No.

# BASIC DESIGN STUDY REPORT
# ON THE PROJECT
# FOR
# IMPROVEMENT OF HONIARA POWER SUPPLY
# IN
# SOLOMON ISLANDS

**FEBRUARY 2005**


**JAPAN INTERNATIONAL COOPERATION AGENCY**
**GRANT AID MANAGEMENT DEPARTMENT**

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# PREFACE

In response to a request from the Government of the Solomon Islands, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Honiara Power Supply in the Solomon Islands and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team from September 14 to October 8, 2004.

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

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

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

February, 2005

Seiji Kojima
Vice-President
Japan International Cooperation Agency

# LETTER OF TRANSMITTAL

February, 2005

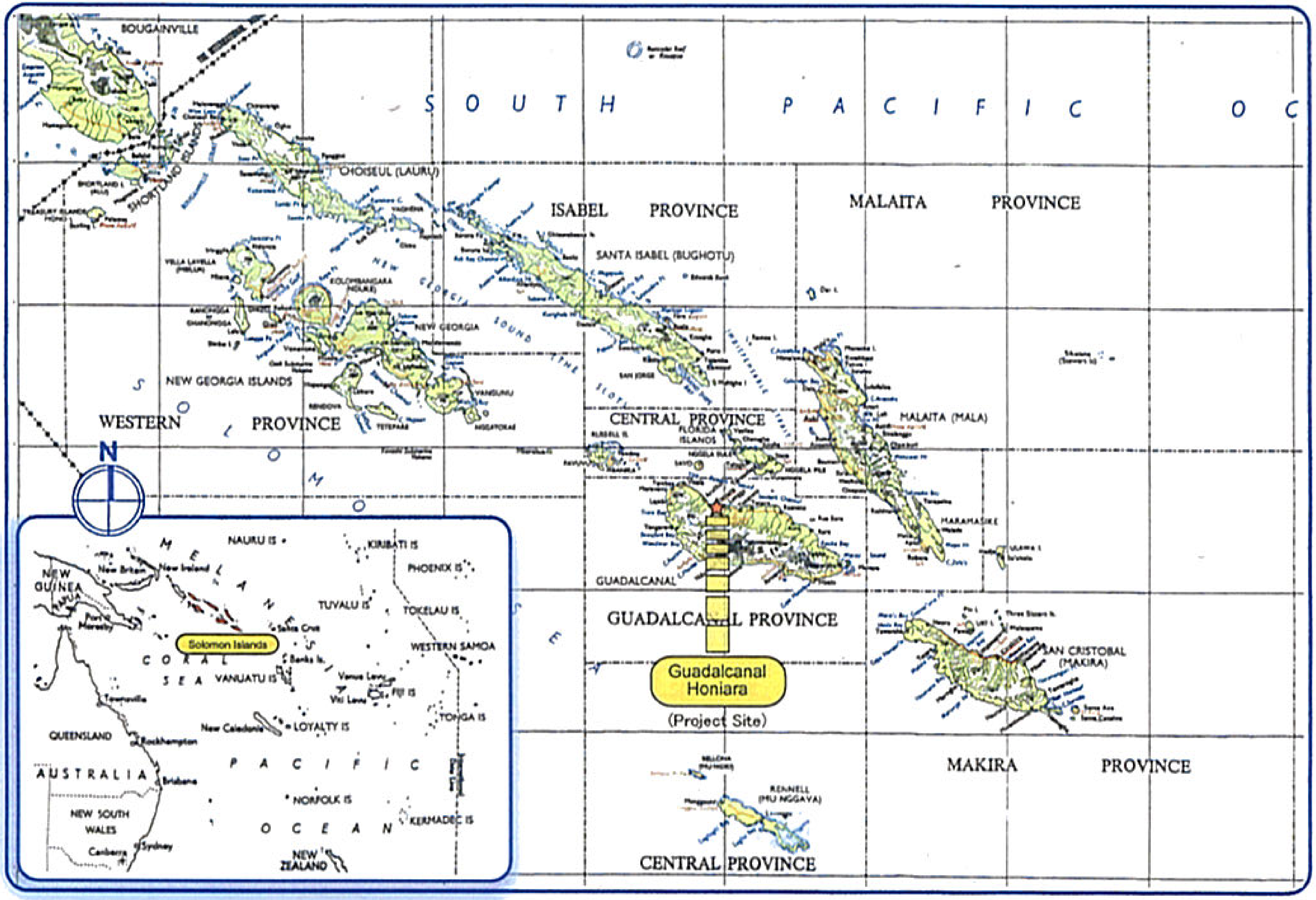
We are pleased to submit to you the basic design study report on the Project for Improvement of Honiara Power Supply in the Solomon Islands.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from August, 2004 to February, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Solomon Islands and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

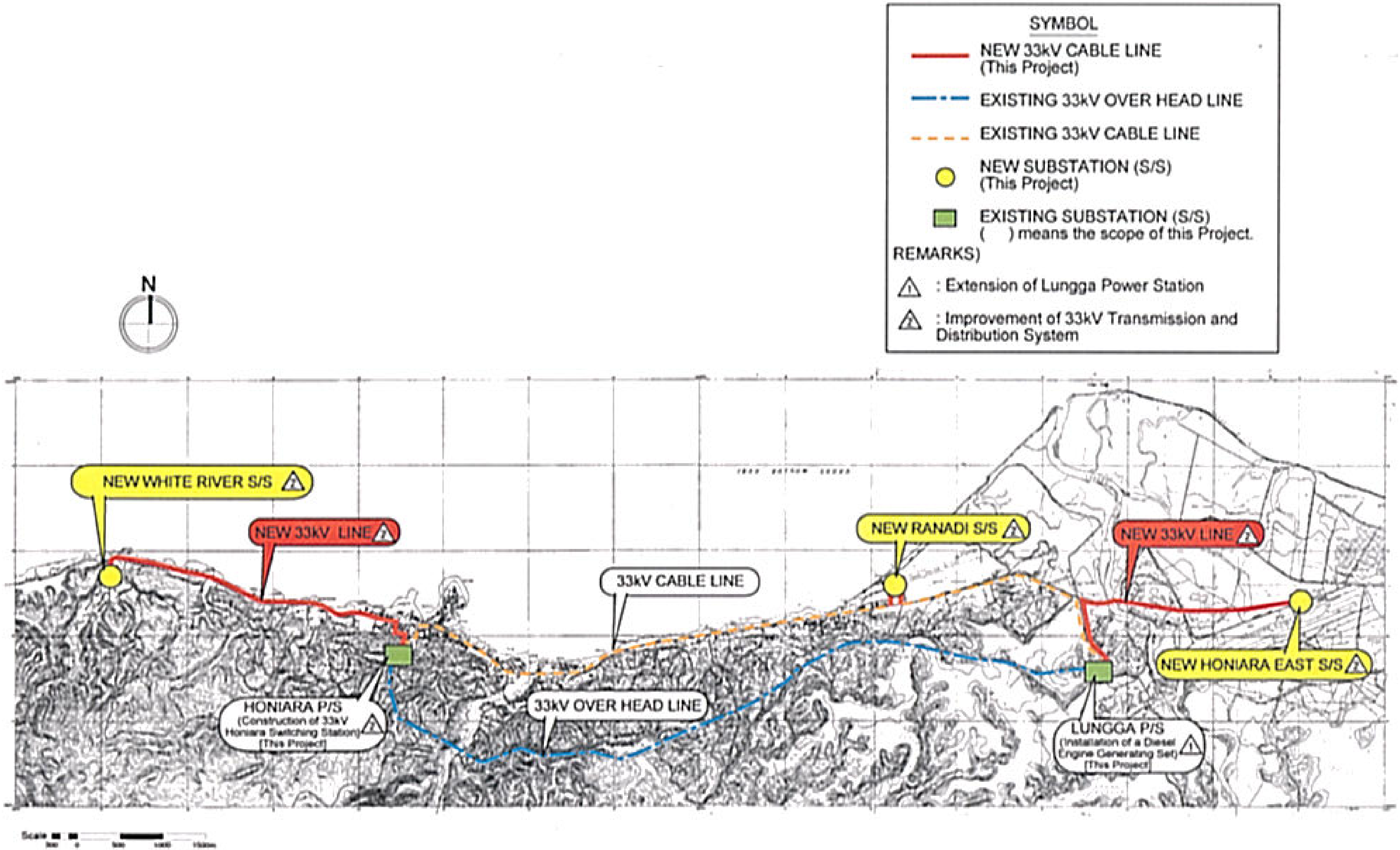
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

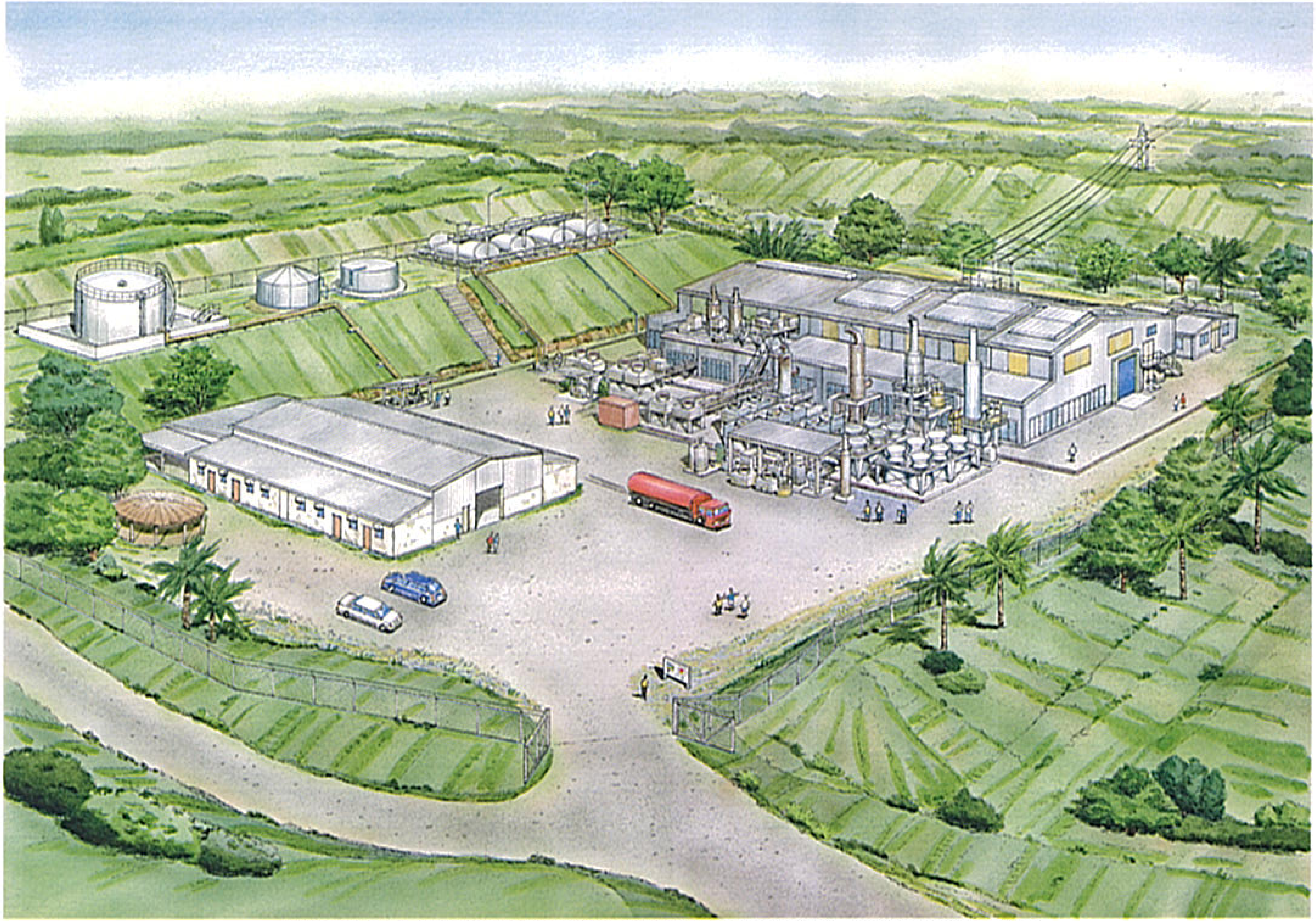
Masatsugu Komiya
Project Manager,
Basic design study team on the Project for
Improvement of Honiara Power Supply
in the Solomon Islands
Yachiyo Engineering Co., Ltd.




Solomon Islands map




33kV HONIARA POWER NETWORK



THE PROJECT FOR IMPROVEMENT OF HONIARA POWER SUPPLY

# LIST OF FIGURES AND TABLES

## CHAPTER 2

# ABBREVIATIONS

| | |
|---|---|
| ADB | Asian Development Bank |
| AIJ | Architectural Institute in Japan |
| ASEAN | Association of Southeast Asian Nations |
| AusAID | Australian Agency for International Development |
| A$ | Australian Dollar |
| DAC | Development Assistance Committee |
| DEG | Diesel Engine Generator |
| DME | Department of Mines and Energy |
| EU | European Union |
| E/N | Exchange of Notes |
| GDP | Gross Domestic Product |
| GNI | Gross National Income |
| HPN | Honiara Power Network |
| IEC | International Electrotechnical Commission |
| ISO | International Organization for Standardization |
| JEAC | Japan Electric Association Code |
| JEC | Japanese Electrotechnical Committee |
| JEM | Standards of Japan Electrical Manufacturer's Association |
| JICA | Japan International Cooperation Agency |
| JIS | Japanese Industrial Standards |
| MOU | Memorandum of Understanding |
| NPF | National Provident Fund |
| O&M | Operation and Maintenance |
| OJT | On the Job Training |
| P/S | Power Station |
| RAMSI | Regional Assistance Mission to Solomon Islands |
| SB$ | Solomon Islands Dollar（1 SB$=¥14.75、 as of August, 2004） |
| SCADA | Supervisory Control And Data Acquisition |
| SIEA | Solomon Islands Electricity Authority |
| SIWA | Solomon Islands Water Authority |
| S/S | Substation |

# SUMMARY

# SUMMARY


The Solomon Islands is an island country consisting of six main islands and some 100 smaller islands lying to the southeast of Bougainville Island of Papua New Guinea and to the northeast of Australia. It has a total national land area of approximately 28,000 $km^2$ (approximately double the size of Fukushima Prefecture in Japan) and a total population of approximately 460,000 (World Bank estimate in 2003). The GNI per capita is US$ 580 (World Bank estimate in 2002).

While the ethnic conflict from 1998 to 2002 caused severe economic as well as social damage to the Solomon Islands, the Government of the Solomon Islands has formulated the National Economic Reform and Development Plan (2003 – 2006) to restore the country's economy and law and order in the aftermath of this conflict. This Development Plan calls for "the rehabilitation of the industrial sector and the rebuilding of infrastructure" as a priority issue for the reconstruction and stabilisation of the country. Power supply is considered to be an essential part of the crucial infrastructure to attract private investment and to reconstruct the national economy.

The Solomon Islands Electricity Authority (SIEA) is solely responsible for the electricity service in the Solomon Islands, ranging from the planning of generation, transmission and distribution to operation and maintenance, under the supervision of the Department of Mines and Energy (DME). Electricity supply to Honiara (the capital of the Solomon Islands with a population of some 49,000 according to 1991 statistics) is made from two diesel power stations (Honiara Power Station and Lungga Power Station) and the 33/11 kV transmission and distribution system run by the SIEA.

While these two power stations situated in Honiara have a total of 11 generating units, the lack of systematic investment in equipment due to the dire financial situation of the electricity sector has resulted in an insufficient reserve supply capacity. During the period of ethnic conflict, the implementation of periodic maintenance was difficult and the operating conditions of the generating units have worsened, resulting in sudden breakdowns and failures. This insufficient availability of a reserve supply capacity has forced the over-working of the existing generating units. For example, the No.9 unit at the Lungga Power Station which was installed under the previous Japan's grant aid project (Power Development Project at the Lungga Power Station in FY 1998; hereinafter referred to as "the Previous project") has been in continuous operation since its commissioning in September, 1999 without any periodic maintenance work. In the face of such a situation, the Government of Japan has provided follow-up cooperation for the procurement of spare parts for the said generating unit and the dispatch of technical advisers and periodical inspection was conducted for approximately one month in September, 2004. Apart from the suspended operation of this generating unit which is the main source of power supply for Honiara, the poor utilization factor of the other generating units due to frequent breakdowns meant that only four generating units were in operation at the end of

September, 2004. Consequently, the available output was only 6,900 kW compared to the peak demand of 9,460 kW in Honiara, creating a supply capacity shortfall of 2,560 kW. As a result, planned load shedding was implemented in one-quarter of the city.

Since October 2004 when the periodical inspection of the No.9 unit, which was assisted by the Japan's follow-up cooperation, was completed, the available output capacity has surpassed the maximum peak demand and no planned load shedding has been implemented. However, reserve supply capacity is still insufficient and planned load shedding can not be avoided if a generating unit is shut down due to periodical maintenance

Meanwhile, almost all of the existing transmission and distribution equipment is 20 years old or more and the notably insufficient capacity and deterioration of the transmission and distribution system are partly responsible for the city's fragile power supply system. The current power supply situation in Honiara is very tight and unstable and the interruption to administrative services due to power cuts is impeding the functions of Honiara as the capital as well as socioeconomic activities and the daily lives of its citizens. One example is water cuts due to the stoppage of water pumps. Under these circumstances, the Government of the Solomon Islands made a request to the Government of Japan for the provision of grant aid for the installation of one new generating unit (4.2 MW) at the Lungga Power Station and upgrading of the transmission and distribution system in Honiara for the purpose of establishing a stable power supply system in Honiara with an increased generating capacity and an improved transmission and distribution system (hereinafter referred to as "the Project").

In response to this request, the Government of Japan decided to conduct a basic design study and the Japan International Cooperation Agency (JICA) dispatched the Basic Design Study Team to the Solomon Islands from 14th September to 8th October, 2004 to reconfirm the contents of the request and also to discuss the implementation contents of the Project with the people concerned on the Solomon Islands side. The Study Team also conducted a survey on the project sites and gathered relevant information.

On its return to Japan, the Study Team examined the necessity, expected socioeconomic effects and relevance of the Project based on the field survey findings and compiled the basic design implementation plan for the optimal project in the Outline of the Basic Design. Following the completion of this Outline document, the JICA dispatched the Study Team to the Solomon Islands again from 8th to 15th January, 2005 to explain the contents of the Outline of the Basic Design.

The scope of the requested Japanese assistance, determined based on the Basic Design Study, covers the entire contents of the Project, consisting of the procurement and installation of equipment related to "extension of the Lungga Power Station", "improvement of the Honiara transmission and distribution system" and extension of the power house and switchgear buildings which is necessary for the extension of the Lungga Power Station.

The following table outlines the basic plan for the requested Japanese assistance which is compiled based on the field survey findings as well as the results of consultations with the Solomon Islands side.

**Planning Contents of the Project**

**Extension of Lungga Power Station**

< Extension of the existing facilities and construction of the foundations >

(1) Extension of the power house (258 $m^2$)
(2) Extension of the switchgear house (62 $m^2$)
(3) Construction of the foundations for the new Diesel Engine Generator (DEG) and fuel tank, etc.

< Procurement and installation of the following equipment >

(1) Procurement and installation of the DEG (4.2 MW)
(2) Procurement and installation of the auxiliary mechanical systems/equipment for the DEG
- Fuel oil storage tank (300 $m^3$); fuel oil supply system; fuel oil service system; lubricating oil purifier unit; air intake and exhaust gas system; cooling water system; compressed air system

(3) Procurement and installation of the auxiliary electrical systems/equipment for the DEG
1) Auxiliary equipment for the Generator
- Generator control panel; protection relay panel; low voltage panels; DC power supply system

2) High voltage facilities
- 11 kV switchgears; station transformer (11 kV/415 - 240 V); cabling facilities

(4) Procurement of spare parts and maintenance tools for the DEG and auxiliary equipment
(5) Preparation of O&M manuals for the DEG and auxiliary equipment and implementation of OJT

**Upgrading of Transmission and Distribution System of Honiara Power Network**

< Procurement and installation of the following equipment >

(1) Construction of the 33 kV Ranadi Substation (S/S)
- 33 kV and 11 kV outdoor type switchgears and low voltage outdoor type panels
- Step-down transformer (33/11 kV, 5 MVA) and station transformer (11 kV/415 - 240 V, 300 kVA)
- Other related facilities and foundations for the above equipment

(2) Extension of the 33 kV line from the Lungga Power Station to the new Honiara East S/S
1) Laying of the 33 kV underground cable (approximately 4.2 km)
2) Installation of the 33 kV indoor type switchgear at the Lungga Power Station
3) Construction of the 33 kV Honiara East S/S
- 33 kV and 11 kV outdoor type switchgears and low voltage outdoor type panels
- Step-down transformer (33/11 kV, 3.5 MVA) and station transformer (11 kV/415 - 240 V, 300 kVA)
- Other related facilities and foundations for the above equipment

(3) Upgrading of the 33 kV switching facilities at the Honiara Power Station
- 33 kV outdoor type switchgears
- Other related facilities and foundations for the above equipment

(4) Extension of the 33 kV line from the Honiara Power Station to the new White River S/S
1) Laying of the 33 kV underground cable (approximately 4.2 km)
2) Construction of the 33 kV White River S/S
- 33 kV and 11 kV outdoor type switchgears and low voltage outdoor type panels
- Step-down transformer (33/11 kV, 3.5 MVA) and station transformer (11 kV/415 - 240 V, 300 kVA)
- Substation building (99.6 $m^2$)
- Other related facilities and foundations for the above equipment/building

(5) Procurement of spare parts and maintenance tools for the 33 kV transmission and 11 kV distribution facilities (including a truck with a basket crane)
(6) Preparation of O&M manuals for the transmission and distribution facilities and implementation of OJT

If the Project is implemented under the grant aid scheme of the Government of Japan, the project cost is estimated to be approximately ¥1,476 million (Japanese portion of ¥1,471 million and Solomon Islands portion of approximately ¥4.5 million). The main expenditure items for the Solomon Islands side are the removal or relocation of existing structures for the purpose of extending the Lungga Power Station and improving the Honiara transmission and distribution system, securing, clearing and levelling of land at the project sites, construction/improvement of an approach road at each site and the detection and removal of buried items along the planned transmission routes. The duration of work under the Project will be some 15 months, including the detailed design period, for Phase 1: Extension of the Lungga Power Station and some 16 months for Phase 2: Improvement of the Honiara Transmission and Distribution System.

The SIEA, i.e. the implementing organization of the Project, will be responsible for the operation and maintenance of the new facilities and equipment provided under the Project in the post-project period. As staff members of the SIEA have basic skills regarding the operation and maintenance of Diesel Engine Generators and transmission and distribution equipment, they should be able to conduct adequate maintenance of the new equipment.

The Project will benefit some 49,000 residents in Honiara. With the implementation of the Project, the available generation capacity of 17.8 MW will exceed the estimated peak demand of 13.0 MW by 4.8 MW in the target year (2011). Accordingly, even if the operation of the No.11 unit at the Lungga Power Station, which will be the largest generating unit at that time, is suspended for periodical inspection, there will be a reserve emergency supply capacity of 800kW. Meanwhile, improvement of the transmission and distribution system will eliminate the capacity shortage of the step-down transformers and transmission lines and, therefore, power cuts caused by an insufficient generating capacity will be avoided. As the Project is expected to have significant positive effects in terms of the reconstruction of the economy in the Solomon Islands, improvement of the standard of living of local residents and the stable operation of social welfare as well as public facilities, the granting of Japanese aid for the requested assistance is appropriate and also relevant to the aims of Japan's grant aid scheme. No special problems in regard to the operation and maintenance system for the new facilities and equipment which would affect the decision on the implementation of the Project are anticipated as the Solomon Islands side has sufficient manpower as well as funding capability.

The Solomon Islands side should meet the following necessities to ensure the emergence and continuation of the positive effects of the Project.

(1) In regard to the installation, operation and maintenance of the new generating unit, it is necessary to (i) secure the reserve supply capacity to allow the stoppage of the said generating unit (and others) for periodic maintenance, (ii) formulate an operation plan for the new as well as existing

generating units for the purpose of establishing the financially self-reliant operation of the Lungga Power Station, (iii) establish a preventive maintenance regime and (iv) maintain and improve the operation and maintenance skills.

(2) In regard to business management and finance, the SIEA must establish healthy finances, ensure the transparency of its business, secure the necessary budget for the procurement of spare parts, constantly stock emergency spare parts and conduct the suitable management of the unit generating cost. In addition, the SIEA must account for the depreciation cost without fail to save the necessary amount in the form of a reserve fund for future investment in new equipment.

(3) In regard to the environment, the SIEA should strictly follow the contents of the IEIA and environmental management plan so that the environmental impacts of the implementation of the Project do not exceed the estimated impacts of the IEIA.

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Appendices

# CHAPTER 1

# BACKGROUND OF THE PROJECT

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# BACKGROUND OF THE PROJECT

The capital of the Solomon Islands is Honiara (population of some 50,000 according to 1999 statistics) which is located on Guadalcanal Island (area of 5,400 $km^2$ and population of some 110,000 according to the same 1999 statistics) and which is the centre for the country's political and economic activities. Honiara has two diesel power stations (Honiara and Lungga) operated by the Solomon Islands Electricity Authority (SIEA). The city experienced a severe power crisis originating from an insufficient available capacity from 1996 to 1998. This power shortage was solved in 1998 as a result of foreign assistance which included the installation of the No.9 generating unit (4.2 MW) at the Lungga Power Station under the Power Development Project in the Lungga District, a Japan's grant aid project (hereinafter referred to as "the previous project"), making a positive contribution to the securing of emergency power supply capacity.

Despite such improvement, sudden breakdowns have been frequently taking place in more recent years due to the aging of the existing generating facilities and insufficient maintenance during the period of ethnic conflict from the end of 1998 to 2000, illustrating the insufficient power supply capacity in Honiara. Consequently, the SIEA has been forced to routinely implement planned load shedding. One major concern is the lack of reserve generating capacity which is required for the suspension of regular operation for periodic maintenance work. This is illustrated by a power cut in an area of approximately one-quarter of the city when the No.9 generating unit provided under the previous project at the Lungga Power Station was overhauled with follow-up cooperation provided by the Government of Japan in September, 2004 and clearly indicates the necessity for the urgent installation of new generating facilities.

Meanwhile, power supply to users is provided by 33 kV transmission lines and 11 kV distribution lines. Almost all of the existing transmission and distribution equipment is 20 years old or more and shows signs of aging as well as wearing out. The resulting insufficient capacity of the distribution lines is causing a voltage drop of some 20% and the step-down transformers are subject to constant overloading because of their insufficient capacity. Consequently, power cuts lasting for several hours occur two or three times a month, making renewal of the existing distribution equipment together with the installation of new distribution equipment to match the present level of the load essential.

While the Solomon Islands is rehabilitating its existing generating facilities with the assistance of AusAID and other donors, its budgetary shortage means that the installation of new generating facilities with its own funding is difficult. In regard to the transmission and distribution system, hardly any renewal or new installation plan is in progress.

As described above, the current situation of power supply in Honiara is very tight as well as unstable and is impeding not only the functions of Honiara as the capital of the Solomon Islands but also socioeconomic activities and the daily lives of its citizens. Against this background, the Government of the Solomon Islands has requested the Government of Japan's provision of grant aid for the installation of one new generating unit (4.2 MW) at the Lungga Power Station and the upgrading of the transmission and distribution system in Honiara for the purpose of establishing a stable power supply system in Honiara with an increased generating capacity and an improved transmission and distribution system (hereinafter referred to as "the Project").

# CHAPTER 2

# CONTENTS OF THE PROJECT

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## 2.1 Basic Concept of the Project

### 2.1.1 Overall Goal and Project Purposes

The Government of the Solomon Islands is implementing a national plan with a target period of from 2003 to 2006 to depart from the socioeconomic confusion caused by the ethnic conflict which lasted from the end of 1998 to 2000 as soon as possible in order to stabilise the country's socioeconomic conditions. The main policy components of this plan are the maintenance of law and order to prevent a recurrence of ethnic conflict and promotion of the development of social infrastructure to vitalise the country's economy. In addition, the power sector established and is implementing (i) "SIEA Development Plan (2004-2014)" which is construction plans of generation, transmission and distribution systems and (ii) "Honiara Repairs and Maintenance Programme" which is repair and maintenance plans of the existing generation, transmission and distribution systems in Honiara in order to increase stability and reliability of electricity supply to Honiara.

Within the overall framework of this national plan, the present Project aims at reinforcing as well as upgrading the power supply facilities which form part of the important social structure and which are essential for improvement of the lives of the citizens, the stable management of social and public facilities and the vitalisation of industries in Honiara.

### 2.1.2 Outline of the Project

The planned implementation of the Project aims at establishing a stable power supply system to vitalise socioeconomic activities and to improve the lives of the citizens of Honiara through the installation of additional generating facilities for base load operation and improvement of the city's transmission and distribution system in order to achieve the overall goal and project purposes described above.

The Project for which Japanese assistance is planned involves (i) the installation of one diesel generating unit (output: 4.2 MW) at the Lungga Power Station which partly supplies electricity to Honiara and (ii) the construction of 33/11kV distribution substations and 33 kV transmission lines to ensure safe and reliable power distribution for users in the city.

## 2.2 Basic Design of Requested Japanese Assistance

### 2.2.1 Design Policies

#### 2.2.1.1 Basic Policies

The scope of the Japanese assistance for the Project covers the procurement and installation of one 4.2 MW generating unit for base load operation in Honiara and the construction of 33/11 kV distribution substations together with the procurement and installation of materials and equipment for new 33 kV transmission lines with a view to securing a stable power supply for the city.

The capacity of equipment to be procured under the Project will be planned in accordance with the demand forecast for the Project Area. To be more precise, the capacity of the generating equipment and the capacity of the transmission and distribution equipment will be comparable with the demand forecast for five years and 10 years after commissioning respectively.

#### 2.2.1.2 Environmental and Social Conditions

In order to evaluate the environmental and social impact of the Project, the SIEA conducted the relevant IEIA (Initial Environmental Impact Assessment) in advance. According to the SIEA's IEIA report, the maximum $NO_2$ concentration on the ground which consists of the emission from the existing and new generating units will exceed the Japan's environmental standard (24 hours mean value: less than 0.06ppm) after the completion of the new generating unit if the height of the existing stacks is unchanged. The IEIA report also mentions that if the existing and new stacks are extended higher than 18m, the maximum $NO_2$ concentration on the ground will be 0.0586ppm and meet the Japan's environmental standard. The maximum $SO_2$ concentrations on the ground in the latter stack height will be 0.0083ppm (one hour mean value) and 0.0032ppm (24 hour mean value) which are far lower than the Japan's environmental standard of less than 0.1ppm (one hour mean value) and less than 0.04ppm (24 hour mean value), respectively. Those $SO_2$ concentrations will meet the Japan's environmental standards even if the existing stack height is as it is. The points of the maximum $NO_2$ and $SO_2$ concentrations on the ground appears in the distance of 1,000m from the Lunnga Power Station. Accordingly, it was reported that no significant impacts on the surrounding environment would occur, but it was recommended that mitigation measures should be conducted by the recipient country. Because of this, the Project was classified as a Category B project of the JICA's Environmental and Social Consideration Guidelines. Since no emission and environmental standards have been established in Solomon Islands, Japan's standards are applied in the IEIA.

SIEA calculated the maximum $NO_2$ concentration on the ground under the $NO_2$ emission amount that all the generating units are operated at the rated output and for 24 hours a day. However, actual daily load fluctuates; for example, night load is almost the half of the mid-day load and without considering such load fluctuation, estimation of $NO_2$ emission amount will be excessive. In regard to this issue, the Study Team assumed that the realistic operating mode of the generating units, taking the daily load fluctuation for the Lungga Power Station into consideration, would be based on nine hour peak operation a day, five hour middle operation a day and ten hour off-peak operation a day. Review of the maximum $NO_2$ concentration on the ground under this operating mode confirmed that the recalculated value of 0.056 ppm would meet the Japanese environmental standard. It was also confirmed that the wind velocity value of 6 m/sec adopted by the SIEA to calculate the maximum $NO_2$ and $SO_2$ concentration on the ground was appropriate in view of the observation data at the Honiara Weather Station (elevation of 55 m) for a period of 34 years.

Based on such recalculation result, the SIEA submitted its formal opinions to the Ministry of Forest and Environmental Conservation (Appendix 6) and the said ministry approved the opinions during the visit by the Study Team to the Solomon Islands (Appendix 7). Regarding noise disturbance, noise level of the nearest house is estimated as 43dB(A) by the IEIA and meets the Japan's noise regulation in residential area (morning, evening and night: 40~45dB(A)). Vibration at the property line will be met the Japan's regulation by the application of common bed foundation with anti-vibration measures for a diesel engine and a generator. It was confirmed that no change of the stack height for the existing generating units would be necessary under the Project and that the air pollution, noise and vibration would not be significant even though some care may be required.

The SIEA prepared and submitted the Environmental Management Plan (EMP), which includes necessary emission, noise and vibration monitoring plans in the post-project period, to the Ministry of Forest and Environmental Conservation (Appendix 8). The EMP requires SIEA to conduct noise level monitoring at the property line at least once a year. It is recommended that $NO_2$ concentration in the exhaust gas is measured at least twice a year.

The scoping and IEE results on the construction and operation of generation, transmission and distribution systems are shown in Table 2-1-1 and Table 2-1-2, respectively. As shown in the tables, the Project will not have any significant impacts on the surrounding environment. Nevertheless, the planning and operation of the Project takes environmental and social impacts into full consideration by (i) the application of low-NOx and low- noise type equipment to the Project, (ii) the implementation of appropriate maintenance by the SIEA to have the best performance of the equipment, (iii) keeping sulphur content of the fuel less than the planned number (0.17%), etc.

Table 2-1-1 Scoping Results

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

Note

(shaded cell) Means an item to be assessed by the IEE.

Evaluation Classification

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

Table 2-1-2 IEE Results

| Environmental Items Assessed by IEE | Evaluation | Reasons |
|---|---|---|
| 1. Involuntary resettlement | A | The extension of the existing power station and improvement of the existing underground transmission lines under the Project will use existing land and underground roadside spaces and will, therefore, not cause any involuntary resettlement or adverse impacts on the ecosystem. |
| 2. Flora, fauna and ecosystem | A | |
| 3. Air pollution | A | Even though some NOx and SOx will be emitted, the total volumes and ground surface concentration will be below the relevant Japanese environmental standards, causing little impact. |
| 4. Noise and vibration | A | The noise and vibration caused by operation of the generating unit during the day and at night will be below the relevant Japanese environmental standards, causing little impact. |

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

### 2.2.1.3 Natural Conditions

(1) Temperature and Humidity

The Project Area is characterised by an oceanic tropical climate and the temperature is high throughout the year, ranging from 23°C (mean monthly minimum temperature) to 31°C (mean maximum monthly temperature). The humidity is also high, ranging from 80% to 90%. As the engine and generator to be procured under the Project will be installed inside a building, no special measures will be required to deal with the outdoor temperature and humidity at the installation site. However, the design ambient temperature is set at 31°C for the design of the combustion air for the engine, cooling air for the radiator and ventilation of indoor air. The maximum allowable temperature for all equipment is set at 40°C to ensure the proper performance and function of each equipment.

Meanwhile, as the planned transforming equipment to be installed under the Project comprises outdoor type sealed switchgears, special attention will be paid to the structure in view of a possible temperature rise due to ambient temperature and direct sunlight to keep the temperature inside these switchgears within the range of the normal functioning of the equipment to ensure its continual operation. In regard to the humidity inside the sealed switchgears, the introduction of a space heater to prevent condensation caused by a temperature difference between the inside and outside of each equipment will be considered. The switchgear at the new distribution substation (White River Substation) at a site along the coast will be housed inside a building to prevent salt damage.

(2) Earthquakes

The Solomon Islands is located on a seismic belt and an earthquake of 7.6 on the Richter Scale has been recorded in the past near Guadalcanal Island. Accordingly, a design horizontal force of 0.25 G is adopted to ensure the safety of equipment, taking such magnitude into consideration.

#### 2.2.1.4 Socioeconomic Conditions

While Solomon Islanders traditionally believed in the existence of spirits in a similar form to ancestor worship, Christianity preached by European and American missionaries since the $19^{th}$ century now prevails throughout the country with Christians accounting for some 95% of the population. There are no special local customs or practices which will affect the construction schedule.

There is a possibility of the discovery of unexploded shells, artefacts and human remains from the Second World War during the excavation work along the 33 kV underground cable route. The Solomon Islands side must probe for the existence of any unexploded bombes along the said route prior to the commencement of the Project and should conduct the excavation work very carefully.

#### 2.2.1.5 Procurement Conditions

Honiara has seen little plant construction work involving generating units and other heavy equipment. Therefore, local construction companies lack experience of the installation work of large generating or transforming equipment and usually work as subcontractors for foreign construction companies. Nevertheless, the local procurement/employment of workers, transport vehicles and small construction machinery is possible. As local construction companies are capable of receiving orders to conduct small-scale civil engineering work, they will be used for such purpose under the Project. Given the fact that the generating unit to be procured under the Project will be installed at the side of the existing generating unit in operation, safety measures, including the introduction of a safety wall, will be considered to protect the existing unit from damage and also to ensure the safety of workers.

#### 2.2.1.6 Use of Local Workforce

(1) Use of Local Subcontractors

Local construction companies will mainly be used for the supply of construction machinery and labour for the planned installation of the generating and transforming equipment under the

Project. The dispatch of engineers from Japan will be required for quality control, schedule control, safety control, equipment testing and adjustment purposes.

Although the local leasing of heavy machinery, including a 100 ton class large crane, is difficult, 35 ton and 50 ton cranes are available in Honiara. These cranes will be used to handle construction materials and heavy items included in general cargo. However, the temporary leasing of a hydraulic low bed trailer(s) from Australia or another third country will be required for the transportation of the engine (weighing some 60 tons) and other heavy items after landing using a crane onboard the cargo ship.

(2) Use of Local Materials

While the local procurement of such materials for the civil engineering work as aggregate, cement and reinforcing bars is possible, materials for the electrical and mechanical work, including pipes and cables, are unavailable in the local market. Therefore, the procurement of the latter from Japan or a third country must be considered.

(3) Procurement of Equipment from Third Country

The price, quality, delivery period, ease of spare parts procurement after commissioning of the equipment, after-service system and compatibility with existing equipment, etc. must be carefully examined before any decision on the procurement of equipment from a third country is made.

The existing generating and distribution equipment in the Solomon Islands has been entirely imported from various countries. Accordingly, all materials and equipment required for the construction of the new generating facility and improvement of the transmission and distribution system under the Project will be imported. For the implementation of the Project, the Solomon Islands side strongly hopes for the procurement of Japanese products which enjoy excellent quality, performance, durability and highly reliable after-service system based on the experience of the previous grant aid project.

#### 2.2.1.7 Operation and Maintenance Capability of Implementing Organizations

Following commissioning, the new generating facilities will be maintained by 35 staff members (30 mechanical and five electrical staff members) led by the Generating Department Head of the SIEA as in the case of the existing generating facilities. This department has experience of conducting the overhaul of the No.9 DEG unit at the Lungga Power Station, the output capacity of which is the same as that of the newly planned unit. The staff members of this department are, therefore, judged to possess basic maintenance skills, including those required for routine maintenance. However, special attention will be paid to the specifications of the planned equipment so that the maintenance requirements do not exceed the existing maintenance capability of the SIEA.

#### 2.2.1.8 Scope of Facilities and Equipment and Their Grade

In consideration of the various conditions described above, the following basic policies are adopted regarding the scope of equipment procurement and installation and the technical level to be applied to the Project.

(1) Scope of Facilities and Equipment

The new generating unit to be procured under the Project will have an output capacity to provide emergency cover for base load operation regarding the estimated power demand in Honiara in 2011 (five years after commissioning). This capacity of the new generating unit is determined as approximately 25% of the power demand of the entire system considering the relatively small service area. The new unit will be configured to ensure the efficient as well as economical operation and maintenance of the power plant.

Meanwhile, the capacity of the substations and transmission lines to be newly installed under the Project will correspond to the demand forecast for Honiara in 2016 (10 years after commissioning).

(2) Grades

Careful attention will be paid to ensuring that the specifications of each equipment of the generating unit to be newly procured under the Project do not exceed the technical level of the SIEA which will be responsible for the operation and maintenance of the said unit after its commissioning.

#### 2.2.1.9 Construction and Procurement Methods and Construction Schedule

As the Project will be implemented in accordance with the grant aid scheme of the Government of Japan, the construction work must be completed in a single fiscal year. Given the large scale of the Project, however, the installation of the new generating unit and improvement of the transmission and distribution system will be conducted in different years as shown below.

First year : extension of the Lungga Power Station (procurement and installation of the 4.2 MW DEG)

Second year : improvement of the Honiara power network (construction of 33 kV distribution substations and construction of 33 kV transmission lines)

### 2.2.2 Basic Plan

#### 2.2.2.1 Overall Plan

(1) Design Conditions

Having examined the various relevant conditions for the Project as described in 2.2.1, the following design conditions are set to determine the applicable scale and specifications for the Project.

1) Planned Construction Sites, Locations and Elevations

① Planned construction site for the new generating facility: on the premises of the existing Lungga Power Station (space earmarked for the No.11 DEG unit); elevation of 24 m

② Planned construction sites for the new substations: SIEA-owned land near the airport in Honiara, Ranadi District and White River District and on the premises of the existing Honiara Power Station; elevation of approximately 6 m to 10 m

2) Climatic and Other Natural Conditions

① Design temperature

| | |
|---|---|
| i) Ventilation system | : 31°C (ambient temperature) |
| ii) Equipment in general | : 40°C (maximum) |

| | |
|---|---|
| ② Design relative humidity | : 95% (maximum) |
| ③ Design wind velocity | : 40 m/sec (maximum: 52 m/sec) |
| ④ Annual rainfall | : 1,900 (mean) |
| ⑤ Annual number of days with thunderstorms (IKL) | : 20 days |
| ⑥ Salt deposit density | : 0.5 $mg/cm^2$ (Heavy pollution) |
| ⑦ Seismic force | : 0.25 G (horizontal); 0 G (vertical) |
| ⑧ Soil bearing capacity | : 10 $tons/m^2$ |

3) Applicable Codes/Standards

① JIS (Japan Industrial Standards): applied to industrial products in general

② JEC (Japanese Electrotechnical Committee): applied to electrical products in general

③ JEM (Standards of Japan Electrical Manufacturers' Association): applied to electrical products in general

④ JCS (Japanese Electrical Wire and Cable Makers' Association): applied to electrical wires and cables

⑤ Technical Standards for Electrical Facilities in Japan: applied to the design of electrical equipment in general

⑥ AIJ (Architectural Institute of Japan): applied to building work in general

⑦ IEC (International Electrotechnical Commission): applied to electrical products in general

⑧ ISO (International Organization for Standards):applied to electrical and mechanical products in general

⑨ AS (Australian Standards): applied to electrical wires, cables and piping

4) Units

In principle, the International System of Units (SI) will be used for the units.

5) Electrical System

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

Table 2-2-3 Electrical System

| Item | Transmission Line | Distribution Line | Low Voltage (AC) | Low Voltage (DC) |
|---|---|---|---|---|
| Nominal Voltage | 33 kV | 11 kV | 415 – 240 V | 110 V |
| Maximum Voltage | 36 kV | 12 kV | 460 – 252 V | 121 V |
| Cabling Method | 3 phase 3 wires | | 3 phase 4 wires | 2 wires |
| Frequency | 50 Hz | | | - |
| Earthing Method | Neutral direct earthing | | | (-) Earth |

6) Basic Insulation Level (BIL)

For the design of the transmission and distribution facilities, the following BIL values applied to the existing facilities will be used as the standard BILs to ensure the coordination of insulation between the equipment and the insulation strength of the entire system.

① 33 kV system : BIL 170 kV

② 11 kV system : BIL 75 kV

7) Environmental Protection Standards

As the Solomon Islands has no environmental standards which are relevant to the planned construction work for the new generating facilities under the Project, the following values will be used as the design conditions, taking the relevant Japanese standards and the local conditions into consideration.

① NOx emission : less than 950 ppm (at a residual oxygen concentration of 13%)

② SOx emission : less than 250 ppm (at a sulphur content of fuel oil of 1%)

③ Oil contamination of effluent: less than 30 ppm

④ Particle emission : less than 100 $mg/Nm^3$

⑤ Noise : less than 110 dB (A) at the time of the sole operation of the generating facilities in question (1 m point from the DEG)

⑥ Vibration : less than 55 dB at the time of the sole operation of the generating facilities in question (at the site boundaries)

(2) Facility Layout Plan

The following facility layout plan is adopted for the generating, transmission and distribution facilities to be installed under the Project.

1) Generating Facilities

The new generating facilities (consisting of an engine, generator and low voltage panels, etc.) to be introduced under the Project will be constructed at the side of the existing No.9 generating unit by extending the existing power house building at the Lungga Power Station (see Basic Design Drawing G-201(page 40)). The existing building has an overhead travelling crane (25 tons) for maintenance purposes and this crane will be used to assist the construction work. The design of the sections which run through the building, such as the air intake and exhaust gas ducts, will take the locations of the pillars and beams of the existing building into consideration. The supervising and control panels will be installed in the existing control room to facilitate their operation and maintenance.

Foundations for the new diesel engine and generator will be constructed. Foundations for the outdoor facilities and equipment, including the fuel oil storage tank and radiator, etc., to serve the new DEG will also be constructed. The existing rainwater collection and storage system will be partially modified following the extension of the power house and switchgear house.

It will be necessary to install the 11 kV switchgears for the generating facilities in parallel with those in the existing switchgear house from an electrical point of view. However, as the existing building does not have space to accommodate the new 33 kV and 11 kV switchgears to be procured under the Project, the existing building will be extended to accommodate these panels. A supervising function regarding these switchgears will be installed at the generator supervising and control panel to be installed under the Project to ensure easy supervising operation. The low voltage and DC 110 V equipment to be procured under the Project will be installed in the extended electrical room so that their operation from the control room and their maintenance can be easily conducted.

2) Transmission and Distribution Facilities

The three substations and one upgraded switching facility will be located at SIEA-owned sites corresponding to important load centres in Honiara. The 33 kV underground transmission cables will be laid under the right of way set aside for the purpose of road maintenance along the existing national road.

### 2.2.2.2 Outline of Basic Plan

Table 2-2-4 outlines the basic plan for the Project based on the basic design policies, design standards and facility layout plan described in 2.2.1 and 2.2.2.1.

Table 2-2-4 Outline of Basic Plan

| Planning Contents of the Project |
| --- |
| **Extension of Lungga Power Station** |
| **Extension of the existing facilities and construction of the foundations**<br>(1) Extension of the power house (258 $m^2$)<br>(2) Extension of the switchgear house (62 $m^2$)<br>(3) Construction of the foundations for the new DEG and fuel tank, etc.<br><br>**Procurement and installation of the following equipment**<br>(1) Procurement and installation of the DEG (4.2 MW)<br>(2) Procurement and installation of the auxiliary mechanical systems/equipment for the DEG<br>• Fuel oil storage tank (300 $m^3$); fuel oil supply system; fuel oil service system; lubricating oil purifier unit; air intake and exhaust gas system; cooling water system; compressed air system<br>(3) Procurement and installation of the auxiliary electrical systems/equipment for the DEG<br>1) Auxiliary equipment for the Generator<br>• Generator control panel; protection relay panel; low voltage panels; DC power supply system<br>2) High voltage facilities<br>• 11 kV switchgears; station transformer (11 kV/415 - 240 V); cabling<br>(4) Procurement of spare parts and maintenance tools for the DEG and auxiliary equipment<br>(5) Preparation of O&M manuals for the DEG and auxiliary equipment and implementation of OJT |
| **Upgrading of Transmission and Distribution System of Honiara Power Network** |
| **Procurement and installation of the following equipment**<br>(1) Construction of the 33 kV Ranadi Substation (S/S)<br>• 33 kV and 11 kV outdoor type switchgears and low voltage outdoor type panels<br>• Step-down transformer (33/11 kV, 5 MVA) and station transformer (11 kV/415 - 240 V, 300 kVA)<br>• Other related facilities and foundations for the above equipment<br>(2) Extension of the 33 kV line from the Lungga Power Station to the new Honiara East S/S<br>1) Laying of the 33 kV underground cable (approximately 4.2 km)<br>2) Installation of the 33 kV indoor type switchgear at the Lungga Power Station<br>3) Construction of the 33 kV Honiara East S/S<br>• 33 kV and 11 kV outdoor type switchgears and low voltage outdoor type panels<br>• Step-down transformer (33/11 kV, 3.5 MVA) and station transformer (11 kV/415 - 240 V, 300 kVA)<br>• Other related facilities and foundations for the above equipment<br>(3) Upgrading of the 33 kV switching facilities at the Honiara Power Station<br>• 33 kV outdoor type switchgears<br>• Other related facilities and foundations for the above equipment<br>(4) Extension of the 33 kV line from the Honiara Power Station to the new White River S/S<br>1) Laying of the 33 kV underground cable (approximately 4.2 km)<br>2) Construction of the 33 kV White River S/S<br>• 33 kV and 11 kV outdoor type switchgears and low voltage outdoor type panels<br>• Step-down transformer (33/11 kV, 3.5 MVA) and station transformer (11 kV/415 - 240 V, 300 kVA)<br>• Substation building (99.6 m2)<br>• Other related facilities and foundations for the above equipment/building<br>(5) Procurement of spare parts and maintenance tools for the 33 kV transmission and 11 kV distribution facilities (including a truck with a basket crane)<br>(6) Preparation of O&M manuals for the transmission and distribution facilities and implementation of OJT |

#### 2.2.2.3 Equipment and Facility Plan

(1) Extension of Lungga Power Station

The details of the new generating facilities to be installed at the Lungga Power Station under the Project are described below. The specifications of each system or equipment are outlined in Table 2-2-5.

1) Basic Items

① Selection of Generating System

A diesel generating unit has been selected in view of compatibility with the existing generating system in the Solomon Islands, ease of operation and maintenance and urgent need for the installation of a new unit.

② Fuel Composition

The fuel currently used by the existing Lungga and Honiara Power Stations is diesel oil supplied by a private oil company (Markworth to which the business right to supply diesel oil has been transferred from Mobil oil). The fuel oil used for the generating unit installed under the previous grant aid project will also be used for the new unit to be constructed under the Project and the net calorific value of this fuel oil is 10,080 kcal/kg.

③ Composition of Lubricating Oil

The recommended composition of the lubricating oil varies depending on the generating unit manufacturer. As the existing power stations purchase lubricating oil produced by Mobil Oil which is available in the domestic market, as in the case of fuel oil, the use of lubricating oil is recommended in view of economy and the ease of procurement.

④ Cooling Water

The cooling water for the existing Lungga Power Station is supplied by the water supply system in Honiara. When the supply volume is low due to a water cut, etc., supplementary water is extracted from a nearby borehole or stored rainwater is used. The total hardness of the groundwater from the borehole near the Lungga Power Station is 36 mg/litre (based on the analysis results of the SIWA in October, 2004). Compared to the Japanese water supply standard (less than 300 mg/litre), while this groundwater can be used as drinking water, its hardness is high for use for radiators or as primary cooling water for the cooling water system, indicating potential scaling inside the equipment. The cooling water to be used for the planned new generating facilities should have a total hardness of approximately less than 10 mg/litre and, therefore, a simple water softener will be installed to reduce the total hardness of the groundwater.

2) Planning Contents

① Verification of Engine Output and Generator Capacity

The purpose of installing a new generating unit under the Project is to establish a stable power supply system through the urgent introduction of a reserve power supply capacity. As the Lungga Power Station is the most important power station responsible for base load supply for Honiara, the capacity of the new generating unit must be determined taking the future mode of operation of this power station into consideration. Accordingly, the capacity of the new generating unit has been decided as described below to secure a reserve supply capacity for emergency operation in the future (target year of 2011).

The experience of Japanese power generating companies indicates that the key generating capacity of a single unit at a power station located in an island country where the service area is relatively small should be some 25 - 33% of the total power demand of the power supply system to ensure efficient as well as economical operation and maintenance and this criterion is commonly applied.

As the estimated maximum power demand in Honiara in the target year of the Project of 2011 is approximately 13.0 MW, the optimal generating capacity of a single unit under this condition is approximately 3.2 - 4.2 MW. In the target year, the total available output of the entire generating units in Honiara will be approximately 17.8 MW, including that of the new generating unit (rated output of 4.2 MW) to be installed under the Project. The resulting supply and demand balance (total current output minus the maximum power demand) will be approximately 4.8 MW which is roughly equivalent to the generating capacity of the No.10 generating unit (rated output: 4.3 MW, current output: 4.0 MW) of the Lungga Power Station, the generating unit with the largest capacity in the Honiara Power Network, securing the minimum required reserve supply capacity. For this reason, the capacity of the generating unit (4.2 MW x one) requested by the Government of the Solomon Islands is judged to be appropriate.

a) Engine Output

$$Pe \geqq \frac{P}{0.7355 \times \eta_G} = 6{,}011\text{PS} \fallingdotseq 6{,}020\text{PS}$$

Where, Pe : engine output (PS)

P : generating-end output (4,200 kW)

ησ : generator efficiency (assumed to be 95%)

b) Generator Capacity

$$P_G = \frac{P}{Pf} = 5{,}250\text{ kVA}$$

Where, PG : generator capacity (kVA)

P : generating-end output (4,200 kW)

Pf : generator power factor (0.8)

② Mechanical Systems

a) Fuel Supply System

The Lungga Power Station has four main fuel tanks of 55 $m^3$ each (total storage volume: 220 $m^3$) and diesel oil is supplied by tank lorries of a private oil company with which a fuel supply agreement has been concluded. In an island country which relies on imported oil, the transportation of fuel oil from outside is often delayed due to the weather. Considering the tank dead (tank capacity which cannot be practically used because of the installation position of the delivery pipe and upper space when receiving fuel oil, etc.), the present total tank capacity will only be able to store three days supply of fuel oil in the target year. For this reason, a fuel oil tank of 300 $m^3$ will be installed under the Project to secure a total fuel oil storage volume of some seven days supply. One outdoor type small fuel oil service tank will be installed as in the case of the existing generating units to deal with any abnormal functioning of the main fuel tank and/or shared pipeline. This small service tank will be located to the north of the power house building (see Basic Design Drawing G-201(page 40)).

Fuel oil will be supplied from the fuel oil storage tank to the fuel oil service tank by means of gravity and a fuel oil circulating pump will supply fuel oil from the fuel oil service tank to the engine.

<u>Fuel Oil Service Tank</u>

The capacity of the fuel oil service tank will be equivalent to some two hours of fuel consumption by the new generating unit as calculated below.

$$Vs = V \times 4{,}200\ \text{kW} \times 2\ \text{hours} \fallingdotseq 2.03\ \text{m}^3$$

Where, Vs : capacity of fuel feeding tank

V : fuel consumption per unit generated energy (0.241 litre/kWh) of the generating unit (rated output: 4.2 MW), assuming a specific gravity of fuel of 0.95

The nominal capacity of the new fuel oil service tank is set at 2.5 $m^3$ to allow a tank dead ratio of 20%.

b) Lubricating Oil System

As the Lungga Power Station has a lubricating oil transfer pump which was provided under the previous project, this pump will be used to supply lubricating oil to the new generating unit. The lubricating oil will be supplied from drums placed outside the power house building to the engine by the said pump.

Given the difficult access to this transfer pump in its current position because of the extension of the power house building, the pump will be relocated to near the entrance of the power house building.

c) Cooling Water System

As described earlier (2.2.2.3-(1)-1)-④), city water stored in the existing water tank will be used as cooling water after softening of its hardness by the softener. The radiator system used by the existing facilities will be adopted as the cooling water system for the new generating facilities. Some of the softened water will be supplied to the lubricating oil purifier unit. The water softener will be connected to the existing cooling water pipeline so that it can be used as an emergency back-up unit for the existing generating units.

d) Compressed Air System

A compressed air system will be installed for the start-up of the new generating unit. This system will be linked to the pipeline of the existing compressed air system for mutual supplementation at the time of an emergency. In view of the high level of humidity, an automatic water discharge valve will be installed to the compressed air tank. Compressed air at a reduced pressure will be supplied from the compressed air tank to the lubricating oil purifier unit.

e) Air Intake and Exhaust Gas System

The intake of fresh air for combustion in the engine will be made by the supercharger via an exclusive duct and, after combustion, the exhaust gas will be discharged outside via the silencer.

f) Ventilation System

The existing power house building uses louvers for natural ventilation. As the ventilation capacity of this system is insufficient for the planned generating unit, a new ventilation system will be installed for the new generating unit (No.11 generating unit) under the Project. In regard to exhaust, the exhaust louvers on the roof of the building will be used.

g) Sludge Treatment System

The Lungga Power Station has an oil separating tank which was provided under the previous grant aid project and this tank has been operating without any problems up to the present. As this tank has a sufficient capacity to treat the sludge to be discharged from the planned generating unit under the Project, this existing tank will be used by installing and connecting new sludge pipes to the existing waste oil tank and oil separating tank. An incinerator to treat separated sludge and waste oil in an appropriate manner was also provided under the previous grant aid project. This incinerator also has a sufficient capacity and will be used to treat the sludge and waste oil discharged by the new generating unit.

h) Piping Systems

The following outdoor piping will be required for the new generating unit. This piping will clearly indicate the system to which it belongs and the flow direction.

- Fuel oil piping system
- Lubricating oil piping system
- Cooling water piping system
- Compressed air piping system
- Waste oil piping system
- Drain piping system

③ Electrical Installations

The generation voltage of the new generating unit to be installed under the Project will be 11 kV as in the case of the existing generating units because of such reasons as (i) a high level of economy due to direct connection to the existing switchgear (11 kV) without involving a transformer and (ii) conformity with the existing units. The main components of the planned electrical installations are described below.

a) Local Control Panel

A local control panel will be installed at the side of the new generating unit for starting, stopping, controlling, measuring and warning purposes.

b) Generator Control Panel

This control panel will be used to centrally supervise and control the generating unit, switchgears and auxiliary equipment to be installed under the Project from the control room. In addition, a brushless thyrister type control unit for exciting will be installed on the generator control panel. Synchronised operation of the generator will also be conducted by this control panel.

c) DC Power Supply System

A DC power supply system (110 V) will be installed inside the electrical room of the extended power house building to act as the power source for the starting, stopping, controlling, measuring and warning operations associated with the new generating unit and its auxiliary equipment.

d) Low Voltage Panel

A low voltage panel equipped with measuring and warning apparatus will be installed at the side of the new generating unit to start and stop the auxiliary equipment.

e) Earthing System

The Lungga Power Station uses an interlocked earthing system. Accordingly, each of the following earthing systems for the new generating facilities will be connected to the existing earthing network.

- Earthing system to protect the power system

- Earthing system to prevent electric shocks from metal objects and electrical equipment
- Lightning protection system to protect the facilities and equipment from lightning

f) Cabling

The power and control cables between the new generating unit and the 11 kV switchgear, main transformer and remote control panel will use underground conduits by installing cable pits as in the case of the existing power house building. Cable trays will be introduced in these pits to improve the maintainability of these cables.

g) 11 kV High Voltage Facilities

A circuit breaker panel for the generator and a bus circuit breaker will be installed in the existing switchgear house building. A new 11 kV switchgear will be provided with operating switches and indicating lamps, etc. As this will be installed in line with the existing switchgears, it will have the same construction as that of the existing switchgears. Its specifications will correspond to the SCADA (supervisory control and data acquisition) system of which the introduction is planned by the SIEA.

The 48 V DC power to operate the switchgear will branch out from the existing 48 V DC system while the 240 V AC power for the space heater will branch out from the existing 240 V AC system.

h) 11 kV Control Panel

This panel will control the switching operation of the 11 kV switchgear.

i) Station Transformer Panel

An outdoor type station transformer will be installed as the power source for the auxiliary equipment for the new generator. The capacity of this new transformer will be 630 kVA which is the standard capacity of the existing station transformers. This new transformer will be installed near the new electrical room in view of minimising the length of extension of the 11 kV and low voltage cables and also of its maintainability.

3) Outline Specifications of Main Equipment

The following outline specifications will be adopted for the main equipment of the new generating unit to be installed under the Project taking the design concept, design standards, design conditions and layout plan, etc. described above into consideration.

Table 2-2-5 Outline Specifications of Main Equipment of New Generating Unit

| No. | Equipment | Specifications | |
|---|---|---|---|
| 1 | Diesel Engine | - Kind of Rating | : continuous (base load operation) |
| | | - Output | : generating-end – 4,200 kW (approx. 6,020 PS) |
| | | - Speed | : not more than 750 rpm |
| | | - Engine Type | : four stroke cycle, trunk piston type with supercharger, water cooling V type diesel engine |
| | | - Cooling Method | : radiator cooling |
| | | - Fuel Oil | : diesel oil |
| | | - Miscellaneous | : vibration isolating common bed |
| 2 | Generator | - Kind of Rating | : continuous |
| | | - Output | : 5,250 kVA (4,200 kW) |
| | | - Frequency | : 50 Hz |
| | | - Number of Phases | : 3 |
| | | - Rated Voltage | : 11 kV |
| | | - Speed | : same as diesel engine |
| | | - Power Factor | : 0.8 (delay) |
| | | - Winding Connection Method | : Y connection, neutral conductor drawn |
| | | - Insulation Class | : F |
| 3 | Mechanical Equipment | | |
| 3.1 | Fuel Oil Storage System | | |
| | 1) Fuel Oil Unloading Pumps | Head of 50 m when the capacity is 30 $m^3$/hr | |
| | 2) Fuel Oil Storage Tank | Capacity of 300 $m^3$; floating suction; cone roof type | |
| | 3) Fuel Oil Flow Meter | Class of 0.5 or lower with non-return valve | |
| 3.2 | Fuel Oil Supply System | | |
| | 1) Fuel Oil Service Tank | Capacity of 2.5 $m^3$ | |
| | 2) Fuel Oil Transfer Pump | Including motor, gear pump and filter | |
| | 3) Fuel Oil Flow Meter | Class of 0.5 or lower | |
| | 4) Fuel Filters | Primary and secondary filters | |
| | 5) Fuel Oil Pressure Regulating Valve | Self-actuating back pressure regulating valve | |
| | 6) Fuel Oil Drainage Discharge Pump | Including motor, gear pump and filter | |
| | 7) Fuel Oil Drain Tank | Capacity of 100 litres | |
| 3.3 | Lubricating Oil System | | |
| | 1) Lubricating Oil Transfer Pump | Including motor, gear pump and filter | |
| | 2) Lubricating Oil Sump Tank | Capacity of approx. 5 $m^3$ | |
| | 3) Lubricating Oil Priming Pump | Including motor and gear pump | |
| | 4) Lubricating Oil Cooler | Including automatic temperature control valve | |
| | 5) Lubricating Oil Main Filter | 50 microns | |
| | 6) Lubricating Oil Backwashing Filter | Bucket type filter | |
| | 7) Lubricating Oil Purifier Unit | Including motor and automatic discharge unit | |
| | 8) Lubricating Oil Pressure Regulating Valve | Thermostat and self-activating valve | |
| 3.4 | Cooling Water System | | |
| | 1) Jacket Cooling Water Tank | Capacity of 0.3 $m^3$ | |
| | 2) Jacket Cooling Water Pump | Including motor and centrifugal pump | |
| | 3) Jacket Cooling Water Cooler | Shell and tube or plate type | |
| | 4) Jacket Cooling Water Temperature Regulating Valve | With thermostat; self-actuating valve | |
| | 5) Radiator | Vertical air flow type; copper cooling pipes | |
| | 6) Secondary Cooling Water Pump | Including motor and centrifugal pump | |
| | 7) Softener | Ion exchange resin type | |
| | 8) Soft Water Supply Pump | Including motor and centrifugal pump | |
| | 9) Soft Water Tank | Capacity of 3 $m^3$ | |
| | 10) Expansion Tank | Capacity of 0.3 $m^3$ | |
| | 11) Soft Water Circulating Pump | Centrifugal pump | |

| No. | Equipment | Specifications |
|---|---|---|
| 3.5 | Compressed Air System<br>1) Air Compressor<br>2) Air Receiver<br><br>3) Low Pressure Air System | <br>Multi-step reciprocating type<br>Sufficient capacity to allow the start-up of the engine three types; with automatic drainpipe<br>Manual pressure regulating valve |
| 3.6 | Air Intake and Exhaust System<br>1) Intake Air Duct<br>2) Intake Air Filter<br>3) Intake Air Silencer<br>4) Exhaust Gas Silencer<br>5) Exhaust Gas Duct | <br>SS (soft steel)<br>Outdoor type<br>With air intake pipe; inlet noise level of ≦ 85 dB (A)<br>With tail pipe; outlet noise level of ≤85 dB (A)<br>SS (soft steel) |
| 3.7 | Sludge Treatment System<br>1) Sludge Tank<br>2) Waste Oil Discharge Pump | <br>Capacity of 0.1 $m^3$<br>Motor and screw pump; 0.5 $m^3$/hr |
| 4 | Electrical Equipment<br>1) 11 kV Switchgear<br>2) Low Voltage Motor Control Panel for Auxiliary Equipment<br>3) Generator Control Panel<br>4) Generator Neutral Panel<br>5) Protective Relay<br>6) DC Power Supply System<br>7) Station Transformer | <br>12 kV circuit breaker; 1,250 A; 50 Hz; 20 kA (one second)<br>Self-starting type; including auxiliary equipment control panel<br><br>Self-standing type; including AVR panel and synchroniser<br>Self-standing type<br>Generator<br>Enclosed type lead batter; 110 V<br>Outdoor self-cooling type; 630 kVA; 11/0.415 kV |

4) Extension Plan for Existing Power House Building

In 1992, the SIEA expanded the power house building of the Lungga Power Station by some 364 $m^2$ (two spans). The No.9 generating unit provided under the previous project is housed in this extended area. Further extension of the building will be conducted under the Project. Similarly, the existing switchgear house will be extended under the Project. The building materials, including roofing and wall materials and structural steel, etc., will have the same specifications as the existing materials to ensure harmony between the extended sections and the existing buildings. Some of the studs, furring strips, windows and doors of the existing buildings will be used for the planned extension work to reduce the construction cost. Table 2-2-6 outlines the building finish.

Table 2-2-6 Outline of Finish of Power House Building

| Section | Finishing Material |
|---|---|
| Roof | Zinc-plated aluminium corrugated plate |
| Walls | Zinc-plated aluminium corrugated plate |
| Structural Steel | AS-1204-250 (equivalent to JIS G3101-SS41) |
| Partition Walls | Reinforced concrete blocks with paint finish |
| Doors and Windows | Aluminium |
| Shutters | Steel; manual operation; coated |

5) OJT Plan

The planned generating facilities under the Project are relatively large with a single generator output of 4.2 MW. OJT during the construction period and after commissioning is proposed to ensure smooth operation after commissioning.

① OJT Plan During Installation Work

OJT will be conducted for the purpose of transferring operation and maintenance techniques and skills for the equipment to be installed under the Project to the counterparts of the Solomon Islands side during the installation work.

The specifications and grades of the new generating unit to be installed under the Project have been decided taking the technical capability of the SIEA engineers involved in the operation and maintenance of the existing generating units into consideration. These engineers have adequate operation and maintenance skills for DEGs manufactured in Japan based on their experience of operating and maintaining the DEGs provided under the previous grant aid project. However, some of the systems incorporated in the generating unit to be procured under the Project have likely adopted the fruits of more recent technological development which are not used by the existing generating facilities. Accordingly, OJT on the operation and maintenance of the new generating unit will be provided by engineers dispatched by the manufacturer of the said generating unit for SIEA engineers during the installation work. Further training on the operation of various instruments which are essential for maintenance work will be provided to equip the SIEA engineers with the latest technical expertise in order to ensure the effective operation of the equipment to be provided.

② Contents of OJT Plan

a) Period and Location of OJT

- Classroom lectures : approx. one week (at site)
- Practical training : approx. two months (at site)

b) Instructors

The instructors for the above OJT will be engineers dispatched by the manufacturer of the generating unit selected and delivered by the Contractor and assigned to supervise equipment installation, test operation and adjustment.

c) Trainees

The trainees for the OJT will be the SIEA engineers listed below who will be directly responsible for the operation and maintenance of the new generating unit after its commissioning. The project implementation body in the Solomon Islands, i.e. the SIEA, must appoint the OJT trainees prior to the commencement of the generating unit installation work.

| | | | |
|---|---|---|---|
| - Chief Engineer | : 1 | | |
| - Operation Staff | Electrical Engineer | : | 1 |
| | Mechanical Engineer | : | 1 |
| | Electrical Technicians | : | 2 |
| | Mechanical Technicians | : | 2 |
| | Sub-Total | : | 6 |
| - Maintenance Staff | Electrical Engineer | : | 1 |
| | Mechanical Engineer | : | 1 |
| | Mechanical Technicians | : | 3 |
| | Sub-Total | : | 7 |
| | Total | : | 14 |

d) Training Contents

i) Classroom Lectures

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

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

ii) Practical Training

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

- Disassembly and maintenance of cylinder head
- Overhaul and maintenance of fuel valve
- Grinding finishing of suction and exhaust valves

- Overhaul and maintenance of pistons
- Disassembly and inspection of crack pin bearings
- Maintenance of motor pump
- Maintenance of suction filter and other filters
- Unit starting up and stopping
- Emergency stop at the time of breakdown
- Remote monitoring and visual inspection
- Maintenance of piping
- Maintenance of cables
- Maintenance of electrical equipment

(2) Improvement of Honiara Transmission and Distribution System

1) General

The ease and safety of operation and maintenance of the substations after their completion are taken into consideration in the selection of the equipment and materials required for substation construction. Outdoor type switchgear is adopted to shorten the installation period of equipment and materials. The transforming facilities basically adopt the method of on-site supervision and control by SIEA staff and an outdoor lighting system will be installed to ensure proper supervision.

The 33/11 kV step-down transformers and switchgears will adopt design features reflecting the climatic conditions of the Project Area. In particular, measures to prevent salt damage will be introduced. All of the substations will be fenced off for the safety of local residents.

The 33 kV transmission lines will adopt the underground cabling method in consideration of the following matters.

- Avoidance of accidents due to strong wind and/or fallen trees caused by a cyclone
- Avoidance of earthing accidents of transmission lines due to contact with fast-growing trees or large bats
- Limited availability of space to install 33 kV overhead transmission lines in urban areas due to the existence of 11 kV distribution lines
- Stable operation and low maintenance of the new 33 kV transmission line by means of using the underground cabling method to avoid salt damage in view of the new transmission route running along the coast
- Unification of the design specifications with the existing 33 kV underground transmission lines in urban areas

The main purpose of the planned 33 kV Honiara switching facilities to be installed at the Honiara Power Station is to ensure safe branching and protection of the 33 kV transmission line connecting the Honiara Power Station and the White River Substation. These switching facilities will be installed after the completion of the improvement work of the 33 kV distribution substation at the Honiara Power Station to be conducted with the assistance of AusAID and will be used for the improved substation (see Basic Design Drawing D-G20 (page 51)).

2) Outline of Improvement Plan

The planned components regarding the improvement of the Honiara transmission and distribution system are outlined below.

① Construction of 33 kV Ranadi Substation

Main Components

- 33 kV and 11 kV outdoor type switchgears (SWGR) : 1 lot
- 5 MVA, 33/11 kV step-down transformer : 1 set
- 300 kVA, 11 kV/415 - 200 V station transformer : 1 set
- Other auxiliary equipment and foundations : 1 lot

② Extension of 33 kV Transmission Line from Lungga P/S to Honiara East S/S

(a) Laying of 33 kV underground cables (approximate length: 4.2 km)

(b) Installation of 33 kV indoor type SWGR (1 lot) at the Lungga P/S in parallel with the existing ones

(c) Construction of the 33 kV Honiara East S/S

Main Components

- 33 kV and 11 kV outdoor type switchgears (SWGR) and outdoor type low voltage panel : 1 lot
- 3.5 MVA, 33/11 kV step-down transformer : 1 set
- 300 kVA, 11 kV/415 – 240 V station transformer : 1 set
- Other auxiliary equipment and foundations : 1 lot

③ Upgrading of 33 kV Honiara Switching Facilities

Main Components

- 33 kV outdoor type SWGR : 1 lot
- Other auxiliary equipment and foundations : 1 lot

④ Extension of 33 kV Transmission Line from 33 kV Honiara Switching Facilities to 33 kV White River S/S

(a) Laying of 33 kV underground cables (approximate length: 4.2 km)

(b) Construction of the 33 kV White River S/S

Main Components

- 33 kV and 11 kV outdoor type switchgears (SWGR) and outdoor type low voltage panel : 1 lot
- 3.5 MVA, 33/11 kV step-down transformer : 1 set
- 300 kVA, 11 kV/415 - 240 V station transformer : 1 set
- Other auxiliary equipment and foundations : 1 lot

⑤ Procurement of Maintenance Tools and Spare Parts for Transmission and Distribution

3) Specifications of Main Equipment

3-1) Generating Unit

① Outline of 33/11 kV Step-Down Transformers

(a) Capacity

For the capacity of the 33/11 kV step-down transformers to be installed at the substations at the project sites, the most appropriate capacity will be selected from the range of standard transformer capacities based on the maximum power demand in the target year (2016) of the Project for the transmission and distribution system taking the power factor (0.85) of the load into consideration. In view of the load fluctuation where the day-time load is approximately double the night-time load, transformers equipped with an on-load voltage regulating function will be adopted. Based on these considerations, the step-down transformers to be installed at the substations at the project sites will adopt the following specifications.

Table 2-2-7 Specifications of Step-Down Transformer

| Substation | Demand in Target Year (2016) for Improved Transmission and Distribution Capacity | | 33/11 kV Step-Down Transformer (kVA) |
|---|---|---|---|
| | Maximum Demand (kW) | Required Capacity (kVA) (Maximum Demand ÷ Power Factor of 0.85) | |
| 33 kV Ranadi S/S | 3,600 | 4,200 | 5,000 |
| 33 kV Honiara East S/S | 2,400 | 2,800 | 3,500 |
| 33 kV White River S/S | 1,800 | 2,100 | 3,500 |

(b) Function

An on-load automatic tap changer (voltage regulating range: +5% ~ -15%: 1.25% x +4, -12 taps) will be installed at the 33 kV side of each step-down transformer to combat voltage drops.

② Outline of 33 kV Receiving Equipment

The 33 kV underground transmission cable will be connected to the 33 kV switchgear. The 11 kV circuit breaker panel will be the outdoor type in view of economy and will be equipped with a distribution circuit breaker (vacuum circuit breaker, 36 kV, 630 A, 25 kA, one second), instruments and protection relay, etc. The 33 kV transmission feeder circuit will be provided with a multi-converter for voltage, current and frequency, etc. in preparation for the future introduction of SCADA. As the Ranadi Substation will be connected to the 33 kV looped transmission system, a synchronoscope will be installed to ensure proper synchronisation when the circuit breaker is in operation.

③ Outline of 11 kV Distribution Facilities

In consideration of the future demand, the 11 kV distribution facilities will be composed of service feeders for the 33/11 kV step-down transformer and distribution feeders (five feeders for the Ranadi S/S, four feeders for the Honiara East S/S and four feeders for the White River S/S).

The circuit breaker panel will be equipped with a circuit breaker (vacuum circuit breaker: 12 kV, 630 A, 20 kA and one second), instruments, low voltage facility to control the substation and DC power supply system (capable of supplying DC power for sixty minutes at the time of service interruption). The existing 11 kV distribution lines are mainly overhead lines which experience service interruption several times a month due to earthing incidents. For this reason, a reclosing system will be adopted for each 11 kV distribution feeder so that the circuit breaker on the distribution side automatically operates at the time of a minor earthing incident to improve the reliability of the power supply.

④ Outline of Station Facilities

The substations to be constructed under the Project will be unmanned due to remote supervision and control by the SCADA system. Outdoor lighting at these substations will be provided by an automatic lighting system using photo cells in view of energy saving and ease of operation. The specifications of the high voltage cables connecting the transforming equipment at the substations are shown in Table 2-2-8.

Table 2-2-8 Specifications of Connecting Cables at Substations

| Section | Cable Specifications | Remarks |
|---|---|---|
| 33 kV Switchgear ↔ Existing 33 kV Transmission Line | 33 kV; 3 core aluminium conductor; XLPE insulated; PVC sheath 50 $mm^2$ (3 core) armoured (70 $mm^3$ for the Ranadi S/S because of the need to extend the existing cable) | • Must satisfy the line capacity of 10 MVA and short circuit current of 10 KA<br>• Procurement quantity: 200 m per feeder |
| 33 kV Switchgear ↔ Step-Down Transformer (33 kV side) | As above | - |
| 11 kV Circuit Breaker Panel ↔ Existing 11 kV Distribution Line | 12 kV; 3 core aluminium conductor; XLPE insulated; PVC sheath 70 $mm^2$ (single core) armoured | • Must satisfy the line capacity of 5 MVA<br>• Procurement quantity: 200 m per feeder |
| 11 kV Circuit Breaker Panel ↔ Step-Down Transformer (11 kV side) | As above | - |

Note: XLPE: cross-linked–polyethylene-insulated wire
PVC: polyvinyl chloride

⑤ Construction Plan for Each Substation

The contents of the construction plan for each substation to be constructed under the Project are shown in the following tables.

(a) 33 kV Ranadi Substation : Table 2-2-9
(b) 33 kV Honiara East Substation : Table 2-2-10
(c) 33 kV Honiara Switching Facilities : Table 2-2-11
(d) 33 kV White River Substation : Table 2-2-12

Table 2-2-9 Planned Contents of 33 kV Ranadi Substation

| Item No. | Item/Equipment | Specifications | Quantity |
|---|---|---|---|
| 1. | Construction of Auxiliary Facilities | | |
| (1) | Outdoor Lighting | Sodium lamp 250 W, 6 m high with individual photocell switch | 1 lot |
| (2) | Fencing and Gate | Including an oil separating tank and fire walls | 1 lot |
| (3) | Cable Pit and Storm Water Drainage, etc. | | 1 lot |
| (4) | Foundations for Step-Down Transformer and Switchgears, etc. | | 1 lot |
| 2. | Procurement and Installation of Step-Down Transformer | | 1 set |
| (1) | Type | Outdoor type; oil immersed self cooling; on-load tap changer; 12 kV 10 kA; arrester to be installed inside the cable box; three phase general surge counter | |
| (2) | Rated Capacity/Voltage | 5 MVA; 33/11 kV; three phase | |
| (3) | Applicable Standards | IEC/JEC | |
| 3. | Procurement and Installation of 33 kV Switchgear | | 3 |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; 36 kV, 630 A, 25 kA; one second; drawer type; synchronisation check relay; earthing switch | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| 4. | Procurement and Installation of 11 kV Switchgear | | |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; draw out type | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Details | 1) For power receiving (12 kV, 630 A, 20 kA, one second) | 1 |
| | | 2) For distribution (12 kV, 630 A, 20 kA, one second) with automatic reclosing facility | 4 |
| | | 3) For station transformer (12 kV, 630 A, 20 kA, one second) with earthing apparatus | 1 |
| 5. | Procurement and Installation of Low Voltage Panel | | 1 |
| (1) | Type | Enclosed outdoor type; air insulation system | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Battery | Enclosed lead battery 110 V (power supply duration: one hour) with DC distribution board | |
| 6. | Procurement of 11 kV Disconnecting Switch | | 4 sets |
| (1) | Type | Outdoor type; vertical single-break; rod for ground handling | |
| (2) | Rated Voltage/Current | 12 kV/600 A (20 kA) | |
| (3) | Applicable Standards | JIS/JEC/JEM | |
| 7. | Procurement of 11 kV Arrester | (for system connection) | 12 |
| (1) | Type | Outdoor gapless type with 3 phase general surge counter | (one/phase) |
| (2) | Rated Voltage | 12 kV | |
| (3) | Discharge Current | 10 kA | |
| (4) | Applicable Standards | IEC | |
| 8. | Procurement and Installation of 33 kV Power Cables | (for system connection and station use) | 1 lot |
| (1) | Type | 33 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 $mm^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 9. | Procurement of 11 kV Power Cables (for connection with distribution line) | (for system connection and station use) | 1 lot |
| (1) | Type | 12 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 $mm^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 10. | Procurement and Installation of Low Voltage Power and Control Cables, etc. | | 1 lot |
| (1) | Power Cable | 600 V XLPE insulated; PVC sheath; copper conductor cable | |
| (2) | Control Cable | 600 V PVC insulated; PVC sheath; copper conductor cable | |
| (3) | Miscellaneous Materials for Wiring Work | Including materials for earthing work | |

Table 2-2-10 Planned Contents of 33 kV Honiara East Substation

| Item No. | Item/Equipment | Specifications | Quantity |
|---|---|---|---|
| 1. | Construction of Auxiliary Facilities | | |
| (1) | Outdoor Lighting | Sodium lamp 250 W, 6 m high with individual photocell switch | 1 lot |
| (2) | Fencing and Gate | Including an oil separating tank and fire walls | 1 lot |
| (3) | Cable Pit and Storm Water Drainage, etc. | | 1 lot |
| (4) | Foundations for Step-Down Transformer and Switchgears, etc. | | 1 lot |
| 2. | Procurement and Installation of Step-Down Transformer | | 1 set |
| (1) | Type | Outdoor type; oil immersed self cooling; on-load tap changer; 12 kV 10 kA; arrester to be installed inside the cable box; three phase general surge counter | |
| (2) | Rated Capacity/Voltage | 5 MVA; 33/11 kV; three phase | |
| (3) | Applicable Standards | IEC/JEC | |
| 3. | Procurement and Installation of 33 kV Switchgear | | 3 |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; 36 kV, 630 A, 25 kA; one second; drawer type; synchronisation check relay; earthing switch | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| 4. | Procurement and Installation of 11 kV Switchgear | | |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; draw out type | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Details | 1) For power receiving (12 kV, 630 A, 20 kA, one second) | 1 |
| | | 2) For distribution (12 kV, 630 A, 20 kA, one second) with automatic reclosing facility | 3 |
| | | 3) For station transformer (12 kV, 630 A, 20 kA, one second) with earthing apparatus | 1 |
| 5. | Procurement and Installation of Low Voltage Panel | | 1 |
| (1) | Type | Enclosed outdoor type; air insulation system | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Battery | Enclosed lead battery 110 V (power supply duration: one hour) with DC distribution board | |
| 6. | Procurement of 11 kV Disconnecting Switch | | 3 sets |
| (1) | Type | Outdoor type; vertical single-break; rod for ground handling | |
| (2) | Rated Voltage/Current | 12 kV/600 A (20 kA) | |
| (3) | Applicable Standards | JIS/JEC/JEM | |
| 7. | Procurement of 11 kV Arrester | (for system connection) | 9 |
| (1) | Type | Outdoor gapless type with 3 phase general surge counter | (one/phase) |
| (2) | Rated Voltage | 12 kV | |
| (3) | Discharge Current | 10 kA | |
| (4) | Applicable Standards | IEC | |
| 8. | Procurement and Installation of 33 kV Power Cables | (for system connection and station use) | 1 lot |
| (1) | Type | 36 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 $mm^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 9. | Procurement of 11 kV Power Cables (for connection with distribution line) | (for system connection and station use) | 1 lot |
| (1) | Type | 12 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 $mm^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 10. | Procurement and Installation of Low Voltage Power and Control Cables, etc. | | 1 lot |
| (1) | Power Cable | 600 V XLPE insulated; PVC sheath; copper conductor cable | |
| (2) | Control Cable | 600 V PVC insulated; PVC sheath; copper conductor cable | |
| (3) | Miscellaneous Materials for Wiring Work | Including materials for earthing work | |

Table 2-2-11 Planned Contents of 33 kV Honiara Switching Facilities

| Item No. | Item/Equipment | Specifications | Quantity |
|---|---|---|---|
| 1. | Construction of Auxiliary Facilities | | |
| (1) | Foundations for Switchgears, etc. | | 1 lot |
| 2. | Procurement and Installation of 33 kV Switchgear | | 6 |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; 36 kV, 630 A, 25 kA; one second; drawer type; synchronisation check relay; earthing switch | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| 3. | Procurement of 33 kV Disconnecting Switch | | 1 set |
| (1) | Type | Outdoor type; vertical single-break; rod for ground handling | |
| (2) | Rated Voltage/Current | 36 kV/630 A (25 kA) | |
| (3) | Applicable Standards | JIS/JEC/JEM | |
| 4. | Procurement of 33 kV Arrester | (for system connection) | 3 |
| (1) | Type | Outdoor gapless type with 3 phase general surge counter | (one/phase) |
| (2) | Rated Voltage | 36 kV | |
| (3) | Discharge Current | 10 kA | |
| (4) | Applicable Standards | IEC | |
| 5. | Procurement and Installation of Low Voltage Panel | | 1 |
| (1) | Type | Enclosed outdoor type; air insulation system | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Battery | Enclosed lead battery 110 V (power supply duration: one hour) with DC distribution board | |
| 6. | Procurement and Installation of 33 kV Power Cables | (for system connection and station use) | 1 lot |
| (1) | Type | 36 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 $mm^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 7. | Procurement and Installation of Low Voltage Power and Control Cables, etc. | | 1 lot |
| (1) | Power Cable | 600 V XLPE insulated; PVC sheath; copper conductor cable | |
| (2) | Control Cable | 600 V PVC insulated; PVC sheath; copper conductor cable | |
| (3) | Miscellaneous Materials for Wiring Work | Including materials for earthing work | |

Table 2-2-12 Planned Contents of 33 kV White River Substation

| Item No. | Item/Equipment | Specifications | Quantity |
|---|---|---|---|
| 1. | Construction of Auxiliary Facilities | | |
| (1) | Outdoor Lighting | Natrium lamp 250 W, 6 m high with individual photocell switch | 1 lot |
| (2) | Fencing and Gate | Including an oil separating tank and fire walls | 1 lot |
| (3) | Cable Pit and Storm Water Drainage, etc. | | 1 lot |
| (4) | Foundations for Step-Down Transformer and Switchgears, etc. | | 1 lot |
| 2. | Procurement and Installation of Step-Down Transformer | | 1 set |
| (1) | Type | Outdoor type; oil immersed self cooling; on-load tap changer; 12 kV 10 kA; arrester to be installed inside the cable box; three phase general surge counter | |
| (2) | Rated Capacity/Voltage | 5 MVA; 33/11 kV; three phase | |
| (3) | Applicable Standards | IEC/JEC | |
| 3. | Procurement and Installation of 33 kV Switchgear | | 3 |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; 36 kV, 630 A, 25 kA; one second; drawer type; synchronisation check relay; earthing switch | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| 4. | Procurement and Installation of 11 kV Switchgear | | |
| (1) | Type | Enclosed outdoor type; air insulation system; vacuum circuit breaker; draw out type | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Details | 1) For power receiving (12 kV, 630 A, 20 kA, one second) | 1 |
| | | 2) For distribution (12 kV, 630 A, 20 kA, one second) with automatic reclosing facility | 3 |
| | | 3) For station transformer (12 kV, 630 A, 20 kA, one second) with earthing apparatus | 1 |
| 5. | Procurement and Installation of Low Voltage Panel | | 1 |
| (1) | Type | Enclosed outdoor type; air insulation system | |
| (2) | Applicable Standards | IEC/JIS/JEM | |
| (3) | Battery | Enclosed lead battery 110 V (power supply duration: one hour) with DC distribution board | |
| 6. | Procurement of 11 kV Line Switch | | 3 sets |
| (1) | Type | Outdoor type; vertical single-break disconnector; rod for ground handling | |
| (2) | Rated Voltage/Current | 12 kV/600 A (20 kA) | |
| (3) | Applicable Standards | JIS/JEC/JEM | |
| 7. | Procurement of 11 kV Arrester | (for system connection) | 9 |
| (1) | Type | Outdoor gapless type with 3 phase general surge counter | (one/phase) |
| (2) | Rated Voltage | 12 kV | |
| (3) | Discharge Current | 10 kA | |
| (4) | Applicable Standards | IEC | |
| 8. | Procurement and Installation of 33 kV Power Cables | (for system connection and station use) | 1 lot |
| (1) | Type | 36 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 mm$^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 9. | Procurement of 11 kV Power Cables (for connection with distribution line) | (for system connection and station use) | 1 lot |
| (1) | Type | 12 kV 3 core aluminium conductor cable; XLPE insulated; PVC sheath; armoured | |
| (2) | Applicable Standards | IEC | |
| (3) | Size | 70 mm$^2$ (3 core) | |
| (4) | Accessories | Terminal treatment material and others | |
| 10. | Procurement and Installation of Low Voltage Power and Control Cables, etc. | | 1 lot |
| (1) | Power Cable | 600 V XLPE insulated; PVC sheath; copper conductor cable | |
| (2) | Control Cable | 600 V PVC insulated; PVC sheath; copper conductor cable | |
| (3) | Miscellaneous Materials for Wiring Work | Including materials for earthing work | |

3-2) 33 kV Transmission Lines

① Selection of Routes

The transmission routes have been decided based on the results of (i) examination of the transmission, distribution, telephone, water supply and sewerage route diagrammes and maps obtained from the SIEA, (ii) field reconnaissance jointly conducted with SIEA engineers and (iii) confirmation of the locations of cable conduits at bridges and of obstacles on the possible routes. The basic routes are included in 2.2.3 - Basic Design Drawings.

② Type of Conductor to be Used for Transmission line

32 kV aluminium cable, which is the standard cable used by the SIEA for 33 kV transmission, will be used for the planned transmission routes under the Project. More detailed specifications are shown in Table 2-2-13.

Table 2-2-13 Specifications of 33 kV Transmission Cable

| Item | Specifications | Remarks |
|---|---|---|
| 33 kV Transmission Cable | 36 kV; aluminium conductor; XLPE insulated; PVC sheath; 50 $mm^2$ (3 core); armoured | Must satisfy the line capacity of 5 MVA and short circuit capacity of 4,000 A and one second. The size of the cables used for the Ranadi S/S will be the same as the existing cables of 70 $mm^2$ for their connection with the existing trunk distribution network. |

Note: XLPE: cross linked – polyethylene – insulated wire
PVC: polyvinyl chloride

The procurement quantity of conductors for the transmission lines is calculated by multiplying the plane distance measured on the map (design quantity) by the margin of safety of 1.03. The resulting quantity of the 33 kV transmission cable to be procured and installed under the Project is shown in Table 2-2-14.

Table 2-2-14 Procurement Quantity of 33 kV Transmission Cable

(Unit: m)

| Item | | Between Lungga P/S and 33 kV Honiara East S/S | Between Honiara P/S and 33 kV White River S/S | Total |
|---|---|---|---|---|
| 33 kV Transmission Cable | ① Design Quantity | 4,200 | 4,200 | 8,400 |
| | ② Planned Procurement Quantity (① x 1.05) | 4,410 | 4,410 | 8,820 |
| | ③ Planned Quantity for Installation (① x 1.03) | 4,330 | 4,330 | 8,660 |

③ Laying Method

The 33 kV transmission cables to be procured under the Project will be directly laid under the ground except at road crossing sections where a conduit will be introduced in view of better maintainability of the cable. In principle, the laying depth will be one metre below the ground surface and a sheet indicating the presence of laid cable will be placed above the laid cable (at an approximate depth of 30 cm from the ground surface). The routes will run along the right of way within 15 m of the centre of the existing road in accordance with the relevant SIEA standard.

The planned routes involve a river crossing at two sites (Honiara River and White River). At these sites, a steel conduit will be attached to the existing bridge girders for laying of the cable inside for the purpose of safety. There is a potential hazard of items and remains from the Second World War being buried along the planned routes. For this reason, the Solomon Islands side must check for any buried items along the planned routes with a view to the disposal of dangerous items by a professional body prior to the commencement of the cable laying work.

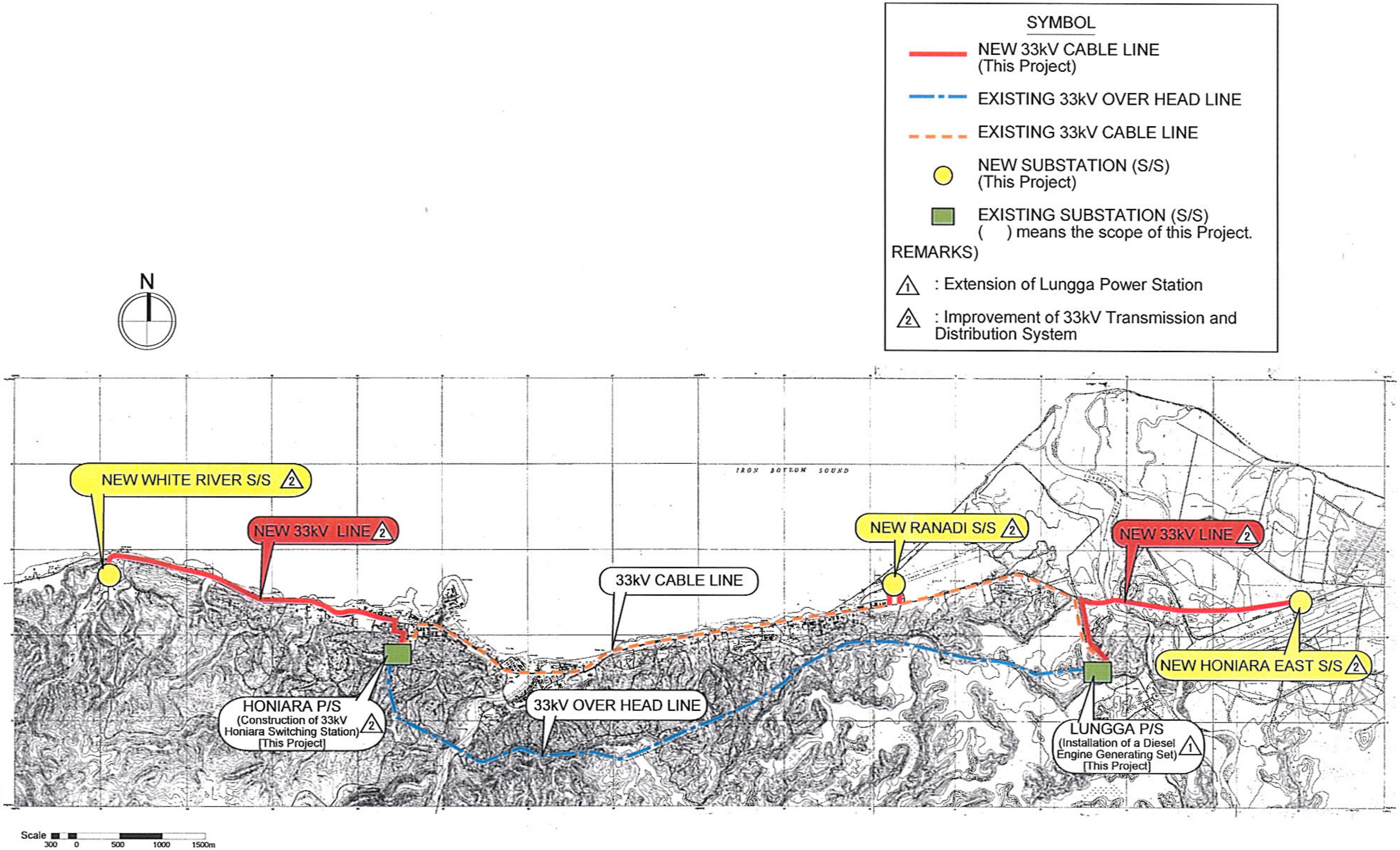
④ Maintenance

A cable fault pointer will be provided under the Project to make fault point investigation at the time of a fault with a buried cable easier for quick restoration.

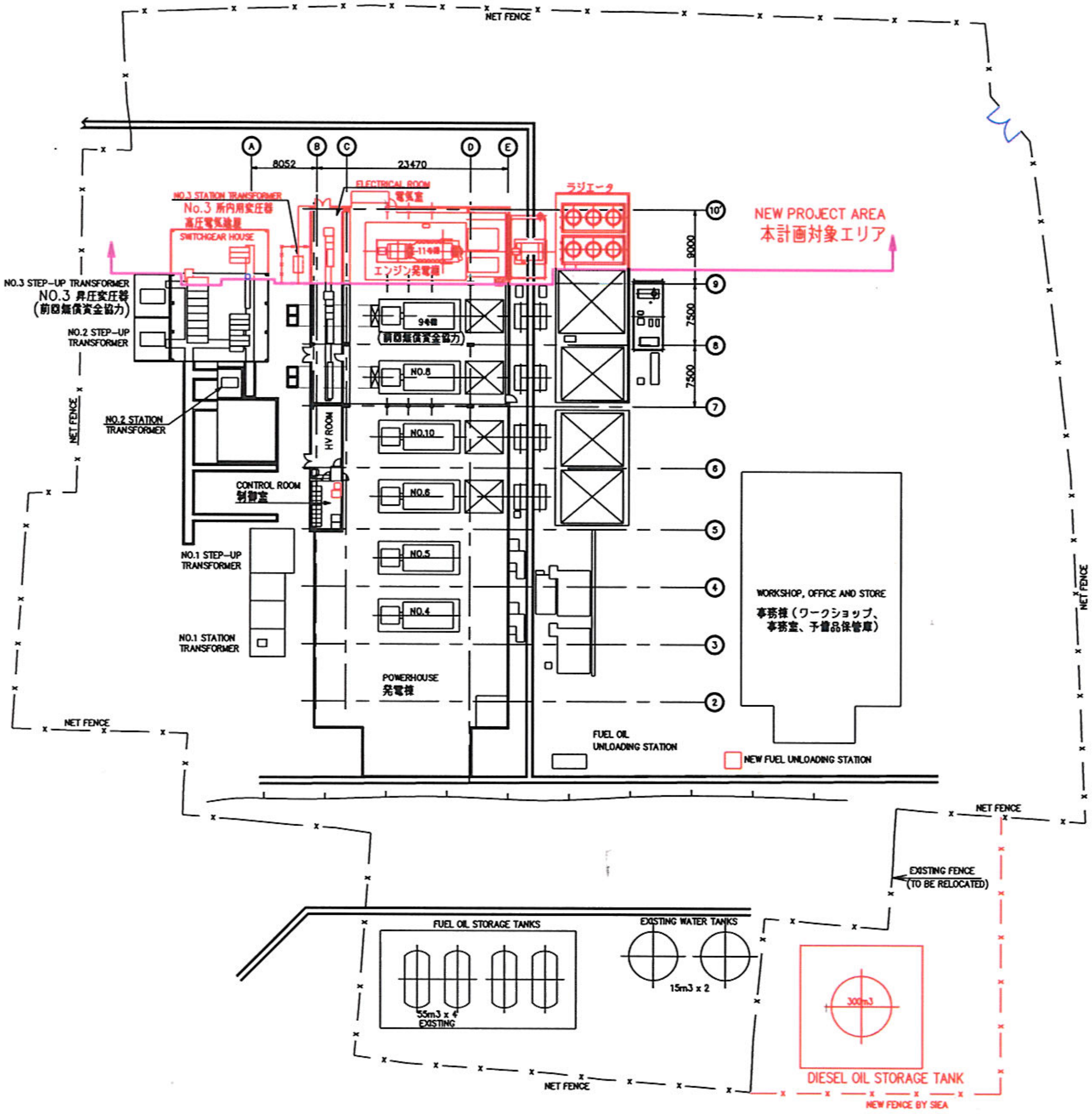
### 2.2.3 Basic Design Drawings

The following basic design drawings have been prepared for the Project.

| Category | Drawing No. | Title |
|---|---|---|
| Overall Plan | D-01 | 33 kV Honiara Power Network |
| Extension of Lungga P/S | G-201<br>G-202<br>A-003<br>E-201<br>M-201 | General Arrangement of Lungga Power Station<br>Arrangement of New DEG Unit<br>Lungga P/S: Extension of Powerhouse: Elevation<br>Lungga P/S: Key Single Line Diagram<br>Lungga P/S: Key Flow Diagram |
| Improvement of Transmission and Distribution System | D-G01<br>D-G02<br>D-G10<br>D-G12<br>D-G12<br>D-G13<br>D-G20<br>D-02<br>D-03 | 33 kV Cable Route Map from: Lungga P/S to Honiara East S/S<br>33 kV Cable Route Map from Honiara P/S to White River S/S<br>Layout of Ranadi S/S<br>Layout of Honiara East S/S<br>White River S/S: Layout Plan<br>Honiara P/S: Layout Plan of 33 kV SWGR<br>Honiara P/S: Improvement Plan of 33 kV System<br>Key Single Line Diagram: Honiara P/S and White River S/S<br>Key Single Line Diagram: Ranadi S/S and Honiara East S/S |



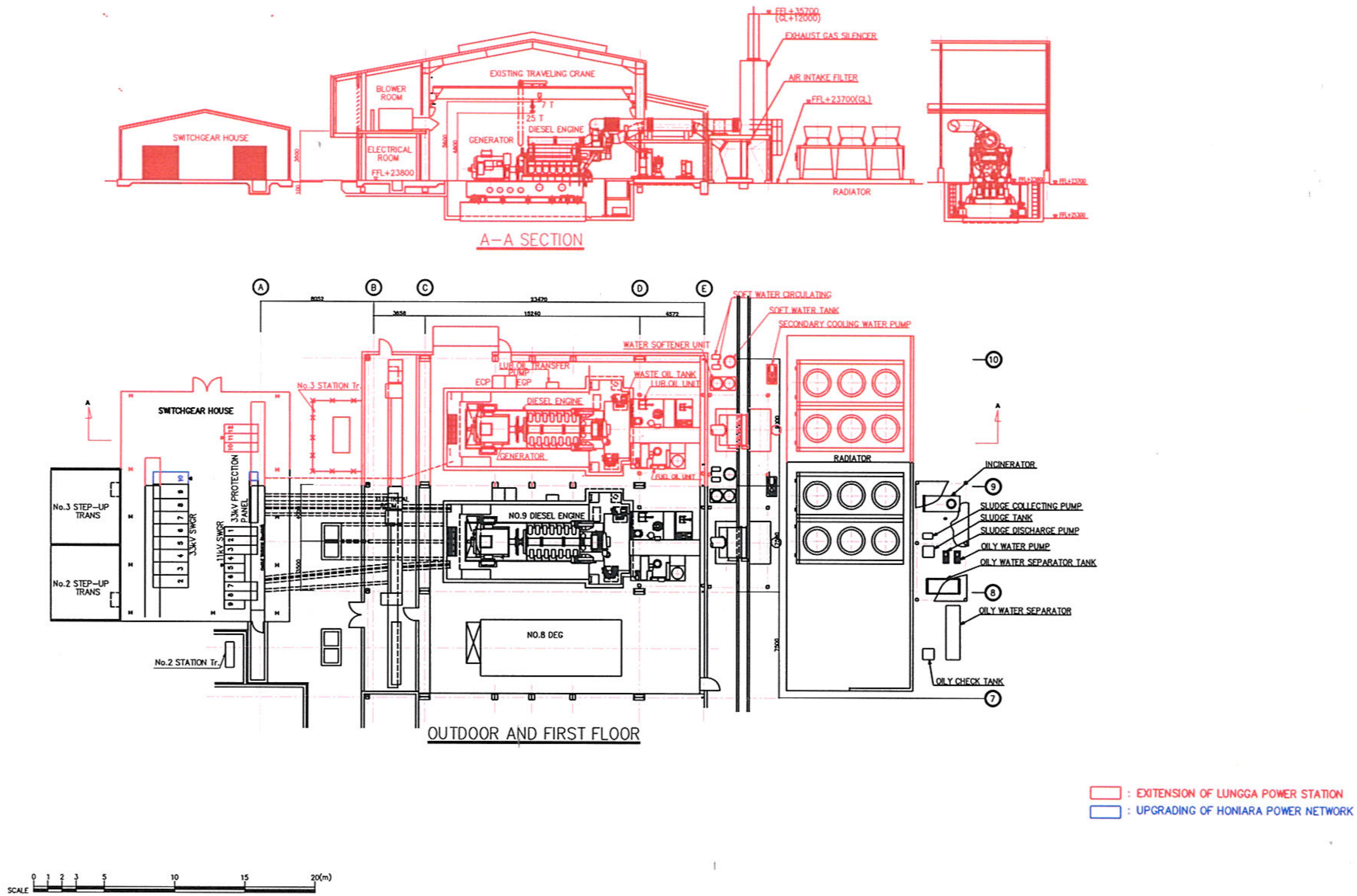

D-01 33kV Honiara Power Network



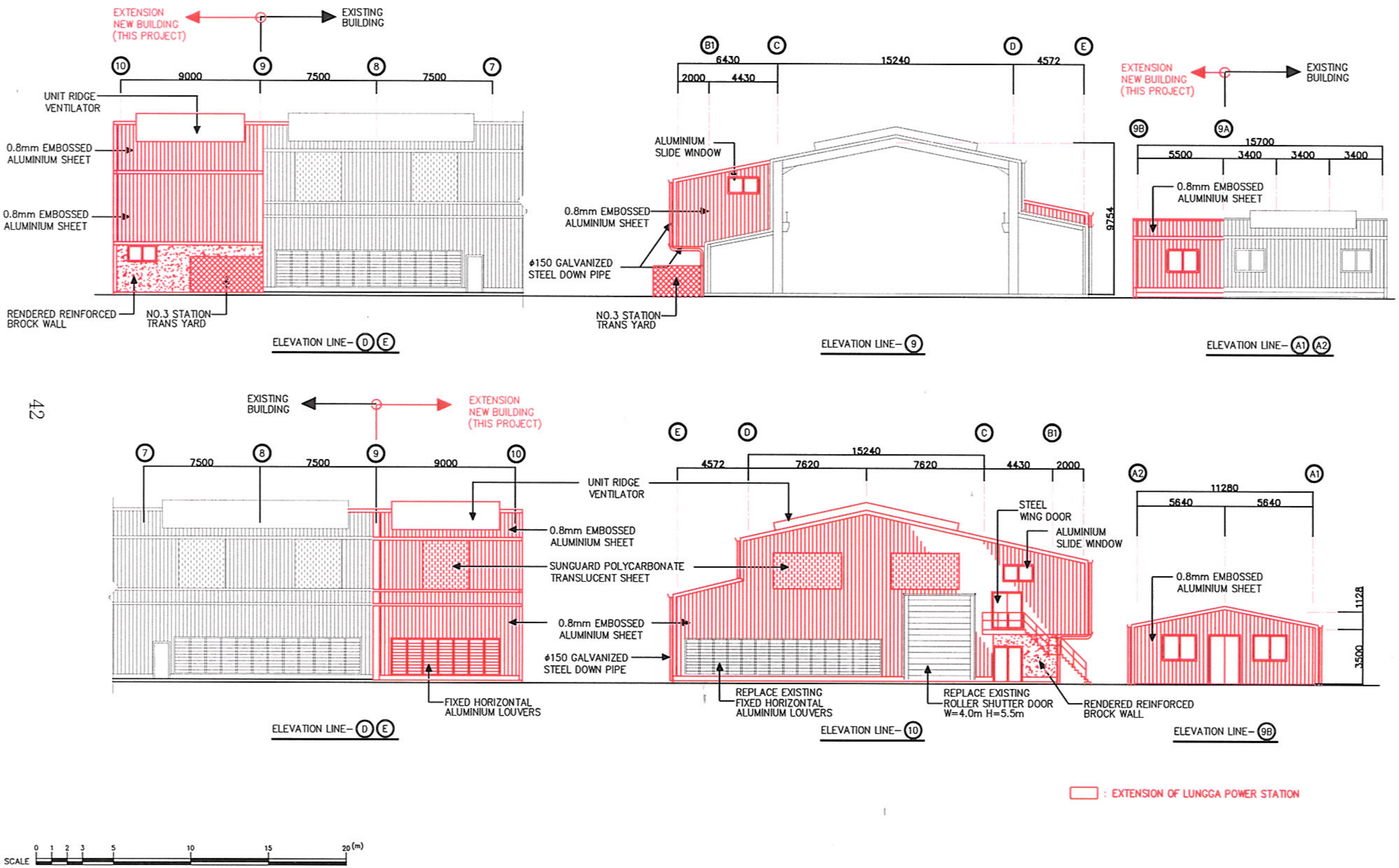

備考
1. □ : 本計画対象発電設備
THIS PROJECT( GENERATING FACILITY)
2. □ : 本計画対象配電設備
THIS PROJECT( TRANSMISSION FACILITY)

SCALE 0 1 2 3 5 10 15 20(m)

G-201 ルンガ発電所:全体配置図
GENERAL ARRANGEMENT OF
LUNGGA POWER STATION

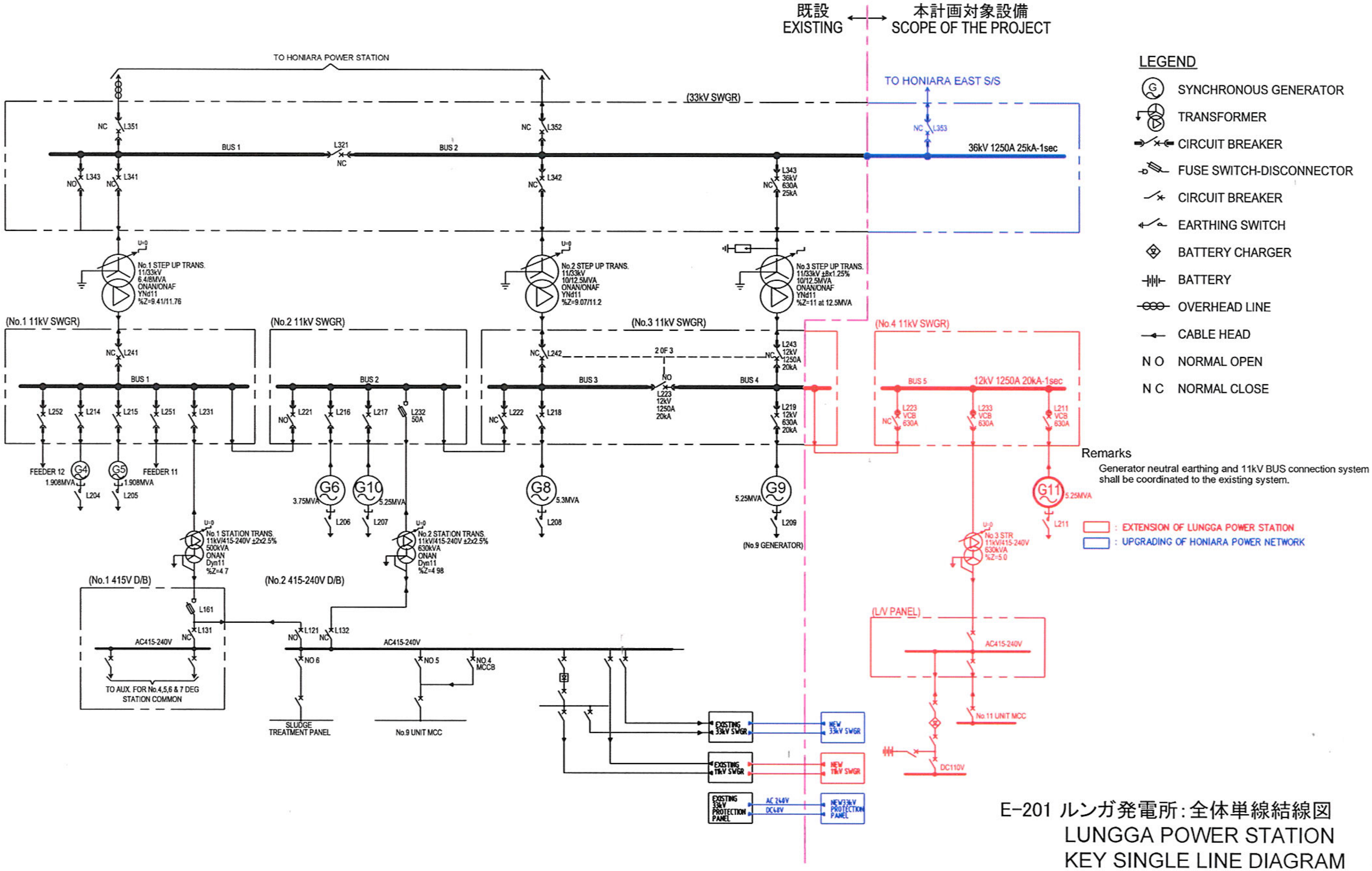



G-202 ルンガ発電所:発電設備配置図
ARRANGEMENT OF NEW DEG UNIT




A-003 ルンガ発電所:増設建屋立面図

LUNGGA P/S EXTENSION OF POWERHOUSE・ELEVATION




E-201 ルンガ発電所:全体単線結線図
LUNGGA POWER STATION
KEY SINGLE LINE DIAGRAM

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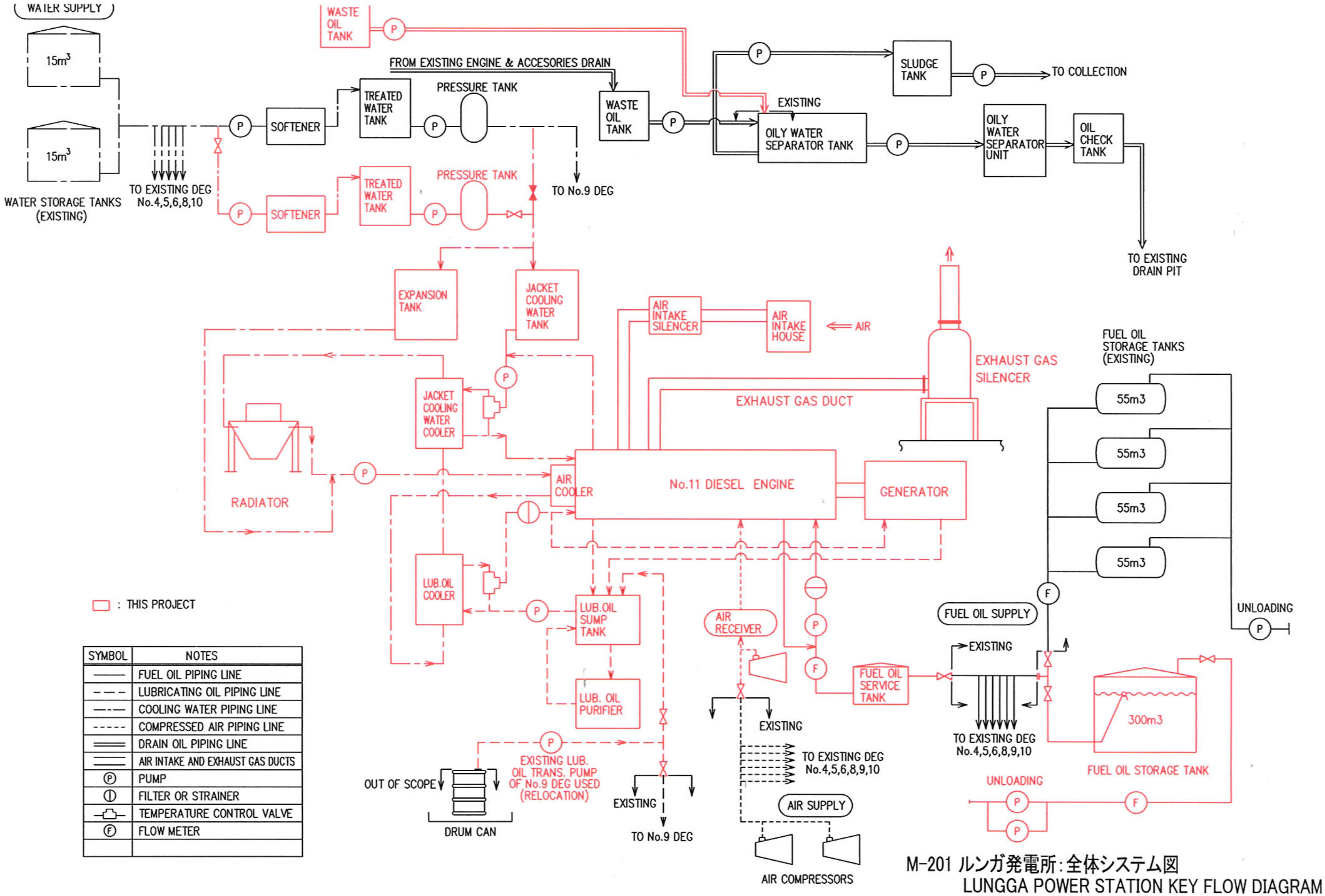


| SYMBOL | NOTES |
|---|---|
| ——— | FUEL OIL PIPING LINE |
| — — — | LUBRICATING OIL PIPING LINE |
| —·—·— | COOLING WATER PIPING LINE |
| - - - - - | COMPRESSED AIR PIPING LINE |
| ═══ | DRAIN OIL PIPING LINE |
| ═══ | AIR INTAKE AND EXHAUST GAS DUCTS |
| Ⓟ | PUMP |
| ⦶ | FILTER OR STRAINER |
| —⌂— | TEMPERATURE CONTROL VALVE |
| Ⓕ | FLOW METER |
| | |

M-201 ルンガ発電所:全体システム図
LUNGGA POWER STATION KEY FLOW DIAGRAM