) Fuel consumption amount	0.275	ℓ/kWh	229g/kWh, fuel specific gravity 0.832 (KUA materials)
(5) Lubricating oil consumption amount	0.0016	ℓ/kWh	
(6) Personnel expenses unit rate	18,381	US$/month	Fiscal 2014 personnel expenses divided by number of employees
(7) Equipment cost	5,137,907	US$	Project generators (2) + WB assisted generator (1)
The Project	4,384,707	US$	525,244,000 yen /1,200kW (exchange rate 1US$=119.79)
WB aid project	753,200	US$	
(8) Depreciation cost	683,301	US$/year	
The Project	263,082	US$/year	10% residual value after 15 years, based on 15 years straight line depreciation
WB aid project	45,192	US$/year	10% residual value after 15 years, based on 15 years straight line depreciation
Other equipment	375,027	US$/year	Depreciation cost in the current KUA budget
(9) Indirect expenses	360,000	US$/year	US$30,000/month x 12 months
(10) Transmission and distribution loss	15	%	

CHAPTER 3 PROJECT EVALUATION

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3-1 Preconditions

By the start of the Project, it will be necessary to implement vegetation cutting and removal of obstructions including an existing pig shed on the planned construction site inside the grounds of Tofol Power Station. As for the Lelu Island distribution line, it will be necessary to reach agreement with landowners to secure their permission for building utility poles or burying cable alongside the road in the following two sections where it is planned to transfer and newly install the line.

1) Pole No. 31~Pole No. 46: This section currently has no distribution line connections. It is planned to newly install distribution line in order to build a loop in the distribution network.

2) Pole No. 16~Pole No. 19: Electric poles are currently erected on a concrete base (foundation) in the ocean, but it is planned to install line along the road.

Moreover, concerning permission for the environmental impact assessment on implementation of the Project, provisional approval was received from KIRMA on July 8, 2013. KIRMA informed KUA of its final approval on February 25, 2016 upon confirming that there have been no major changes to the contents of the Project works and construction of the generators under World Bank assistance that were provisionally approved in 2013. Hence, the preconditions for implementation of the Project will be the securing of agreement to use land from the abovementioned landowners and acquisition of the environmental permission.

3-2 Necessary Inputs by Recipient Country

In order for the overall plan of the Project to be realized, the main issues that need to be implemented by the Federated States of Micronesia side are as follows.

1) It will be necessary to appropriately implement routine maintenance to ensure that the generating equipment procured and installed by the Japanese side is utilized to the maximum.

2) It will be necessary to plan and implement the assignment, education and training of operation and maintenance staff for the power station and distribution line to be constructed in the Project, and to take steps to ensure that operation of the overall power supply system is started smoothly.

3) It will be necessary to procure and replenish without delay the spare parts and consumables needed for maintenance of the power station and distribution lines to be constructed in the Project, and also to definitely implement periodic maintenance.

4) It will be necessary to introduce and implement preventive maintenance in order to prevent major accidents such as burning of the generator crank axes or shorting of distribution lines and so on.

5) It will be necessary to improve revenue in KUA to ensure that maintenance budget for generating equipment can be secured.

3-3 Important Assumptions

In order for KUA to do the above things, it will be necessary to secure revenue from the electricity utility that is commensurate with expenditure. With the understanding of the residents of Kosrae, it will be necessary for the power tariffs to be appropriately revised and for consumers to pay tariffs without delay.

3-4 Project Evaluation

3-4-1 Relevance

As is described below, since the Project will contribute to the realization of Federated States of Micronesia development plans and energy policy and impart benefits to the residents of Kosrae State, it is deemed to have a high degree of relevance.

(1) Benefiting population

Implementation of the Project will enable supply of stable, good quality electricity to approximately 6,600 residents of Kosrae State. In the Project target area, there are approximately 1,920 power consumers, comprising approximately 1,500 ordinary households, 250 commercial facilities, 155 government and public facilities, and 15 industrial facilities.

(2) Urgency

1) As of January 2016, Tofol Power Station in Kosrae State has three generators in operation. One of these (G-8) started operation in 2008 and is the primary generator of the power station, however, one of the generators (G-4) has been in operation for 31 years, and another (G-6) for 25 years. There are frequent troubles and unscheduled power interruptions that arise from deterioration. This triggers problems such as deterioration of the living environment and decline of public services for residents, and damage to tourism in Kosrae State. Accordingly, the urgent renewal of equipment is needed.

2) Moreover, as if November 2015, the fish transshipment facilities have started operation, while the water bottling facility is scheduled to go into operation at the beginning of 2016, and Dr. Sigrah Memorial Hospital is scheduled to open at the start of 2019. For this reason too, it is essential that generating equipment undergo urgent renewal.

3) Power supply to Lelu Island is distributed along overhead lines composed of wooden poles and bare wire lines (3 phase, 13.8 kV, 60 Hz). This distribution line was constructed in 1975 and has been operating for almost 40 years; moreover, due to harsh natural conditions (salt damage, heavy rain, insect damage, etc.) and deterioration over time, the poles and lines are badly deteriorated. Accordingly, there is need to carry out urgent renewal of the distribution line.

4) Power supply to the airport island (Okat) is conducted through two 2,600 m underground cables (13.8 kV, AWG1/0, XLPE aluminum cable) that were constructed along the causeway in 1986. However, one circuit of the cables has been disconnected, while the

remaining circuit cable, which is deteriorated, supplies power to the airport facilities (the physical distribution gateway to Kosrae State), large-scale fuel storage facilities, landing facilities and so on that constitute the core of physical distribution in Kosrae State. Accordingly, it is urgently necessary to renew both these cables.

(3) Contribution to Stable Operation of Public Welfare Facilities

The frequently occurring power interruptions in Kosrae State hinder the stable operation of the local public welfare facilities (elementary and secondary schools, junior college, hospital, etc.), and this situation needs to be addressed urgently.

Implementation of the Project will secure power supply capacity in the power station, while the renewal of distribution lines will reduce power interruptions in public welfare facilities and allow such facilities to be operated stably.

(4) Operation and Maintenance Capacity

In Kosrae State, Kosrae Utilities Authority (KUA) routinely conducts operation and maintenance of diesel generators and 13.8 kV overhead distribution lines and underground distribution lines of the same types that will be procured in the Project. Accordingly, KUA has sufficient capacity to operate and maintain the generating equipment and distribution equipment that will be procured and installed in the Project, and there should be no particular problem regarding Project implementation.

Moreover, since the equipment supplier will conduct OJT and the Consultant will implement the soft component in the Project, it is anticipated that operation and maintenance capacity will be improved even more.

(5) Project that Contributes to Development Plans in the Federated States of Micronesia

The FSM National Energy Policy 2010, which is the supreme plan for the electric power sector has the following objective: “To supply economical, reliable and environmentally friendly energy and improve the lives of all people in Kosrae State.”

Moreover, the following energy supply goals have been raised, and policies are being advanced in each state towards their attainment.

1) To supply economic and safe electricity to all households in islands that contains state capitals by 2015.
2) To raise the electrification rate to 80% of public facilities in regional areas by 2015.
3) To raise the electrification rate to 90% of general households in regional areas by 2015.
4) To improve energy efficiency on the power supply side by 20% by 2015.

In Kosrae State, based on FSM National Energy Policy 2010, Kosrae State Energy Action Plan

2013 has been formulated and this contains the following power development project.

* Project goal 1. : General improvement items
  - Reduction of fuel consumption
  - Reduction of distribution loss
  - Saving on maintenance costs

* Project goal 2. : Energy efficiency
  - Reduction of fuel consumption
  - Reduction of distribution loss
  - Improvement of fuel consumption management methods
  - Improvement of power measurement methods

* Project goal 3. : Renewable energy
  - Reduction of fuel imports through introduction of renewable energy

Since the Project aims to stabilize power supply and improve the quality of electric power through improving power generating capacity in Kosrae State and renewing the distribution network, etc. on Lelu Island, which has high population concentration, it will make a contribution towards realization of the abovementioned development plans and energy policies of the Government of the Federated States of Micronesia.

(6) Environmental and Social Impacts

Examination was implemented based on environmental legislation in the Federated States of Micronesia and JICA's Environmental and Social Consideration Guidelines. As a result, it was concluded that, although there will be some minor impacts in terms of air pollution, noise and vibration, these will be within Federated States of Micronesia and international standard levels and, moreover, current conditions will be improved. Concerning other impacts, it will be possible to avert or mitigate them through taking countermeasures.

Moreover, through implementing the Project, compared to the case where the Project is not implemented, CO_2 emissions will be reduced from 0.79 kg/CO_2/kWh to 0.73 kg/CO_2/kWh by the third year after completion. In terms of the climate change mitigation effect (rough reduction in GHG emissions), the Project will realize an effect equivalent to approximately 460.6 ton/year-CO_2.

In consideration of the above points, the Project will not impart any particular impacts in terms of environment and society.

(7) Government of Japan's Grant Aid Scheme

Since the main items of equipment will be procured in Japan, the Project will be completed within the E/N period, its contents and schedule area feasible within the Japan's Grant Aid Scheme and there should be no major difficulty concerning implementation.

3-4-2 Effectiveness

The following effects are anticipated from Project implementation.

(1) Quantitative Effects

Indicator	Reference Value (2014)	Target Value (Following project completion in March 2021)
Power generating equipment capacity installed in the Project (kW)	0	1,200
Tofol Power Station Total generating capacity (MWh) *1	5,463	7,450
Power supply interruptions (times/year) *2	48	24
Fuel consumption per unit of generated power (g/kWh) *3	234	229

[Notes] *1: Total generating capacity obtained by adding the Project to the existing G-8 unit (1,000kW) and the diesel generator G-9 unit scheduled for assistance by the WB (planned as 600kW). This does not include solar power generating equipment.
*2: Number of power interruptions per year (unscheduled and scheduled interruptions)
*3: Fuel consumption regarding the total generating capacity of the Project plus the existing G-8 unit and the diesel generator G9 unit scheduled for assistance by the WB

(2) Qualitative Effects (Overall Project)

Current Conditions and Problems	Project Measures (Grant Aid Project)	Degree of Projects Effects and Improvement
1. Two out of three generators in operation at Tofol Power Station in Kosrae State have been operating for 31 and 25 years respectively, and troubles and unscheduled power interruptions are frequently caused by the equipment deterioration. This triggers problems such as deterioration of the living environment and decline of public services for residents, and damage to tourism in Kosrae State. Moreover, it is urgently necessary to respond to scheduled increase in demand of approximately 460 kW.	Construct a new power station, renew the deteriorated generators, and thereby improve fuel consumption and secure backup capacity.	Through renewing the generating equipment, troubles and power interruptions caused by deteriorated equipment will be reduced and stable power supply will be achieved, thereby leading to improvement in the living environment and public services for residents, and tourism in Kosrae State. This will improve the living standard of residents and public service and make it possible to respond to the planned increase in demand.
2. Power supply to Lelu Island is distributed along overhead lines composed of wooden poles and bare wire lines. This distribution line was constructed in 1975 and has been operating for almost 40 years; moreover, due to harsh natural conditions (salt damage, heavy rain, insect damage, etc.) and deterioration over time, the poles and lines are badly deteriorated and unable to provide stable power supply.	Conduct renewal of the distribution line to Lelu Island, and thereby reduce unscheduled power interruptions.	Through renewing the distribution line, it will become possible to supply power to Lelu Island, which has high population concentration, and this will lead to improvement in the living environment and public services for residents.
3. Power supply to the airport island (Okat) is conducted through two 2,065m underground cable lines that were constructed along the causeway in 1986. However, one of the lines has been disconnected, while the remaining line, which is deteriorated, supplies power to the airport facilities (the physical distribution gateway to Kosrae State), large-scale fuel storage facilities, landing facilities and so on. Therefore, in addition to urgently replacing the disconnected cable, it is necessary to replace the other deteriorated cable that has been in use for approximately 29 years and thereby secure stable electricity supply.	Through replacing two power distribution lines, power supply to the airport island will be made more secure.	Through replacing the two power distribution lines, it will be possible to conduct stable power supply, thereby vitalizing activities at the airport facilities, large-scale fuel storage facilities, landing facilities and so on. Operation of these facilities will lead to improvement in the living environment and public services for residents of Kosrae State.