BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
LUNGGA POWER GENERATION DEVELOPMENT
IN
SOLOMON ISLANDS

MARCH, 1998

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.

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PREFACE

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

JICA sent to Solomon Islands a study team from November 16 to December 10, 1997.

The team held discussions with the officials concerned of the Government of 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 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 Solomon Islands for their close cooperation extended to the teams.

March, 1998

Kimio Fujita
President
Japan International Cooperation Agency

March, 1998

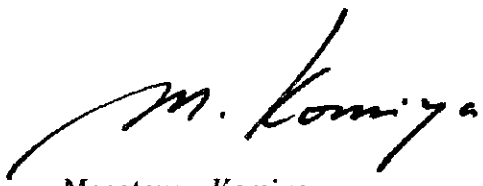
LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Lungga Power Generation Development in Solomon Islands.

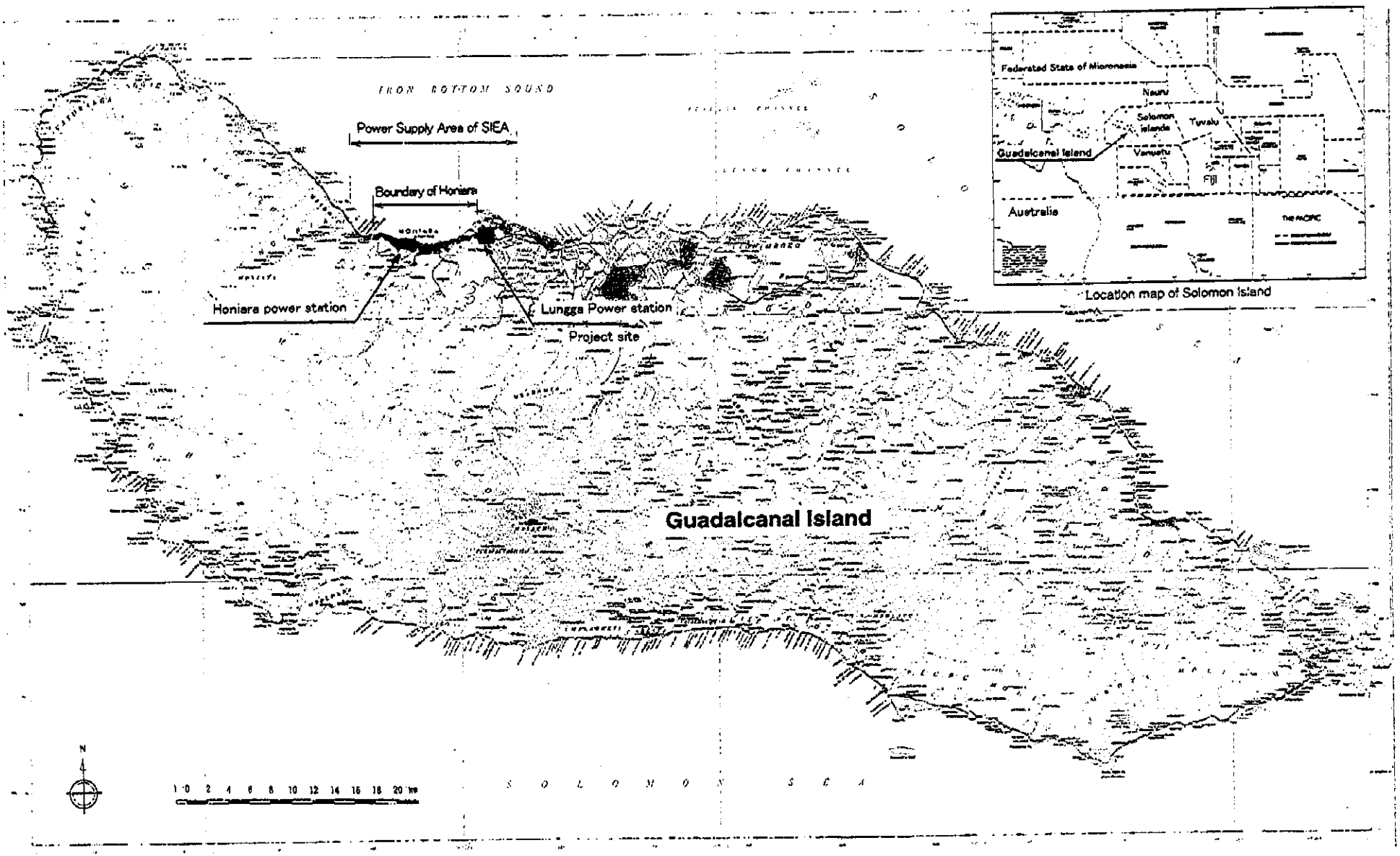
This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from November 11, 1997 to March 31, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Solomon Islands and 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 Lungga Power
Generation Development
Yachiyo Engineering Co., Ltd.



SITE LOCATION MAP

ABBREVIATIONS

DEG	Diesel Engine Generator
E/N	Exchange of Notes
GDP	Gross Domestic Product
GNP	Gross National Product
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
MME	Ministry of Mines and Energy
O & M	Operation and Maintenance
OJT	On-the-Job Training
OLTC	On-Load Tap Changer
SIEA	Solomon Islands Electricity Authority

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CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

The Solomon Islands are a constitutional sovereign state which gained independence in July, 1978. They are located to the southeast of Bougainville Island of Papua New Guinea and constitute an island country consisting of six major islands and some 100 smaller islands. The Solomon Islands have 10 administrative areas, i.e. the capital and nine provinces. The total land area is approximately 28,450 km^2 with a population of approximately 384,000 (1996 estimate).

The economy of the Solomon Islands depends on such primary products as fish, timber and palm oil and is, therefore, significantly affected by price fluctuations of the international market. The expenditure of the government exceeds its revenue and the small budget size means that investment in development almost exclusively relies on foreign assistance.

The political and economic centre of the Solomon Islands is the capital of Honiara (population of 37,160: 1995 statistics) on Guadalcanal Island. The power demand in Honiara has noticeable increased in recent years due to the concentration of a population and the incresing of commercial facilities. While the generation capacity has not increased since 1993, the maximum power demand has been steadily increasing at an annual rate of 7.7% in the last five years, reaching 9.7 MW in 1996.

The Lungga Power Station and Honiara Power Station, both owned and run by the SIEA, supply Honiara with power. However, the power supply of the generating facilities of these power stations is unable to meet the increasing demand as their deterioration and excessive operation have reduced the available output (total of approximately 10 MW) to some 67% of the rated output (total of 14.9 MW).

Facing a power supply shortage, the SIEA introduced restrictive measures around 1995, including limited power connection for new users and reduced power supply for existing users, and has somehow managed to continue power supply operation. There is currently no surplus power supply capacity which is necessary for stable power supply. When a generator (unit No. 8, 4.2 MW which is 40% of total available capacity) recently broke down, the SIEA was forced to restrict power supply by means of planned power cuts, causing frequent blackouts in not only the government, commercial and industrial quarters but also in all other parts of the capital. This extremely tight power supply situation is causing much confusion in the lives of the public as well as socioeconomic activities.

In the meantime, the electricity demand in the city has been conspicuously increasing. The demand forecast for 1999 is approximately 15.4 MW which is expected to increase to approximately 16.2 MW by 2001, the target year of the Project. In order to provide a sufficient generating capacity to meet this demand, the Government of the Solomon Islands is attempting to install new power generation facilities (rated output of 1.5 MW x three units) at the Honiara Power Station with the financial assistance of the Government of Taiwan and is also planning to replace the broken-down engine of the No. 6 Unit at the Lungga Power Station with a new unit (rated output of 2.8 MW) with its own funding. Of these, the three units (1.5 MW each) to be installed at the Honiara Power Station are high speed power generating units and are expected to operate as emergency units to cover the breakdown or repair of other units or as units to cater for the peak load. Therefore, they cannot be expected to operate as base load units.

On the other hand, it is foreseen that a total available output in the city in 2001 will be approximately 12.2MW considering the deterioration of the existing units and additional capacity of Lungga No.6 unit.

While this situation indicates the urgent necessity to establish a new base load supply capacity, the tight fiscal situation of the Government of the Solomon Islands makes the procurement of new generating facilities difficult. Against this background, the Government of the Solomon Islands has made a request to the Government of Japan for the provision of grant aid for the project for Lungga Power Generation Development (hereinafter referred to as the Project). The contents of the request are the procurement and installation of the following equipment.

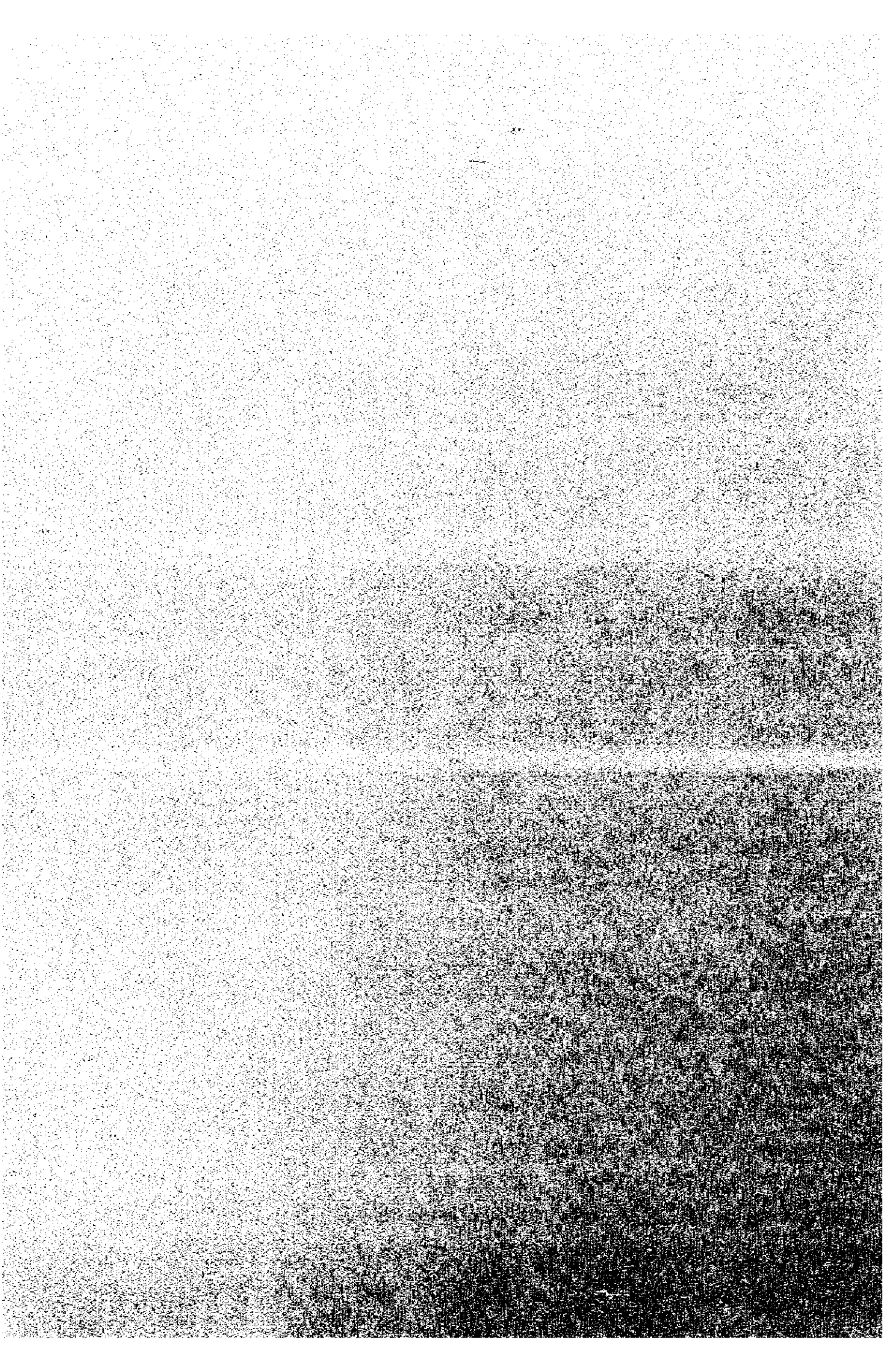
- Diesel Engine Generator (DEG) : one unit (4.2 MW)
- Main Transformer : one set (11/33 kV, 10/12.5 MVA)
- Control Panels : two units
- Indoor Protection Panels : two units (one for generator and one for transformer)
- Switchboards : four units (three for 11 kV and one for 33 kV)
- Main Fuel Tank : one unit (55 m^3)

It has been agreed to withdraw the main fuel tank, originally requested by the Government of the Solomon Islands as an addition to the existing main fuel tanks (55 m^3 x 4), from the scope of the Japanese grant aid due to the following reasons.

① The existing fuel tanks are owned by the private sector and it has not been confirmed that the ownership of these tanks will be transferred to the SIEA in the future.

② The distance of some 5 km between the oil storage base at Port Honiara and the Project site can be easily covered by a tank lorry. The increased frequency of transportation does not pose any problem, negating the urgency to construct a large fuel tank which can store the two weeks consumption volume referred to earlier.

CHAPTER 2 CONTENTS OF THE PROJECT



CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Objectives of the Project

The Government of the Solomon Islands believes that improvement of the power supply in Honiara, which is an important social infrastructure component in the capital, is an urgent task. The objective of the Project is to improve the power supply conditions urgently, in order to install new diesel generating facilities at the Lungga Power Station, which is Honiara's core power station, with a target year of 2001 as part of the measures to increase the base load power supply in the capital.

2-2 Basic Concept of the Project

As described in Chapter 1, the actural power supply capacity of the Lungga and Honiara Power Stations, however, falls below the demand as the deterioration and excessive operation of the DEGs at these stations have reduced the total rated output. In order to deal with the power supply shortage situation, the SIEA introduced restrictive measures including limited power connection for new users and reduced power supply for existing users. When the Lungga Power Station's No. 8 Unit, the current output of which of 4.2 MW is the largest of all the generating units and which meets some 40% of Honiara's power demand, broke down at the end of November, 1997, the SIEA had no alternative but to restrict the power supply by means of planned power cuts, causing frequent blackouts in the government, commercial and industrial quarters as well as all other parts of the capital. This extremely tight and unreliable power supply situation is causing much confusion in the lives of the public as well as socioeconomic activities.

In order to improve these circumstance, the Government of the Solomon Islands is attempting to install new power generation facilities (1.5 MW x three units) at the Honiara Power Station and is also planning to replace the broken-down engine of the No. 6 Unit at the Lungga Power Station with a new unit (2.8 MW). However, it is estimated that the conspicuous power demand increase will reach some 16 MW in 2001, requiring the urgent expansion of new power supply facilities. Despite this pressing need, the country's tight fiscal situation is making it difficult for the government to procure new generating facilities.

The requested DEG unit (4.2 MW) under the Project will become the No. 9 Unit of the Lungga Power Station in accordance with the Corporate Plan which was prepared by SIEA as a power development plan. The proposed generating capacity of this unit is suitable for base load supply

in Honiara in the Project's target year of 2001 and will greatly contribute to the urgent improvement of the tight power supply and also to the establishment of a stable power supply capability in Honiara.

Based on the above analysis, the basic concept of the Project is to avoid urgently in order to procure and install diesel generating facilities (4.2 MW x 1 unit) to establish new power supply facilities which constitute important social infrastructure in the capital of Honiara which acts as the centre for socioeconomic activities in the Solomon Islands with a view to improving the lives of the public and bringing about stable socioeconomic activities in the city.

2-3 Basic Design

2-3-1 Design Concept

(1) Natural Conditions

1) Temperature and Relative Humidity

The project site is characterised by an oceanic tropical climate and the temperature of approximately 31°C is high throughout the year with equally high relative humidity of 80 - 90%. As the engine and generator to be procured under the Project will be installed indoors, there is no need for any special measures in regard to temperature and relative humidity. However, a design temperature of 35°C is adopted for building ventilation and combustion air of the engine while a design temperature of 40°C is adopted for outdoor facilities to ensure the proper functioning of both indoor and outdoor facilities.

2) Earthquakes

The Solomon Islands are located in a seismic zone and an earthquake with a magnitude of 7.6 on the Richter scale has occurred in the past near Guadalcanal Island. Therefore, seismic design conditions of a lateral seismic factor of 0.25 G are adopted for the Project to ensure facility safety.

(2) Local Construction Industry

There are several general construction companies in Honiara which are run by Australian or New Zealand engineers. These are mainly engaged in civil and building works and have some 130 - 200 employees each. As the local level of construction activities involving power generation and other plants is low, these local construction companies have no direct

foreign construction companies. However, the local employment of labour, transportation vehicles and small construction machinery is possible. As small-scale civil and building works can be directly entrusted to a local construction company, the use of such a local company for the Project is planned.

As the generating unit to be procured under the Project will be installed next to the operating unit of the existing power station, safety measures such as temporary protection wall, must be introduced to prevent damage to the existing facilities and also to protect workers from the existing units, during the construction period.

(3) Use of Local Construction Companies and Materials

1) Use of Local Construction Companies

As already described in (2) above, local construction companies have no direct experience of installing large generating units. Accordingly, the use of these companies for the Project will be mainly restricted to the provision of construction machinery and labour as far as the planned installation of the generating unit is concerned. The dispatch of Japanese engineers to conduct quality control, schedule control, safety control, testing, adjustment, etc. will be necessary. Although it is difficult to locally obtain heavy machinery, including a 100 ton class large crane, a locally available 35 ton class crane and 50 ton trailer will be used for transportation of construction materials as well as heavy cargo (engine about 50 ton).

2) Use of Locally Available Materials

The local procurement of aggregate, cement, reinforcing bars, etc. for the civil engineering and building works is possible. However, some materials for the mechanical and electrical work, such as pipes and cables for the generating unit, are not locally available. Consequently, their procurement from Japan or third countries will be planned.

3) Procurement from Third Countries

The procurement of equipment or materials related to the generating unit from third countries will take their prices, quality, delivery reliability, ease of purchasing spare parts, etc. after commissioning of the generating unit, after-service system and compatibility with the existing facilities into consideration.

(4) Maintenance Capability of Project Implementation Body

The operation and maintenance of the new generating unit after its commissioning will be conducted by a team of 25 staff members (18 mechanical staff members and 7 electrical staff members) led by the head of the Power Generation Division, of the SIEA as in the case of the existing facilities. Although this Division has not yet had the experience of overhauling the No. 8 Unit (the rated output capacity of which is the same as that of the new unit under the Project: 4.2 MW) at the Lungga Power Station due to the fact that the operation hours necessitating an overhaul have not yet been reached, it has overhauled other units without external assistance, indicating that it has the skill to conduct daily maintenance and other basic maintenance work. Operation of the Lungga Power Station is conducted by three shifts (2 - 3 persons/shift) led by a high school graduate engineer with six years or more practice experience and the assignment of staff appears adequate. One problem is that the instruments to measure the output, etc. are not calibrated, leading to a lack of accurate operational records.

In view of the above situation, an appropriate instrumentation system for the new generating unit to facilitate operation and maintenance will be installed under the Project. Also it is recommended to conduct OJT on the operation and maintenance of the new generating unit by Japanese engineers, during the construction period to ensure the efficient operation of the said unit.

(5) Scope and Technical Grades of Facilities, Equipment and Materials

The scope for the procurement and installation of the facilities, equipment and materials and their technical grades are determined based on the following principles, taking the conditions described in (1) - (4) above into consideration.

1) Scope of Facilities, Equipment and Materials

The new generating unit to be procured under the Project will have a sufficient generating capacity to urgently supplement the base load operation to meet the power demand in Honiara in 2001. It will have a generating capacity of some 25% of the total power demand of the power supply system, a level which is generally accepted as an efficient power generating capacity of a single unit at a power station in an island country where the service area is relatively small, and the configuration of the new facility will be such as to ensure its efficient and economical operation and maintenance.

2) Technical Grades

The specifications of the equipment constituting the generating unit to be procured under the Project will be carefully determined so that they are not beyond the technical capability of the SIEA which will be responsible for the operation and maintenance of the said equipment after commissioning of the new unit.

2-3-2 Basic Design

(1) General

1) Design Conditions

The following design conditions are adopted for the scale and specifications of Facilities, Equipment and Materials for the Project, following examination of the various conditions described in 2-3-1 above.

① Construction Site, Location and Altitude

a) Construction site: existing Lungga Power Station premises (for No. 9 DEG)

b) Altitude: 24m above sea level

② Climatic and Other Natural Conditions

a)	Design temperature :	for indoor facilities - 35°C (maximum) for outdoor facilities - 40°C (maximum)
b)	Design relative humidity :	maximum 100%
c)	Design wind velocity :	40 m/sec (instantaneous maximum wind velocity: 52 m/sec)
d)	Rainfall :	2,500 mm (annual average)
e)	Isokeraunic level (IKL) :	40 days/year
f)	Salt deposition equivalent density :	0.5 mg/cm^2
g)	Seismic force :	0.25 G for horizontal direction Nil for vertical direction
h)	Soil bearing capacity :	10 tons/m^2 (assumed)

③ Codes and Standards to be Applied

a) JIS : applied to general industrial products

b) JEC : applied to general electrical products

c) JEM : as above

d) JCS : applied to electrical wires and cables

e) Technical Standards on Electrical Facilities in Japan: applied to general electrical work

f) IEC : applied to general electrical products

g) ISO : applied to general electrical products and machinery

h) Australian Standards (AS) : applied to electrical cables and piping

④ Units

In principle, SI units are used.

⑤ Power System

The power system to be employed under the Project will conform to the existing system as shown in Table 2-3-1.

Table 2-3-1 Power 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	440 - 252 V	-
Wiring System	three phase three wire	three phase three wire	three phase four wire	two wire
Frequency	50 Hz	50 Hz	50 Hz	-
Earthing System	neutral direct earthing	neutral direct earthing	neutral direct earthing	positive (+) side earthing

⑥ Basic Impulsive Insulation Level

The following Basic Impulsive Insulation Levels (BIL) which are employed for the existing facilities will be applied in the design of the new transmission and substation facilities to ensure insulation coordination between equipment and also to ensure the insulation level of the entire network.

a) 33 kV system : BIL 170 kV

b) 11 kV system : BIL 75 kV

⑦ Environmental Protection Standards

The following reference standards will be employed as the design conditions for the Project, as relevant environmental standards are not yet in place in the Solomon Islands, taking the Japanese standards and local conditions into consideration.

a) NOx emission level : 950 ppm or less (at 13% O_2 dry)

b) SOx emission level : 250 ppm or less (at a sulphur content of fuel oil of 1%)

c) Oil contamination : 30 ppm or less

d) Particulates : 100 mg/Nm^3 or less

e) Sound noise level : 110 dB (A) or less during sole operation of the new generating unit (at a distance of 1 m from the unit)

f) Vibration : 65 dB or less at the site boundary during sole operation of the new generating unit

2) Layout Plan

The layout plan for the generating facilities and transmission and substation facilities to be installed under the Project is described below.

① Generating Facilities

The new generating facilities to be constructed under the Project will be installed in the area set aside for the No. 9 Unit in the existing power house building at the Lungga Power Station (see Basic Design Drawing G-01). The main components of the new generating facilities (engine, generator, low voltage motor control panel, etc.) will be installed inside the power house building using the existing 25 ton overhead travelling crane which has been installed for maintenance purposes. The locations of the air intake and exhaust ducts which run through the walls will be designed taking the locations of the beams columns, etc. of the existing building into consideration. The remote control panel will be installed in the expanded space of the existing control room in view of easy operation and maintenance.

As there are no existing foundations for the new engine and generator, new foundations will be constructed under the Project while the radiator will be installed outside the power house building. As the outdoor equipment, such as the radiator, fuel oil service tank, etc., of the new generating facilities will be installed on the existing concrete foundations. Therefore, such existing foundations will be reinforced if necessary.

② Electrical Equipment

The 33 kV and 11 kV high voltage panels will be installed at the side of the panels in the existing electrical house. The 11/33 kV main transformer (No. 3 Transformer) will be installed on the existing outdoor foundations designed to accommodate the No. 3 Main Transformer. The remote control panel for this transformer will be installed at the side of the generator remote control panel to be newly installed under the Project. The protective relay panel for the main transformer will be installed in the electrical room in the power house building as in the case of the DC 110 V equipment to be procured under the Project in view of easy operational control from the control room and also easy maintenance.

(2) Outline of Basic Design

The outline of the basic design for the Project is shown in Table 2-3-2 based on the basic design concepts, design standards and layout plan described in 2-3-1 and 2-3-2.

Table 2-3-2 Outline of Basic Design

Categories	Descriptions of the Design
Procurement and Installation	1. Procurement and installation of diesel engine generating unit (4.2 MW) 2. Procurement and installation of following mechanical systems for above generating unit • Fuel supply system • Lubricating oil filtering system • Air intake and exhaust system • Cooling water system • Compressed air system • Sludge treatment system 3. Procurement and installation of following electrical equipment for above generating unit (1) Auxiliary equipment for generator • Generator remote control panel (synchronising panel) • Generator protection relay panel • DC power supply system • Low voltage motor control panel (2) 11/33 kV high voltage electrical installation • 33 kV switchboard • 11/33 kV main transformer • 11 kV switchboard • Protective relay panel for main transformer • 11/33 kV remote control panel • 11 kV/0.415 kV station transformer • Cabling system 4. Procurement of spare parts and maintenance tools for generating unit and auxiliary equipment 5. Provision of operation and maintenance manuals for generating unit and auxiliary equipment and implementation of OJT
Remodelling of Existing Power House Building	1. Improvement of power house building (construction of duct through the wall, etc.) 2. Foundations for generator, engine, fuel oil service tank and auxiliary equipment

(3) Generating Facility Plan

The details of the new generating facilities to be installed at the Lungga Power Station are described below. The specifications of the equipment and facilities are outlined in Table 2-3-5.

1) Basic Items

① Selection of Generating System

A diesel engine generating unit has been selected in view of the type of existing power generation facilities 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 purchased from Mobil Oil. This fuel will be used for the new generating unit to be installed under the Project and the composition of this fuel is shown in Table 2-3-3.

Table 2-3-3 Fuel Composition (Diesel Oil)

Item	Unit	Testing Method	Result
Specific Gravity	15/4	JIS K 2249	0.853
API (60°F)	°C	-	34.30
Aniline Point	°C	JIS K 2256	71
Flash Point	°C	JIS K 2265	80 (PMC)
Viscosity 50°C	C St	JIS K 2283	2.9
Viscosity 100°C	C St	JIS K 2283	1.38
Pour Point	°C	JIS K 2269	-10 or less
Chemical Reaction	-	JIS K 2252	neutral
Sulphur Content	wt %	JIS K 2541	0.17
Water Content	wt %	JIS K 2275	0.02 or less
Ash Content	wt %	JIS K 2272	0.01 or less
Residual Carbon Content	wt %	JIS K 2270	0.01 or less
Hydrogen Content	wt %	-	13.0
Nitrogen Content	wt %	JIS K 2609	0.04
Sediment	wt %	JIS K 2601	0.01 or less
Diesel Index	-	-	54.8
Total Calorific Value	kcal/kg	JIS K 2279	10,780
Net Calorific Value	kcal/kg	JIS K 2279	10,080

Source: Fuel Analysis Results of Study Team

③ Composition of Lubricating Oil

The recommended composition of lubricating oil varies depending on the diesel engine manufacturer. As the existing power stations purchase lubricating oil from Mobil Oil as in the case of fuel oil, the use of a lubricating oil which can be supplied by Mobil Oil is recommended for a new unit.

④ Cooling Water

Cooling water for the existing Lungga Power Station is supplied by the city water supply system for Honiara. When the volume is in short supply due to the suspension of water supply, etc., supplementary water is extracted from a nearby well. Although rain water cooling system can be considered, this idea should not be suitable because double cooling system (city water and rain water) makes

complicated maintenance works. Therefore, he existing water supply will be used for the new generating unit, branching out from the reserve valve of the existing cooling water system located near the planned installation site of the new generating unit. The analysis results of the cooling water currently used are shown in Table 2-3-4.

Table 2-3-4 Cooling Water Analysis Results

Analysis Item	Unit	Result
pH (at 20°C)	-	8.2
Electric Conductivity (at 25°C)	μS/cm	990
Alkalinity (as $CaCO_3$)	mg/litre	420
Total Hardness (as $CaCO_3$)	mg/litre	126
Calcium Hardness (as $CaCO_3$)	mg/litre	83
Magnesium Hardness (as $CaCO_3$)	mg/litre	43
DS	mg/litre	600
COD	mg/litre	1.0
T-Fe	mg/litre	0.3 or less
Mn	mg/litre	0.05 or less
SiO_2	mg/litre	35
Cl^-	mg/litre	84
SO_4^{2-}	mg/litre	7.5
Langelier Index	-	+0.71

Source: Water Analysis Results of Study Team

The total hardness of 126 mg/litre shown in Table 2-3-4 suggests that while water can be used as drinking water based on Japan's water quality standard (300 mg/litre), it is unsuitable for radiators or primary cooling unit because of the possible accumulation of scales due to its high hardness level. A water softener will, therefore, be installed under the Project to reduce the total hardness to approximately 10 mg/litre or less, same as the existing units.

2) Design Criteria

① 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 new power supply capacity. As the Lungga Power Station is the most important power station responsible for base supply for Honiara, the capacity of the new generating unit must be decided taking the future operation system into consideration. Accordingly, the capacity of the new generating unit has been decided to meet the following conditions.

- To secure a stable power supply in the future (target year: 2001) to meet the demand forecast.
- To secure a reserve supply capacity (the reserve generating capacity should be capable of supplementing the generating capacity of the largest generating unit of the system when such a unit breaks down or when the operation of such a unit is suspended for maintenance purposes)

The experience of Japanese electric power companies indicates that the 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 - 30% 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 used.

As the estimated maximum power demand in Honiara in the Project's target year of 2001 is approximately 16.2 MW, the optimal generating capacity of a single unit is approximately 4 MW (approximately 25% of the maximum power demand) based on the above criterion. In the same target year, the total available output of the generating units in Honiara will be some 20.9 MW, including the rated output of the new generating unit to be installed under the Project (4.2 MW). The resulting supply and demand balance (total available output - maximum power demand) will be approximately 4.6 MW which is equivalent to the generating capacity of the largest generating unit of the power supply system in Honiara, i.e. the No. 8 Unit at the Lungga Power Station (rated output: 4.5 MW, current output: 4.2 MW), securing the required reserve supply capacity. Therefore, it can be judged that the capacity of the generating unit (4.2 MW x one) requested by the Government of the Solomon Islands is appropriate under the Project.

The required engine output and rated capacity of the generator for the planned generating unit are calculated below. These figures will be used only as a yardstick, however, as the specifications of engine and generator slightly vary from one manufacturer to another.

a) Engine Output

$$Pe \geq \frac{P}{0.7355 \times \eta_G} = 6{,}011PS$$

$$\fallingdotseq 6{,}020PS$$

Where,

Pe : engine output (PS)

P : output of generator terminal (4,200 kW)

η_G : generator efficiency (assumed to be 95%)

b) Generator Capacity

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

Where,

P_G : generator capacity (kVA)

P : output of generator terminal (4,200 kW)

Pf : generator efficiency 0.8

② Mechanical Systems

a) Fuel Supply System

The Lungga Power Station has four main fuel tanks of 55 m^3 each and diesel oil is supplied by tank lorries of Mobil Oil with which a fuel supply agreement has been concluded.

As a fuel pipeline which is connected to the above fuel tanks is in place at the existing power house building, this pipeline will be used to supply fuel oil to the new generating unit, eliminating the need for the installation of a new fuel tank through the use of the existing fuel supply system. However, as in the case of the existing generating units, a fuel oil service tank will be installed outdoors as a reserve for the abnormal functioning of the main fuel tank and/or common pipeline. This fuel oil service tank will be located to the north of the power house building (see Basic Design Drawing G-01).

Fuel will be supplied from the existing main fuel tank to the fuel oil service tank by means of gravity and a fuel oil transfer pump will supply fuel from the fuel oil service tank to the engine. The configuration of the fuel supply system is shown in Basic Design Drawing M-01.

Fuel Oil Service Tank

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.

$$Vs = V \times 4{,}200\ kW \times 2\ hours \fallingdotseq 2.32\ m^3$$

Where,

Vs : capacity of fuel oil service tank

V : fuel consumption per generating unit (rated output: 4.2 MW), assuming a specific gravity of fuel of 0.85

The actual capacity of the new fuel oil service tank is set at 2.5 m^3 to allow some margin.

b) Lubricating Oil System

As the Lungga Power Station does not have a lubricating oil system for common use, an independent lubricating oil system will be established for the new generating unit. Lubricating oil will be supplied from drums placed outside the power house building to the engine by a lubricating oil transfer pump. The configuration of the lubricating oil system is shown in Basic Design Drawing M-02.

c) Cooling Water System

The municipal water stored in the existing water tank will be used as cooling water after reducing its hardness by a water softener. The radiator system used by the existing facilities will be used as the cooling water system. Some of the softened water will be supplied to the lubricating oil cleaner.

The configuration of the cooling water system is shown in Basic Design Drawing M-03.

d) Compressed Air System

The Lungga Power Station has a compressed air system which serves all of the generating units and also has a piping system with a connecting flange for the new generating unit to be installed under the Project. It is, therefore, planned to extend the air pipe from the said flange to the engine via the compressed air

receiver. The configuration of the compressed air system is shown in Basic Design Drawing M-04.

In view of the high relative humidity, an automatic drain trap will be installed to the compressed air receiver. Compressed air at a reduced pressure level will also be supplied to the lubricating oil cleaner from the compressed air receiver.

e) Air Intake and Exhaust System

In regard to the air intake for engine combustion and the exhaust of combustion gas, the intake of fresh outside air will be made by the supercharger via an exclusive duct and waste gas after combustion will be discharged outside via the silencer. The configuration of the air intake and exhaust system is shown in Basic Design Drawing M-05.

f) Ventilation System

The existing power house building uses louvres for natural ventilation. As the ventilation capacity is sufficiently designed to accommodate the planned new generating unit, the existing ventilation system will be used without any addition under the Project. In regard to exhaust, the exhaust louvres on the roof of the building will also be used.

g) Sludge Treatment System

The Lungga Power Station has outdoor on oil separator which serves the existing generating units. However, there is concern in regard to environmental contamination as rainwater could invade the oil separator in the rainy season, causing the spillage of waste oil. In order to prevent such environmental contamination, an independent sludge separation tank and an oil separating system will be installed to serve the new generating unit to separate waste oil and water so that only separated water is discharged to the existing drainage channel. The configuration of the sludge treatment system is shown in Basic Design Drawing M-02.

An incinerator will also be installed to properly dispose of the separated sludge and waste oil.

h) Piping Systems

The new generating unit will require several piping systems as listed below. All of the pipes will have clear indication of which systems they belong to in the form of different colours and 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 Facilities

The rated voltage of the new generating unit to be installed under the Project will be 11 kV. This voltage has been decided in view of (i) same generating voltage of the existing generating units at the Lungga Power Station, (ii) high level of economy due to direct connection to the existing switchboard (11 kV) without involving a transformer and (iii) conformity of all generating units, both new and old. The main components of the planned electrical facilities are described below.

a) Local Control Panel

A local control panel and low voltage motor control panels will be installed at the side of the new generating unit for starting, stopping, control, measurement and alarm purposes.

b) Generator Remote Control Panel

In order to ensure easy, centralised operation and monitoring of the new generating unit, a remote control panel to control the generator, an on-load tap changer (OLTC) panel and a high voltage panel will be installed in the control room of the power house building. Synchronised operation of the generator will also be conducted at the control room.

In addition, brushless thyristor-type excitation control apparatus will be installed on the generator control panel.

c) DC Power Supply System

A DC power supply system will be installed inside the Electrical room of the power house building to act as the power source for the starting, stopping, control, measurement and alarm operation of the new generating unit and its auxiliary equipment. The DC voltage will be 110 V.

d) Low Voltage Distribution Board

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

e) Earthing System

As the Lungga Power Station uses a common earthing system, the following earthing requirements of the new generating unit will be met through connection to the existing earthing network.

- Earthing system to protect the electrical system from the Earth fault
- 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

As for installations of the power and control cables between the new generating unit and the 11 kV switchboard, main transformer, 33 kV switchboard and remote control panel, the existing pits and conduits in the power house building will be used. Cable trays will be introduced to improve the cable maintenance performance.

g) 33 kV Switchgear

One 33 kV switchgear will be installed at the side of the existing 33 kV switchboards in view of easy operation and maintenance and will connect the generated power of the new generating unit with the existing transmission network. This switchboard will be equipped with current and voltage transformers, operating switches, indicating lamps, etc. to protect the main

transformer and 33 kV bus line. As it will be installed in line with the existing switchboards, it will be recommended the same shape as that of the existing switchboards as much as possible (see Basic Design Drawing G-03).

The 48 V DC power to operate the switchboard will be branched from an existing switchboard while 240 V AC power for the space heater will also be branched from an existing switchboard.

h) Main Transformer

One main transformer (11/33 kV) will be installed to step-up the generating voltage of 11 kV to the transmission voltage of 33 kV. Because of the direct impact of the high voltage side of this transformer on the transmission voltage, an on-load tap changer (OLTC) will be installed at the high voltage side to maintain an appropriate transmission voltage.

This transformer will be installed at the side of the existing No. 2 main transformer. An arrester will be installed at the 33 kV side to arrest surge voltage and a protective relay panel will be installed at the electrical room of the power house building.

i) 11 kV Switchgear

The generator breaker panel, bus circuit breaker and feeder panel for the new main transformer will be installed in the existing electrical house. These 11 kV switchgear will be equipped with operating switches, indicating lamps, etc. As they will be installed in line with the existing switchboards, it will be recommended the same shape as that of the existing switchboards.

The 48 V DC power to operate the switchboard will be branched from an existing switchboard while 240 V AC power will be used for the space heater.

j) 11/33 kV Switchgear Control Panel

This panel will control the 11 kV and 33 kV switchgear and the on-load tap changer (OLTC) of the main transformer.

k) Station Transformer

An outdoor-type station transformer will be installed as the power source for the auxiliary equipment of the new generator. As this transformer will be shared by the existing generating unit (No. 8 Unit), its capacity is set at 630 kVA in view of the supply of power to the auxiliary equipment of the existing generating unit (No. 8 Unit). It will be installed on the existing foundations for the existing No. 2 station transformer following relocation of the No. 2 station transformer.

3) Basic Specifications of Main Equipment

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

Table 2-3-5 Outline Specifications of Main Equipment of New Generating Unit

No.	Equipment	Outline Specifications	
1	Diesel Engine	• Rated operation:	continuous (base load operation)
		• Output:	generating-end - 4,200 kW (approx. 6,020 PS)
		• Revolving speed:	not more than 750 rpm
		• Engine Type:	four stroke cycle, trank piston-type with turbocharger, water cooling V or L-type diesel engine
		• Cooling Method:	radiator cooling
		• Fuel Oil:	diesel oil
		• Others:	vibration isolating common bed
2	Generator	• Rated operation:	continuous
		• Output:	5,250 kVA (4,200 kW)
		• Frequency:	50 H z
		• Number of phases:	3
		• Rated voltage:	11 kV
		• Revolving speed:	same as diesel engine
		• Power factor:	0.8 (lagging)
		• Connection method:	Y connection, neutral earthing
		• Class of insulation:	F
3	Mechanical Equipment		
3.1	Fuel Oil System		
	1) Diesel Fuel Oil Service Tank	2.5 m^3	
	2) Fuel Oil Circulating Pump	Including motor, gear pump and filter	
	3) Fuel Oil Flowmeter	less than Class 0.5	
	4) Fuel Oil Filters	Primary and secondary filters	
	5) Fuel Oil Pressure Regulating Valve		
	6) Fuel Oil Drain Discharge Pump	Including motor, gear pump and filter	
	7) Fuel Oil Drain Tank	100 litres	
3.2	Lubricating Oil System		
	1) Lubricating Oil Transfer Pump	Including motor, gear pump and filter	
	2) Lubricating Oil Sump Tank	approx. 5,000 litres	

No.	Equipment	Outline Specifications
	3) Lubricating Oil Priming Pump	Including motor and gear pump
	4) Lubricating Oil Cooler	Including automatic temperature control valve
	5) Lubricating Main Oil Filter	50 microns
	6) Backwashing Oil Filter	
	7) Lubricating Oil Purifier	Including motor and automatic discharge unit
	8) Lubricating Oil Pressure Regulating Valve	
3.3	Cooling Water System	
	1) Jacket Cooling Water Tank	300 litres
	2) Jacket Cooling Water Pump	Including motor and centrifugal pump
	3) Jacket Cooling Water Cooler	
	4) Jacket Cooling Water Temperature Regulating Valve	
	5) Radiator	
	6) Secondary Cooling Water Pump	Including motor and centrifugal pump
	7) Softener	
	8) Water Supply Pump	Including motor and centrifugal pump
	9) Soft Water Tank	3,000 litres
	10) Expansion Tank	300 litres
	11) Soft Water Circulating Pump	
3.4	Compressed Air System	
	1) Air Receiver	With sufficient capacity to start three times in succession and an automatic drain trap
	2) Air Pressure Reducing Valve	
3.5	Air Intake and Exhaust System	
	1) Intake Air Duct	
	2) Intake Air Filter	
	3) Intake Air Silencer	
	4) Exhaust Gas Silencer	With exhaust pipe; exhaust outlet noise: 100 dB (A) or less
	5) Exhaust Gas Duct	
3.6	Sludge Treatment System	
	1) Waste Oil Tank	100 litres
	2) Sludge Collecting Pump	Including motor and screw pump (0.5 m^3/hr)
	3) Sludge Separator Tank	1,000 litres
	4) Oily Water Pump	Including motor and screw pump (0.5 m^3/hr)
	5) Oily Water Separator Tank	2 m^3
	6) Waste Oil Discharge Pump	Including motor and screw pump (0.5 m^3/hr)
	7) Waste Oil Tank	100 litres
	8) Oily Water Separator	oil discharge level: not more than 30 ppm
	9) Oil Check Tank	1,000 litres
	10) Sludge Discharge Pump	
	11) Incinerator	50 litres/hr
4	Electrical Equipment	
	1) 33 kV Switchgear	33 kV circuit breaker; 1,250 A; 50 Hz; 25 kA (1 sec.)
	2) 11 kV Switchgear	11 kV circuit breaker; 1,250 A; 50 Hz; 20 kA (1 sec.)
	3) D/B for No. 9 DEG Auxiliary	Self-standing type; including auxiliary equipment control panel
	4) Generator Control Panel	Self-standing type; including AVR panel and synchronising panel
	5) 11/33 kV Switchgear Control Panel	Self-standing type; including on-load tap changer
	6) Transformer Protection panel	For generator and main transformer
	7) No. 3 Step up Transformer	Outdoor-type with 11/33 kV on-load tap changer and arrester; 10/12.5 MVA (ONAN/ONAF)
	8) Battery and Charger	Lead acid battery; 110 V
	9) No. 2 Station Transformer	Outdoor, self-cooling type; 630 kVA; 11/0.415 kV

(4) Improvement Plan for Existing Power House Building

1) Plan Contents

The facilities to be improved or constructed at the Lungga Power Station under the Project are listed below.

- Power house building : remodelling of the openning of the north wall
- Equipment foundations : construction of foundations for engine, generator, oil tank, radiator, sludge treatment system, etc.

2) Improvement Details

The existing power house building already has a designated installation space for the new generating unit to be installed under the Project. Accordingly, the following improvements are planned under the Project.

① Foundations for new DEG

② Foundations for outdoor auxiliary equipment

③ Remodelling of such openings as ducts, pipes on the building wall, etc.

(5) On-the-Job Training (OJT) Plan

Since the new generating unit under the Project will have a large capacity compared with the other units, it is recommended to conduct OJT on the operation and maintenance of the new unit during the installation work as well as after commissioning of the new unit, in order to ensure the sufficient operation.

1) OJT Plan During Installation Work

① Purpose of OJT

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

The specifications and grade of the new generating unit selected under the Project have been decided taking the technical capability of the local engineers involved in the operation and maintenance of the existing generating units into consideration. As far as the basic technological aspects of the diesel engine generating facilities are concerned, there is little difference between the planned generating unit and the

existing generating units or between different manufacturers of such units. However, most of the existing equipment comprises old systems which are more than 10 years old and the manufacture of some of this equipment has been terminated by the manufacturers. In view of the likelihood that some of the mechanical components, electrical components, instruments and systems combining these items which constitute the generating unit to be installed under the Project may not be used by the existing generating facilities, OJT on the operation and maintenance of the new generating unit will be provided by engineers dispatched by the manufacturers of the generating equipment delivered by the Contractor for local engineers during the installation work period. In addition, upgrading OJT of the basic skills possessed by local engineers at the same time should prove highly beneficial to achieve the efficient, effective and safe operation and maintenance of the new generating unit after its commissioning.

② Outline of OJT

a) Period and Type of OJT

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

b) Instructors

The instructors for the above OJT will be engineers dispatched by the manufacturers of the generating equipment 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 local 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. SIEA, must appoint the OJT trainees prior to the commencement of the generator unit installation work.

- Chief Engineer : 1
- Operation Staff

  Electrical Engineer : 1

Mechanical Engineer : 1

Electrical Technicians : 2

Mechanical Technicians : 2

- Maintenance Staff

Electrical Engineer : 1

Mechanical Engineer : 1

Electrical Technicians : 2

Mechanical Technicians : 3

d) Training Contents

i) Classroom Training

Using the operation and maintenance manuals and audio-visual materials (television, video tapes, etc.), 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 (mechanical)
- Overhaul and maintenance of fuel valve (mechanical)
- Grinding finishing of suction and exhaust valves (mechanical)
- Overhaul and maintenance of piston (mechanical)
- Disassembly and maintenance of crank pin bearings (mechanical)

- Maintenance of motor pump (mechanical)
- Cleaning of suction filter and other filters (mechanical)
- Unit starting up and stopping (electrical)
- Emergency stopping in case of trouble (electrical)
- Remote monitoring and visual inspection methods (mechanical and electrical)
- Maintenance of piping (mechanical)
- Maintenance of cables (electrical)

2) Dispatching of Japanese Engineers After Commissioning

① Obejctives for Dispatch

Japanese engineers will be dispatched to SIEA by the generating equipment manufacturers to provide technical guidance on the practical operation and maintenance of the new generating unit after commissioning. Details of the on-site guidance by dispatched engineers are given in Appendix 7.

② Details of Dispatch

a) Duration

Japanese engineers will be dispatched from the time of commissioning to the expiry date of the E/N with a maximum duration of dispatch of five and a half months.

b) Engineers

One mechanical engineer and one electrical engineer will be dispatched.

c) Descriptions of On-Site Guidance by Dispatched Engineers

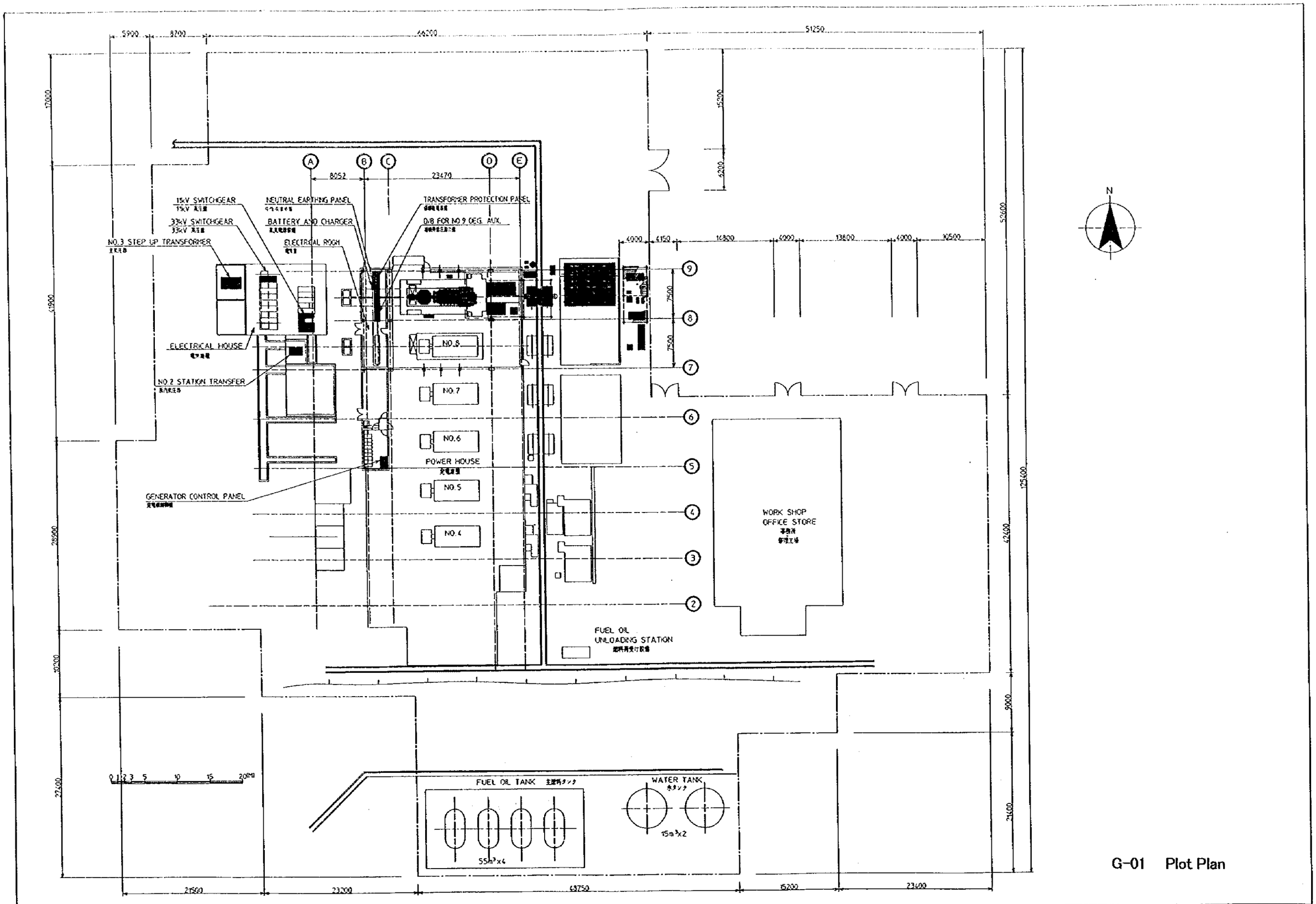
i) Technical guidance on the operation and maintenance of the new generating unit (including on-site guidance on overhauling after 3,000 hours operation)

ii) Education on preventive maintenance of the new generating unit

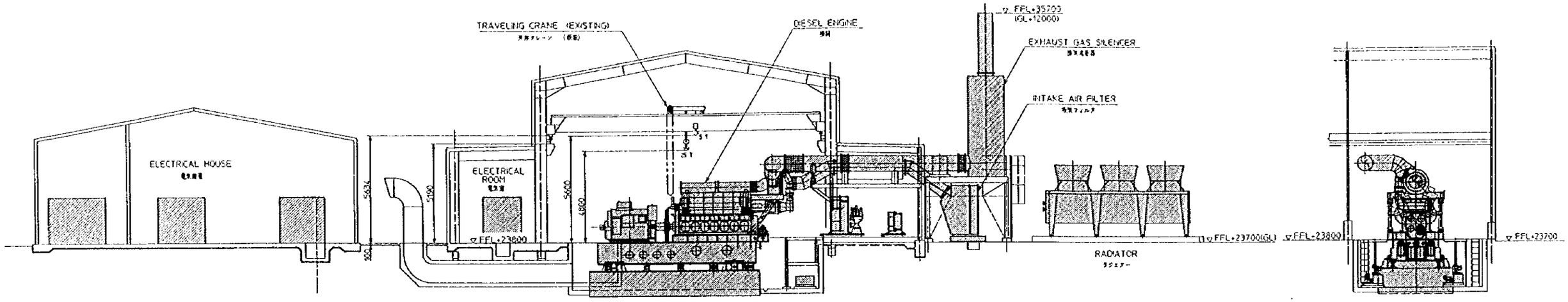
(6) Basic Design Drawings

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

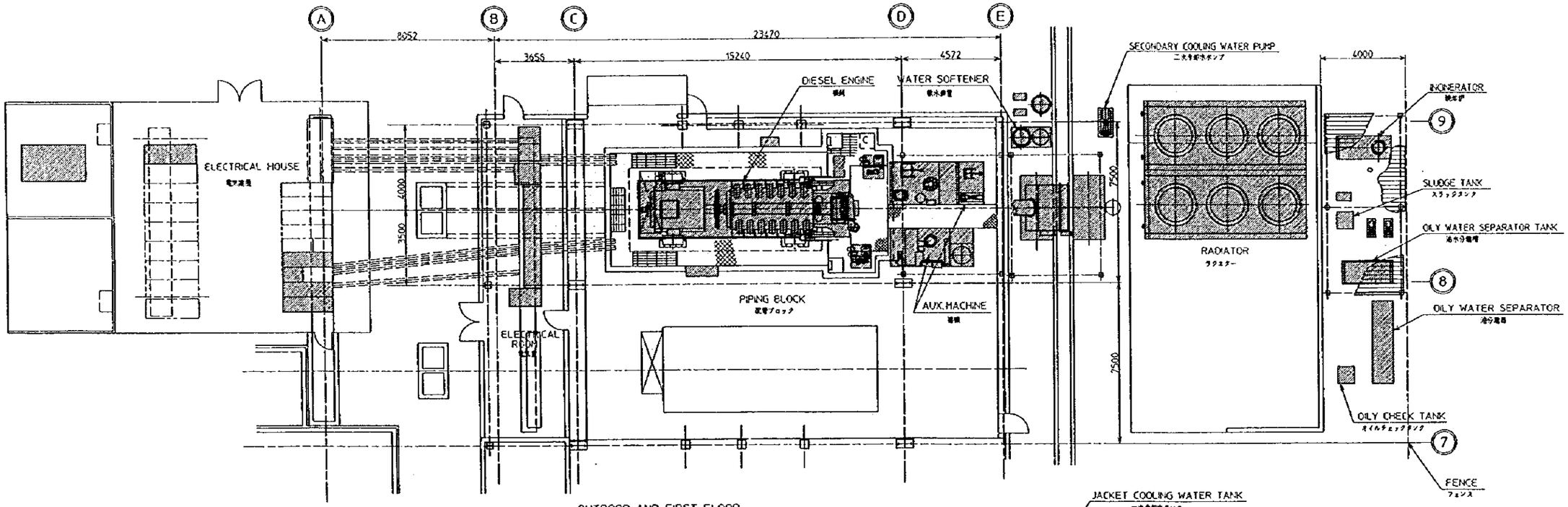
G-01	Plot Plan
G-02	General Arrangement of Generating Facility
G-03	Arrangement of 33 kV and 11 kV Equipment
M-01	Fuel Oil System Diagram
M-02	Lubricating Oil and Sludge Treatment System Diagram
M-03	Cooling Water System Diagram
M-04	Compressed Air System Diagram
M-05	Intake Air and Exhaust Gas System Diagram
E-01	Single Line Diagram (High Voltage System)
E-02	Single Line Diagram (Unit Aux. Power)



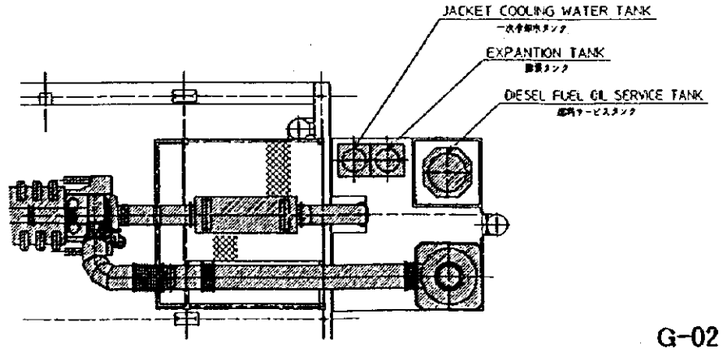
G-01 Plot Plan



CROSS SECTION



OUTDOOR AND FIRST FLOOR



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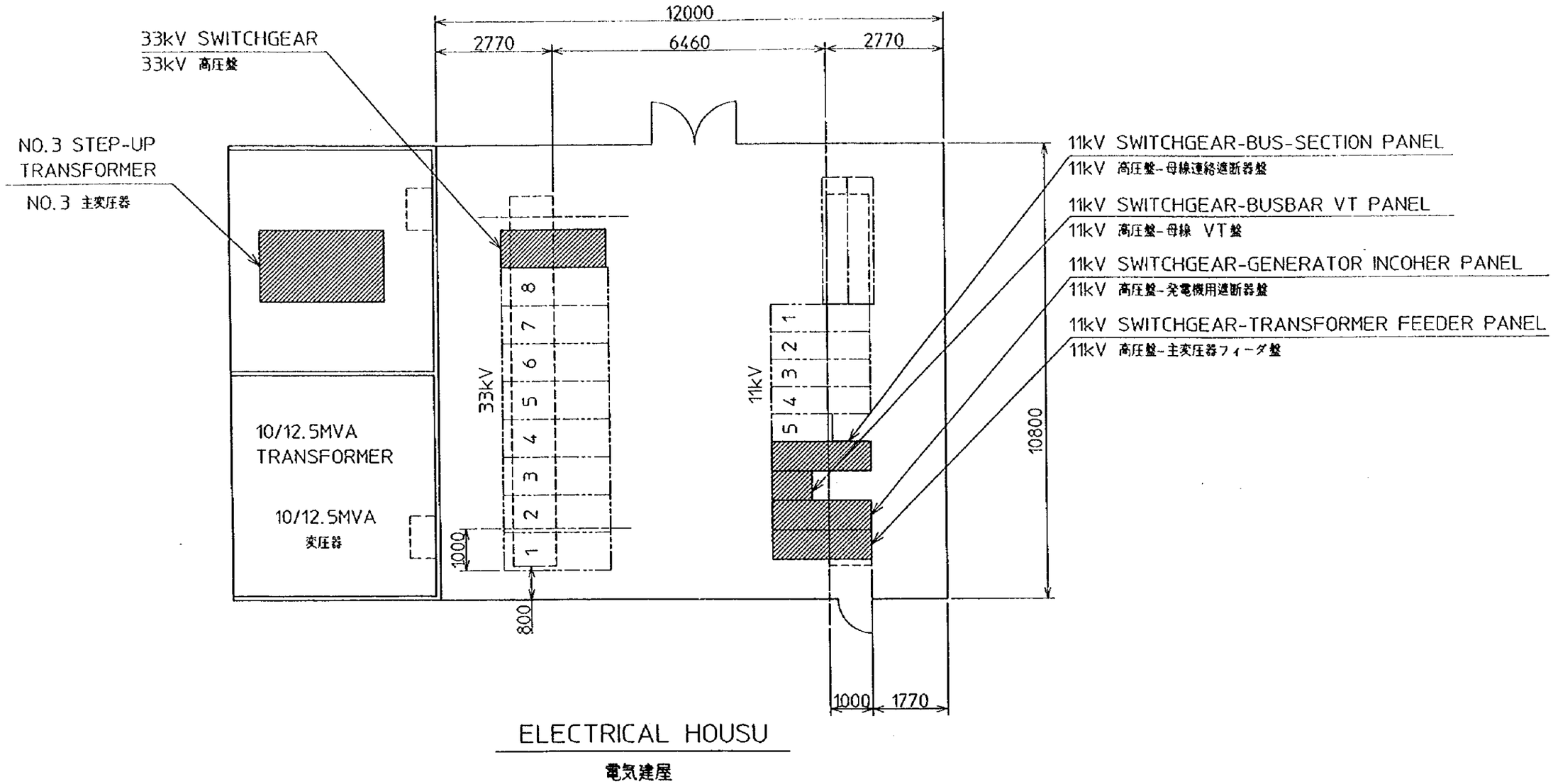
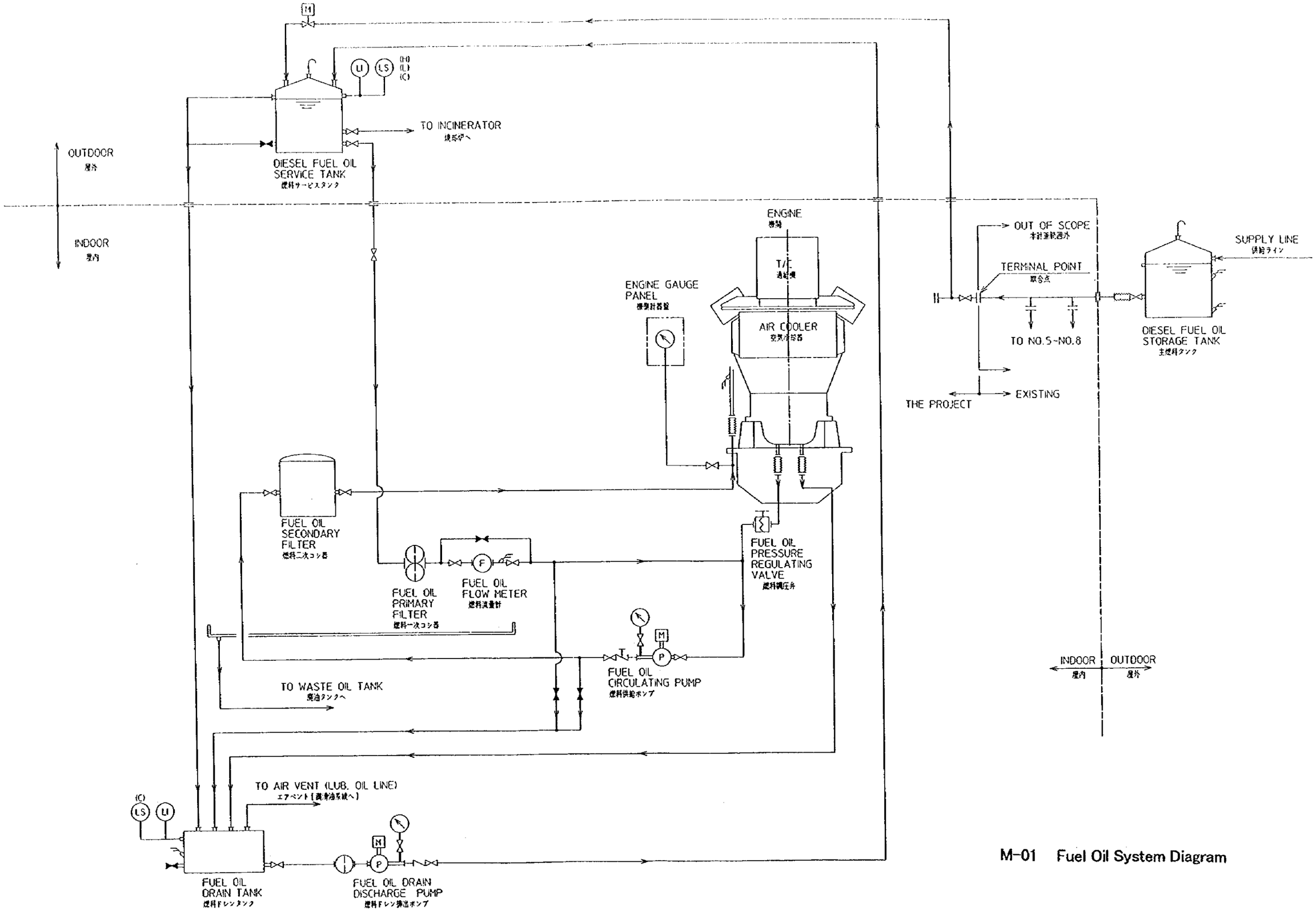
0 1 2 3 5 10 15 20 m

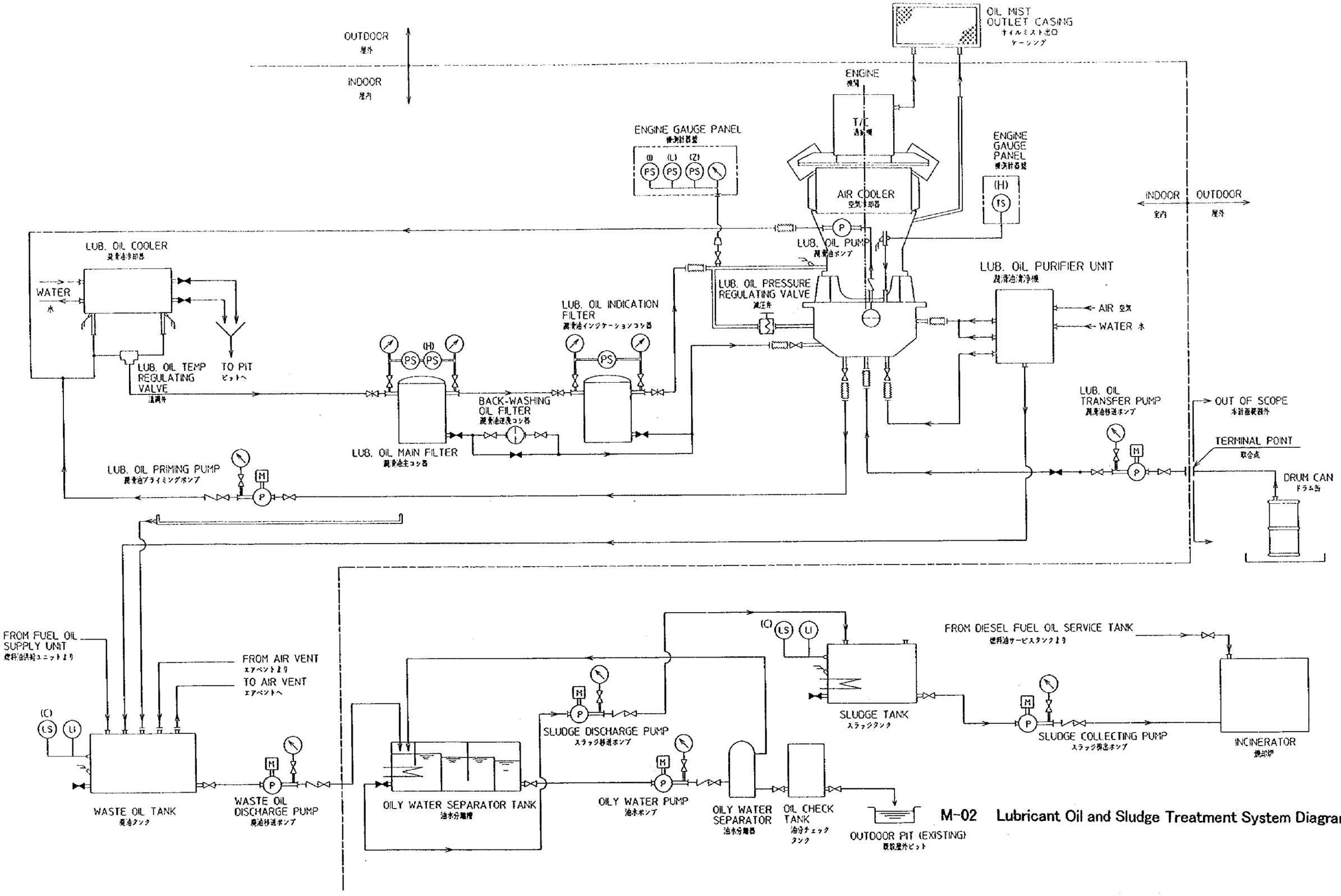
G-02 General Arrangement of Generating Facility



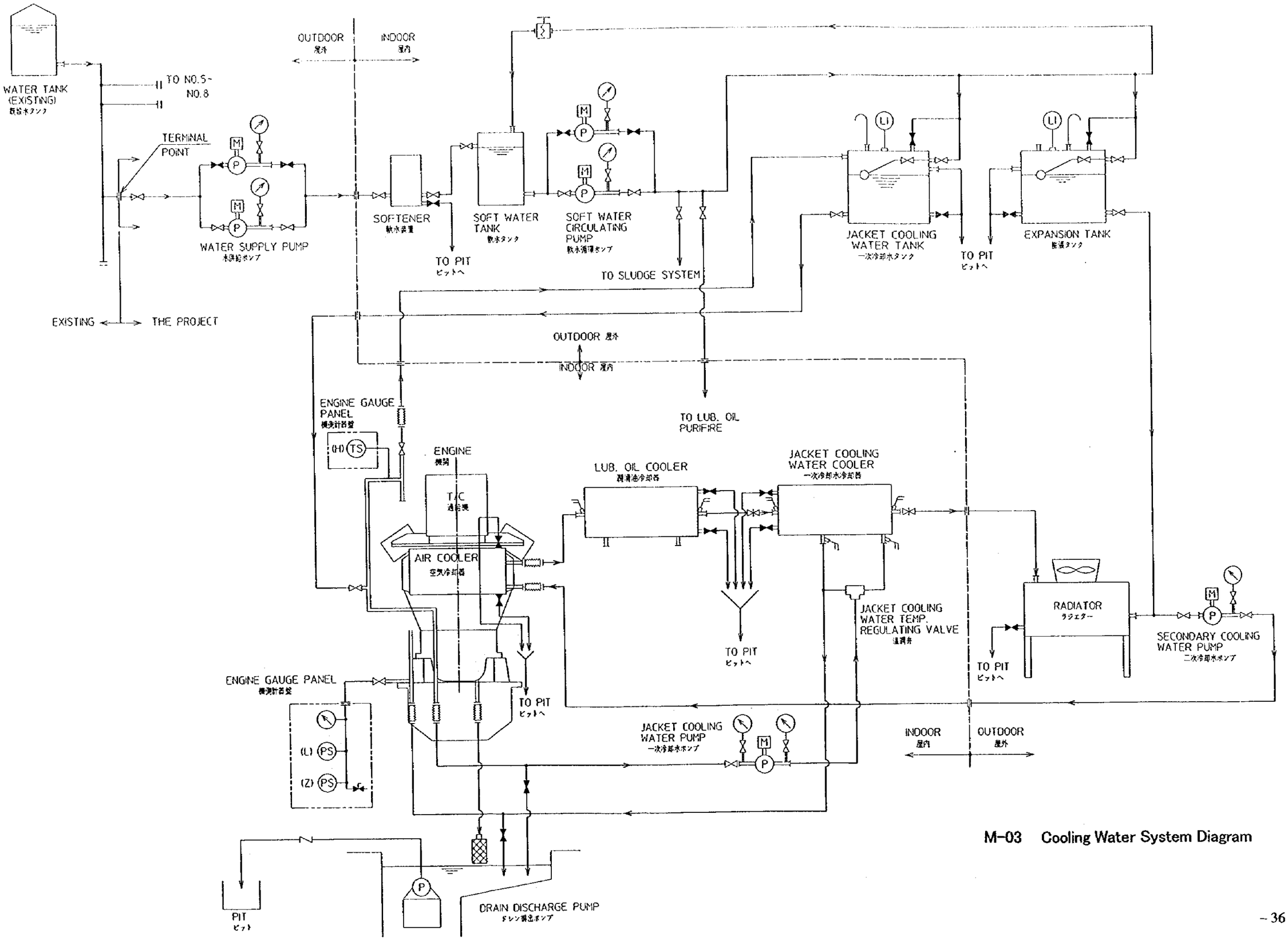
G-03 Arrangement of 33kV and 11kV Equipment



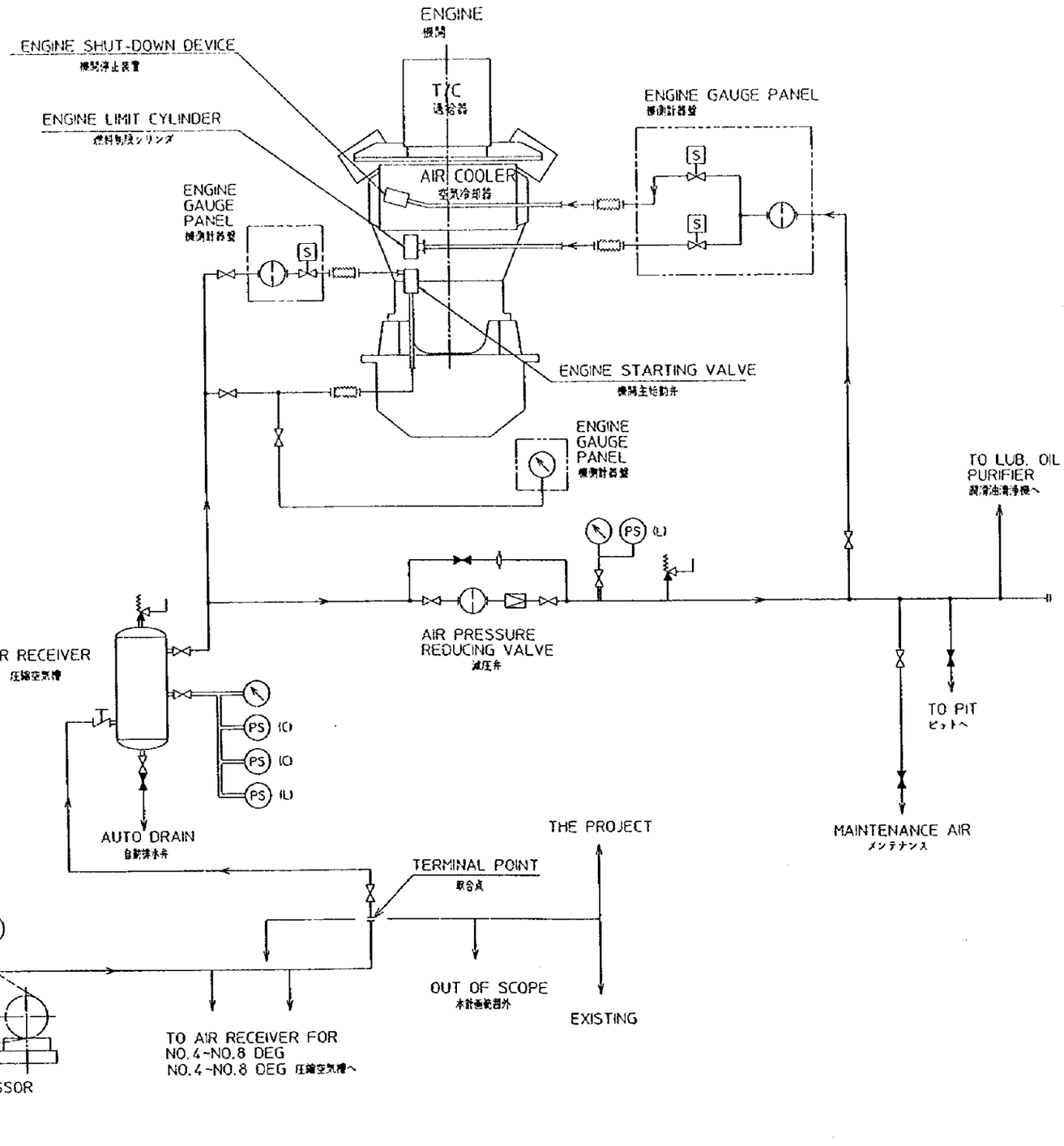
M-01 Fuel Oil System Diagram



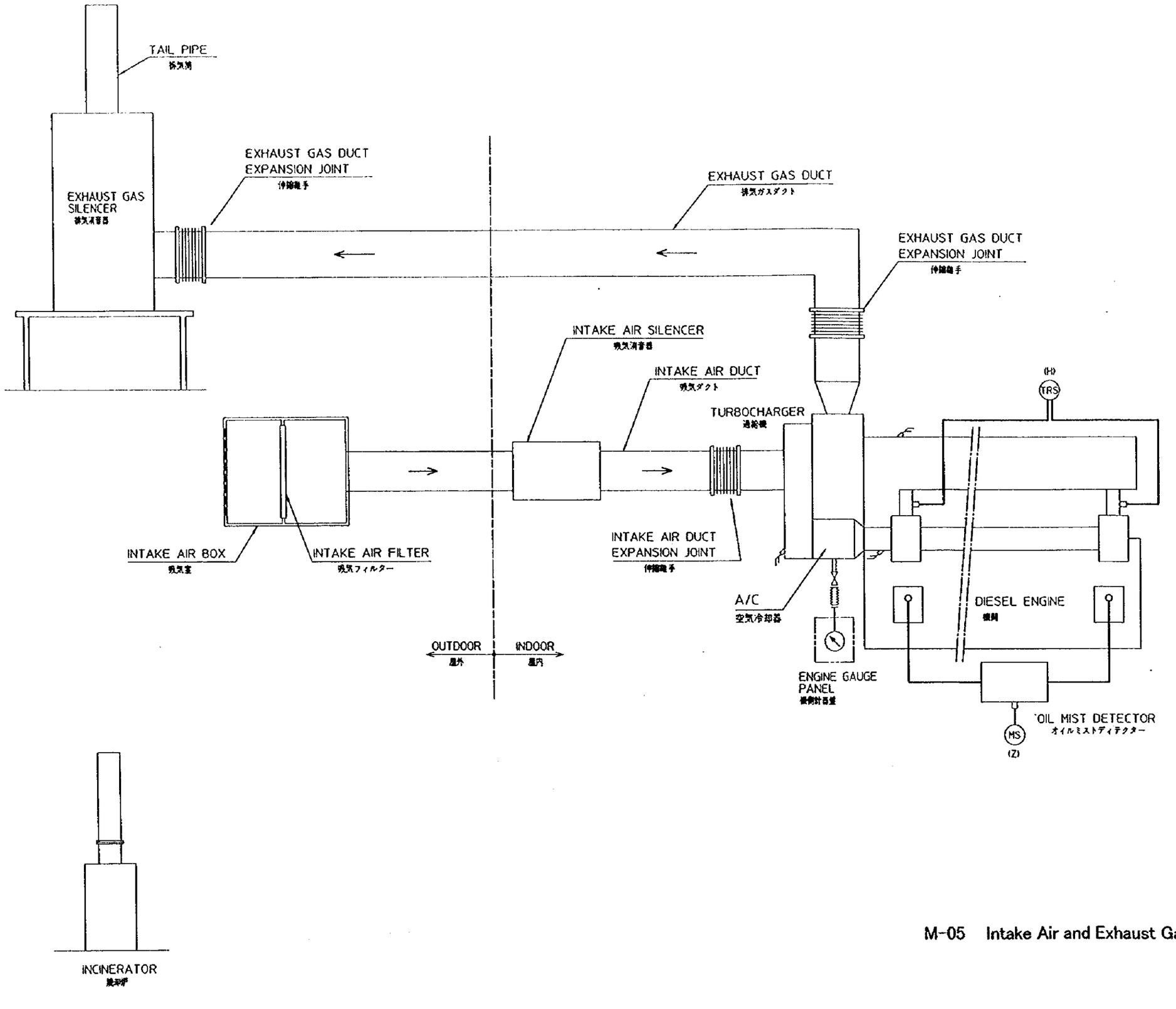
M-02 Lubricant Oil and Sludge Treatment System Diagram



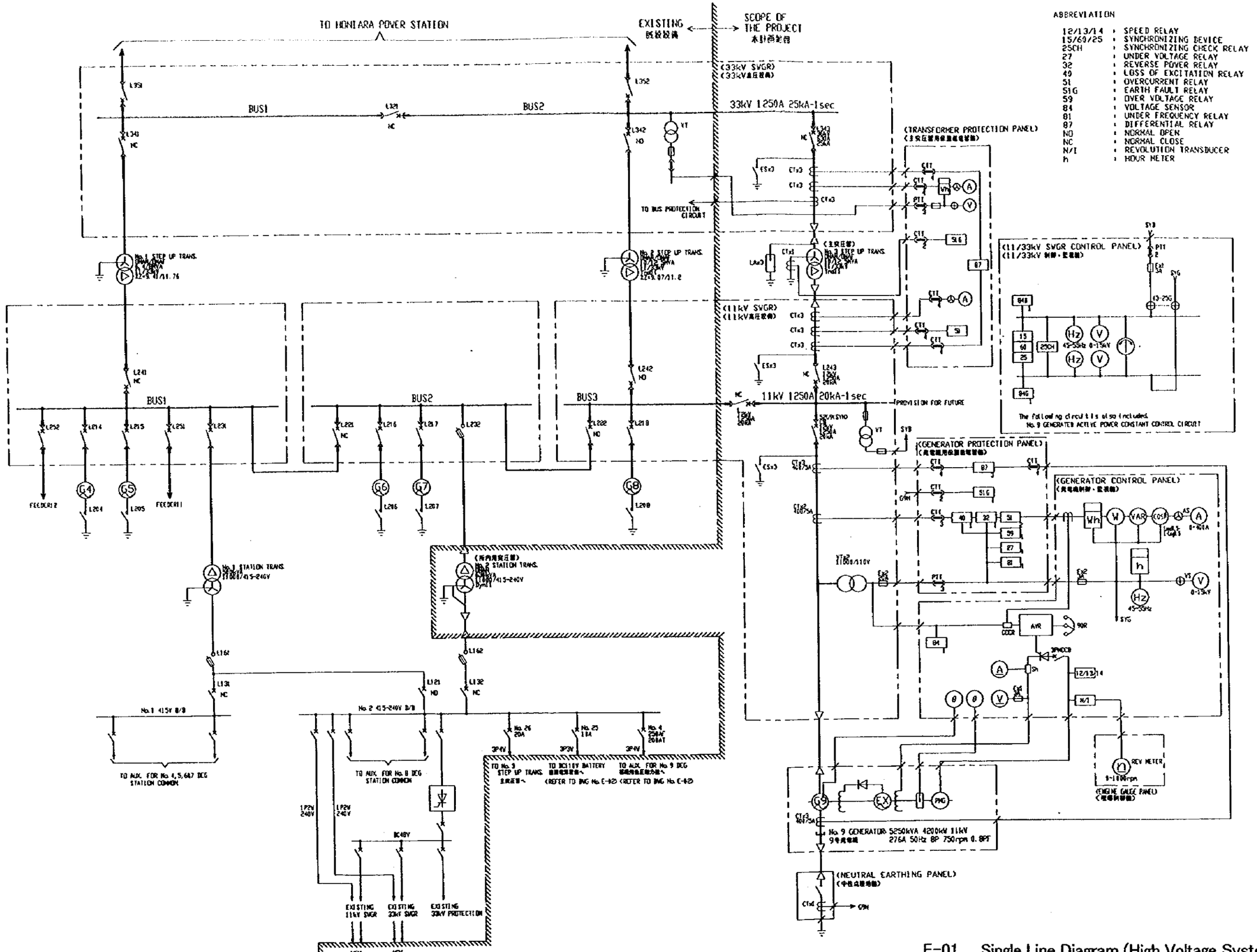
M-03 Cooling Water System Diagram



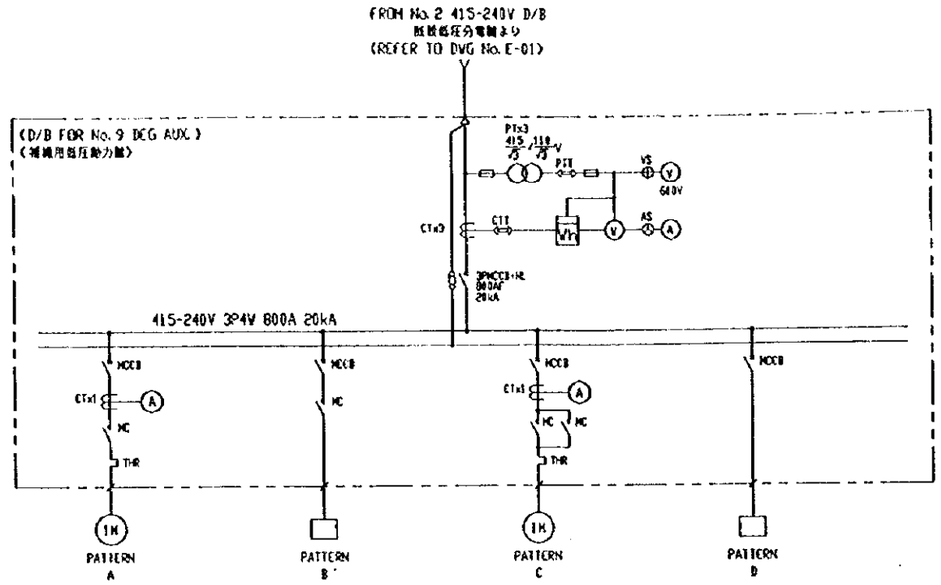
M-04 Compressed Air System Diagram



M-05 Intake Air and Exhaust Gas System Diagram



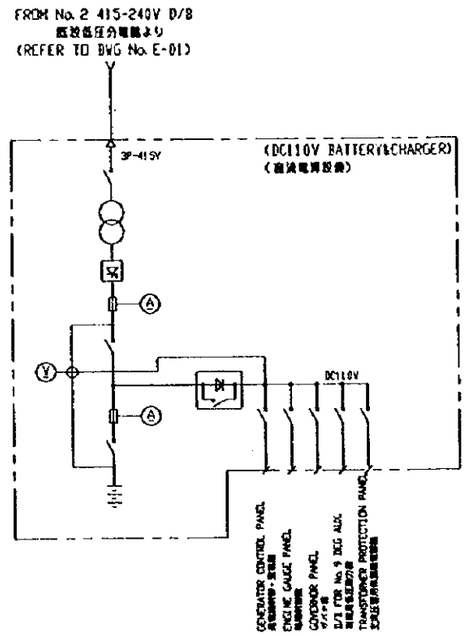
E-01 Single Line Diagram (High Voltage System)



NO.	SERVICE		Q'TY	CAPACITY (kW)	VOLTAGE(V)	PATTERN	SELECTOR SWITCH	OPERATION	LOCAL STAND	REMARKS
1	FUEL OIL MOTOR VALVE	燃料油電動弁	1	0.4	240	B	AUTO/MAN	AUTO (LEVEL)	YES	
2	FUEL OIL CIRCULATING PUMP	燃料油供給ポンプ	1	1.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
3	FUEL OIL SECONDARY FILTER	燃料油二次濾器	1	0.06	240	D				MCCB FEEDER
4	FUEL OIL DRAIN DISCHARGE PUMP	燃料油ドレン移送ポンプ	1	0.75	415	A	AUTO/MAN	AUTO (LEVEL)	YES	
5	LUB. OIL TRANSFER PUMP	潤滑油移送ポンプ	1	1.5	415	A	——	MANUAL	YES	
6	LUB. OIL PRIMING PUMP	潤滑油プライミングポンプ	1	5.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
7	LUB. OIL MAIN FILTER	潤滑油主濾器	1	0.3	415	D				MCCB FEEDER
8	LUB. OIL PURIFIER UNIT	潤滑油清浄機ユニット	1	60	415	D				MCCB FEEDER
9	JACKET COOLING WATER PUMP	一次冷却水ポンプ	1	7.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
10	SECONDARY COOLING WATER PUMP	二次冷却水ポンプ	1	30	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
11	RADIATOR-1	ラジエター1	1	18.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
12	RADIATOR-2	ラジエター2	1	18.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
13	RADIATOR-3	ラジエター3	1	18.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
14	RADIATOR-4	ラジエター4	1	18.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
15	RADIATOR-5	ラジエター5	1	18.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
16	RADIATOR-6	ラジエター6	1	18.5	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
17	INTAKE AIR FILTER	吸気フィルタ	1	0.4	415	D				
18	DRAIN PIT PUMP	雑水ピットポンプ	1	1.5	415	A	AUTO/MAN	AUTO (LEVEL)	YES	
19	SLUDGE COLLECTING PUMP	スラジ抽出ポンプ	1	0.75	415	A	——	MANUAL	YES	
20	HEATER FOR SLUDGE TANK	スラジタンクヒーター	1	8	415	B	AUTO/MAN	AUTO (TEMP)	YES	
21	SLUDGE DISCHARGE PUMP	スラジ移送ポンプ	1	0.75	415	A	AUTO/MAN	AUTO (LEVEL)	YES	
22	WASTE OIL DISCHARGE PUMP	廃油移送ポンプ	1	0.75	415	A	——	MANUAL	YES	
23	TURNING GEAR	ターニングギヤ	1	1.5	415	C	——	MANUAL	YES	
24	GENERATOR SPACE HEATER	発電機スペースヒーター	1	0.6	240	B		AUTO (ENGINE)		
25	GENERATOR CONTROL PANEL	発電機制御・監視盤	1		240	D				MCCB FEEDER
26	ENGINE GAUGE PANEL	機関計測盤	1	0.3	240	D				MCCB FEEDER
27	GOVERNOR PANEL	ガバナ盤	1	0.65	240	D				MCCB FEEDER
28	CHEMICAL FEED UNIT	薬注装置	1	0.06	415	D				MCCB FEEDER
29	INCINERATOR	焼却炉	1	10	415	D				MCCB FEEDER
30	OILY WATER SEPARATOR UNIT	油水分離装置ユニット	1	2.5	415	D				MCCB FEEDER
31	WATER SOFTENER	軟水装置	1	3	415	D				MCCB FEEDER
32	OILY WATER SEPARATOR TANK HEATER (OILY WATER)	油水分離装置タンクヒーター(油水)	1	6	415	A	AUTO/MAN	AUTO (TEMP)	YES	
33	OILY WATER SEPARATOR TANK HEATER (OILY WATER)	油水分離装置タンクヒーター(油水)	1	6	415	A	AUTO/MAN	AUTO (TEMP)	YES	
34	OILY WATER SEPARATOR TANK HEATER (SLUDGE)	油水分離装置タンクヒーター(スラジ)	1	8	415	A	AUTO/MAN	AUTO (TEMP)	YES	
35	SOFT WATER CIRCULATING PUMP	軟水循環ポンプ	2	2.2	415	A	AUTO/MAN	AUTO (ENGINE)	YES	
36	CITY WATER SUPPLY PUMP	本水供給ポンプ	2	1.5	415	A	AUTO/MAN	AUTO (LEVEL)	YES	
37	OILY WATER PUMP	油水ポンプ	1	0.75	415	A	AUTO/MAN	AUTO (LEVEL)	YES	

ABBREVIATION

NL : NEUTRAL LINK



CHAPTER 3 IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3-1 Implementation Plan

3-1-1 Implementation Concept

The Project will be implemented within the framework of Japan's grant aid scheme and, therefore, the Project will only be implemented after its approval by the Government of Japan and the formal Exchange of Notes (the E/N) between the Government of Japan and the Government of the Solomon Islands. The basic issues and special points for consideration for the implementation of the Project are described below.

(1) Project Implementation Body

The organization responsible for the implementation of the Project on the Solomon Islands side is the Ministry of Mining and Energy (MME) which operates and controls public works, mainly power generation as well as supply and mining. Following the completion of the installation work of the new generating unit under the Project, the SIEA will be responsible for the operation and maintenance of the said unit under supervision of MME. Consequently, in order to ensure the smooth implementation of the Project, the MME and SIEA should maintain close contact and consult with the Japanese Consultant and Contractor, both of which will be selected by the Government of the Solomon Islands in accordance with Japan's grant aid scheme. For this purpose, the MME and SIEA should select a person to be responsible for the implementation of the Project. The selected person will be required to explain the contents of the Project to the staff members of the Lungga Power Station and citizens of Honiara where the planned new generating unit will be installed with a view to obtaining their cooperation for the implementation of the Project.

(2) Consultant

In order to procure and install the necessary equipment for the Project, the Japanese Consultant recommended by JICA will conclude a consulting service agreement with the Government of the Solomon Islands and will conduct the detailed design and supervision of the site work for the Project. The Consultant will also prepare the tender documents and will conduct the tender on behalf of the project implementation body.

(3) Contractor

The Contractor, which will be a Japanese firm or company selected by the Government of the Solomon Islands through an open tender in accordance with Japan's grant aid system, will conduct the procurement of the necessary equipment and installation of the new generating unit. As it is deemed necessary for the Contractor to provide after-services in terms of the supply of spare parts and the repair of equipment breakdowns in regard to the new equipment, the Contractor must pay proper attention to continual liaison with the SIEA.

(4) Necessity to Dispatch Japanese Engineers

As the installation of a new generating unit under the Project at an existing power station which is in operation, it will be necessary to coordinate the new structures with the existing foundations, building and other facilities in addition to the establishment of a reliable link and coordination with the existing control and other systems. These requirements make the dispatch of a site manager from Japan essential to provide consistent management and guidance on schedule control, quality control and work safety.

In regard to the foundation work, the local shortage of skilled workers (technicians) with adequate technical expertise regarding large-scale power generation work makes it essential for the Contractor to dispatch Japanese engineers for both quality and schedule control. Moreover, the installation of the planned generating unit will demand wide-ranging knowledge and expertise regarding the functions and configuration of such a unit, making the dispatch of experts by the equipment manufacturers necessary to supervise the installation work as well as test operation and adjustment.

3-1-2 Implementation Conditions

(1) Construction Industry in Solomon Islands

1) Use of Local Construction Companies and Dispatch of Supervisory Engineers

There are several general construction companies in Honiara, all of which are small with some 100 - 200 employees and which are run by Australian or New Zealand owners. Most of the engineers and workers employed by these companies are local or Fijians. Engineers and workers are recruited from Fiji when a large construction project is launched. Consequently, the capability of local construction companies is not particularly high and their use for the Project should mainly focus on the supply of workers.

Even though the generating unit installation work, transmission and distribution line construction work and existing facility improvement work are not technically too demanding, the dispatch of Japanese engineers and technicians will be necessary to supervise local engineers and workers in regard to construction plan preparation, schedule control, quality control and commissioning.

2) Procurement of Construction Machinery

As in the case of the engineers referred to above, while little construction machinery is available in the Solomon Islands, all of the necessary machinery, including a 50 ton trailer, can be procured in Honiara.

(2) Points to Note for Work Plan

1) Installation of Generating Unit

The new DEG and other equipment will be unloaded at Port Honiara. Due to the lack of appropriate unloading facilities for the new generating unit (weighing approximately 50 tons) at this port, it will be necessary to consider the use of a cargo vessel or barge equipped with a large crane.

The lack of a large mobile crane in the Solomon Islands means that the work plan should involve the use of a hydraulic jack and rollers for the installation of the new generating unit on its foundations. Proper safety measures as well as protection measures should also be introduced during the installation work as the new generating unit will be installed next to the operating No. 8 Unit.

Although the approach road of the Lungga Power Station is paved with asphalt, some sections are damaged. The Solomon Islands side must repair or reinforce the existing road to withstand the transportation of equipment prior to the commencement of the site work in view of the smooth progress of the work to be conducted by the Japanese side.

2) High Voltage Electrical Facilities

The 11 kV and 33 kV switchgears will be installed in line with the existing similar switchgears to connect their main bus lines to the existing bus lines. All safety aspects, including secure interlocking, etc., must be thoroughly verified. As the stoppage of power supply to the existing facilities will be required for this connection work and testing purposes, the Contractor must prepare an appropriate work schedule under the SIEA's consultations.

3-1-3 Scope of Works

The scope of work to be undertaken by the Government of the Solomon Islands and the Government of Japan is shown in Table 3-1-1.

Part of the equipment and materials stock yard inside the existing workshop will be used for the storage of spare parts, expendables, inspection and maintenance tools and repair equipment/tools, the supply of which is planned under the Project. While the remodelling of the exhaust gas duct, etc. in the existing power house building will be conducted by the Japanese side.

In regard to the transmission and distribution facilities, the installation of the 11 kV and 33 kV switchgears inside the existing power house building will be conducted by the Japanese side.

Table 3-1-1 Scope of Works

Work Item	Japan	Solomon Islands	Remarks
1. Common Items (for installation work of the Project)			
(1) Provision of sites for temporary facilities (office, stock yard and various processing sites) and their free lease to the Contractor		To carry out	
(2) Extension of water supply, electricity supply and telephone services to the site for temporary use.	After T.P.	Upto T.P.	T.P. Terminal Point
(3) Water, electricity and telephone charges for installation work	To pay		
(4) Fuel oil and lubricating oil used for testing of new generating unit		To procure	
(5) Compressed air, water and power for auxiliary equipment for testing of new generating unit		To procure	
(6) Relocation of existing No. 2 station transformer		To carry out	
2. Generating Unit			
(1) DEG (4.2 MW x 1)	To procure and install		
(2) Mechanical auxiliaries for (1)	"		
(3) Electrical equipment for (1)	"		
(4) 11/33 kV high voltage switchgears	"		
(5) Project-related spare parts, inspection tools and expendables	To procure	To store	
(6) OJT	To carry out	To attend	
3. Remodelling Work of power house building			
(1) Foundations for generating unit	To carry out		Including those for radiator and fuel oil service tank
(2) Building remodelling work for the Project	Construction of ducts through the wall, etc.		

3-1-4 Consultant Supervision

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

(1) Supervision Principles

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

1) Schedule Control

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

① Quantity of work conducted

② Quantity of equipment and materials delivered

③ Work efficiency and actual number of engineers, technicians and workers

2) Quality Control

The Consultant will supervise the Contractor in regard to the following so as to adhere to the quality of the facilities and equipment indicated in the contract documents (technical specifications, detailed design drawings, etc.) If the Consultant believes that the quality does not meet the requirements, he will demand that the Contractor correct, change or modify the situation.

① Checking of shop drawings and specifications for equipment

② Checking of factory inspection results for equipment or attendance at shop inspection

③ Checking of installation manual, site operation, inspection and test manuals, and working drawings for equipment

④ Supervision of site installation of equipment and inspection at test running

⑤ Checking of working drawings for foundations, etc.

⑥ Comparison between working drawings and completed works

3) Safety Control

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

① Establishment of safety control rules and selection of a person responsible for work safety

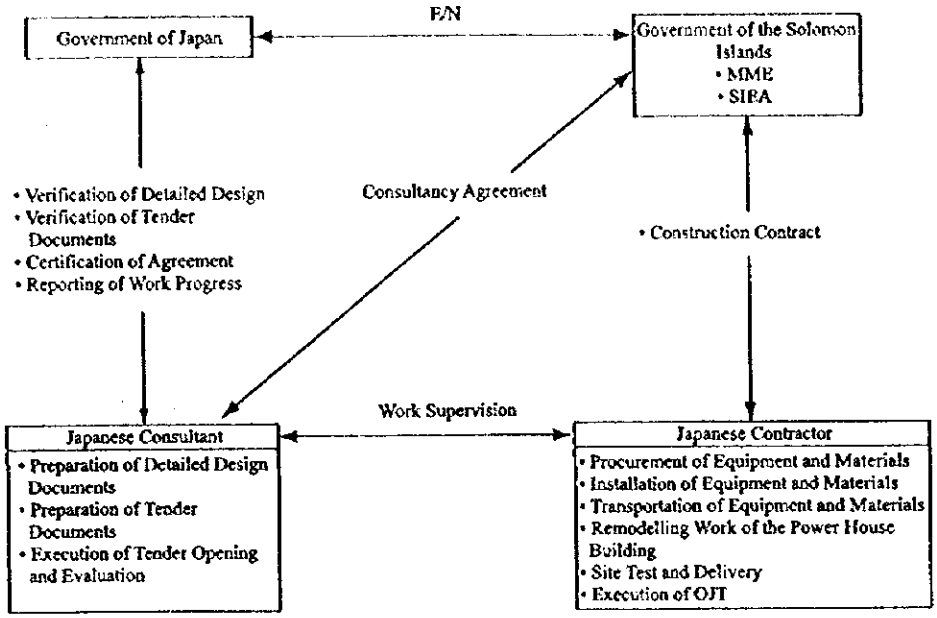
② Prevention of accidents to workers by means of periodical inspection of the construction machinery

③ Introduction of travelling routes for work vehicles, construction machinery and thorough enforcement of slow driving on the site

④ Enforcement of welfare measures and days-off for workers

(2) Project Implementation Regime

The project implementation regime, i.e. relationship between parties involved in the implementation of the Project, including the work supervision stage, is shown in Fig. 3-1-1.



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

Fig. 3-1-1 Project Implementation Regime

(3) Work Supervisors

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

- Site Manager (1) : general management of on-site work and in charge of OJT
- Generating Engineer (1) : instructions on schedule control of generating unit installation work

In addition to the above, the further dispatch of engineers will be required in accordance with the work progress. These engineers will include an equipment installation supervisor and a commissioning test engineer.

3-1-5 Procurement Plan

The equipment and materials for the planned generating equipment and transmission/substation equipment to be used under the Project are not manufactured in the Solomon Islands. Some construction materials, such as cement and reinforcing bars etc., imported from Australia, New Zealand, etc., are available locally. Accordingly, the equipment and materials to be used for the Project will be procured in the following manner.

(1) Equipment and Materials to be Procured Locally (for Remodelling Work)

Ready mix concrete, cement, sand, aggregate for concrete, concrete blocks, reinforcing bars, timber, paint, plywood, nails, petrol, diesel oil, small vehicles, mobile crane (15 - 20 ton class) and other materials for temporary structures

(2) Equipment and Materials to be Procured in Japan

1) Equipment and Materials for Generating Facilities

Diesel engine generating facility, auxiliary equipment, electrical equipment, fuel piping materials, power cables, etc.

2) Transmission/Substation Facilities

Main transformer, station transformer, arrester, etc.

(3) Equipment and Materials to be Procured in Third Country

The possibility of procuring equipment and materials for the Project from a third country was examined at the field survey stage as well as the subsequent analysis stage in Japan and at the project cost estimation stage. It has been concluded that procurement from third countries, i.e., Australia and New Zealand, will be considered for only the 11 kV and 33 kV switchboards, cables and piping due to the following reasons.

1) Equipment and Materials for Generating Facility

① European Products

There are several manufacturers in Europe which manufacture generating units which meet the specifications adopted for the Project. In fact, the existing generating units of the Lungga Power Station were made in the UK and Finland. However, Europe is geographically quite distant from the Solomon Islands and the past delivery performance of European manufacturers in regard to spare parts and

expendables for the existing generating units suggests that an emergency need for such items may not be quickly met. Moreover, the insufficient after-service is illustrated by the fact that the completion documents have not yet been submitted four years after the commissioning of commercial operation, causing difficulties for the SIEA in terms of operation and maintenance.

② Australian and New Zealand Products

There is no manufacturer of a large DEG in these countries. Even though there are local sales agents of the existing DEGs, the after-service is provided by the original manufacturers in the UK and Finland. As the reaction to an emergency is rather slow, the after-service is inadequate to say the least.

③ US Products

There is a tendency among US generating equipment manufacturers not to manufacture the medium and low speed diesel engine generators (continuous rating of 720 rpm or less) which are required for the Project. Instead, they mainly manufacture high-speed (1,000 - 1,500 rpm) generators with a short time rating for emergency and peak cut purposes. One manufacturer indicates the availability of medium-speed engines in its catalogue but has not produced many such engines. This manufacturer may accept an order but would require to start from the design stage for a new order. Given the fact that the required engine generators are not part of its standard manufacturing line, it would be extremely difficult for this manufacturer to offer a definite delivery schedule. Even if this US manufacturer could meet the delivery deadline, spare parts and consumable would have to be specially made as in the case of the generating unit itself. This could mean a long wait for the delivery of such items after commissioning of the new generating unit and the operation of the generating unit could be hampered due to such a lengthy delivery time and the possibly high price of spare parts, etc.

Based on the above analysis result, the generating units, auxiliary equipment and electrical equipment, etc. required for the Project will be procured in Japan.

2) Transmission/Substation Equipment

① Australian Products

As the 11 kV and 33 kV switchgear to be procured under the Project will be installed in line with the existing switchgear (made in Australia), their bus layout,

equipment specifications and operating methods must be the same as those of the existing switchgear to ensure smooth operation and maintenance. Accordingly, the inclusion of Australia as a possible supply source is desirable. In view of the fact that the completion drawings for the existing switchgear have not yet been submitted, however, careful consideration will be required before selecting the manufacturer of the existing switchgear.

② European Products

The existing 11/33 kV main transformers were made in Europe and have produced minor oil leakages. According to the SIEA, an enquiry regarding measures to stop this leakage has not yet been answered. Moreover, the failure of the manufacturer to submit the completion drawings, etc. which are essential for proper operation and maintenance indicates a poor after-service system. Consequently, the transformers, etc. will be procured in Japan to ensure proper operation and maintenance.

3-1-6 Implementation Schedule

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

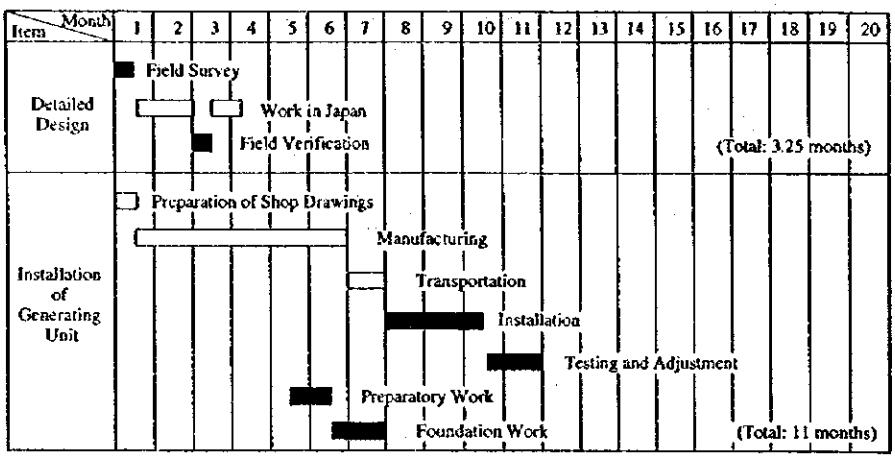


Fig. 3-1-2 Project Implementation Schedule

3-1-7 Obligations of Recipient Country

The Government of the Solomon Islands has the obligation to provide or conduct the following items in connection with the implementation of the Project.

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

(2) To ensure speedy unloading and customs clearance of the goods for the Project at port and /or airport of disembarkation in Solomon Islands.

(3) To accord Japanese nationals whose services may be required in connection with the supply of products and services under the verified contracts such facilities as may be necessary for their entry into the Solomon Islands and stay therein for the performance of their work.

(4) To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in the Solomon Islands with respect to the supply of the products and services under the verified contract. And to take necessary measures for such tax exemption.

(5) To bear commissions to the Japanese foreign exchange bank for the banking services based upon the banking arrangement.

(6) To bear all the expenses other than those to be borne by the Grant Aid necessary for the execution of the Project.

(7) To assign exclusive counterpart engineers and technicians to the Project in order to transfer the operation and maintenance technique for the Project and to witness and to confirm installation works and qualities of equipment and materials when inspection is carried out.

(8) To use and maintain properly and effectively all the facilities constructed and equipment and materials purchased and installed under the Japan's Grant Aid.

(9) To secure and provide cleared areas for new equipment for the Project in the Lungga power station, prior to the commencement of the construction for the Project.

- Area for No.9 unit shall be cleared for new diesel engine generator set.
- Storage yard for spare parts to be supplied under the Project shall be provided in the existing workshop building of Lungga power station.

(10) To construct incidental outdoor facilities, boundary fence and entrance gate at Lungga power station by the completion of the construction for the Project.

- Relocation of boundary fence shall be done by SIEA, if necessary.

(11) To take necessary measure for the prevention of the environment pollution such as disposal of oil sludge, etc.

(12) To provide proper disposal places of excavated soil, waste water and oil discharged during the implementation period.

(13) To provide temporary yard for the contractor's office, the consultant's office, equipment and materials storage yard, etc., with approx. 600 m^2 in the Lungga power station.

(14) To provide load for test operation during the implementation period.

(15) To rehabilitate and/or to reinforce the existing access road to the Lungga power station necessary for the inland transportation of the heavy cargo, before the commencement of the construction work by Japanese side.

(16) To secure the stoppage of power supply when new facilities is required to connect with the existing facilities such as switchgears, transformers, fuel piping, etc.

(17) To replace the existing No.2 station transformer in order to reutilize for auxiliary supply to No.4,5,6 & 7 DEG units, before the installation of new No.2 station transformer by Japanese side.

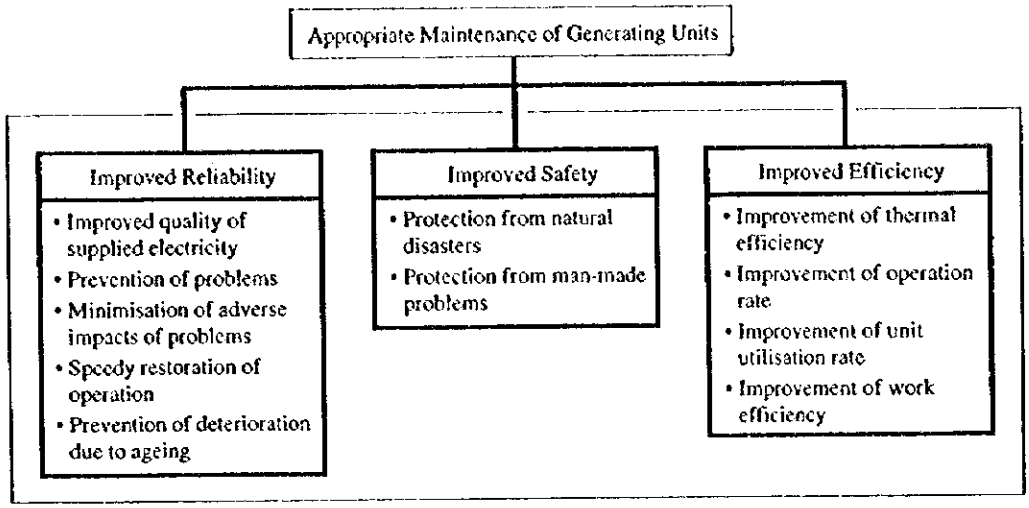
(18) To provide necessary fuel oil and lubrification oil for the initial change and site tests for the new DEG unit.

3-2 Operation and Maintenance Plan

(1) Basic Principles

The most important facilities to be provided under the Project from the maintenance point of view is the generating unit. The proper maintenance of this unit and the upkeep of its operating environment are essential to ensure a stable power supply in response to daily demand fluctuations. In order to maintain the proper performance and functions of the planned generating unit to ensure a stable power supply, the implementation of appropriate

preventive maintenance designed to improve the reliability, safety and efficiency of the generating unit is desirable. Fig. 3-2-1 shows the basic concept of such maintenance.



< Three Pillars of Maintenance >

Fig. 3-2-1 Basic Concept of Generating Unit Maintenance

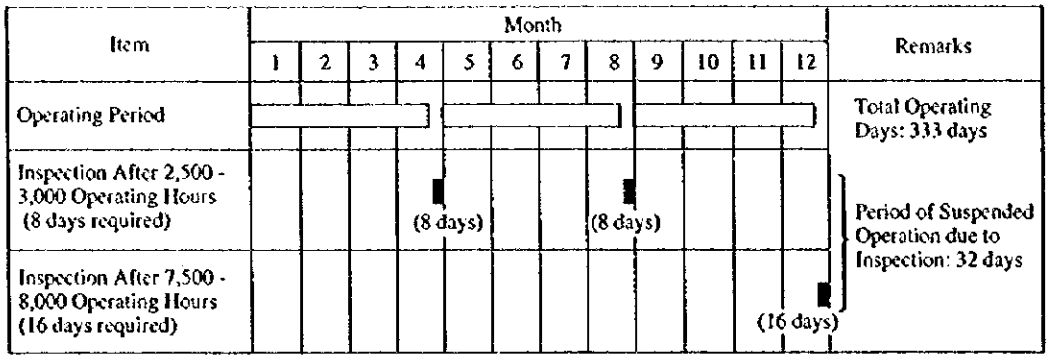
Bearing the above three principles of maintenance in mind, it will be necessary for the SIEA to use the O & M techniques and skills transferred through the OJT conducted by engineers dispatched by the Contractor during the work period and the O & M manuals supplied by the Japanese side.

(2) Operating Plan for New Generating Unit

The planned new generating unit will provide the base load for Honiara city as described in 2-3-2 and the adoption of the following operating conditions is deemed appropriate.

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

Table 3-2-1 shows the regular inspection items required for the proper operation of the new generating unit while Fig. 3-2-2 shows the annual operation programme for the same unit for the first year based on the operating conditions mentioned above, taking the regular inspection items into consideration. It is expected that the operation of the new generating unit will be suspended for 32 days/year as shown in Fig. 3-2-2. Power supply by the reserve unit at the Lungga Power Station or Honiara Power Station should be made during this period to compensate for the loss of power supply by the new generating unit.



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

Fig. 3-2-2 Annual Operation Programme for New Generating Unit

(3) Regular Inspection Items

The standard regular inspection items of the planned generating unit are shown in Table 3-2-1. The SIEA will be required to prepare an operation and maintenance plan for the planned generating unit in accordance with this table and the O & M manuals to be submitted by the unit manufacturer with a view to establishing the unit's operation programme in line with the actual power demand. The following number of days will be required to complete the standard inspections listed in the table.

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

Table 3-2-1 Standard Regular Inspection Items

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

(4) Fuel Oil Procurement Plan

The estimated annual fuel (diesel oil) consumption volume to run the generating unit to be procured and installed under the Project is approximately 7,900 kilolitres based on an assumed operating rate of 90%. The SIEA will be required to prepare and implement a practical fuel oil procurement plan to ensure the steady operation of the said generating unit.

(5) Spare Parts Procurement Plan

The spare parts for the generating unit are classified as standard spare parts which require replacement after a certain length of operation and spare parts reserved for emergency

replacement at the time of an accident, etc. The Government of the Solomon Islands is required to procure an appropriate quantity of spare parts for the periodic inspection cycle shown in Table 3-2-1.

The procurement of the spare parts required for 16,000 hours, i.e. two (2) years of operation to complete the regular inspection cycle, is planned under the Project and the main items determined from the periodic inspection schedule are listed in Table 3-2-2. Accordingly, the Government of the Solomon Islands is required to set aside the necessary budgets to procure the standard spare parts (approximately 3% of the generating unit cost) and emergency spare parts by the end of the second year of the commissioning of the new generating unit.

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

I. Spare Parts

No.	Item	Quantity	Remarks
1	Cylinder Cover 1. Packing and O-Ring, etc. 2. Gasket Packing 3. Packing (Air Feed Pipe) 4. Cylinder Cover (Complete) (including Various Valves)	six sets × cylinder " " one set	ESP
2	Intake Valve 1. Funnel Cap 2. Valve Spindle 3. O-Ring 4. Intake-Valve (Complete)	one set × cylinder " six sets × cylinder two sets	ESP
3	Exhaust Valve 1. Valve Spindle 2. Sleeve 3. Valve Seat 4. O-Ring 5. Funnel Cap 6. Exhaust Valve (Complete)	1.5 sets × cylinder " " six sets × cylinder one set × cylinder one set	ESP
4	Fuel Injection Valve 1. Nozzle Chip 2. O-Ring 3. Fuel Injection Valve (Complete)	six sets × cylinder " seven sets	ESP
5	Piston 1. Piston Ring 2. Oil Ring 3. Piston Pin Bearing 4. Piston Head Tightening Bolt 5. O-Ring 6. Piston (Complete)	two sets × cylinder " one set × cylinder " two sets × cylinder one set	ESP
6	Connecting Rod 1. Crank Pin Bearing 2. Tightening Bolt	two sets × cylinder one set × cylinder	
7	Main Bearing 1. Main Bearing 2. Thrust Bearing	two sets × cylinder two sets	
8	Cylinder Liner	one set	ESP
9	Fuel Injection Pump 1. Plunger Sleeve 2. Delivery Valve (Complete) 3. Deflector 4. O-Ring 5. Fuel Injection Pump (Complete)	two sets × cylinder one set × cylinder two sets × cylinder six sets × cylinder four sets	ESP
10	Turbo Charger 1. Bearing 2. Thrust Bearing	two sets "	
11	Air Cooling 1. Packing	two sets	
12	Starting Valve 1. Packing 2. Starting Valve (Complete)	six sets × cylinder two sets	ESP
13	Cylinder Safety Valve 1. Packing 2. Cylinder Safety Valve (Complete)	two sets × cylinder two sets	ESP
14	Indicator Valve (Complete)	one set × cylinder	
15	Exhaust Expansion Pipe	one set × cylinder	
16	Fuel Injection Pipe	1/2 set × cylinder	

No.	Item	Quantity	Remarks
17	Governor		
	1. Governor Actuator	one set	ESP
18	Instrumentation Parts		
	1. Pressure Switches	one of each kind	ESP
	2. Temperature Switches	"	ESP
	3. Pressure Gauges	"	ESP
	4. Temperature Gauges	"	ESP
19	Auxiliary Pumps		
	1. Fuel Oil Drain Discharge Pump	one set	ESP
	2. Oily Water Pump	"	ESP
	3. Waste Oil Transfer Pump	"	ESP
	4. Fuel Oil Circulating Pump	"	ESP
	5. Lubricating Oil Priming Pump	"	ESP
	6. Jacket Cooling Water Pump	"	ESP
	7. Secondary Cooling Pump	"	ESP
	8. Sludge Discharge Pump	"	ESP
	9. Sludge Collecting Pump	"	ESP
	10. Spare Parts for Auxiliary Pumps	200%	
	11. Spare Parts for Oily Water Separator	one set	ESP
	12. Packing for Cooler	200%	
	13. Spare Parts for Softener	200%	
	14. Spare Parts for Incinerator	200%	
20	Electrical Spare Parts		
	(a) For generator		
	1. Bearing	one set	ESP
	2. Silicon Rectifier	"	ESP
	(b) For exiter		
	1. AVR	"	ESP
	(c) For control panels		
	1. Auxiliary Relays	one of each kind	
	2. Timers	"	
	3. Magnet Relays	"	
	4. Protection Relays	"	
	5. MCCB	"	
	6. Indicating Lamps	100%	
	7. Fuse	"	
	8. Vacuum Bulb	3	ESP
	9. Selector Switch	2	
	10. Control Relay Unit for CB	2	ESP
	11. CB Closing Coil	2	ESP
	12. CB Trip Coil	2	ESP
	13. Relay Glass Cover	1	ESP
	(d) Spare pants for MCC	one set	

ESP: Emergency Spare Parts

II. Maintenance Tools

No.	Item	Quantity	Remarks
1	Maintenance Tool Set (for engine)	one set	
2	Maintenance Tool Set (for Generator and Panels)	"	
3	Intake and Exhaust Valve Grinding Machine	"	
4	Oil Control Instruments	"	
5	Water Control Instruments	"	
6	Testing and Maintenance Equipment		
	1. AC Ammeter (2 - 20 A)	1	
	2. AC Ammeter (10 - 100 A)	1	
	3. AC Voltmeter (75 - 150 V)	1	
	4. AC Voltmeter (300 - 750 V)	1	
	5. DC Ammeter (1 - 30 A)	1	
	6. DC Ammeter (30 - 1,000 A)	1	

No.	Item	Quantity	Remarks
	7. AC Voltammeter (13 ranges)	1	
	8. DC Voltammeter (17 ranges)	1	
	9. DC Voltmeter (0~500V)	1	
	10. Wh-meter (3 phase, class 0.5)	1	
	11. Wh-meter (1 phase, class 0.5)	1	
	12. Frequency meter (class 0.5)	1	
	13. Power factor meter (class 0.5)	1	
	14. Insulation Resistance Tester (500 V/1,000 M ohm)	1	battery type
	15. Insulation Resistance Tester (1,000 V/2,000 M ohm)	1	generator type
	16. Circuit Meter	1	
	17. Cycle Counter	1	
	18. Millisecond Counter	1	
	19. Phase Meter (0 - 360°)	1	
	20. Single Phase Voltage Regulator (0 - 250 V; 0 - 50 A)	1	
	21. Three Phase Voltage Regulator (0 - 260 V; 0 - 360°)	1	
	22. Slide Rheostat (170 ohm/1 A)	1	
	23. Slide Rheostat (39 ohm/2 A)	1	
	24. Slide Rheostat (10 ohm/4 A)	1	
	25. Phase Tester (50 - 450 V; 40 - 65 Hz)	1	
	26. Insulating Transformer (5 kVA)	1	
	27. Withstand Voltage Tester (DC 100 kV; 10 mA)	1	
	28. High Tension Detector (AC/DC 90,000 V)	1	
	29. High Tension Detector (AC/DC 7,000 V)	1	
	30. Operaing Rod	1	
	31. Protective Relay Tester (0 - 50 V; 0 - 300 A)	1	
	32. Earth Resistance Meter (0 - 100 ohm; 0 - 30 V)	1	
	33. Watthour Meter	1	
	34. Digital Multi-meter	1	
	35. Digital Clamp-meter	1	

III. OJT Equipment

No.	Item	Quantity	Remarks
1	Television (20" colour)	1	
2	Video Cassette Recorder	1	
3	Video Tape	1	

(6) Electricity Tariff Plan

The SIEA currently charges 0.375 SI$/kWh for its public electricity supply service and Table 3-2-3 shows the estimated operating income and expenditure of the new generating unit based on this charge level. As the table shows, an annual operating rate of 90% (8,000 hours/year) results in a favourable balance. However, the balance goes into the red if the operating rate drops to 63% or below, making it difficult to sustain the self-financing operation of the power station. In view of this prospect, the SIEA should conduct proper maintenance to maintain the new generating unit and other units at an operating level which promises a healthy financial balance.

Table 3-2-3 Estimated Income and Expenditure of Planned Generating Unit

Item	Unit	Annual Operating Rate (%)				
		60	63	70	80	90
I. Income						
1. Generating Capacity	(KW)	4,200	4,200	4,200	4,200	4,200
2. Annual Operating Hours	(hrs)	5,259	5,522	6,136	7,012	7,889
3. Electric Energy Generated	(KWH)	22,087,800	23,192,190	25,769,100	29,450,400	33,131,700
4. Station Loss	(KWH)	662,634	695,766	773,073	883,512	993,951
5. Transmission Loss	(KWH)	1,546,146	1,623,453	1,803,837	2,061,528	2,319,219
6. Electric Energy Sold (3-4-5)	(KWH)	19,879,020	20,872,971	23,192,190	26,505,360	29,818,530
7. Average Unit Sales Price	(US$/KWH)	0.10	0.10	0.10	0.10	0.10
Total Income	(US$)	1,987,902	2,087,297	2,319,219	2,650,536	2,981,853
II. Expenditure						
1. Fuel (3 x (3) x (6))	(US$)	1,069,817	1,123,308	1,248,120	1,426,422	1,604,725
2. Lubricating Oil (3 x (4) x (6))	(US$)	74,401	78,121	86,801	99,201	111,602
3. Cooling Water	(US$)	18	19	21	24	27
4. Personnel (15 x (7))	(US$)	75,000	75,000	75,000	75,000	75,000
5. Maintenance (8)	(US$)	180,000	180,000	180,000	180,000	180,000
6. Head Office Management (8 x (9))	(US$)	218,669	229,603	255,114	291,559	328,004
7. Depreciation (10)	(US$)	400,000	400,000	400,000	400,000	400,000
Total Expenditure	(US$)	2,017,905	2,086,050	2,245,056	2,472,207	2,699,358
III. Operating Balance	(US$)	-30,003	1,247	74,163	178,329	282,495

Preconditions

1. The unit sales price is set at 0.1 US$ (0.375 SI$)/kWh which is currently charged by the SIEA.
2. The station loss and transmission loss are assumed figures.
3. The fuel cost is estimated to be 0.206 US$/litre.
4. The lubricating oil cost is estimated to be 0.206 US$/litre.
5. The cooling water cost is estimated to be 0.256 US$/$m^3$.
6. The consumption volumes of fuel, lubricating oil and cooling water are estimated as follows:
   - Fuel : 0.235 litres/kWh
   - Lubricating Oil : 0.0016 litres/kWh
   - Cooling Water : 0.004 litres/kWh
7. The personnel cost is calculated on the basis of an annual wage level of 5,000 US$/person for 15 employees.
8. The maintenance cost covers the cost of regularly replaced spare parts, etc. and is estimated to be 3% of the original equipment cost.
9. The management cost (head office cost) is estimated to be 11% of the power sales income.
10. The depreciation cost is calculated on the basis of the straight line method using the main cost of the generating unit in question with an expected life of 15 years and a residual value after 15 years of 0%.
11. The foreign exchange rate used is 1 US$ = ¥130 = 3.8 SI$.

(7) Operating Plan

The SIEA currently operates the Lungga Power Station and the Honiara Power Station on Guadalcanal Island. Based on the actual operating performance of these power stations during the period from January to October, 1997, the thermal efficiency at the generating-end in each month is shown in Fig. 3-2-3.

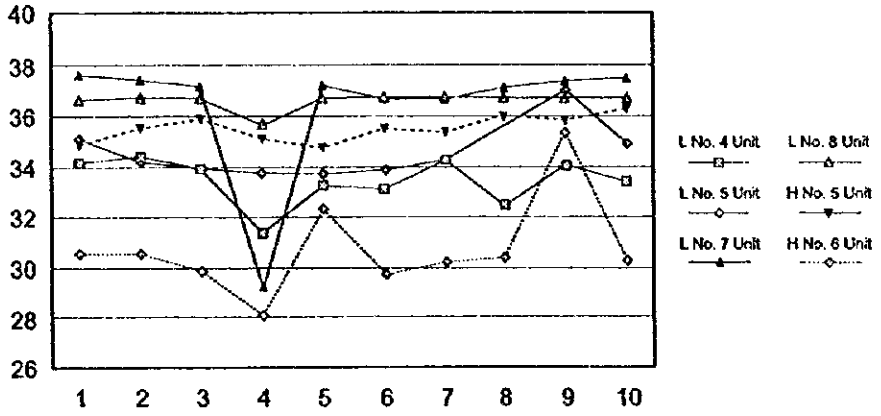


Fig. 3-2-3 Changes of Thermal Efficiency by Generating Unit

As Fig. 3-2-3 shows, the average thermal efficiency at the generating-end of the existing units at the Lungga and Honiara Power Stations of approximately 36% is relatively high. However, the lack of records on fuel analysis results and station loss, i.e. station service power and transformer losses, means that the general thermal efficiency at the generating-end cannot be established. The thermal efficiency of the No. 4 Unit and No. 5 Unit at the Lungga Power Station and the No. 6 Unit at the Honiara Power Station ranges from approximately 30% to 34% which is lower than average (thermal efficiency).

Based on the current operational status of the existing generating units, the optimal operating mode for each generating unit in 1999 (the planned completion year of the Project), including the new generating unit planned under the Project, is shown in Table 3-2-4. Moreover, whereas the forecast maximum power in 1999 is approximately 14.6 MW, the total available output of Lungga Power Station according to the same table is 15.4 MW, meaning that approximately 6.4 MW of spare capacity can be secured (include available capacity of Honiala P/S). Therefore, Honiala Power Station can be used as a further backup source of power during emergency situations that may arise during the same period.

Table 3-2-4 Operating Mode of Each Generating Unit and Current Output (1999)

Operating Mode	Operating Hours	Lungga Power Station	Honiara Power Station	Total Output
Base Load	24 hours	No. 8 Unit: 4 MW No. 9 Unit: 4.2 MW	-	8.2 MW
Middle Load	6 - 18 hours	No. 6 Unit: 2.8 MW No. 7 Unit: 2.4 MW	-	5.2 MW
Peak Load	1 - 6 hours	No. 4 Unit: 1 MW No. 5 Unit: 1 MW	No. 5 Unit: 0.6 MW No. 6 Unit: 0.6 MW No. 7 Unit: 1.5 MW No. 8 Unit: 1.5 MW No. 9 Unit: 1.5 MW	7.7 MW
Total		15.4 MW	5.7 MW	21.1 MW

Table 3-2-5 shows the operating mode that other generators need to adopt in the case where the Unit No.9 (to be supplied under the Project) is closed down for maintenance purposes in the Project target year of 2001. The forecast maximum demand in the target year is approximately 16.2 MW, however, as is indicated in the table, this can be supplied by the other power generation facilities and a stable power supply setup can be secured even in the case where Unit No.9 is closed down.

Table 3-2-5 Operating Mode When Operation of No. 9 Unit at Lungga Power Station is Suspended (2001)

Operating Mode	Operating Hours	Lungga Power Station	Honiara Power Station	Total Output
Base Load	24 hours	No. 6 Unit: 2.8 MW No. 8 Unit: 3.9 MW	-	6.7 MW
Middle Load	6 - 18 hours	No. 7 Unit: 2.3 MW	-	2.3 MW
Peak Load	1 - 6 hours	No. 4 Unit: 1 MW No. 5 Unit: 1 MW	No. 5 Unit: 0.6 MW No. 6 Unit: 0.6 MW No. 7 Unit: 1.5 MW No. 8 Unit: 1.5 MW No. 9 Unit: 1.5 MW	7.7 MW
Total		11 MW	5.7 MW	16.7 MW