No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
REHABILITATION OF POWER SUPPLY
IN
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

AUGUST, 2003

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

PREFACE

In response to a request from the Government of the Democratic Republic of Timor-Leste, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Power Supply in the Democratic Republic of Timor-Leste and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Timor Leste a study team from March 20 to April 26, 2003.

The team held discussions with the officials concerned of the Government of Timor-Leste, 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 Timor-Leste in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Timor-Leste for their close cooperation extended to the teams.

August, 2003

Takao Kawakami
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

August, 2003

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Power Supply in the Democratic Republic of Timor-Leste.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from March, 2003 to August, 2003. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of East Timor and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Mitsuhisa Nishikawa
Project Manager,
Basic design study team on the Project for
Rehabilitation of Power Supply
in the Democratic Republic of Timor-Leste
Yachiyo Engineering Co., Ltd.

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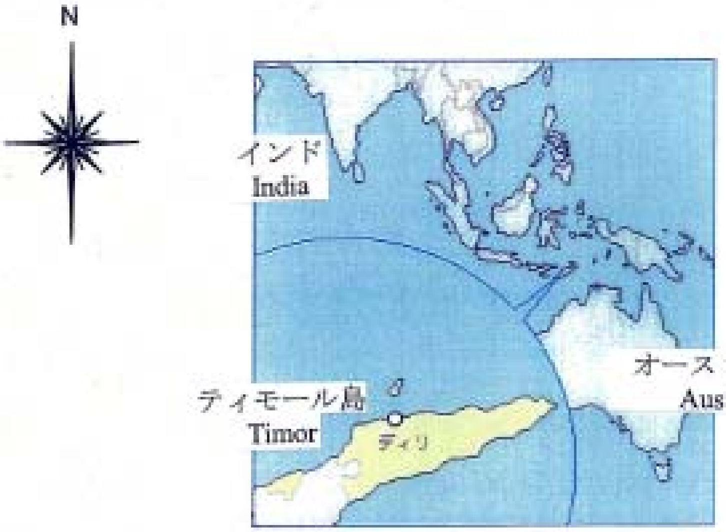
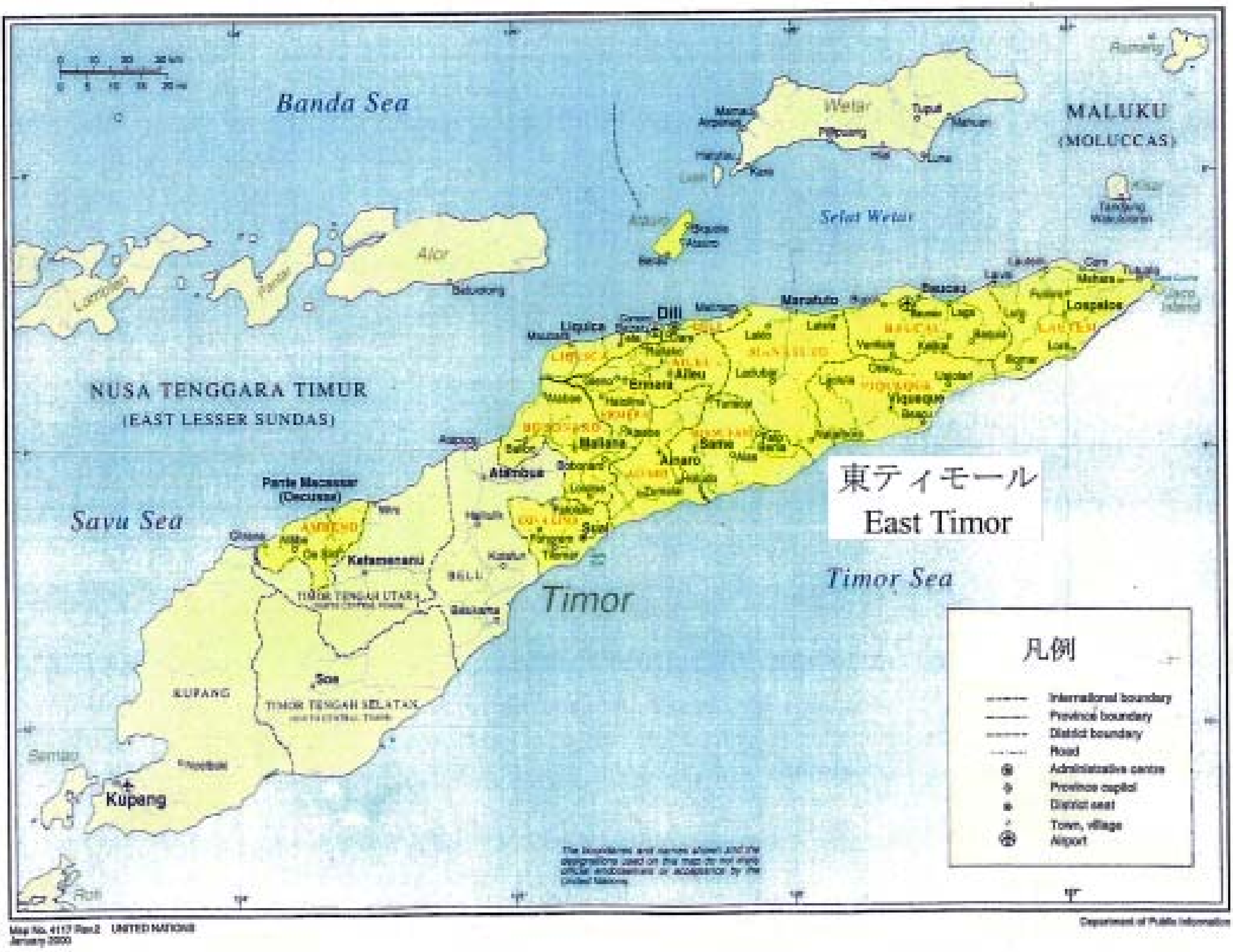
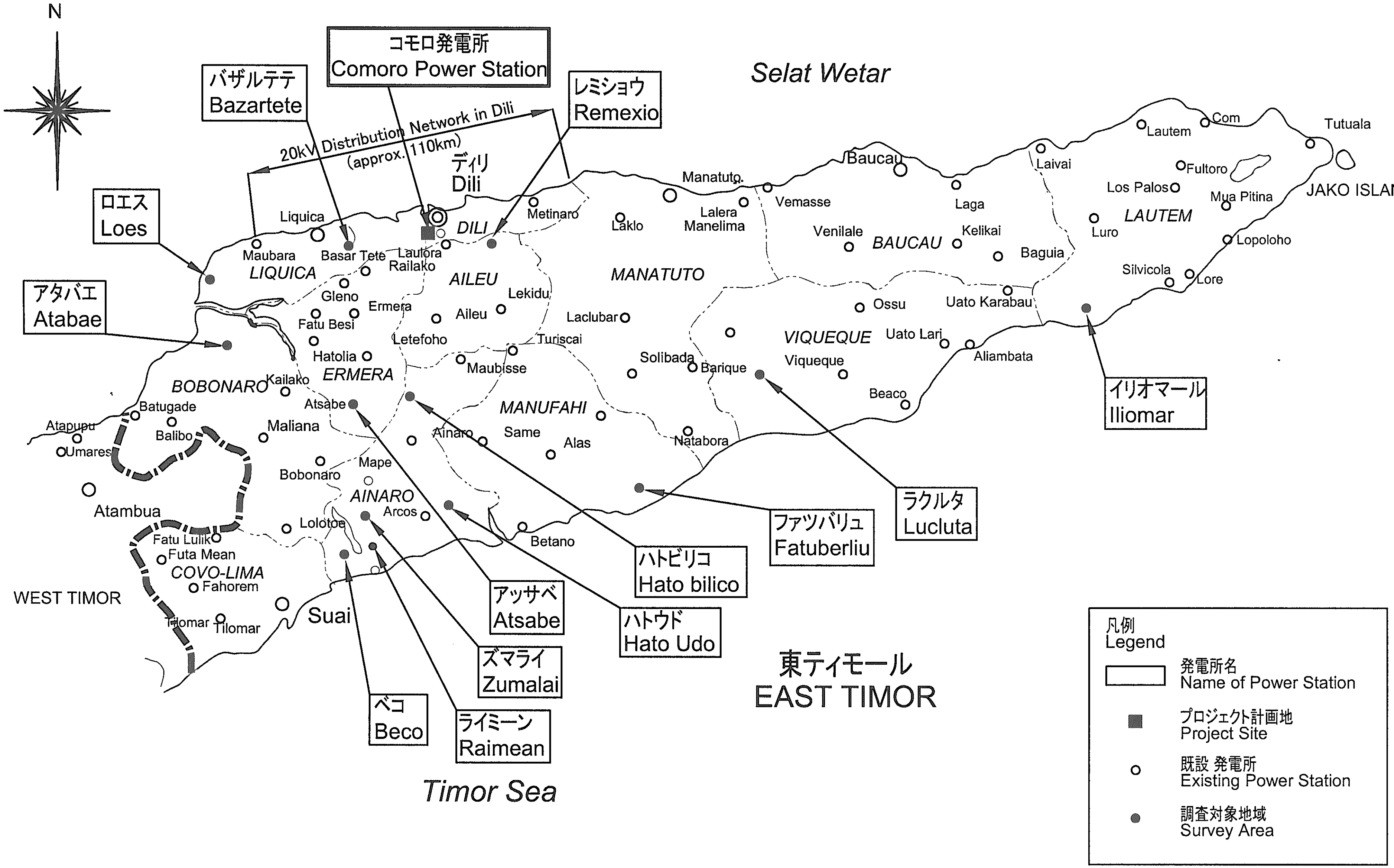




東ティモール国位置図
Location Map of East Timor



プロジェクト計画地 位置図
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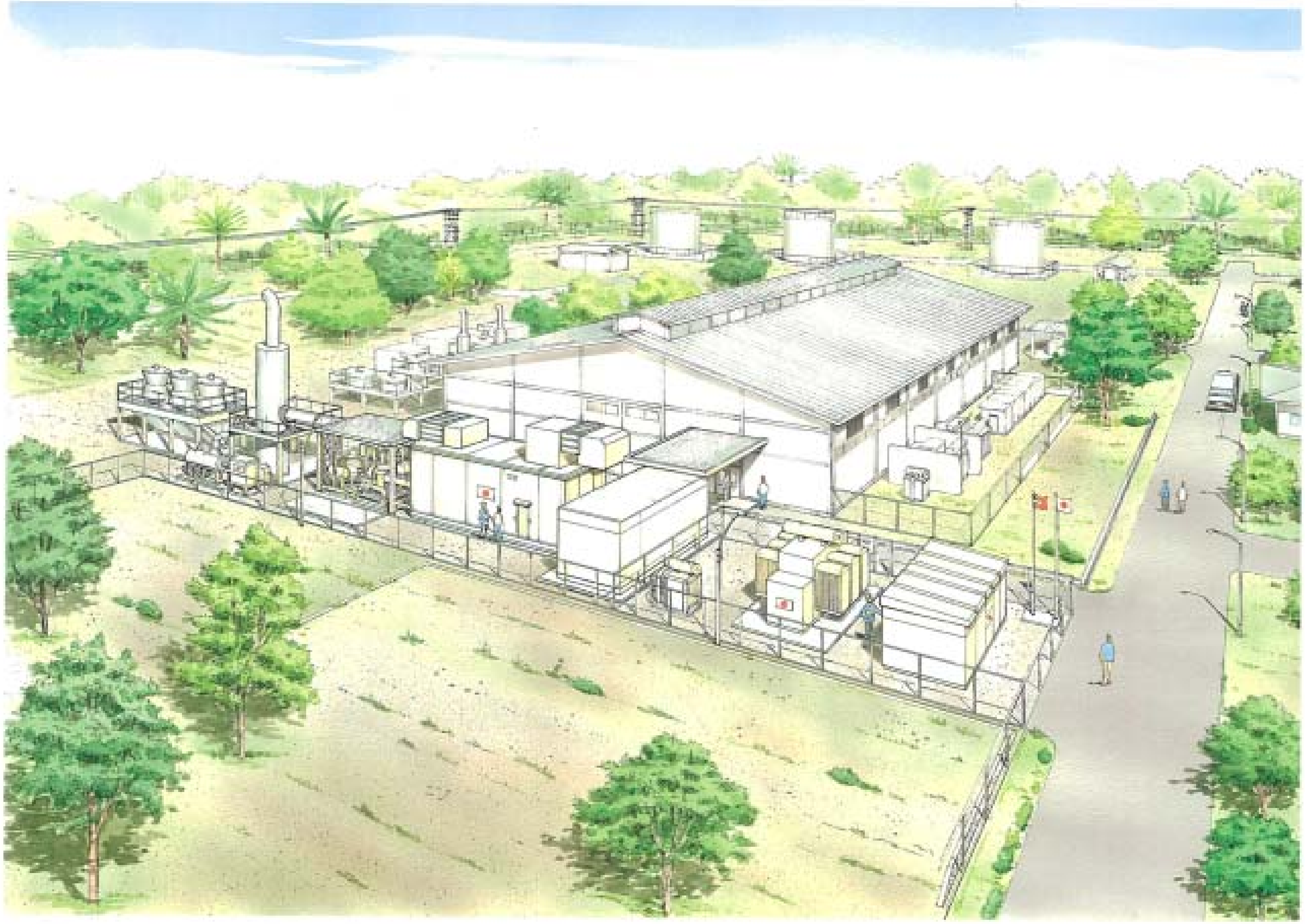

The Project for Rehabilitation of Power Supply in the Democratic Republic of Timor-Leste

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AIS	Architectural Institute in Japan
AusAID	Australian Agency for International Development
BHN	Basic Human Needs
CB	Circuit Breaker
DEG	Diesel Engine Generator
DT	Distribution Transformer
DWG	Drawing
EDTL	Electricidade De Timor Leste
EMP	Environmental Management Plan
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
JOCV	Japan Overseas Cooperation Volunteers
MD	Minutes of Discussion
MOE	Ministry of Environment
MPF	Ministry of Planning and Finance
MTCPW	Ministry of Transport, Communications and Public Works
M/C	Management Contract
ODA	Official Development Assistance
OJT	On the Job Training
O&M	Operation and Maintenance

SUMMARY

SUMMARY

The Democratic Republic of East Timor (hereinafter referred to as “East Timor”) occupies the eastern half of Timor Island which is part of the Lesser Sunda Islands to the east of Jawa Island and Bali Island. This island country situated along 9°S near Australia has an approximate population of 800,000 with a national land area of some 14,000 km^2. Its GDP per capita is US$ 452 (2001).

Since its official independence from Indonesia on 20th May, 2002, East Timor has been in the process of nation building with the assistance of the international community. Its public finance predominantly relies on the contributions of donors and some 90% of the fiscal expenditure in 2002 was financed by the donors. The main industries in East Timor are agriculture and fisheries. The growth of them is the key to the country’s economic development. The manufacturing industry accounts for only 2.5% (2002) of GDP and East Timor mainly relies on imports for the principal industrial products. Dili, the capital, is situated in the northwestern part of East Timor and is the centre for the country’s political, economic and industrial activities.

The electric utility in East Timor is run by the Electricidade De Timor Leste (EDTL) which is part of the Ministry of Transport, Communications and Public Works (MTCPW). In August, 1999, the people of East Timor opted for independence from Indonesia in a referendum but civil unrest led by those opposing independence took place immediately after the referendum, subsequently destroying some 70% of infrastructure facilities, including electric power supply facilities, in the country. Although the work to restore the destroyed infrastructure facilities has been conducted since immediately after the civil unrest in collaboration involving the Asian Development Bank (ADB), various UN organizations and donors, there are still many unrestored sites. The slow progress of restoring the power generation and distribution facilities as part of the major infrastructural facilities means disruption of the power supply for users. In the capital of Dili, the increasing power demand due to rapid rehabilitation has been forcing planned power cuts in Dili and the full-time operation of generating units including peak operation units designed to meet peak demand at the Comoro Power Station making it impossible to conduct the necessary maintenance work.

The Government of East Timor has adopted poverty reduction, fair and sustainable economic growth and the improvement of quality of life as the main goals of its National Development Plan (2002 – 2007) and has identified the stable supply of highly reliable power as the development goal for the power sector to achieve these national goals. However, the country’s fiscal constraints mean that not only the construction of new generating units requiring major funding but also the rehabilitation of the existing generating units and distribution network are difficult to implement.

In order to improve the situation described above, the Government of East Timor has made a request to the Government of Japan for grant aid for the rehabilitation of the power supply facilities.

In response to this request, the Government of Japan decided to conduct a basic design study and the Japan International Cooperation Agency (JICA) sent the Basic Design Study Team to East Timor for the period from 19th March to 27th April, 2003. The Study Team discussed and reconfirmed the contents of the request with officials of the Government of East Timor, conducted a survey on the subject sites and collected relevant information and data.

On its return to Japan, the Study Team examined the necessity, urgency, socioeconomic effects and suitability of the Project and proposed the basic design and implementation plan for the optimal project. The JICA then sent a mission to East Timor for the period from 27th July to 10th August, 2003 to explain the draft final report of the Basic Design Study to the East Timor side.

The contents of the finally proposed Project to be implemented by the Japanese side are outlined below.

Project Contents
A. Procurement and installation of No. 5 generating unit for Comoro Power Station
(1) Procurement and installation of a Diesel Engine Generator (DEG), Output 4.0 MW (outdoor type) (2) Procurement and installation of auxiliary mechanical equipment/systems for the DEG - Fuel supply system - Lubricating oil system - Cooling water system - Compressed air system - Air intake and exhaust system - Governor panel - Piping materials (3) Procurement and installation of auxiliary electrical equipment for the DEG 1) Generator monitoring and control panel 2) Protective relay panel for the generator 3) DC power source 4) House power panel 5) House transformer (500 kVA; 20 kV/400 – 230 V) 6) Transformer panel for 6.3 kV instruments 7) Cables (for 6.3 kV and lower voltage) (4) Common power equipment 1) Main transformer (5 MVA; 20/6.3 kV) 2) 20 kV high voltage panel board (outdoor type) 3) Protective relay panel for 20 kV system 4) Outdoor lighting system 5) Cables (for 20 kV and lower voltages) 6) Grounding system (5) Common equipment for the DEG 1) Waste oil treatment system 2) Fire extinguisher (6) Civil engineering work, etc. 1) Procurement and installation of sheds for auxiliary equipments and passageways 2) Foundations for the generating unit and auxiliary equipment (7) Procurement of spare parts necessary for two (2) years operation and maintenance tools (8) Procurement of operation and maintenance manuals (including textbooks for OJT) and implementation of OJT
B. Rehabilitation of 20 kV Dili distribution network
(1) Procurement and installation of automatic reclosers (2) Renewal of distribution transformers and procurement and installation of related equipment (3) Procurement of equipment for maintenance of the distribution lines (two trucks with a bucket, one truck with a crane) (4) Procurement of spare parts necessary for two (2) years operation (5) Procurement of operation and maintenance manuals (including textbooks for OJT) and implementation of OJT

In the case of the Project's implementation under the grant aid scheme of the Government of Japan, the total project cost is estimated to be approximately ¥765 million (approximately ¥762 million to be borne by the Japanese side and approximately ¥3 million to be borne by the East Timor side). The main cost items for the East Timor side are land clearance and leveling at the planned project site for the new generating unit and the preparation of an environmental management plan. The total period of the Project, including the design period, is estimated to be approximately 20 months.

The operation and maintenance of the facilities and equipment after the completion of the Project will be conducted by EDTL. In regard to the technical level of EDTL staff, even though the main engineers left Indonesia after the civil unrest, the technical level of the remaining East Timor engineers and technicians has improved under training provided by experts dispatched by various aid organizations to the point where they are able to conduct routine inspections without external assistance. The appropriate maintenance of the facilities and equipment to be introduced under the Project is judged to be feasible provided that the transfer of basic mechanical and electrical skills as well as operation and maintenance (O&M) skills is conducted together with the supply of the necessary spare parts and O&M manuals during the period from the commencement of the construction work to the handing over of the completed facilities and that JICA expert(s) or JOCV is dispatched after the completion of the Project for the further transfer of O & M skills.

The implementation of the Project is expected to have several direct effects as described below and some 135,000 people living in Dili and neighboring Liquica Province will benefit from the Project.

- Availability of stable power supply

  The present base load generating capacity of the Comoro Power Station of 10.88MW will increase to 14.88MW by 4.0 MW.

- Reduction of duration of power cuts

  Seven automatic reclosers will be replaced and the duration of power stoppages along each 20kV distribution circuit will be reduced by approximately 120 hours compared to the present 1,200hours per year.

The supply of electric power generated by the new generating unit to users will be charged and the profitability of this operation by EDTL will be determined by the number of uses, the amount of electric energy consumed by users and the collection rate of electric tariff. In regard to the operation cost of the generating unit to be constructed under the Project after its commissioning and of the distribution facilities, the operating balance of the said unit will go into the black if its annual capacity factor is approximately 52% or higher based on the current tariff for ordinary households (US$ 0.16/kWh). At this level, the appropriate operation of the new facilities will become feasible as the necessary funds for the procurement of spare parts for proper maintenance of the generating unit will be available. At a capacity factor of 52%, the size of the expected profit, however, will be just enough to smoothly conduct the O&M of the new facilities and equipment.

In order to reduce the fuel consumption per kWh and increasing of thermal efficiency of the power station, the East Timor side shall make an adequate plan including capacity factor of the new generating unit shall be more than 80 % in a year.

Given the significant effects of the Project described above and its contribution to the basic human needs (BHN) of local people, the part financing of the Project under Japan’s grant aid scheme is judged to be relevant. Moreover, it is believed that the East Timor side has sufficient manpower and funds to properly conduct the operation and maintenance of the facilities and equipment in the post-project period.

For the smooth and effective implementation of the Project, the East Timor side should, without delay, complete its undertakings, including preparation of the planned construction site for the new generating unit, appointment of persons to receive OJT and preparation of a power cut-off plan for the existing distribution network during the rehabilitation work period. Moreover, EDTL must prepare (i) an economic operation plan for the generating and distribution facilities, (ii) a supply increase plan to ensure stable power supply after 2008, i.e. the target year of the Project, and (iii) the necessary funds required to procure new facilities to support the plan described in (ii) above.

CONTENTS

CHAPTER 1　BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

In August, 1999, while the people of East Timor opted for independence from Indonesia in referendum, civil unrest led by those opposing independence took place immediately after the referendum, subsequently destroying some 70% of public facilities, including power supply facilities, throughout the country.

The Government of Japan regards the development of infrastructure as a priority area for Japanese assistance for East Timor and has been actively providing assistance for the rehabilitation of power infrastructure in collaboration with other donors and the ADB, etc. since the time of the provisional administration under the UNTAET. However, such assistance was an emergency measure and its scope was limited.

Since the official declaration of independence on 20th May, 2002, the Government of East Timor has been proceeding with nation building with the assistance of the international community. At present, the increasing power demand due to rapid rehabilitation has been forcing regular power cuts in Dili and the full-time operation of generating units including peak operation units designed to meet the peak demand at the Comoro Power Station (the subject power station of the request), making it impossible to conduct necessary maintenance work.

In addition, some of the generators provided at 13 sites in nine provinces with Japanese emergency grant aid are not functioning because of damage to the distribution facilities constructed during the period of Indonesian rule, including theft of the distribution cables. Even though the ADB is also providing funds for the repair of such damage, the overall power supply for rural area is being hampered.

In order to improve the situation described above, the Government of East Timor has made a request to the Government of Japan for grant aid for rehabilitation of the power supply facilities.

[Contents of the Request]

① Rehabilitation of Generating Unit No. 5 (MAK-IV) at the Comoro Power Station

- Procurement and Installation of a diesel power generating unit with a capacity to meet the estimated power demand in the target year of the Project in order to rehabilitate the said unit of which the operation has been suspended since its breakdown in September, 2001

- Procurement and Installation of auxiliary equipment and electrical systems required for the said generating unit
- Implementation of civil engineering work required for the said generating unit
- Rehabilitation of common facilities (waste oil treatment facilities, incinerator and fire extinguishing system, etc.) at the Comoro Power Station
- Procurement of spare parts necessary for two years operation for the said generating unit as well as existing Units No. 1 through No. 4

② Rehabilitation of 20 kV Dili Distribution Networks

- Renewal of pole-mounted transformers and distribution panels due to over-loaded, damage or deterioration
- Rehabilitation of damaged or deteriorated reclosers and section switches
- Replacement of damaged or deteriorated steel poles with concrete poles
- Procurement and installation of metal assemblies and insulators, etc. to new concrete poles
- Partial relocation of distribution lines underground in view of frequent grounding faults
- Procurement of distribution line maintenance equipment (two trucks with a bucket, one truck with a crane and sets of spare parts for these vehicles)

③ Rehabilitation of Distribution Network in 13 Rural Areas

- Rehabilitation of generating units which are out of operation due to damage
- Rehabilitation of electrical systems relating to damaged generating units
- Rehabilitation and extension of 20 kV high voltage distribution lines (electric poles, cables, metal assemblies and insulators, etc.)
- Rehabilitation and extension of 400/230 V low voltage distribution lines (electric poles, cables, metal assemblies and insulators, etc.)
- Procurement and installation of pole-mounted transformers
- Installation of service wires to users and procurement and installation of circuit breakers for service wires

CHAPTER 2　CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

(1) Overall Goals and Project Objectives

In its National Development Strategy (2000 – 2003), the Government of East Timor sets out the economic development of the country and the improvement of quality of life as its main objectives.

Against the background, the Project aims at the construction of new generating facilities and the rehabilitation as well as development of the 20 kV Dili distribution network to secure a reliable and stable power supply which is highly ranked on the priority development list in East Timor as part of the improvement of essential social infrastructure to improve the standard of living, to ensure the stable operation of social and public facilities and to vitalize industries in Dili, the centre for social and economic activities in East Timor, and also in other areas.

(2) Outline of the Project

The Project intends the rehabilitation and improvement of the existing power facilities in East Timor to achieve the objectives described above. The successful implementation of the Project is expected to secure a stable supply of power as an essential component of the social infrastructure in Dili and also to improve the reliability of the power supply system. The actual components of the Project are the installation of a new generating unit at the existing Comoro Power Station and the improvement of the existing 20 kV Dili distribution network.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Principles

The basic principles for the formulation of the framework for the scope and scale, etc. of the assistance are described below.

1) Scope of Assistance

Installation of a new generating unit and replacement of 20 kV distribution transformers and reclosing equipment, etc. will be implemented to ensure a stable power supply in Dili in 2008, the target year of the Project.

2) Site Selection

In principle, the premises of the existing power facilities and land owned by the government will be used in an effective manner. The new generating unit will be constructed next to the existing generator building at the Comoro Power Station while the new 20 kV distribution equipment will be installed adjacent to existing equipment.

3) Scale of Facilities

The scale of the new facilities will be sufficiently large to ensure a stable supply of power in 2008, three years after the completion of the Project.

(2) Natural Conditions

1) Temperature and Relative Humidity

The Project Area has a tropical savannah climate and the temperature in Dili is quite high as illustrated by a maximum temperature of 31.6°C, minimum temperature of 19.8°C and an annual mean temperature of 26.5°C. Meanwhile, the maximum relative humidity is 98% and the minimum relative humidity is 50% with a mean annual relative humidity of 75%. Although the generating unit to be procured under the Project will be protected by an outer shell, certain protective measures against the high temperature and relative humidity are required for much of the auxiliary equipment to be installed outdoors. Similar measures are also required for the 20 kV Dili distribution network. Accordingly, a maximum relative humidity of 98% is assumed when determining the equipment specifications, making the adoption of condensation prevention measures necessary.

2) Wind and Rain

The maximum wind velocity in the Project Area is 20 m/sec and the mean wind velocity throughout the year is 2 – 5 m/sec. The prevailing wind directions are southeast and northwest. The annual rainfall is 1,000 mm in Dili and 1,500 – 3,000 mm in rural areas, indicating the relatively high rainfall level in East Timor with a high maximum hourly rainfall of 20 mm. The dry season lasts from April to

September while the rainy season lasts from October to March. Appropriate storm drainage must be planned around the generating unit to avoid any disruption of its operation and maintenance due to standing water. Moreover, the minimum but essential roofing for passageways should be considered to avoid any disruption of the routine monitoring and recording work. The planning of the project implementation schedule must allow the main installation work, including that for the generating unit, to be conducted during the dry season from April to September. It is assumed that thunderstorms occur some 50 times a year, necessitating the installation of arresters and the coordination of insulation with the existing equipment.

3) Damage by Salt Contamination

The planned installation site for the new generating unit and the 20 kV distribution network is located near the coast. The main generating unit will, therefore, be protected from salt contamination by an outer shell. This arrangement will also reduce the level of noise in the neighboring area. In regard to auxiliary equipment, including the radiator, fuel tank and pump to be installed outdoors, salt-resistant paint and anti-corrosion materials will be used to protect them from salt damage. A highly anti-corrosion material, such as FRP, and salt-resistant paint will also be employed for the 20 kV equipment.

4) Earthquakes

As earthquakes of about 7 on the Richter scale have been recorded in the past, the necessary measures will be introduced to protect the new equipment.

(3) Socioeconomic Conditions

As most people in East Timor are Christians, there are no local customs which will severely affect the construction schedule, such as Ramadan in the case of Muslim countries. Government offices are open five days a week (closed on Saturdays and Sundays) and there are some 10 national holidays a year. The planning of the distribution line rehabilitation work must ensure the shortest duration of power cuts to minimize any adverse impacts on the public and social activities and must uphold the safety of the workers involved and others as the highest priority.

(4) Construction and Procurement Conditions

Although the construction materials will, in principle, be procured locally as much as possible when preparing the work plan, only a limited range of materials such as sand

and aggregate for concrete, are available locally. Other construction materials will, therefore, be procured from such neighboring countries as Australia and Indonesia. It will be necessary for the work plan to take the possible transportation routes and procurement period, etc. from these countries into careful consideration.

The installation of the generating unit, including test operation and adjustment, will require skill and experience and the dispatch of a Japanese engineer(s) will be necessary to provide technical guidance for the local subcontractor and also to conduct quality as well as schedule control from the viewpoint of ensuring the planned quality and schedule.

The work to install the new 20 kV distribution equipment will take place at practically the same site as the existing equipment and temporary power cuts will be required to conduct this work. In order to minimize any adverse impacts of power cuts on the lives of the public, work involving live wiring will be necessary. Accordingly, the preparation of a detailed work plan, including advance checking, will be required.

(5) Use of Local Contractor (Construction Company)

1) Use of Local Contractor

There are a few local construction companies which has direct experience of conducting foundation and installation work involving equipment of the planned scale. Although a local contractor will be used to provide construction machinery and labor for the Project, the dispatch of a Japanese engineer(s) will be necessary for quality, schedule and safety control.

2) Use of Local Materials

Only limited construction materials, such as sand and aggregate for concrete, are available in East Timor and it will be necessary to import most of the construction materials from such neighboring countries as Australia and Indonesia.

All types of equipment and materials for power generation and distribution network used in East Timor are imported from various countries. For the implementation of the Project, the East Timor side has strongly expressed a preference for Japanese products which offer high quality, performance, functions and after-service.

The procurement sources for the generating and distribution equipment, etc. for the Project will be decided taking several factors into consideration, including the local situation, ease of operation and maintenance by local engineers, planned manufacturing period of spare parts, number of days required procurement of spare parts, and the availability of after-service by the manufacturer to deal with equipment breakdowns.

3) Dispatch of Japanese Engineer(s)

The installation of the generating and distribution equipment, including test operation and adjustment, will require a high level of skill and it will, therefore, be necessary to dispatch an engineer(s) from Japan to provide technical guidance and to conduct quality and schedule control in order to ensure the planned quality and schedule.

(6) Operation and Maintenance Capability of Implementation Body

Power in East Timor is mainly supplied by diesel engine generator (DEG) with a small to medium capacity. Since the end of the conflict in East Timor, the operation and maintenance of such generating equipment has relied on technical guidance by engineers and technicians dispatched under foreign assistance schemes. Accordingly, the EDTL cannot be said to have sufficient basic technical capability to properly conduct the operation and maintenance of the generating and distribution equipment to be procured and installed under the Project. The dispatch of a Japanese engineer(s) will, therefore, be necessary to conduct On the Job Training (OJT) on the medium capacity DEG (4.0 MW class) to be procured under the Project during the installation, test operation and adjustment period in view of the effective and efficient operation and maintenance of these generators. For the purpose of OJT, the provision of textbooks which are appropriate for the technical level in East Timor will be necessary.

The Project includes the supply of spare parts covering a period of two years after the handing over of the new equipment to the East Timor side and it is anticipated that some of the income from the power supply business will be used to fund the maintenance and procurement of spare parts and tools, etc. in subsequent years.

(7) Scope and Grade of Equipment, etc.

In consideration of the various conditions described above, the scope and technical grade of the equipment to be procured under the Project will be based on the following principles.

1) Scope of Equipment Procurement

For the construction of the generating facilities and procurement of the 20 kV distribution equipment and spare parts, etc., the minimum range and quantity of equipment will be selected to satisfactorily achieve the objective of the Project, i.e. a stable power supply for the residents and social/public facilities of Dili, the capital of East Timor.

Standard products conforming to international standards will be selected as much as possible to ensure an economical and technically optimal design and the configuration and specification of the equipment and components will be determined so as to achieve their interchangeability in view of the early stage of technical development in East Timor, a country in its second year since official independence.

2) Technical Level

The specifications of the generating and distribution equipment to be procured under the Project should be comparable with those of the existing equipment where possible because of the familiarity of such equipment on the part of EDTL engineers for maintenance purposes. Special attention should be paid to the new equipment not significantly exceeding the technical grade of the existing equipment.

The planned OJT to be provided during the installation, test operation and adjustment period by engineers of the equipment manufacturer(s) on operation and maintenance will aim at upgrading the existing operation and maintenance skills of EDTL engineers to the level of being capable of analyzing the operation and breakdown records of the generating equipment, planning and implementing a suitable response and also implementing preventive maintenance.

(8) Construction and Procurement Methods and Schedule

As the Project will be implemented under the Japan's Grant Aid Scheme, it must be completed within a single year. In regard to the 20 kV Dili distribution network in particular, it will be necessary for the work to be simultaneously conducted at multiple sites in order to shorten the work period because of the large number of pole-mounted transformers to be installed. Preparation of the optimal implementation schedule will be necessary, taking such parallel work into consideration. As the planned rehabilitation of the distribution equipment will involve the renewal of the existing distribution transformer and reclosing equipment using the existing route, it will be necessary for the installation of the new equipment to be conducted concurrently with the removal of the existing equipment. Because of the overlapping of this work, the Japanese side will conduct the removal of the existing equipment together with the installation of the new equipment.

(9) Environment

Possible environmental issues associated with the implementation of the Project are pollution and adverse impacts on the natural and social environments. These will be dealt with based on the relevant environmental standards in East Timor. If no relevant standard exists in East Timor, the comparable Japanese standard will be applied.

2.2.2 Basic Plan (Equipment Plan)

(1) Preconditions

Having examined the various conditions described in 2.2.1, the following conditions have been established for the preparation of the scope and specifications of the equipment to be provided.

1) Climatic and Site Conditions

Table 2-2-1 Climatic and Site Conditions

No.	Item	Unit	In Dili
1	Design temperature	°C	Maximum: 32
2	Diesel generator room	°C	Maximum: 40
3	Relative humidity	%	Mean annual: 75 (maximum: 98)
4	Rainfall	mm	Mean annual: 1,000 (hourly maximum: 20)
5	Wind velocity	m/sec	Maximum: 20 (average: 2 – 5)
6	Earthquakes	-	M7
7	Salt contamination level	mg/cm^2	0.12 (Middle contamination area)
8	Noise level	dB (A)	55 (at property line)
9	Dust level	-	Not considered
10	Bearing capacity of soil	$tons/m^2$	20
11	Annual occurrence of thunderstorms	times	50
12	Elevation (above mean sea level)	m	10
13	Groundwater level	cm	150 - 200

2) Applicable Standards and Units

For the design of the planned equipment under the Project, the Japanese standards as well as such international standards as IEC and ISO listed below will be referred to for the main functions of the equipment to achieve compatibility with the existing equipment. Because of the absence of local standards for electrical installation work, Japanese standards will basically be used. SI units will be used for the units.

①	International Electrotechnical Commission (IEC)	:	applied to the main functions of electrical products in general
②	International Standards Organization (ISO)	:	applied to the performance evaluation of industrial products in general
③	Japanese Industrial Standards (JIS)	:	applied to industrial products in general
④	Standards for the Japan Electrical Committee (JEC)	:	applied to electrical products in general
⑤	Standards of Japan Electrical Manufacturers Association (JEM)	:	as above
⑥	Japanese Electric Association Code (JEAC)	:	as above
⑦	Japanese Cable Makers Standards (JCS)	:	applied to electrical wires and cables
⑧	Technical Standards for Electrical Facility	:	applied to electrical design and installation work in general
⑨	Architectural Institute of Japan (AIJ)	:	applied to building work in general

3) Power Supply and Demand Forecast and Scale of Equipment

The power supply and demand forecast and the design scale of equipment for the Project Area (Dili, the capital) will be based on the following conditions.

① Preconditions

a) The power demand increase rate is generally proportional to the past trend of demand and the GDP growth rate, etc. The average annual increase in Dili in the last 15 years is 7.5% with a recent increase rate of 3.8% from 2000 to 2001. In view of (i) the existence of private power generating capacity totaling some 3.5 MW at the end of 2002 and (ii) the target annual GDP growth rate in East Timor of 5%, etc., the mean annual increase rate of the maximum power demand is assumed to be 5% up to 2007 and 3% from 2008 onwards for the Project.

b) It is assumed that the commercial operation of the new generating unit to be installed under the Project will commence in the end of 2005.

c) The remaining life of the existing generating units will be determined based on the power supply and demand balance (Appendix 8), taking the current situation of their operation into consideration.

d) The target year of the Project is set at 2008, i.e. three years after commissioning. Considering that the development of Timor gap will be started from 2005 and income by oils and gases is estimated about 180 million US$ per year which will be helpful to maintain and increase the generating facilities.

e) The scale of the equipment will be decided to allow the regular inspection of one generator used for base operation in 2008 and also to achieve the most economical operation of the entire generating unit

② Examination of Optimal Equipment Scale

a) Examination Based on Power Demand

The power supply and demand balance prepared based on the conditions described above is shown in Appendix 8. The decision on the generating capacity of a single generator must be based on the maximum power demand, daily load fluctuation and other relevant factors of the power grid in Dili. The experience of Japanese power companies suggests that, for an island country, a capacity of a single generator of approximately 20 – 30% of the total power demand of the system generally promises the most efficient and economical operation and maintenance. The actual capacity is then determined, taking the auxiliary power supply at the power station and the power loss through distribution facilities into consideration.

i) Estimation based on the maximum power demand (16,700 kW) in the target year of the Project (2008)

- 20% of the maximum power demand: approximately 3,840 kW (16,700 kW x 0.2 x 1.15 [*1])

- 30% of the maximum power demand: approximately 5,760 kW (16,700 kW x 0.3 x 1.15 *1)

  *1 An additional demand of 5% for the power consumption at the power station and 10% for the distribution loss are assumed.

Based on the above, the optimal generating capacity of a single generator is 3.8 – 5.8 MW.

ii) Examination based on load fluctuation

On the day when the maximum power demand was recorded in 2002, the maximum load for the power grid in Dili was 12.7 MW with an average load zone of 7 – 8 MW. To meet the average load which continues for approximately three-quarters of the day, a generating capacity of generators, which are capable of continually operating to provide the base and middle loads, of 7 – 8 MW is required. Considering outage for regular inspection purposes, there must be surplus capacity equivalent to one generator used for base load operation. Given the fact that the specification of the existing No. 6 through No. 13 units are determined for peak operation units with assumed annual operation of 500 – 1,000 hours (approximately 1 – 3 hours/day), their operation at times other than the peak hours from 18:00 to 24:00 must be avoided as much as possible to prevent any deterioration of their expected life. Considering the likely increase of the power demand, the average load in 2008 is expected to be around 9.2 – 10.5 MW. As the total generating capacity of the generators (No. 1, No. 2 and No. 4 units) to cover the base and middle loads is 6.0 MW at the time of the regular inspection of the No. 3 unit which is the largest base load generator among the existing generating units and excluding the No. 5 unit (subject to renewal under the Project), the required generating capacity of the new No. 5 unit to meet the average load (9.2 – 10.5 MW) is 3.2 – 4.5 MW.

The generating capacity required of the new generating unit is, therefore, 3.8 – 4.5 MW which takes the maximum power demand and daily load fluctuation examined above into consideration. However, only a 4.0 MW class DEG is in the required generating capacity range among the diesel generators currently available in the market. Consequently, 4 MW is the optimal generating capacity from the viewpoint of the power demand.

b) Examination Based on Operational Mode

When the generating capacity described in a) above is opted for, the optimal operational mode of each generating unit in 2008 is shown below provided that the existing generating units are properly maintained and that all of the units are operational.

Table 2-2-2 Optimal Operation Mode in 2008

Operational Model	Daily Hours of Operation	Continuous Output (MW)	Total Max. Output (MW)	Remarks
Base Load	24 hours	No. 5 Unit: 3.9 No. 4 Unit: 2.3 No. 3 Unit: 2.5	8.7	No.5 is subject unit of the Project
Middle Load	6 – 18 hours	No. 1 Unit: 1.8 No. 2 Unit: 1.9	3.7	Also used for base load operation for a short time
Peak Load	1 – 3 hours	No. 6 Unit: 0.75 No. 7 Unit: 0.75 No. 8 Unit: 0.85 No. 9 Unit: 0.85 No. 10 Unit: 0.85 No. 11 Unit: 0.85 No. 12 Unit: 0.85 No. 13 Unit: 0.85	6.6	Also used for middle load operation for a short time
		Total	19.0	

The operation of each unit when the new No. 5 unit is stopped for maintenance in 2008 (overhaul after operation for 30,000 hours) is shown below.

Table 2-2-3 Operation Mode when No. 5 is Maintaining in 2008

Operational Model	Daily Hours of Operation	Continual Output (MW)	Total Max. Output (MW)	Remarks
Base Load	24 hours	No. 4 Unit: 2.5 No. 3 Unit: 2.3	4.8	
Middle Load	6 – 18 hours	No. 1 Unit: 1.8 No. 2 Unit: 1.9	3.7	Used for base load operation for a short time
Peak Load	1 – 3 hours	No. 6 Unit: 0.75 No. 7 Unit: 0.75 No. 8 Unit: 0.85 No. 9 Unit: 0.85 No. 10 Unit: 0.85 No. 11 Unit: 0.85 No. 12 Unit: 0.85 No. 13 Unit: 0.85	6.6	
		Total	15.1	

As the maximum power demand in 2008 is assumed to be 16.7 MW, outage of the new generating unit will produce a temporary shortfall of the generating capacity of 1.6 MW. The outage of this unit for regular inspection must, therefore, be carefully planned so that it is conducted at a time of low maximum power demand along with planned power cuts for some areas.

c) Examination of Economy

Compared to the average unit fuel consumption of 221 g/kWh of the existing Comoro Power Station as of the end of 2002, the expected unit fuel consumption of the new 4.0 MW generator of 203 g/kWh will represent almost a 10% saving of the fuel.

③ Examination Results

Based on the above examination results, the required scale of the new generating unit in the end 2005 following the implementation of the Project will be 4.0 MW (one unit). With the installation of this new generating unit, the power supply up to the target year of the Project will exceed the demand and reserve supply capacity allowing the outage of one generating unit for maintenance work will be secured, establishing a stable power supply regime.

4) Environmental Considerations

In connection with the installation of the generating and distribution equipment to be procured under the Project, the following reference values are set as the design conditions in the list of Japanese standards because there is no set of established environmental standards relevant to the equipment in question in East Timor.

(a) NOx : ≦ 950 ppm (when the residual oxygen concentration is 13%)

(b) SOx : ≦ 250 ppm (when the sulphur content of the fuel oil is 1%)

(c) Oil : ≦ 30 ppm

(d) Particles : ≦ 100 mg/Nm^3

(e) Noise : ≦ 55 dB (A) at the boundary of the power station site during operation of the No. 5 generating unit only

(f) Vibration : ≦ 55 dB at the boundary of the power station site during operation of the No. 5 generating unit only

5) Equipment Layout Plan

① Generating Unit

In consideration of the effective use of the existing power station, reduction of noise affecting nearby houses, etc., the removable of the existing generating units for the maintenance and the securing of an access road for a maintenance crane, etc., the new generating unit will be located to the south of the existing generator building. Careful attention must be paid to the underground fuel and water pipelines serving the existing generating units at the planned construction site. Basic Design Drawing G-01 shows the overall site layout.

The main conditions to be considered for the layout plan are listed below.

(a) The existing Comoro Power Station site should be effectively used.

(b) The DEG, monitoring and protective relay panel and low voltage power equipment will be located in the enclosure to allow ease of operation and maintenance even during the rainy season while the introduction of a shed is considered for the motor and other auxiliary equipment to be located outdoors to ensure ease of maintenance and also to prevent rapid deterioration due to direct sunlight.

(c) The floor around the generating unit should be a concrete floor to ensure the ease of maintenance of the diesel generator.

(d) The enclosure for the DEG should have a sound insulation structure to prevent noise pollution while measures to reduce noise should be adopted for the air intake and exhaust system.

(e) An oil separator and an incinerator should be installed to remove waste oil and to dispose of sludge respectively.

(f) The layout of the new equipment should take space to move the existing generating equipment in and out into consideration.

② Distribution Equipment

By reusing the site of the existing distribution equipment, the need for the acquisition of new land is minimized. The layout will take the safety of people living in the vicinity into careful consideration. Basic Design Drawing D-01 shows the standard layout.

The main conditions to be considered for the layout plan for the distribution equipment are listed below.

(a) Effective land use should be aimed at by means of using the site of the existing distribution equipment.

(b) As the planned site is near the coast, measures to prevent salt damage to the equipment should be considered.

(c) The safety of people living in the vicinity should be the highest priority in the planning of the equipment layout together with ease of maintenance and other aspects.

(2) Outline of Basic Plan

The basic plan for the Project based on the concept and principles of the basic design is outlined in Table 2-2-4.

Table 2-2-4 Outline of Basic Plan

Project Contents
A. Procurement and installation of No. 5 generating unit for Comoro Power Station
(1) Procurement and installation of a Diesel Engine Generator (DEG), Output 4 MW (outdoor type) (2) Procurement and installation of auxiliary mechanical equipment/systems for the DEG - Fuel supply system - Lubricating oil system - Cooling water system - Compressed air system - Air intake and exhaust system - Governor panel - Piping materials (3) Procurement and installation of auxiliary electrical equipment for the DEG 1) Generator monitoring and control panel 2) Protective relay panel for the generator 3) DC power source 4) House power panel 5) House transformer (500 kVA; 20 kV/400 – 230 V) 6) Transformer panel for 6.3 kV instruments 7) Cables (for 6.3 kV and lower voltage) (4) Common power equipment 1) Main transformer (5 MVA; 20/6.3 kV) 2) 20 kV high voltage panel board (outdoor type) 3) Protective relay panel for 20 kV system 4) Outdoor lighting system 5) Cables (for 20 kV and lower voltages) 6) Grounding system (5) Common equipment for the DEG 1) Waste oil treatment system 2) Fire extinguisher (6) Civil engineering work, etc. 1) Procurement and installation of sheds for auxiliary equipments and passageways 2) Foundations for the generating unit and auxiliary equipment (7) Procurement of spare parts necessary for two (2) years operation and maintenance tools (8) Procurement of operation and maintenance manuals (including textbooks for OJT) and implementation of OJT
B. Rehabilitation of 20 kV Dili distribution network
(1) Procurement and installation of automatic reclosers (2) Renewal of distribution transformers and procurement and installation of related equipment (3) Procurement of equipment for maintenance of the distribution lines (two trucks with a bucket, one truck with a crane) (4) Procurement of spare parts necessary for two (2) years operation (5) Procurement of operation and maintenance manuals (including textbooks for OJT) and implementation of OJT

(3) Generating Unit Plan

The generating unit to be procured under the Project will be operated as a base load generating unit for the power grid in Dili. This unit will be installed outdoors, the introduction of a protective cover for the main equipment will be considered in view of the need to ensure operability and ease of maintenance during the rainy season and to prevent salt damage. At present, East Timor is considering a change of fuel from the current A heavy oil to C heavy oil to reduce the generating cost in the future and, therefore, the new generating unit should be capable of being operated using C heavy oil in the future, if necessary, with the minimum modifications.

The construction work to be used for the installation of the generating unit will be selected based on the basic conditions and outline of the unit configuration described below.

1) Basic Conditions

① Generating Method

The generating method will be diesel engine generation in view of the facts that this method is currently used in East Timor and that it diesel equipment is easy to operate and maintain.

② Monitoring and Control Method

The monitoring and control of the new generating unit will be conducted locally as in the case of the existing units and the panels will be placed under cover so that the entire range of equipment can be monitored from one location. As the operators of the new unit will be stationed in the existing generator building, grouped alarm relating to the new generating unit will be given at the monitoring place inside the existing building.

③ Fuel Composition

The fuel currently used at the Comoro Power Station is diesel oil produced in Indonesia. The use of the same fuel is planned for the new generating unit and the composition of this fuel is shown in Table 2-2-5.

Table 2-2-5 Fuel Composition

Item	Unit	Value
Specific gravity	-	0.852
Ignition point	°C	40.0
Kinematic viscosity	CSt	4.07
Combustion point	°C	17.0
Water content	Vol.g	≤ 0.01
Ash content	Wtg	≤ 0.01
Sulphur content	wt%	0.35
Calorific value (HHV)	kcal/kg	10,830

Source: PERTAMINA

④ Lubricating Oil Composition

Different manufacturers of generating equipment recommend different compositions of lubricating oil. For the new generating unit, the same types of lubricant oil (MEDITRAN SAE 30, 40 and 50) currently used for the existing units will be used to ensure interchangeability and minimization of the storage place.

⑤ Cooling Water

The cooling water for the new generating unit will be the same type of cooling water used by the existing units. This cooling water is city water which is treated by a water softening plant and fully meets the water quality required by the new generating unit. Therefore, the introduction of new water treatment facilities is unnecessary.

2) Equipment Details

① Determination of Engine Output and Generator Capacity

The rated output of the generating unit to be installed under the Project is determined based on the following conditions.

(a) The target year of the Project is 2008, i.e. three years after the planned completion of the Project in 2005.

(b) The annual continual operating hours (as base load operation) are at least 8,000 hours.

(c) In view of the estimated maximum power demand and daily load fluctuation in the target year (2008), the generating capacity of the new unit should be large enough to provide stable power supply even if another base load operation unit is stopped for maintenance purposes.

Based on the above conditions, the optimal generator capacity is one 4.0 MW generator as described in 2.2.2-(1)-3). The required engine output and rated generator capacity are calculated below. As the specifications of the engine, etc. slightly differ from one manufacturer to another, the following figures are used as general yardsticks.

- Engine output

$$Pe \geqq \frac{P}{0.7355 \times \eta_G} = 5{,}725 \text{ PS}$$

Pe : engine output (Ps)

P : generator output (4.0 MW)

η_G : generator efficiency (assumed to be 95%)

- Generator capacity

$$P_G = \frac{P}{Pf} = 5{,}000 \text{ kVA}$$

P_G : generator capacity (kVA)

P : generator output (4.0 MW)

Pf : power factor of generator 0.8 (lag)

Table 2-2-6 Engine Output and Generator Capacity for the Project

Item	Value
Engine Output (Pe)	5,725 (PS)
Generator Capacity (P_G)	5,000 (kVA)

② Examination of Engine Speed

In the case of Japanese power companies, a medium engine speed of 750 rpm or lower is generally adopted for a single base load 4.0 MW generating unit for the purpose of economic operation and maintenance and the operational reliability of this type of generating unit has been proven. Meanwhile, the engine speed of the existing base load generating units at the Comoro Power

Station is also 750 rpm or lower and, therefore, the engine speed of the new generating unit is set at 750 rpm or lower, taking the properties of the lubricating oil to be used also into consideration.

③ Auxiliary Mechanical Systems Plan

The auxiliary systems will be the same as the existing systems where possible in view of ease of operation and maintenance, energy saving and economy in terms of the spare parts procurement cost, etc. The mechanical auxiliary systems to be installed are outlined below.

(a) Fuel Supply Plan

The total fuel storage capacity of the Comoro Power Station is 1,900 m^3 which is large enough to support the operation of the entire power station, including the new generating unit to be installed under the Project. Therefore, no new fuel storage tank will be installed. As a fuel supply pipeline already exists to the existing generator building, an extension line which branches out from the existing pipeline is planned to supply fuel to the new generating unit. As in the case of the existing generator units, however, a daily service tank with a small capacity will be installed outdoors to ensure a stable supply of fuel to the engine for a short period of time at the time of the occurrence of an abnormal situation concerning the main fuel tank and/or the common piping system. The capacity of this daily service tank will be equivalent to two hours operation of the new unit, taking the facts that the existing units do not have a transfer pump and that the pipe size is small into consideration. Basic Design Drawing M-05 shows the configuration of the fuel supply system.

(b) Lubricating Oil System

The lubricating oil tank will be installed inside the diesel engine body. The lubricating oil will be changed every 8,000 hours and an oil filter will be installed to reduce the maintenance cost. The lubricating oil will be directly supplied from the drum to the tank inside the generator building using an electric pump. Basic Design Drawing M-06 shows the configuration of the lubricating oil system.

(c) Cooling Water System

As in the case of the existing units, a closed circulation system using a radiator will be used to reduce the water consumption. A supplementary water supply tank will be installed to compensate for the loss of cooling water. As this tank will not be frequently used, it will only have a capacity of 0.5 m^3. This outdoor tank will be made of FRP because of its excellent salt resistance. Basic Design Drawing M-07 shows the configuration of the cooling water system.

(d) Start-Up System

A compressed air start-up system will be used to start the diesel engine because of its high start-up torque and also because of its use by the existing units. For this purpose, the existing air compressor will be used. The compressed air tank required for the start-up of the generating unit will have a capacity capable of starting a diesel engine three times. Given the likelihood of water accumulation in this tank because of the high relative humidity level, an automatic water drainage valve will be installed to regularly drain water in the tank. Basic Design Drawing M-08 shows the configuration of the compressed air system.

(e) Air Intake and Exhaust System

The outer cover will be given a ventilation system for air intake for combustion and ventilation inside the cover and exhaust gas from the engine will be discharged outside via a silencer to reduce the level of noise which is leaked to the outside. Basic Design Drawing M-09 shows the configuration of the air intake and exhaust system.

(f) Sludge Treatment System

The simple oil separator installed to serve the existing generating units at the Comoro Power Station is not functioning, causing concern in regard to environmental pollution by the overflow of waste oil due to the incursion of rainwater. In view of this situation, a sludge separation tank and an oil separator exclusively serving the new generating unit will be installed under the Project to prevent environmental contamination by means of separating oil from water and discharging the separated water only. An incinerator will also be installed to adequately dispose of the separated sludge and waste oil. As most of the components of the new generating unit will be installed outdoors, suitable materials and paint to prevent salt damage to the equipment will be selected. Basic Design Drawing M-06 shows the configuration of the sludge disposal system.

(g) Pipelines

The components of the Project include pipelines for fuel, compressed air, cooling water and drain. These will be laid inside a trench or will be supported to ensure their ease of maintenance.

④ Electrical Equipment Plan

The main electrical equipment of the new generating unit is described below. Basic Design Drawing E-01 is a single line diagram for the Comoro Power Station.

(a) Generator

The specifications for the generator are the same as those of the existing generators, i.e. 3 phase 3 wire, synchronous, horizontal axis, air-cooling and salient pole or non-salient pole with a removable cover which has holes for air cooling. The generator voltage is 6.3 kV, the same voltage as that of the existing generators, and the generator can operate alone if necessary. The main specifications are listed below. Basic Design Drawing E-02 shows the configuration of the generator and the 6.3 kV circuit diagram.

- Rated operation : continuous
- Capacity : ≧ 5,000 kVA
- Voltage : 6.3 kV
- Frequency : 50 Hz
- Power factor : 0.8 (lag)
- Speed : same as the diesel engine (direct connection to the engine)
- Excitation method : brushless, thyristor
- Neutral grounding : non-grounding

(b) 6.3 kV High Voltage Panel

The instrument transformer for the measurement required for the operation of the new generator will be installed in this high voltage panel. As this high voltage panel incorporates vital equipment relating to the operation and protection of the generating unit, it will be placed in the same enclosure as the generator control panel. Basic Design Drawing E-02 shows the configuration of the generator and the 6.3 kV circuit diagram.

(c) Step-Up Transformer

This transformer will step up the generating voltage 6.3 kV to 20 kV for distribution voltage and will be installed outdoors as in the case of the existing step-up transformers. In view of safety, it will be guarded by fencing. The capacity of the step-up transformer is determined for its exclusive use for the new generating unit and no consideration is given to its potential use for another generating unit in the future. For the voltage change-over of this transformer, the non-load change-over method will be adopted because of the little load fluctuation.

(d) Auxiliary Transformer

This transformer will step down the voltage from 20 kV to 400/230 V to supply the power to the auxiliary equipment for the Project. It will be installed inside the fenced area as in the case of the main transformer. The capacity is determined to serve the new generating unit and no consideration is given to the future project.

(e) 20 kV and 6.3 kV High Voltage Panels

This high voltage panel will receive stepped-up 20 kV by the transformer via the circuit breaker for the generator and will distribute power to the required locations. It will have outdoor specifications in view of its outdoor location. A vacuum circuit breaker will be used for this high voltage panel in consideration of the environment and the components of the panel are listed below. Basic Design Drawing E-02 shows the configuration of the generator and the 6.3 kV circuit diagram.

・Generator panel (1)
・Distribution feeder panel (1)
・Bus-tie panel with existing 20 kV high voltage panels (1)
・Auxiliary transformer feeder panel (1)
・Instrument transformer panel (1)

The rated current and short-circuit current of the bass bar of this 20 kV high voltage panel will be 630 A and 12.5 kA (1 second) respectively in consideration of the existing specifications.

(f) Auxiliary Power supply Boards

This 400/230 V low voltage distribution boards will be installed inside the enclosure as in the case of the control panel for the generator and will supply power to the auxiliary equipment and the DEG. Basic Design Drawing E-03 shows the single line diagram for the 400/230 V low voltage circuit.

(g) Engine Control and monitoring Panel

This panel to monitor the operating status of the engine will be installed inside of the enclosure.

(h) DC Power Supply Unit

A common use DC power supply unit will be installed as the power source for the control and circuit breaker panels, etc. The DC voltage will be 110 V. A maintenance-free sealed battery will be used for ease of maintenance and will be placed inside the DC power supply panel. The capacity of this battery will be sufficient for 30 minutes at rated operation as this capacity level is commonly adopted. In view of its use, it will be placed inside the enclosure.

(i) Grounding Systems

The required grounding systems under the Project are described below.

- Grounding system to protect the power system

  (The direct grounding method is used for both the 20 kV and 400 V systems while the generator voltage of 6.3 kV is ungrounded.)

- Grounding system to prevent electrical shock by metallic items and electrical equipment

- Grounding system for the fuel service tank

(j) Cabling

The cables for the new DEG unit will be laid inside a trench, tray, conduit pipe or duct. The cables to be laid in a trench or conduit will not have any sheathing while the cables to be directly buried will have sheathing for safety. A copper conductor will be used for these cables in view of easy workability and the insulation material will be general-purpose cross-linked polyethylene.

(k) Instruments

Given their prospective use for power supply, the accuracy of the instruments to be used will be 0.5 class for watt-hour meters and fuel oil flow meters because of their importance for the operation and maintenance of the new generating unit and 1.5 – 3.0 class for other ammeters, voltmeters and pressure gauges, etc. because of their lower importance.

3) Specifications of Main Equipment

Table 2-2-7 shows the specifications of the main equipment for the new generating unit to be installed under the Project.

Table 2-2-7 Specifications of Main Equipment for Generating Unit

Equipment	Quantity	Specifications
(1) Diesel Generating Unit		
1) Diesel Engine	1	Rated operation : continuous Output : 5,725 PS Engine speed : ≦ 750 rpm Engine type : 4 cycle diesel engine Cooling method : radiator method Fuel : diesel oil With common frame and vibration-isolator
2) Generator	1	Rated operation : continuous Rated output : 5,000 kVA Phases : 3 phase 3 wire Rated voltage : 6,300 V Speed : ≤ 750 rpm Power factor : 0.8 (lag) Frequency : 50 Hz Coil connection : Y connection (non-grounding of neutral) Excitation : brushless, thyristor
3) Electrical Equipment		
① Monitoring and Control Panel	1 set	Independent-type with AVR and synchronizing system; installed inside the enclosure
② Protective Relay Panel	1 set	Independent-type serving generator and main transformer
③ 20/6.3 kV Transformer	1 set	5,000 kVA; 20/6.3 kV; non-load voltage changer; outdoor-type
④ 20 kV High Voltage Panel	1 set	20 kV; vacuum circuit breaker; outdoor independent-type
⑤ 6.3 kV High Voltage Panel	1 set	6.3 kV; installed inside the enclosure
⑥ 400 V Low Voltage Power Panel	1 set	400 V; distribution circuit breaker; installed inside the enclosure
⑦ DC Power Supply System	1 set	Lead battery; 110 V; rated 30 minutes operation; installed inside the enclosure
⑧ House Transformer	1 set	6.3 kV/400 – 230 V; 3 phase 4 wire; 500 kVA; outdoor-type
4) Mechanical Equipment		
① Daily Fuel Supply Tank	1	Vertical-type; 0.5 m^3; installed outdoors
② Oil Separation and Treatment System	1 set	
(2) Spare Parts for DEG	2 years supply (16,000 hours)	
1) Normal Operation (Consumables)		Oil filter elements, lubricating oil filter elements, O-rings, fuel injection nozzles and others
2) Emergencies (Accidents)		Fuel injection valves, fuel injection pump, spare parts for pump and others
(3) Generating Unit Maintenance Tools	1 set	Engine tools, relay tester and liner extractors, etc.
(4) Repair Tools	1 set	Tool set for mechanics, tool set for electricians, measuring tools, grounding and short-circuiting tools and others

(4) 20kV distribution network Plan for Dili

The work for distribution network to be conducted by the Japanese side under the Project consists of the renewal of distribution transformers and recloser. The equipment to be used for this work will be selected based on the following basic conditions and required specifications. Basic Design Drawing D-01 shows the 20 kV Dili distribution network.

1) Basic Conditions

① Power Supply System

The following power supply system used for the existing equipment will be adopted for the Project.

a) High voltage	:	20 kV, 3 phase 3 wire (maximum voltage: 22 kV)
b) Generator voltage	:	6.3 kV, 3 phase 3 wire (maximum voltage: 6.9 kV)
c) Low voltage	:	400 – 230 V, 3 phase 4 wire (maximum voltage: 452 V, 3 phase plus neutral conductor)
d) Frequency	:	50 Hz
e) Rupturing capacity	:	22 kV system → 12.5 kA (1 sec., sym.) 6.3 kV system → 12.5 kA (1 sec, sym.)
f) Grounding system	:	direct grounding for both 20 kV and 400 V systems; ungrounded for 6.3 kV system
g) Basic insulation level (BIL)	:	20 kV system → 125 kV, AC 50 kV 6.3 kV system → 60 kV, AC 22 kV
h) Surface leakage distance (Creepage distance)	:	25 mm/kV (coastal area), 20 mm/kV (inland area and indoor facility)
i) DC control voltage	:	DC 110 V
j) Permissible voltage fluctuation	:	400 – 230 V system → +10 to –10% DC 110 V system → +10 to –10%

② Power Equipment

The following conditions will apply to the electrical equipment in view of the existing method and natural conditions

a) Phase identification : IEC standards (red, yellow, blue and black)

b) Insulator : porcelain, color is brown

c) Fouling category : IEC standards (medium pollution area)

d) Protection class and board thickness of distribution panel

Type of Application	Board Thickness	Protection Class
Outdoor	≧ 2.3 mm	≧ IP 43
Indoor	≧ 1.6 mm	≧ IP 21

e) 20 kV distribution cable : stranded aluminum cable 95, 120 or 150 mm^2

f) Control method : local control

2) Basic Issues

The distribution network in question is the trunk distribution network in Dili. As all of the target equipment for renewal is located within 1 km of the coastline, highly corrosion-resistant equipment and materials will be selected to avoid salt damage.

In the selection of the equipment and materials required for the construction of the distribution system, due consideration will be given to the ease of operation as well as maintenance and the safety of such equipment after its installation. Moreover, the installation period for such equipment must be as short as possible to minimize the adverse impacts of power cuts during the work period on the lives of the public and traffic.

As the new distribution equipment to be installed under the Project will be installed adjacent to private houses and general workplaces, careful consideration will be required to ensure safety and to minimize the adverse impacts of an accident involving electrical work pieces. Furthermore, grounding of the equipment must be properly conducted.

Given the fact that the planned work is the renewal of existing equipment, removal of the existing 20 kV overhead wiring, steel poles and accessories with the minimum impact on the lives of the public and traffic due to power cuts will be necessary. This removal work must be efficiently and safely conducted and is, therefore, included in the scope of the Project.

3) 20 kV Substation Facilities

These facilities are required to step down the high distribution voltage of 20 kV to a low distribution voltage of 400/230 V and will consist of a distribution transformer, arrester to protect the transformer, main distribution panel to supply power to users, concrete poles and related equipment including accessories. These facilities will have outdoor specifications and will be installed near the existing units to minimize the problem of securing additional land. As a measure to avoid salt damage, the facility structure will ensure the minimum exposure of the live part. In addition, highly salt-resistant paint and materials will be used.

The capacity of the distribution transformers will be determined in view of the estimated power demand in the target year of the Project, taking the load situation of the existing distribution network and likely increase of the load in the future into consideration.

High efficiency transformers will be selected to reduce the power loss. Basic Design Drawing D-12 shows the configuration of the transformers (50 in total, 9,180 kVA).

4) 20 kV Recloser

The recloser to be procured under the Project for the 20 kV distribution networks will play an important role in terms of the operation and maintenance of the distribution lines. Because of the malfunctioning of the existing section switches, these new recloser will have the extra function of switching off a necessary section to conduct the work for distribution line restoration. As these switches will be mounted on poles, the necessary concrete poles and stringing accessories will be procured together with the switches.

The operating method will be on-site operation which is adopted for existing switches in view of ease of operation and maintenance. As the EDTL is familiar with the maintenance of European distribution equipment, the procurement of recloser for the distribution lines from Europe will be considered. The fact that these switches are not manufactured in Japan reinforces the necessity to consider such procurement. The work to remove the existing switches will be conducted by the Japanese side to ensure the completion of this work within the planned short period. The location and related feeder of each switch to be renewed are shown in the table below.

No.	Location	Related Feeder No.	Remarks
1	Tasi Tolu	1	REC
2	Lahane	2	REC
3	Balide	2	REC
4	Fefatuahi	2	REC
5	Mandarin	4	REC
6	Hudilaran	5	AVS
7	Turismo	Express	AVS

5) Specifications of Main Equipment

Table 2-2-8 shows the specifications of the main distribution equipment, etc. to be procured under the Project. Outline of D/T is shown on Table D-21 in section 2.2.3.

Table 2-2-8 Specifications of Main Distribution Equipment, etc.

Equipment	Quantity	Specifications
A. 20 kV Distribution Equipment		
1) Distribution Transformers (D/T)		Outdoor-type, 20 kV ± 2 x 2.5%/400 – 230V; includes concrete poles, arresters, main distribution panel, disconnecting switches, cables and metal accessories
- 100 kVA	5 sets	
- 160 kVA	23 sets	
- 200 kVA	15 sets	
- 250 kVA	6 sets	
- 500 kVA	1 set	
2) Recloser	7 sets	Automatic-type; SF6 or vacuum circuit breakers; concrete poles; arresters; on-site control panels; cables; metal accessories
B. Maintenance Equipment and Tools, etc.		
1) Vehicles for High Rise Work	2	Truck with crane and bucket; maximum rise: 1.2 m; 4WD
2) Trucks with Crane	2	Truck with crane; loading capacity: 3 tons; 4WD
3) Maintenance Tools	1 set	Volt-ammeter and insulation resistance meter, etc.
4) Spare Parts for Two Years Supply	1 set	

(5) Independent Power Supply System in 13 Rural Areas

A plan to restore the power supply system in the 13 areas to its state prior to the conflict in August, 1999 is not included in the Project because the required scale and scope of equipment for restoration cannot be determined due to uncertainty surrounding the external factors listed below. Apprndix-9 shows present situation of 13 rural areas.

1) Implementation of the Management Contract (M/C) (scheduled for three years from May, 2003)
2) Scope and completion date of the rehabilitation project currently being implemented by the UNOPS in six areas
3) Planned recruitment of new employees scheduled to start in 2003 by the EDTL for the operation and maintenance of power supply systems in rural areas.

Table 2-2-9 shows the draft rehabilitation plan based on the field survey results at the time of the Basic Design Study.

Table 2-2-9 Draft Rehabilitation Plan for 13 Rural Areas

No.	Area	Distribution Equipment				
		Transformer		Feeder Line (km)		
		Capacity (kVA)	Quantity	20kV	400-230V	Service Wire
1	Iliomar	-	0	0	2.7	4.5
2	Remexio	-	0	0	(*1) 1.2	(*1) 2.7
3	Lacluta	25	2	1.5	(*1) 3.1	(*1) 1.7
4	Hato Udo	25	2	3.4	6.1	3.0
5	Hatobilico	-	0	0	(*1) 3.8	(*1) 0.8
6	Fatuberliu	25	3	4.5	(*1) 9.6	(*1) 4.9
7	Atsabe	25	4	7.1	7.5	12.0
8	Atabae	25	4	18.4	10.5	10.5
9	Zumalai	-	0	0	5.8	3.0
10	Beco	25	6	5.3	9.8	9.0
11	Raimean	25	3	6.5	8.6	6.0
12	Loes	25	3	10.6	15.5	6.0
13	Bazartete	-	0	0	(*1) 2.4	(*1) 1.6
	Total	-	27	57.3	86.6	65.7

Note: *1 These were in operation when the field survey took place in March, 2003.

2.2.3 Basic Design Drawings

The Basic Design Drawings for the Project are listed below.

New Generating Unit Construction Plan

G-01 Layout of Comoro Power Station

G-02 General Arrangement of New DEG

E-01 Key Single Line Diagram (Comoro Power Station)

E-02 Single Line Diagram for 20 and 6.3 k

E-03 Single Line Diagram for LV System

M-03 Key Flow Diagram

M-04 List of Symbol

M-05 Flow Diagram of Fuel Oil System

M-06 Flow Diagram of Lubricant Oil and Sludge Treatment System

M-07 Flow Diagram of Cooling Water System

M-08 Flow Diagram of Compressed Air System

M-09 Flow Diagram of Intake Air and Exhaust Gas System

20 kV Distribution Unit Plan

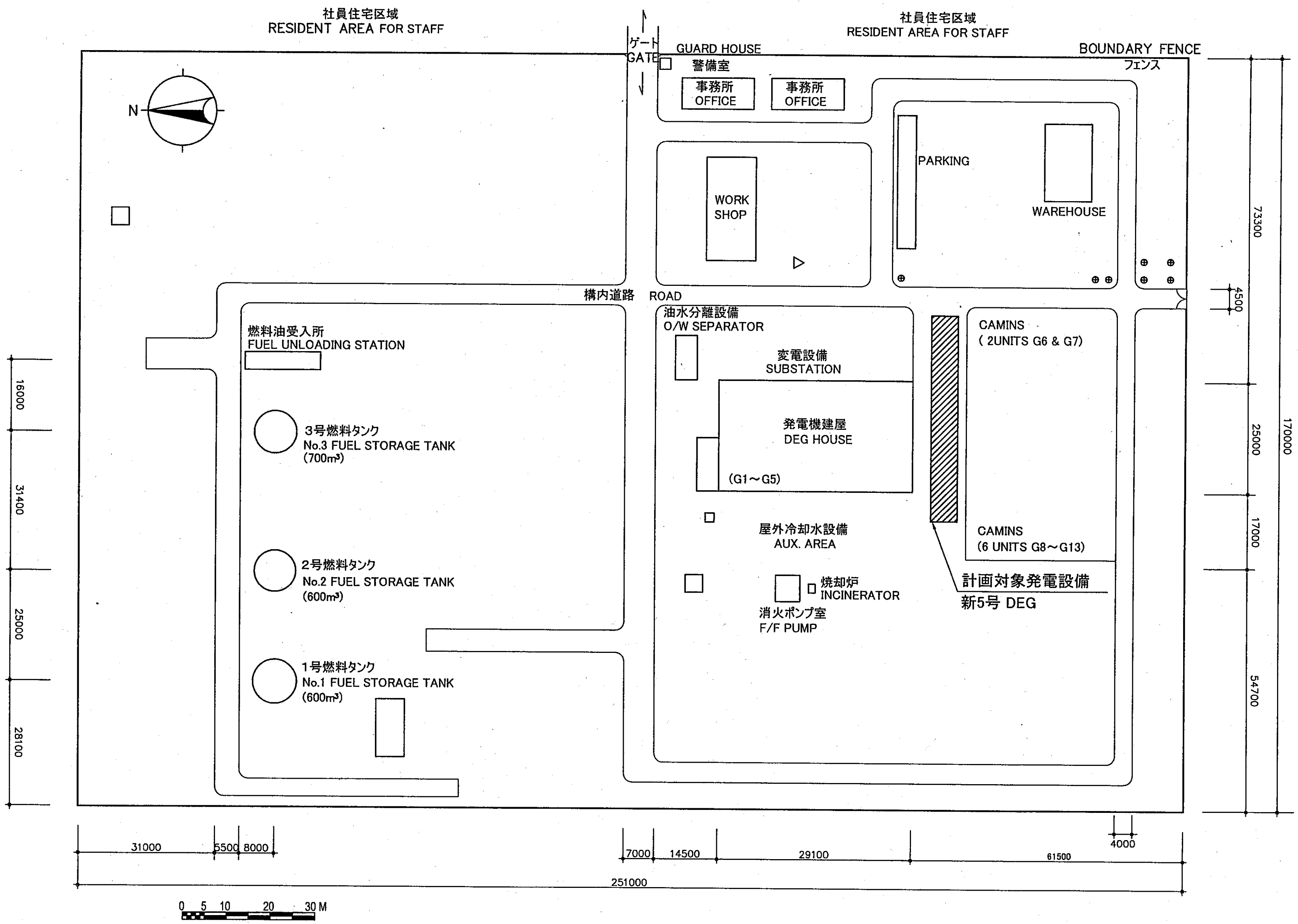
D-01 20 kV Distribution Networks

D-02 20 kV Distribution System (1/5 to 5/5)

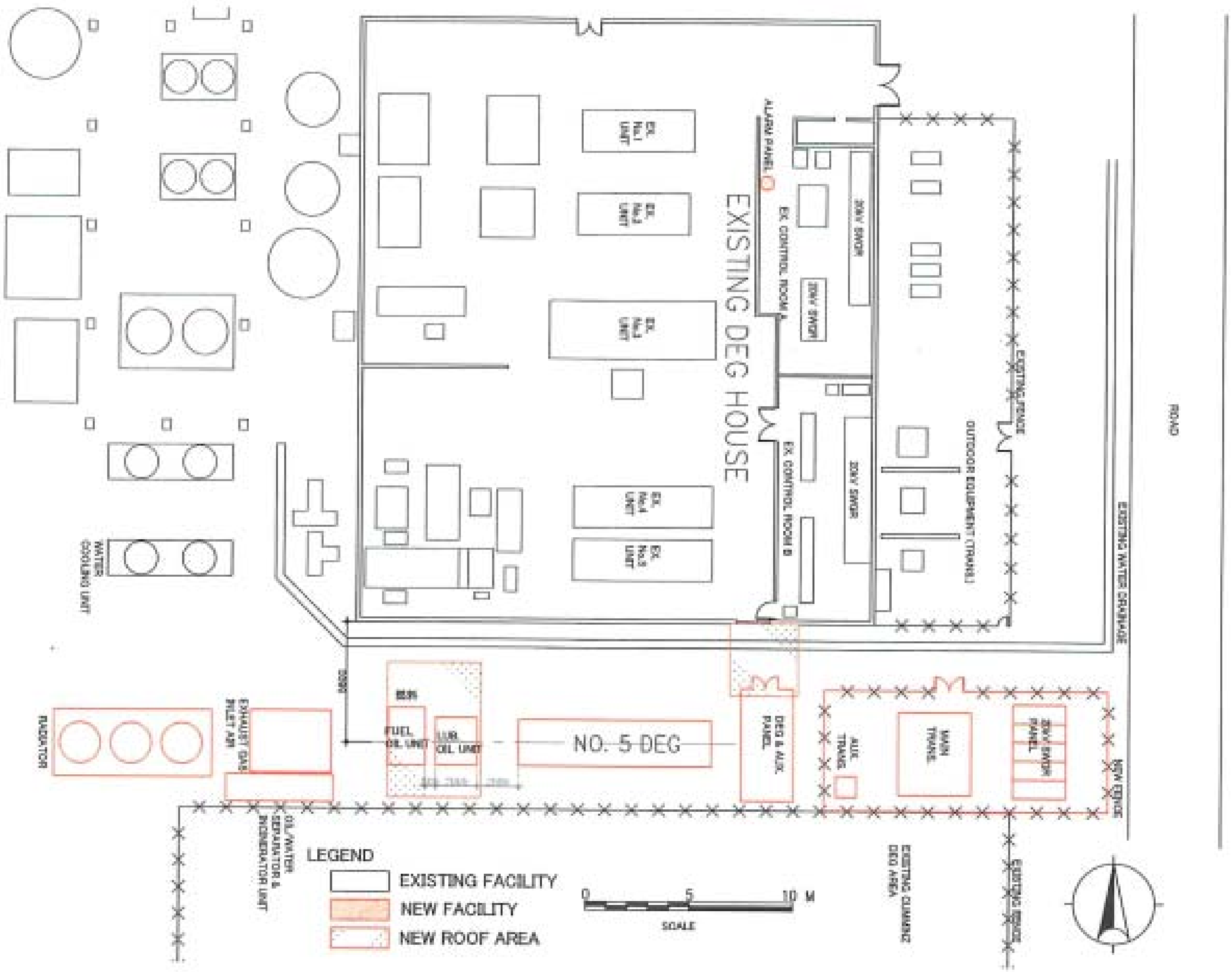
D-11 Typical Arrangement of Transformer Pole

D-12 Typical Arrangement of Auto Recloser Pole

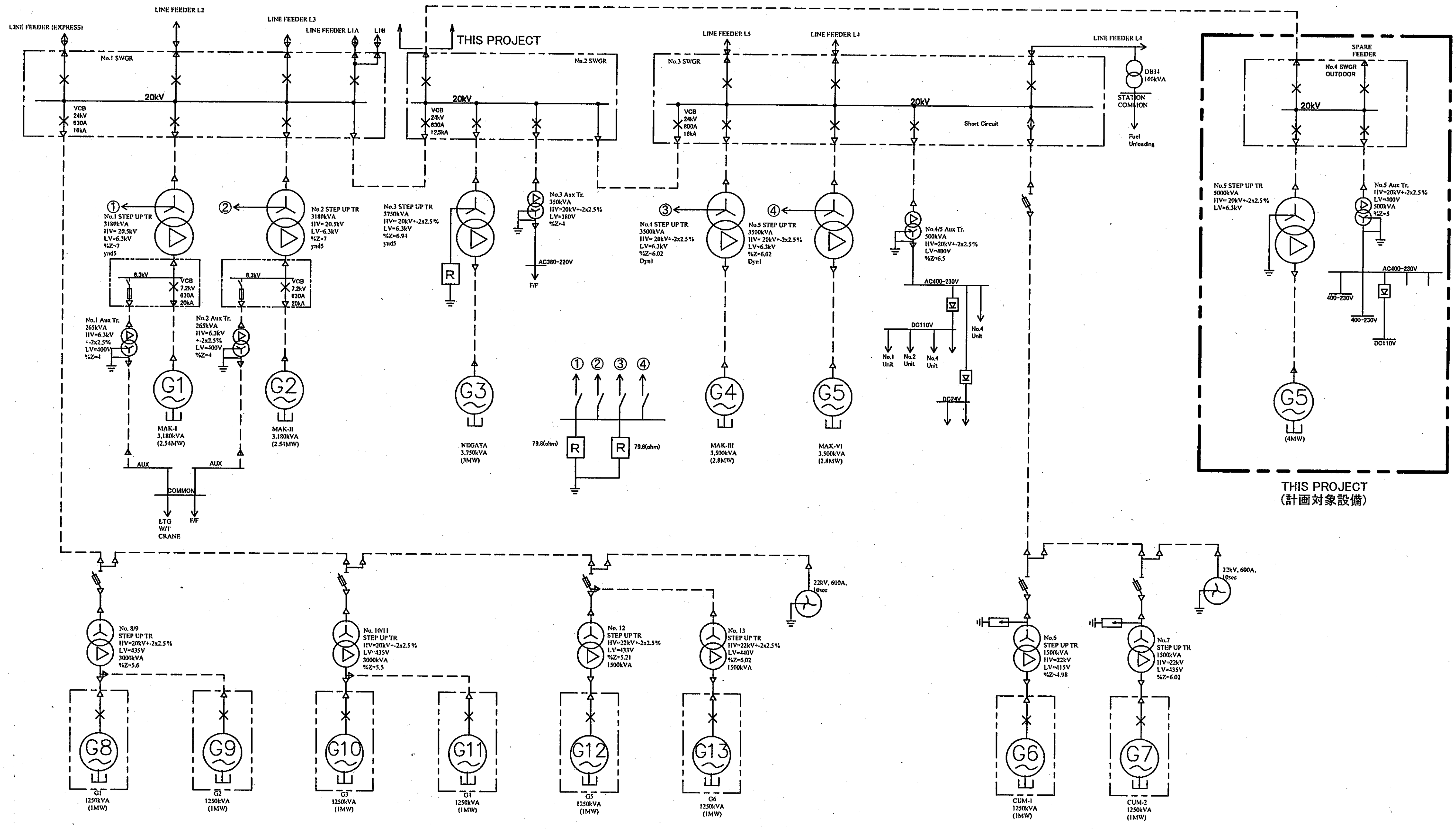
D-21 Distribution Transformers to be replaced



コモロ発電所全体配置図
LAY OUT OF COMORO POWER STATION
G-01

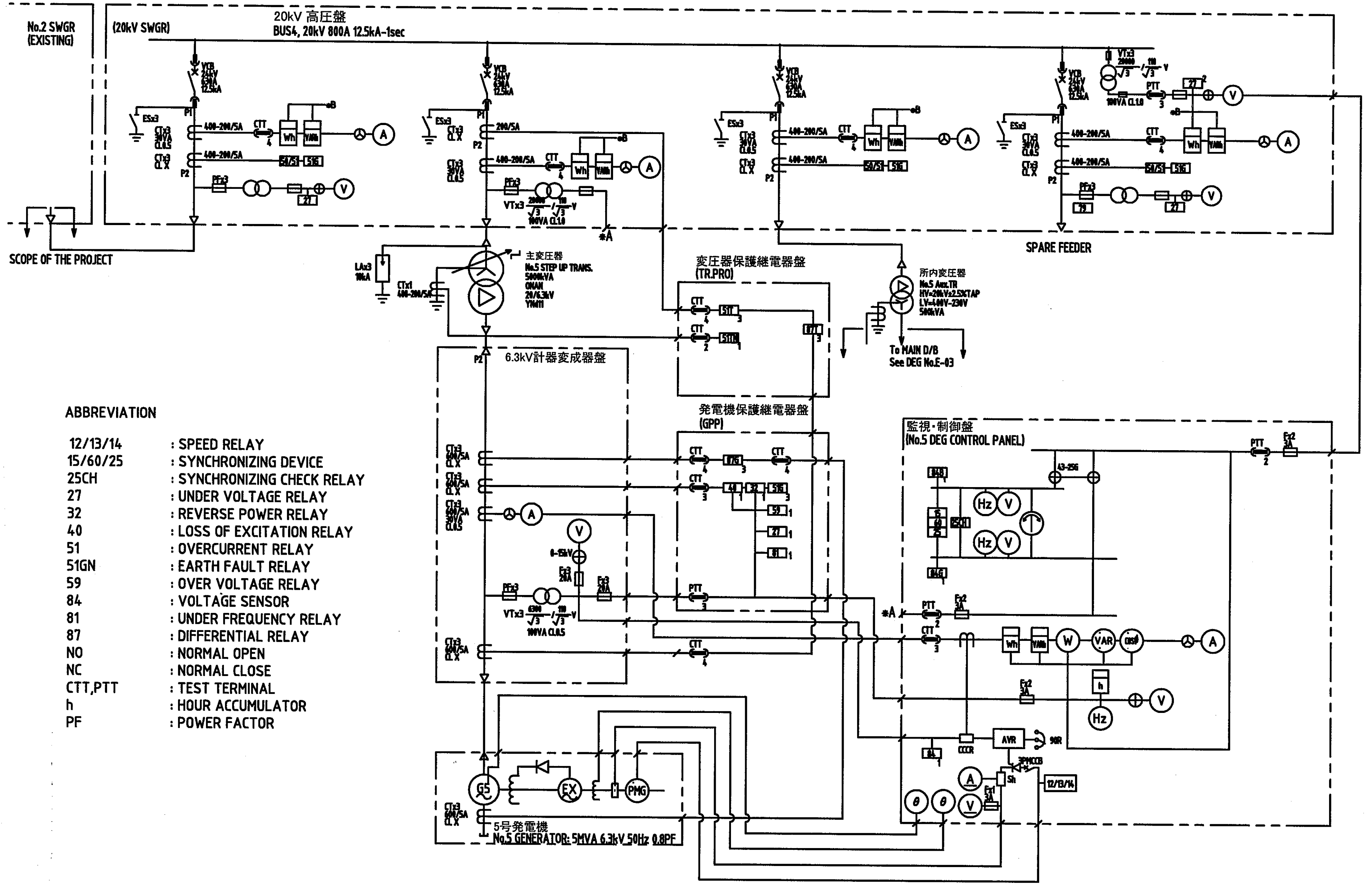


新ディーゼルエンジン発電機 配置図 GENERAL ARRANGEMENT OF NEW DEG	G-02



コモロ発電所：単線結線図
KEY SINGLE LINE DIAGRAM

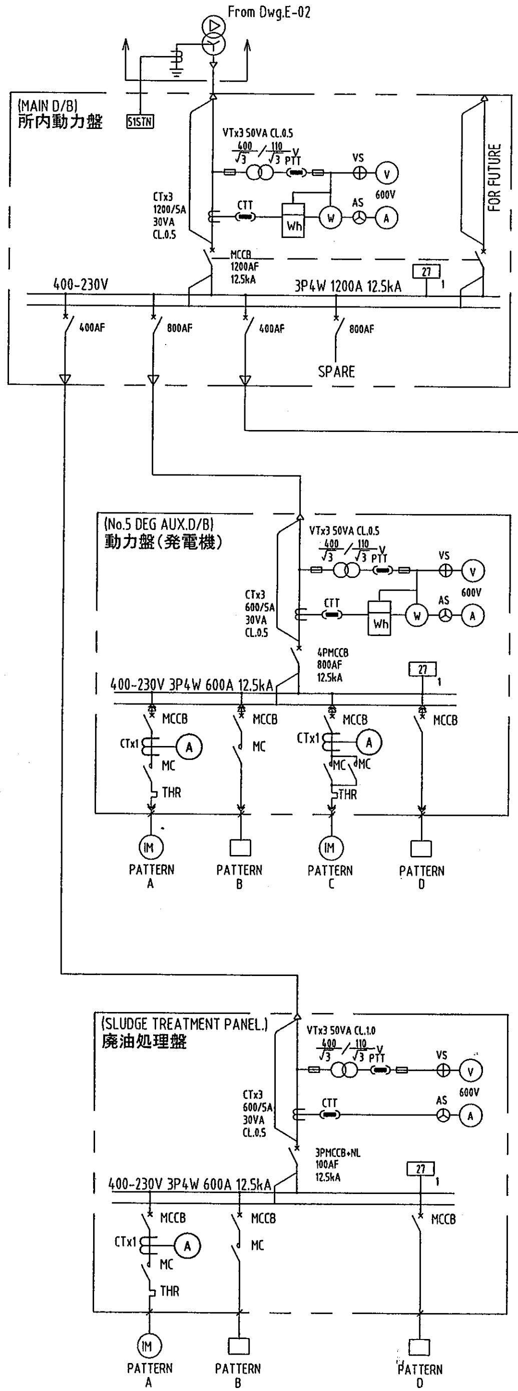
E-01



ABBREVIATION

12/13/14	: SPEED RELAY
15/60/25	: SYNCHRONIZING DEVICE
25CH	: SYNCHRONIZING CHECK RELAY
27	: UNDER VOLTAGE RELAY
32	: REVERSE POWER RELAY
40	: LOSS OF EXCITATION RELAY
51	: OVERCURRENT RELAY
51GN	: EARTH FAULT RELAY
59	: OVER VOLTAGE RELAY
84	: VOLTAGE SENSOR
81	: UNDER FREQUENCY RELAY
87	: DIFFERENTIAL RELAY
NO	: NORMAL OPEN
NC	: NORMAL CLOSE
CTT,PTT	: TEST TERMINAL
h	: HOUR ACCUMULATOR
PF	: POWER FACTOR

20及び 6.3kV 単線結線図
SINGLE LINE DIAGRAM FOR 20 AND 6.3kV
E-02



Notes

The meanings of "OPERATION" column are as follows ;

AUTO(LEVEL)	:	Automatic operation by level switch
AUTO(ENGINE)	:	Automatic operation by engine sequence
AUTO(PRESS)	:	Automatic operation by pressure switch
AUTO(TEMP)	:	Automatic operation by temperature switch
AUTO(GENE)	:	Automatic operation by generator sequence
MANUAL	:	Manual operation
(AUTO(LEVEL))	:	Automatic operation at local by level switch
(AUTO(DP))	:	Automatic operation at local by differetial pressure switch
(AUTO)	:	Automatic operation at local
(MANUAL)	:	Manual operation at local

ABBREVIATION

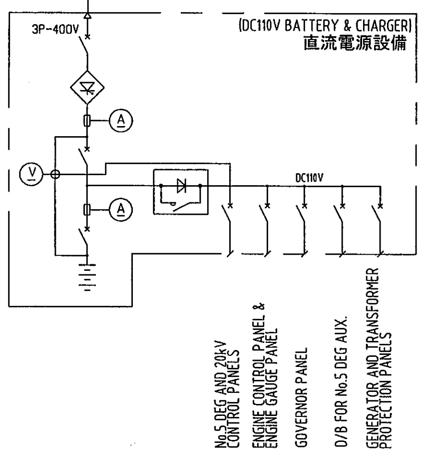
27 : UNDER VOLTAGE RELAY

LOAD PATTERN TABLE FOR No.5 DEG AUX D/B

NO.	SERVICE	Q'TY	VOLTAGE (V)	PATTERN	SELECTOR SWITCH ON D/B	OPERATION	LOCAL STAND	REMARKS
1	FUEL OIL MOTOR VALVE	1	230	B	——	AUTO (LEVEL)	——	
2	FUEL OIL CIRCULATING PUMP	1	400	A	——	AUTO (ENGINE)	——	
3	FUEL OIL SECONDARY FILTER	1	230	D	——	(AUTO (DP))	——	
4	LUB. OIL PRIMING PUMP	1	400	A	AUTO/MAN	AUTO (ENGINE)	——	
5	LUB. OIL MAIN FILTER	1	400	D	——	(AUTO (DP))	——	
6	JACKET COOLING WATER PUMP	1	400	A	AUTO/MAN	AUTO (ENGINE)	——	
7	SECONDARY COOLING WATER PUMP	1	400	A	AUTO/MAN	AUTO (ENGINE)	——	
8	INTAKE AIR FILTER	1	400	D	——	(AUTO (DP))	——	
9	TURNING GEAR	1	400	C	——	MANUAL	YES	
10	GENERATOR SPACE HEATER	1	230	B	——	AUTO (GENE)	——	
11	No.9 DEG CONTROL PANEL	1	230	D	——	——	——	WITH 11/33kV CONTROL PANEL
12	ENGINE GAUGE PANEL	1	230	D	——	——	——	WITH ENGINE CONTROL PANEL
13	GOVERNOR PANEL	1	230	D	——	——	——	
14	SOFT WATER CIRCULATING PUMP	2	400	A	AUTO/MAN	AUTO (PRESS)	YES	
15	FUEL OIL DRAIN DISCHARGE PUMP	1	400	A	AUTO/MAN	AUTO (LEVEL)	YES	
16	LUB. OIL TRANSFER PUMP	1	400	A	——	MANUAL	YES	
17	LUB. OIL PURIFIER UNIT	1	400	D	——	(MANUAL)	——	
18	RADIATOR-1	1	400	A	AUTO/MAN	AUTO (ENGINE)	YES	
19	RADIATOR-2	1	400	A	AUTO/MAN	AUTO (ENGINE)	YES	
20	RADIATOR-3	1	400	A	AUTO/MAN	AUTO (ENGINE)	YES	
21	RADIATOR-4	1	400	A	AUTO/MAN	AUTO (ENGINE)	YES	
22	RADIATOR-5	1	400	A	AUTO/MAN	AUTO (ENGINE)	YES	
23	RADIATOR-6	1	400	A	AUTO/MAN	AUTO (ENGINE)	YES	
24	DRAIN PIT PUMP	1	400	D	AUTO/MAN	(AUTO (LEVEL))	YES	
25	WASTE OIL DISCHARGE PUMP	1	400	A	AUTO/MAN	AUTO (LEVEL)	YES	
26	SOFTENER	1	230	D	——	(AUTO)	——	
27	WATER SUPPLY PUMP	2	400	A	AUTO/MAN	AUTO (LEVEL)	YES	
28	DC110V BATTERY & CHARGER	1	400	D	——	——	——	
29	GENERATOR PROTECTION PANEL	1	230	D	——	——	——	WITH TR. PTOTECTION PANEL

LOAD PATTERN TABLE FOR SLUDGE TREATMENT PANEL

NO.	SERVICE	Q'TY	VOLTAGE (V)	PATTERN	SELECTOR SWITCH ON D/B	OPERATION	REMARKS
1	SLUDGE COLLECTING PUMP	1	400	A	——	MANUAL	
2	HEATER FOR SLUDGE TANK	1	400	B	——	AUTO (TEMP)	
3	SLUDGE DISCHARGE PUMP	1	400	A	AUTO/MAN	AUTO (LEVEL)	
4	INCINERATOR	1	400	D	——	(MANUAL)	
5	OILY WATER SEPARATOR	1	230	D	——	(MANUAL)	
6	OILY WATER SEPARATOR TANK HEATER (OILY WATER)	2	400	B	——	AUTO (TEMP)	
7	OILY WATER SEPARATOR TANK HEATER (SLUDGE)	1	400	B	——	AUTO (TEMP)	
8	OILY WATER PUMP	1	400	A	AUTO/MAN	AUTO (LEVEL)	

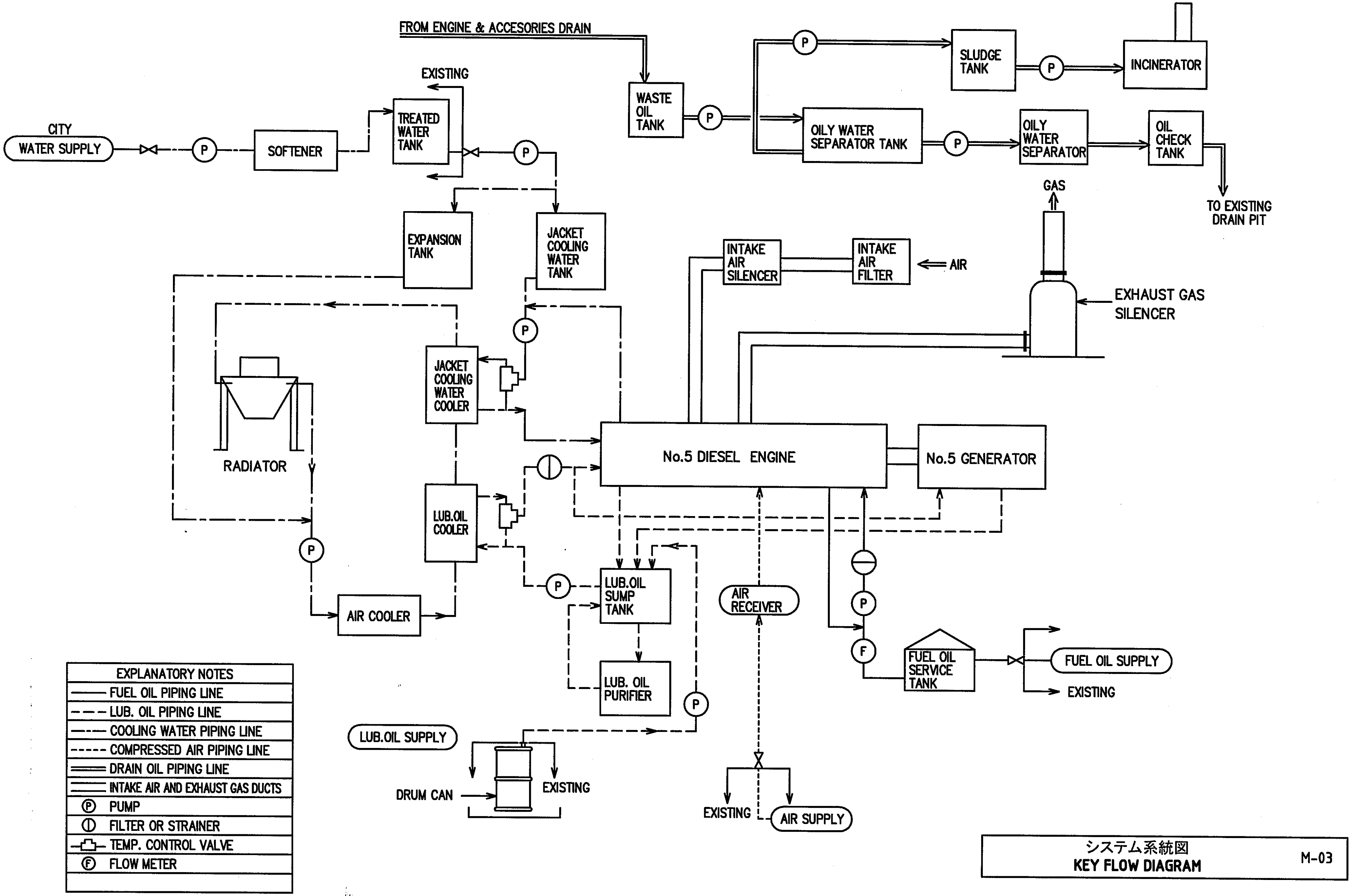


Remarks:

1. One spare feeder for all kind of MCCB shall be provided.
2. THR shall be adjustable type

LV 単線結線図
SINGLE LINE DIAGRAM FOR LV SYSTEM

E-03


FROM ENGINE & ACCESORIES DRAIN
EXISTING
CITY WATER SUPPLY
P
SOFTENER
TREATED WATER TANK
WASTE OIL TANK
SLUDGE TANK
INCINERATOR
OILY WATER SEPARATOR TANK
OILY WATER SEPARATOR
OIL CHECK TANK
TO EXISTING DRAIN PIT
GAS
EXPANSION TANK
JACKET COOLING WATER TANK
INTAKE AIR SILENCER
INTAKE AIR FILTER
AIR
EXHAUST GAS SILENCER
RADIATOR
JACKET COOLING WATER COOLER
LUB.OIL COOLER
No.5 DIESEL ENGINE
No.5 GENERATOR
AIR COOLER
LUB.OIL SUMP TANK
LUB. OIL PURIFIER
AIR RECEIVER
F
FUEL OIL SERVICE TANK
FUEL OIL SUPPLY
EXISTING
LUB.OIL SUPPLY
DRUM CAN
EXISTING
EXISTING
AIR SUPPLY
EXPLANATORY NOTES
FUEL OIL PIPING LINE
LUB. OIL PIPING LINE
COOLING WATER PIPING LINE
COMPRESSED AIR PIPING LINE
DRAIN OIL PIPING LINE
INTAKE AIR AND EXHAUST GAS DUCTS
Ⓟ PUMP
FILTER OR STRAINER
TEMP. CONTROL VALVE
Ⓕ FLOW METER
システム系統図
KEY FLOW DIAGRAM
M-03

1. PIPING AND ACCESSORIES

SYMBOL	DESCRIPTIONS
	PIPING LINE
	STEAM TRACED PIPING LINE
	INSULATED PIPING LINE
	CONNECTED PIPE
	NON-CONNECTED PIPE
	GLOBE VALVE
	CLOSED VALVE AT NORMAL OPERATION
	BUTTERFLY VALVE
	CHECK VALVE
	SCREW-DOWN CHECK VALVE
	THREE WAY VALVE
	AUTOMATIC TEMP. CONTOROL VALVE
	PRESSURE REGULATING VALVE
	SOLENOID VALVE
	PISTON VALVE
	REGULATING VALVE
	PRESSURE REDUCING VALVE
	SAFETY VALVE
	FLOAT VALVE

SYMBOL	DESCRIPTIONS
	MOTOR VALVE
	MOTOR DRIVEN PUMP
	DUPLEX FILTER
	SINGLE FILTER OR Y TYPE FILTER
	Y-TYPE STRAINER
	EXPANTION JOINT
	FLEXIBLE TUBE
	HOPPER
	REDUCER
	AIR VENT
	ORIFICE
	OIL PAN
	ELECTRIC HEATER
	DRAIN TRAP

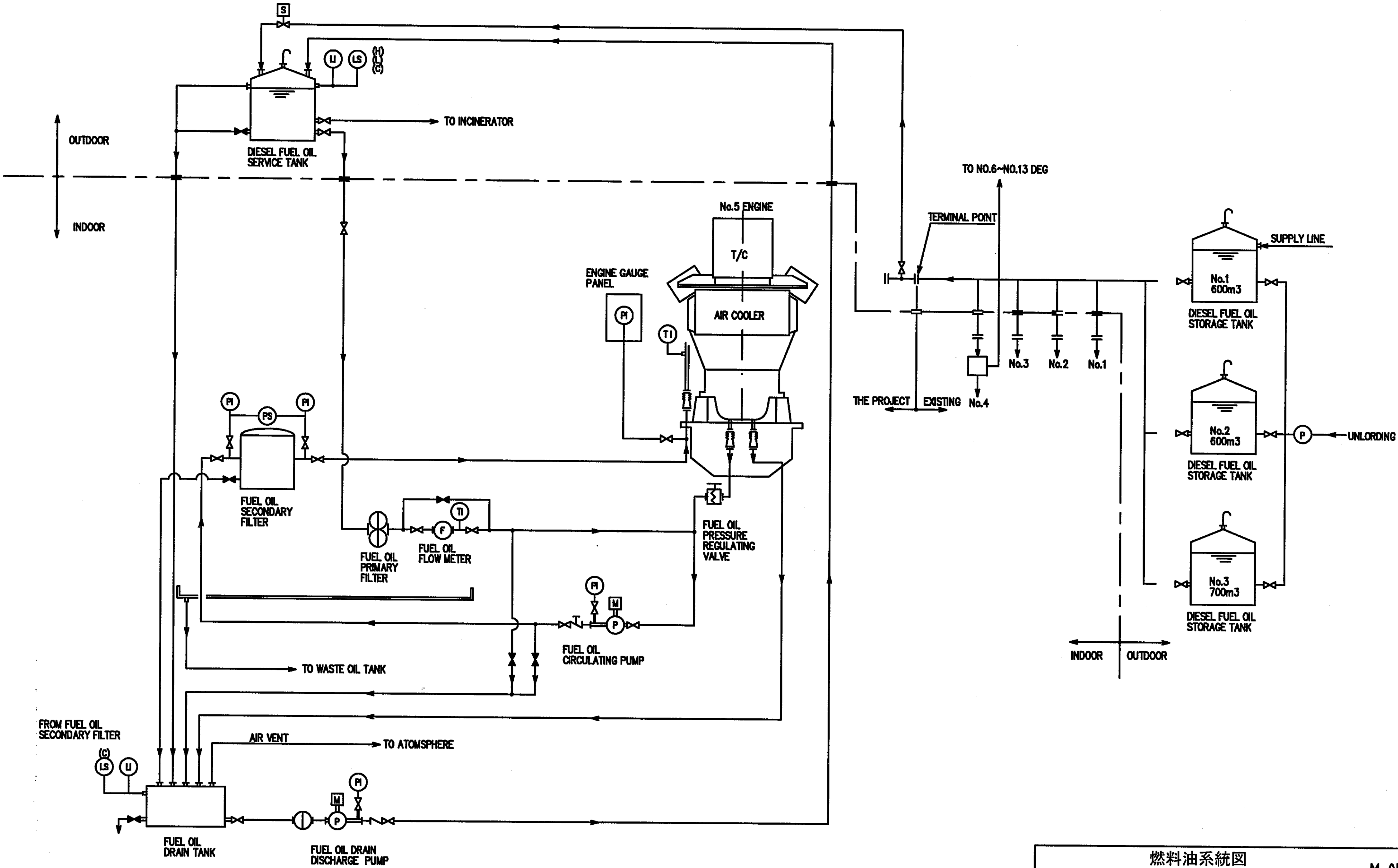
2. INSTRUMENTS

SYMBOL	DESCRIPTIONS
DP	DIFFERENTIAL PRESSURE
L I	LEVEL INDICATOR
LS	LEVEL SWITCH
MS	OIL MIST ABNORMAL SWITCH
P I	PRESSURE INDICATOR
PS	PRESSURE SWITCH
T I	TEMPERATURE INDICATOR
TRS	TEMPERATURE RECORDER WITH SWITCH
TS	TEMPERATURE SWITCH
(C)	AUTOMATIC CONTROL
(L)	LOW
(H)	HIGH
(LL)	EXTREME LOW
(HH)	EXTREME HIGH
(I)	INTERLOCK
(Z)	ALARM AND SHUT DOWN HEAVY FAULT

3. GRAPHIC

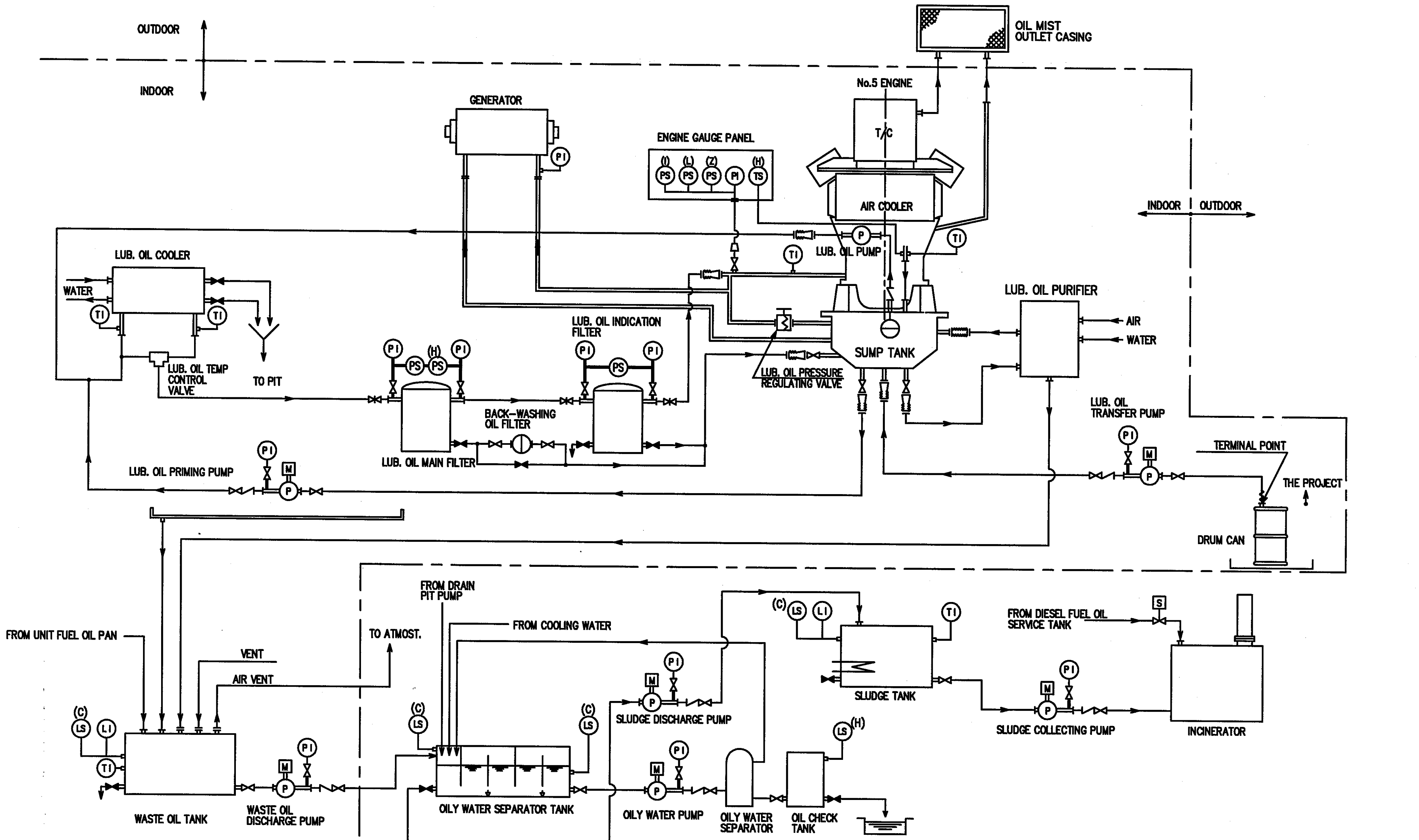
SYMBOL	DESCRIPTIONS
	LOCAL
	LOCAL PANEL (TERMINAL BOX(TB) OR AUX. EQUIPMENT PANEL)

凡例リスト
LIST OF SYMBOL
M-04

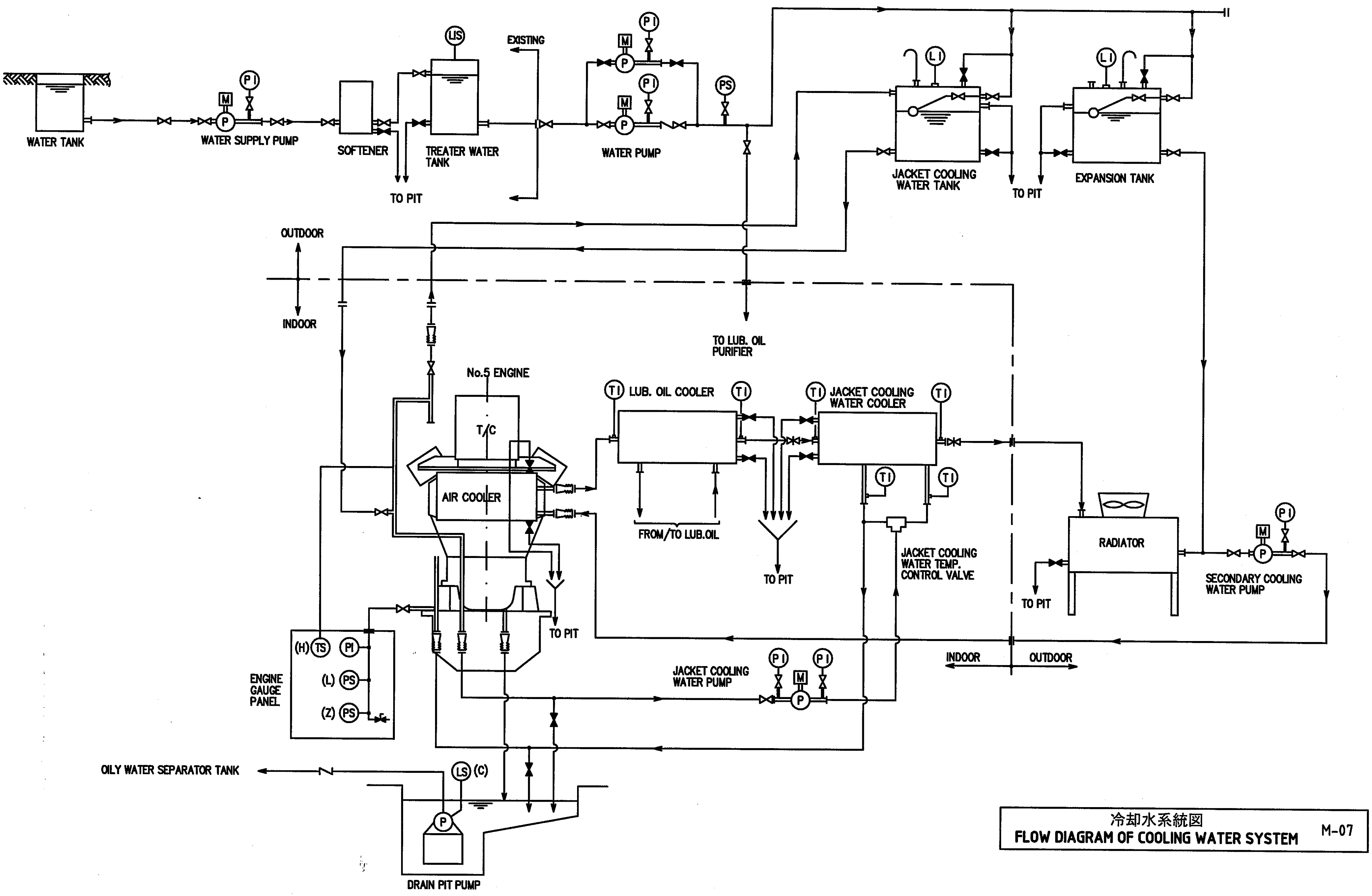


燃料油系統図
FLOW DIAGRAM OF FUEL OIL SYSTEM

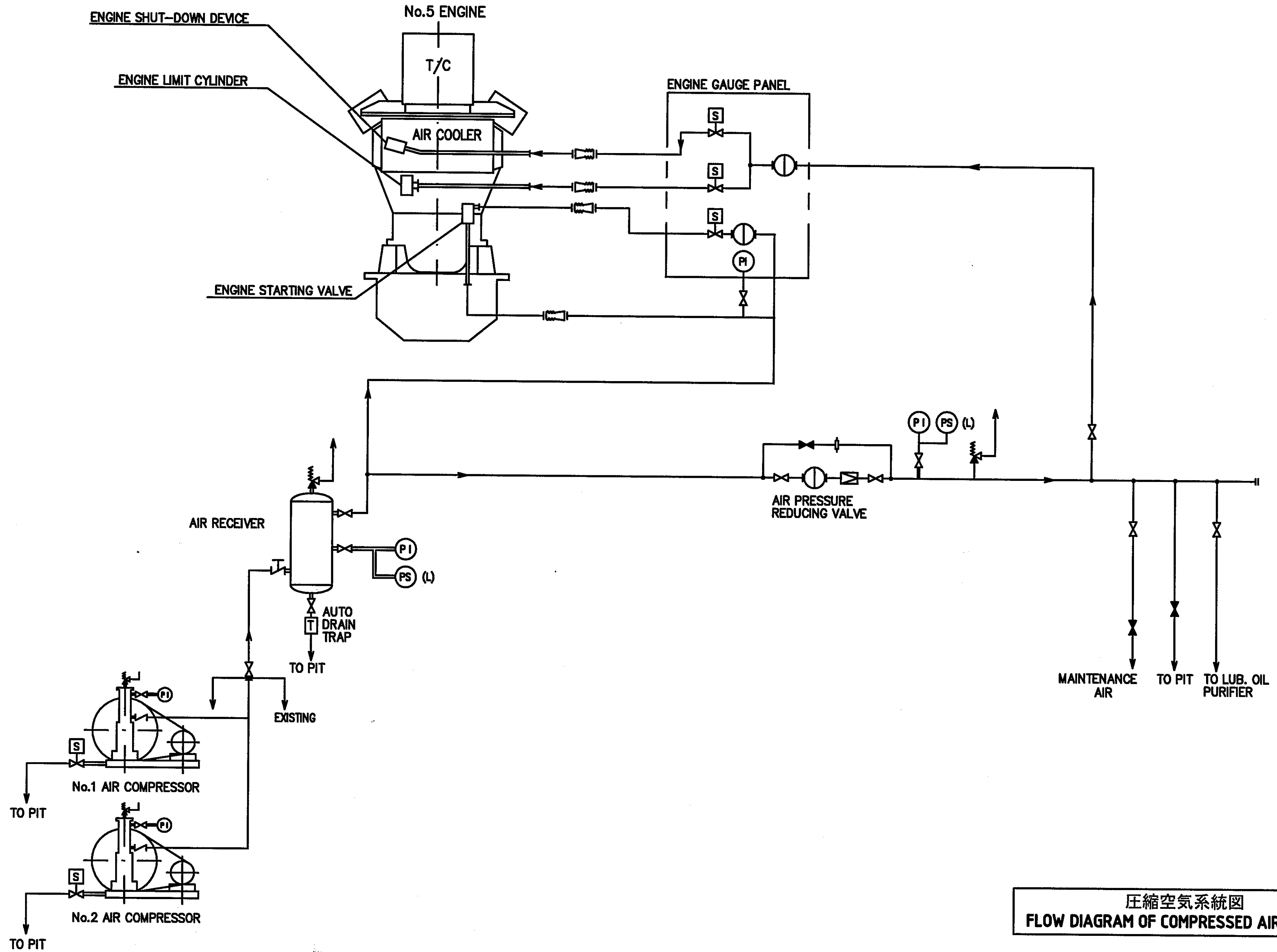
M-05



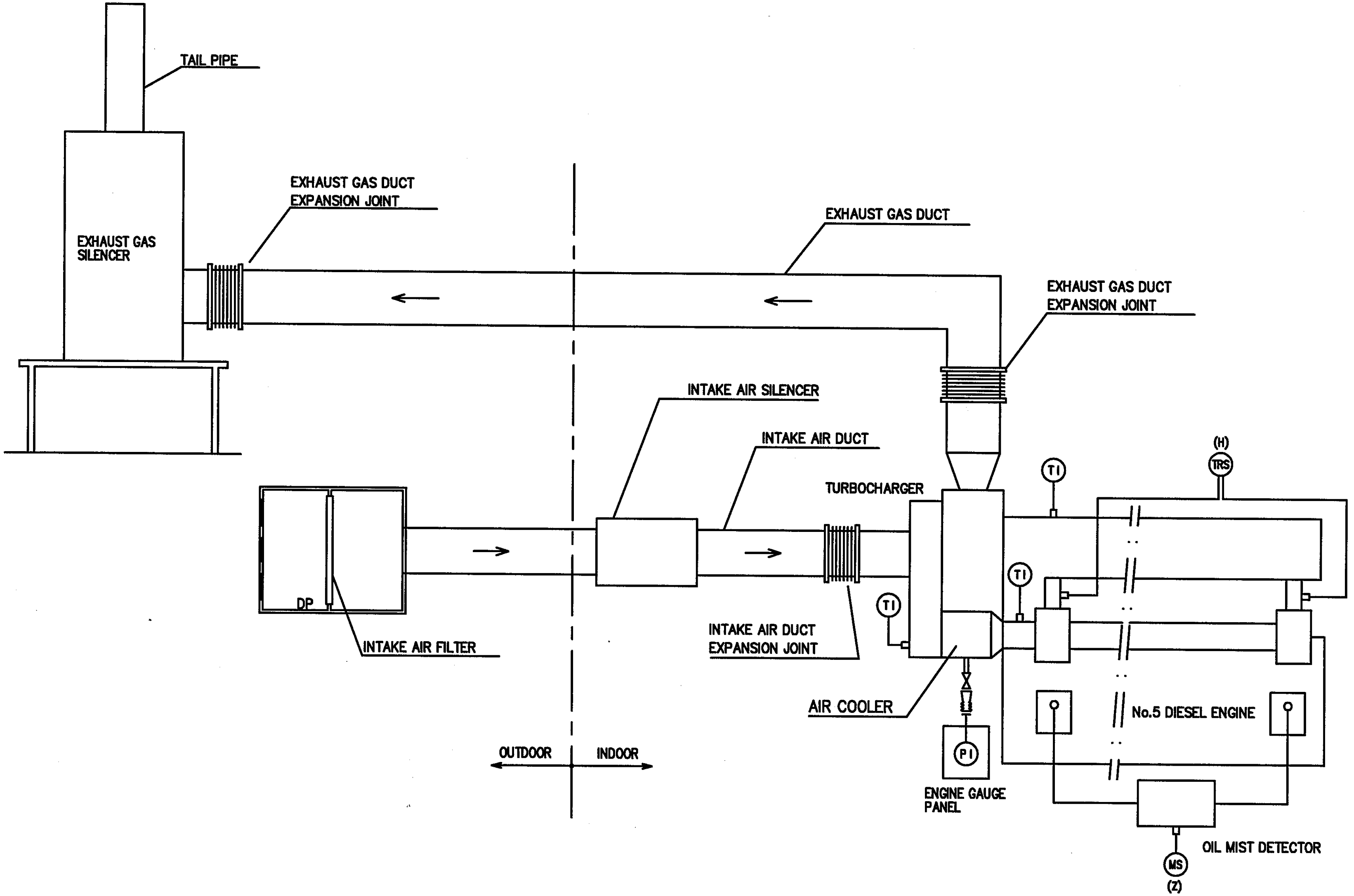
潤滑油・廃油処理系統図
FLOW DIAGRAM OF LUBRICANT OIL AND SLUDGE TREATMENT SYSTEM M-06



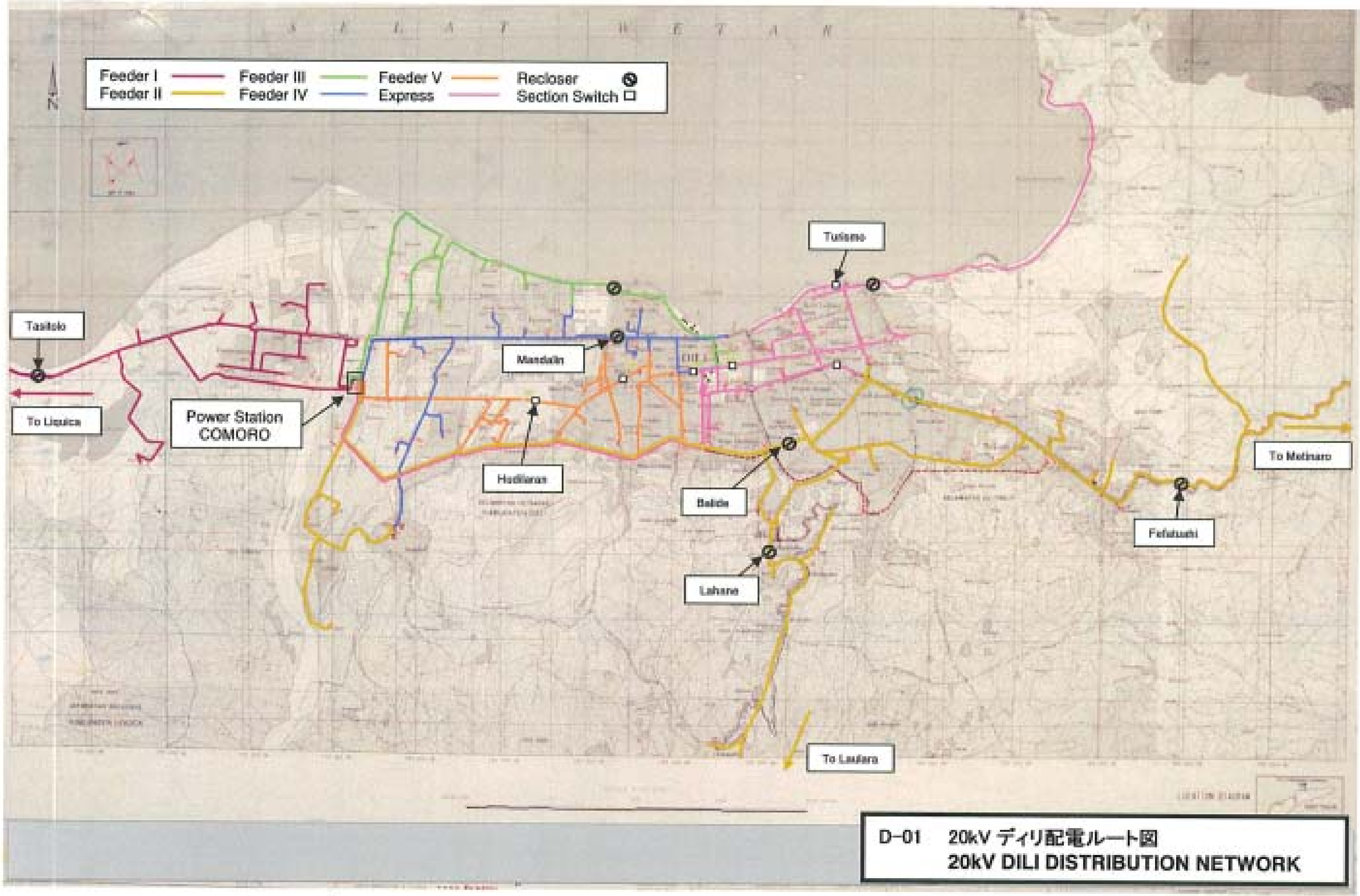
冷却水系統図
FLOW DIAGRAM OF COOLING WATER SYSTEM M-07



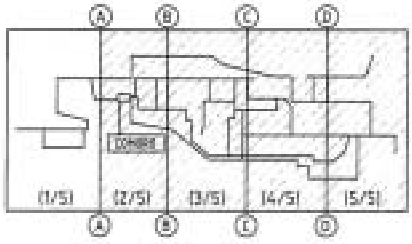
圧縮空気系統図
FLOW DIAGRAM OF COMPRESSED AIR SYSTEM M-08



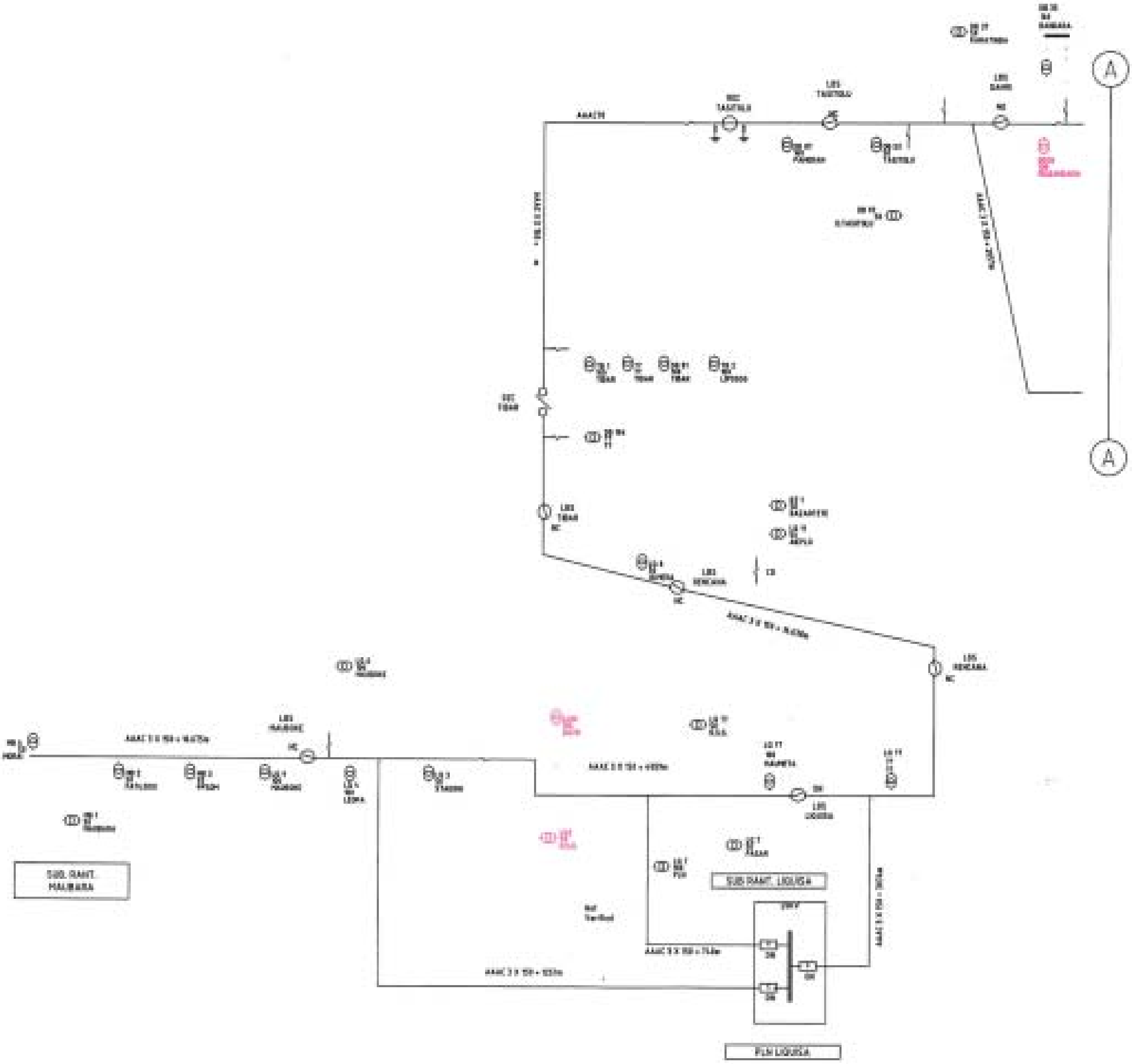
吸排気系統図
FLOW DIAGRAM OF INTAKE AIR AND EXHAUST GAS SYSTEM
M-09



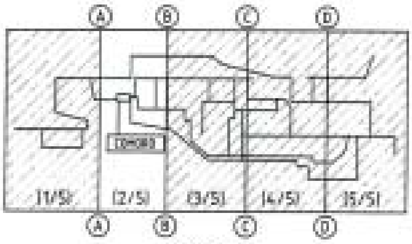
D-01 20kV ディリ配電ルート図
20kV DILI DISTRIBUTION NETWORK



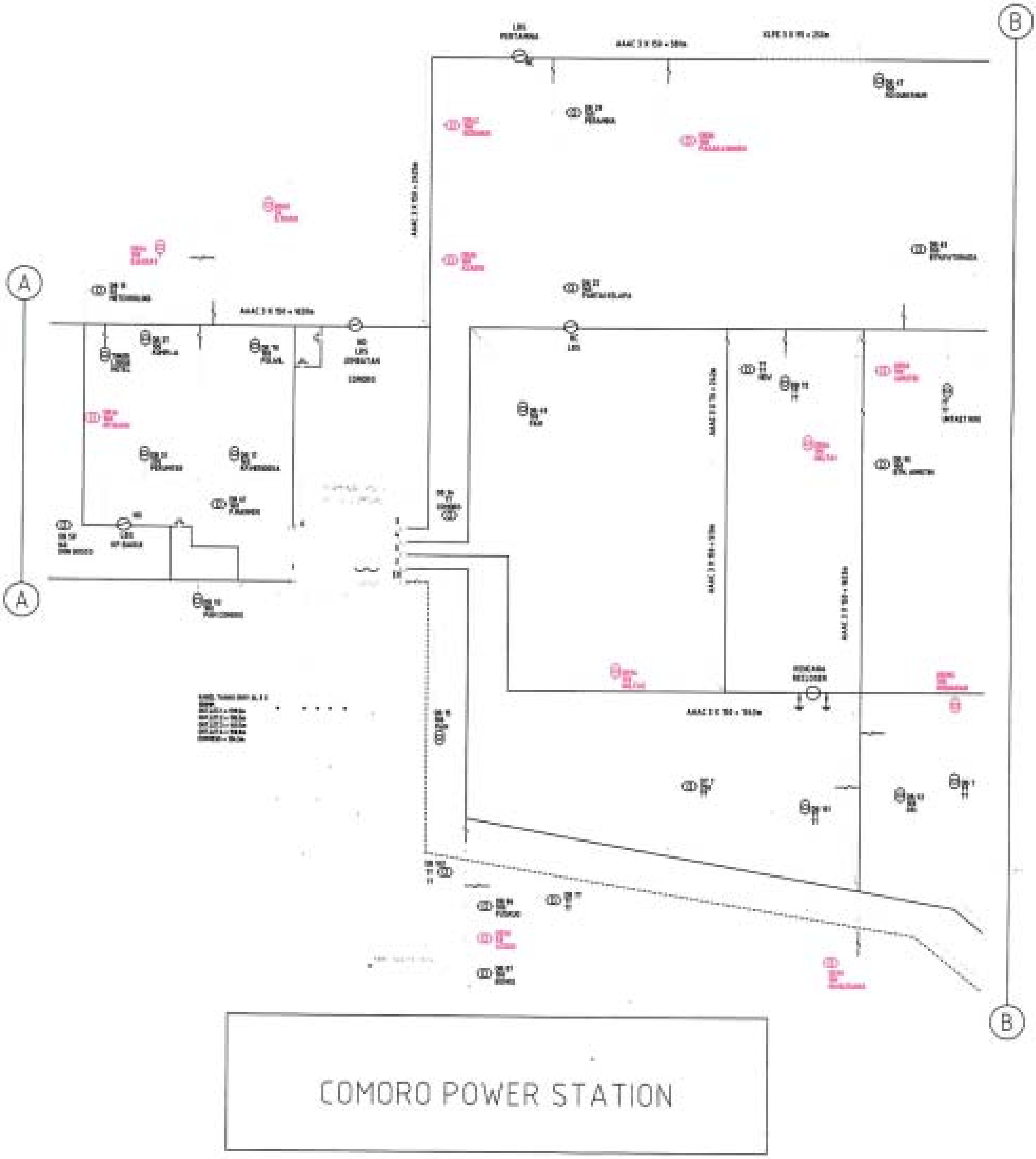
KEY PLAN



20kV配電系統図 (1/5)
20 kV DISTRIBUTION SYSTEM IN DILI
D-02

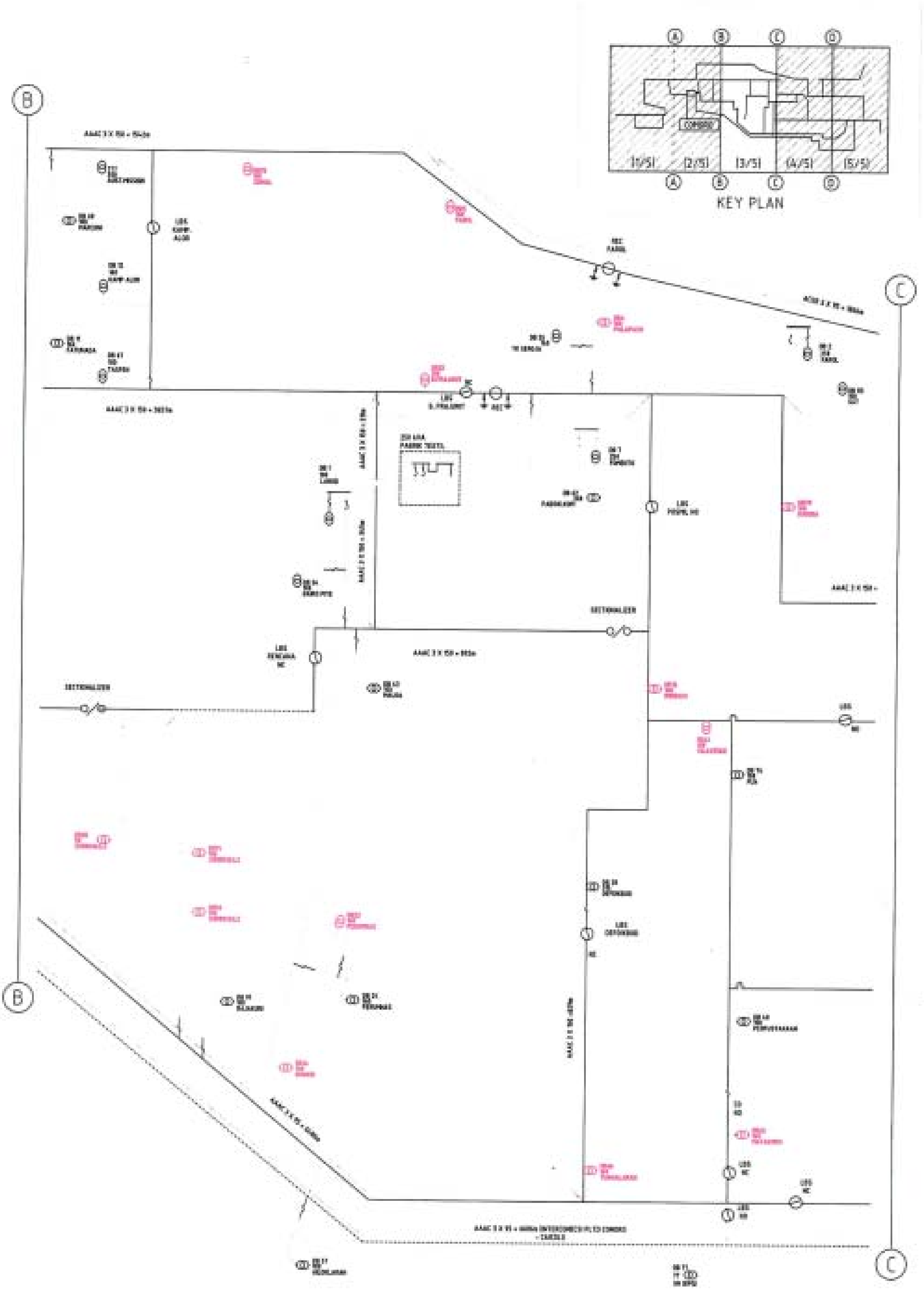


KEY PLAN



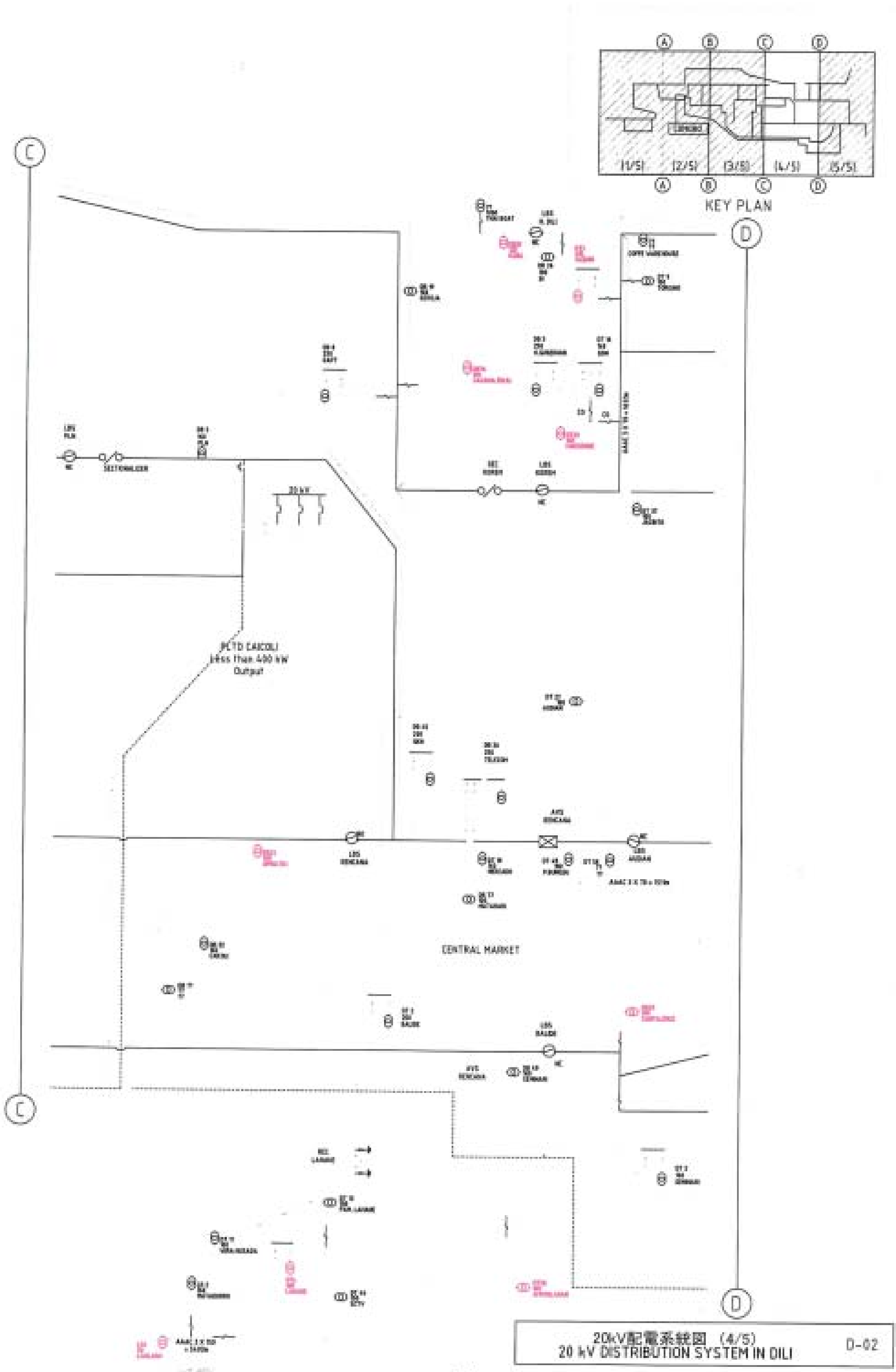
20kV配電系統図 (2/5)
20 kV DISTRIBUTION SYSTEM IN DILI

D-02

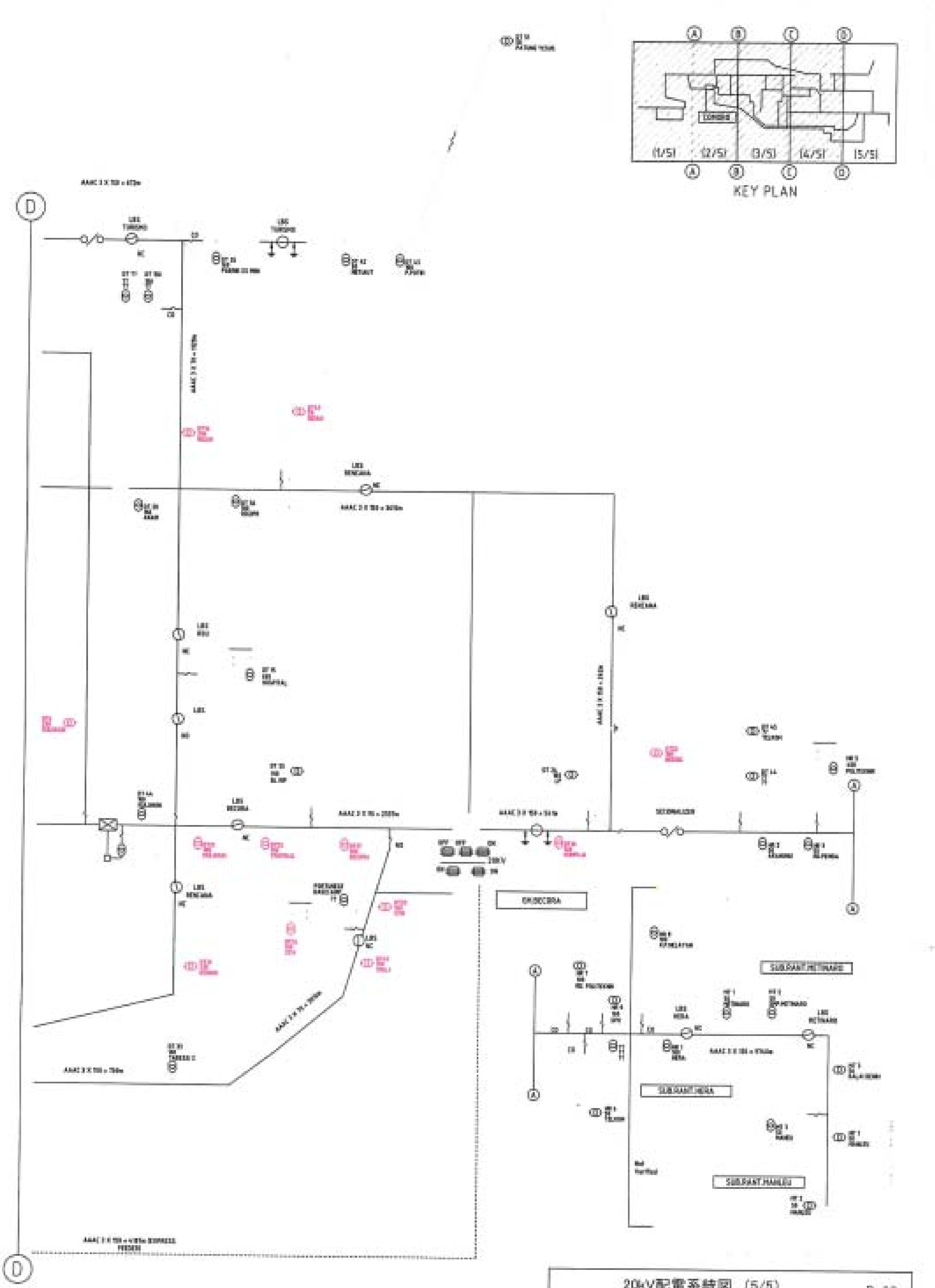


20kV配電系統図 (3/5)
20 kV DISTRIBUTION SYSTEM IN DILI

D-02

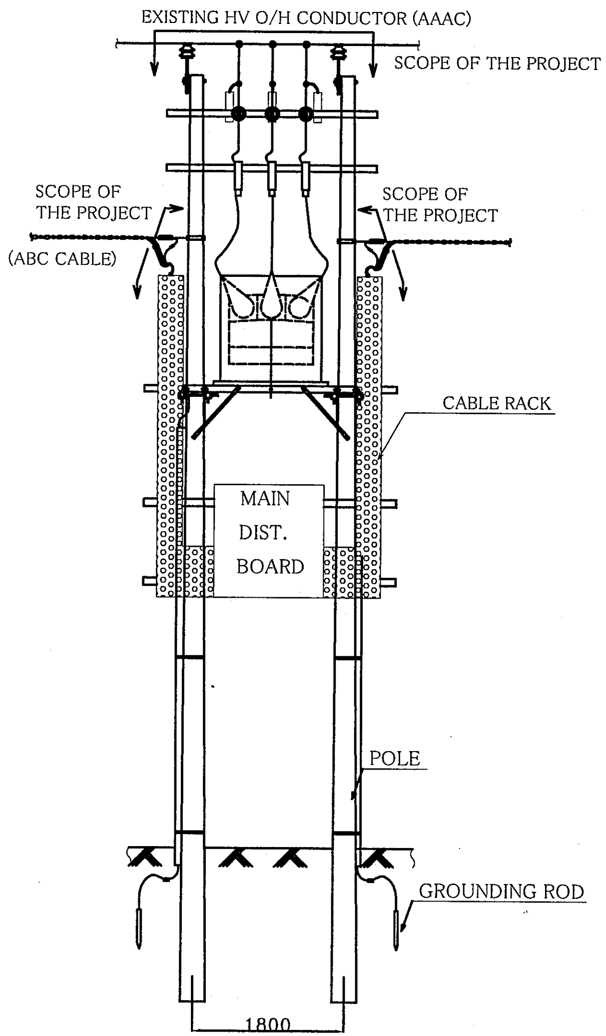


20kV配電系統図 (4/5)
20 kV DISTRIBUTION SYSTEM IN DILI
D-02

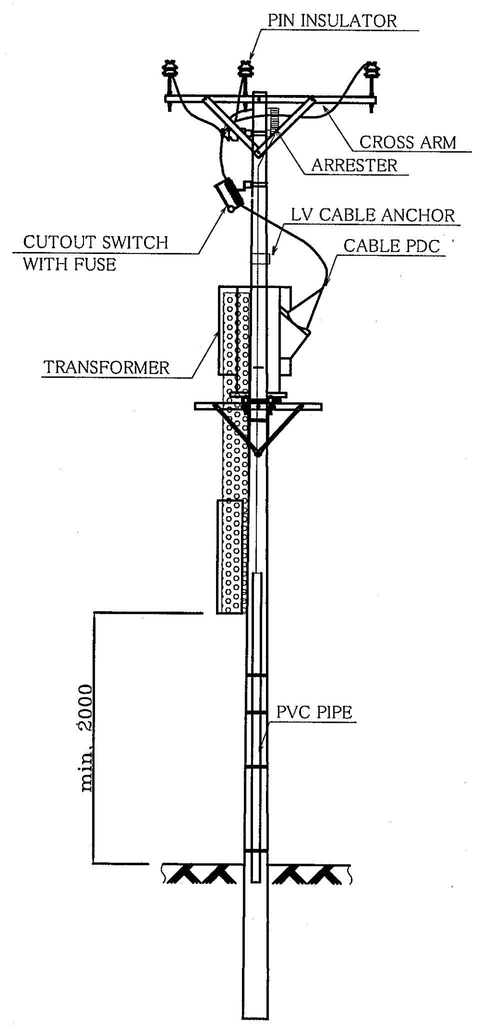


20kV配電系統図 (5/5)
20 kV DISTRIBUTION SYSTEM IN DILI

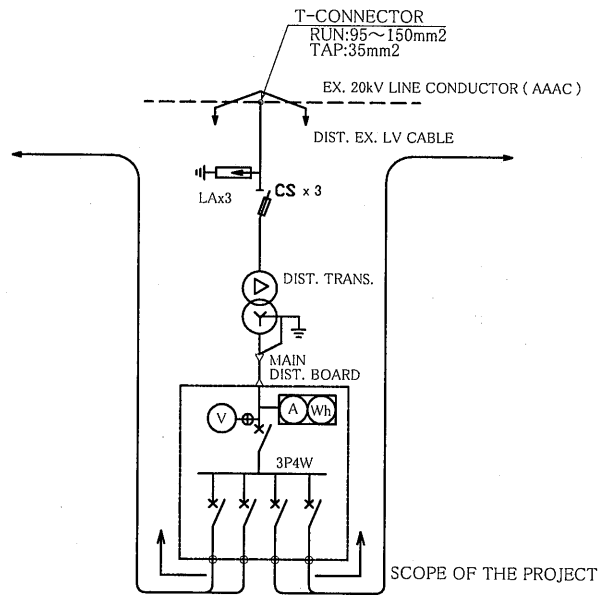
D-02



LINE VIEW



SIDE VIEW



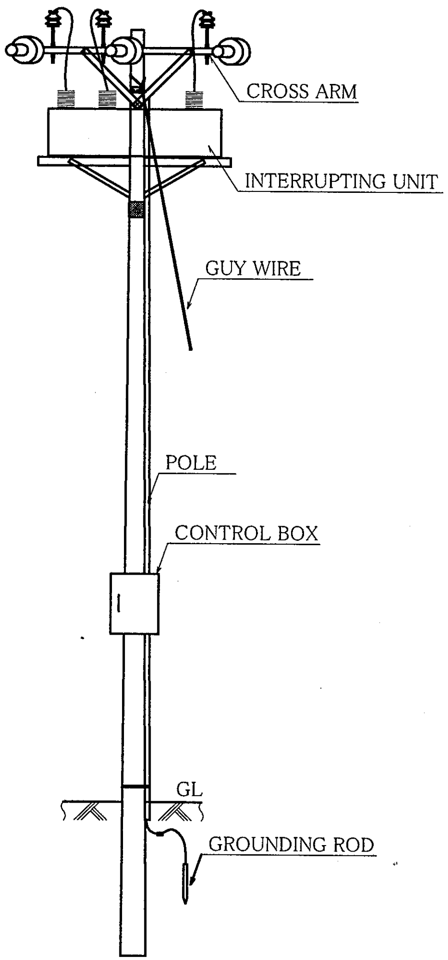
機材構成表

材料名	数量	備考
コンクリート柱	2本	12m
配電用変圧器 (TR)	1台	高効率変圧器 20kV/400-230V,架台付
避雷器 (LA)	3個	20kV,10kA,架台付
フューズ付 カットアウトスイッチ (CS)	3個	架台付
腕金	2本	LA及びCS用, ボルト,ナット
ピン碍子	9個	20kV
T-コネクター	3個	ボルト・タイプ・RUN:95～150mm2,TAP:35mm2
低圧用引き留めクランプ	2個	ボルト・タイプ
低圧用クランプアンカー	2個	ボルト・タイプ
ABCケーブル	50m	95×3+75×1
直線ジョイントキット	式	端子および、絶縁材料付(上記ABCケーブル用)
AAAC 35mm2 (幹線・CS間用)	9m	35mm2, コネクター付
PDC電線(CS・TR間用)	10m	20kV用
低圧配電用分電盤	1台	電力量計、電流計、電圧計等を含む
上記分電盤用サポート	1組	
ケーブルラック	10m	幅300cm、高7cm 蓋付き
ケーブルラックサポート	6本	
接地棒	2組	長さ1.5m 接地線含む, 2連結
PVC PIPE	5m	取付金物付(接地線用)
接地線 IV 14mm2	24m	

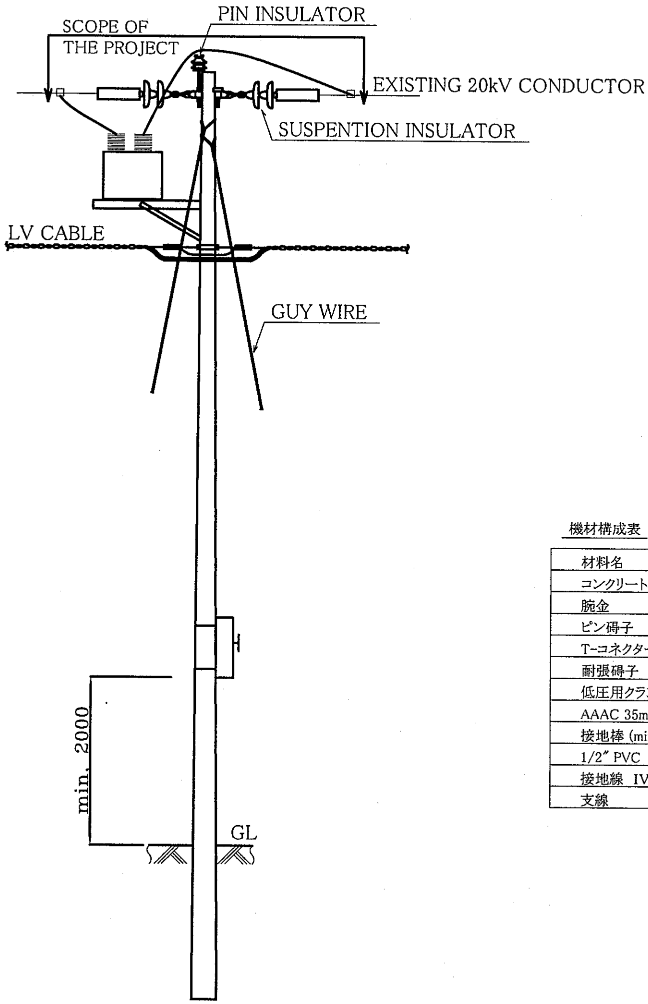
Remarks

1. All metallic materials shall be hot dip galvanized.
2. All metallic parts shall be grounded.
3. Name plate for poles shall be stainless steel or aluminum.

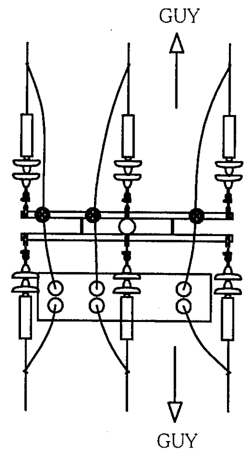
配電変圧器柱構成図 TYPICAL ARRANGEMENT OF TRANSFORMER POLE	D-11



LINE VIEW



SIDE VIEW



TOP VIEW

機材構成表

材料名	数量	備考
コンクリート柱	2本	12m
腕金	2本	LA及びCS用，ボルト,ナット
ピン碍子	6個	20kV
T-コネクター	3個	ボルト・タイプ・RUN:95～150mm2,TAP:35mm2
耐張碍子	6個	
低圧用クランプアンカー	2個	ボルト・タイプ
AAAC 35mm2	9m	35mm2, コネクター付
接地棒 (min : 1.5m)	1組	接地線含む, 2連結
1/2″ PVC	2.5m	取付金物付
接地線 IV 14mm2	12m	
支線	2組	

Remarks

1. All metallic materials shall be hot dip galvanized.
2. All metallic parts shall be grounded.
3. Name plate for poles shall be stainless steel or aluminum.

自動再閉器柱構成図 TYPICAL ARRANGEMENT OF AUTO RECLOSER POLE	D-12

D-21: Distribution Transformers to be replaced

No.	ID	Location	Feeder No.	Capacity (kVA)	Remarks
1	DB-64	B. Timor	1	160	
2	DB-65	B. Barat	1	160	
3	DB-14	KP. Baru	1	200	
4	LQ-10	Dato	1	160	
5	LQ-2	RSU	1	100	
6	DB-38	RD. Bandara	1	160	
7	DB-96	Asgor/Bumi Sejahtera	2	100	
8	DT-4	Lahane	2	160	
9	DT-34	Taibessi	2	160	
10	DB-39	Santa Cruz	2	160	
11	DT-38	Aiturilaran	2	160	
12	DT-19	Bemori	2	250	
13	DT-21	Kuluhum	2	200	
14	DT-52	Bekora	2	160	
15	DT-17	Bekora	2	160	
16	DT-18	Bekora	2	200	
17	DT-22	Bedois	2	160	
18	DT-47	Becusse	2	160	
19	DT-29	Becora STM	2	160	
20	LR-1	Laulara	2	100	
21	DB-68	Asabri	3	160	
22	DB-42	Bebonuk	3	200	
23	DB-75	Sional	3	200	
24	DB-88	Pasar Comoro	3	100	
25	DB-5	Farol	3	200	
26	DB-76	Sasana Tinju	3	160	
27	DB-58	Aimutin	4	200	
28	DB-39	Manleuana	4	160	
29	DB-33	Balai Prajurit	4	250	
30	DB-4	SD Farol	4	200	
31	DB-79	Marina	4	200	
32	DB-105	Hudiaran	5	160	
33	DB-85	Surikmas 2	5	100	
34	DB-71	Surikmas 2	5	160	
35	DB-56	Surikmas 2	5	200	
36	DB-23	Perumnas	5	160	
37	DB-16	Brimob	5	200	
38	DB-15	Imigrasi	5	250	Indoor-type
39	DB-41	Vila Verde	5	160	Indoor-type
40	DB-94	Delta-2	5	250	
41	DB-84	Delta-1	5	160	
42	DB-26	Matadoro	5	250	
43	DB-66	Tuanalaran	5	160	
44	DB-21	Caicoli ex. DPR	Express	200	
45	DT-23	Hotel Resende	Express	200	
46	DT-6	Kuluhun	Express	250	
47	DT-41	Bidau Massaur	Express	160	
48	DT-14	Senggol	Express	200	
49	DT-1	Suzuki	Express	500	Indoor-type
50	DT-31	Hotel Dili	Express	160	
		Total		9,180	

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The Project will be implemented within the framework of Japan's grant aid scheme. Accordingly, the Project will only be implemented after the approval of project implementation by the Government of Japan and the signing of the Exchange of Notes (E/N) by the two governments. The basic matters and important points in relation to the implementation of the Project are described below.

(1) Project Implementation Body

The government office responsible for the implementation of the Project and the actual implementation body on the East Timor side are the Ministry of Transport, Communications and Public Works (MTCPW) and the EDLT of the MTCPW respectively. The EDTL is the body responsible for all aspects of power supply, ranging from study, planning and construction to operation and maintenance, in the main cities in East Timor. A project manager to be responsible for the implementation of the Project should be appointed within the EDTL. This appointed manager will closely liase and hold discussions with the Japanese consultant and the Japanese contractor to ensure the smooth implementation of the Project.

The manager will also explain the project contents to staff members of the Comoro Power Station, the EDTL and other related government offices in East Timor as well as residents of the areas adjacent to the planned construction sites to obtain their understanding of and cooperation for the Project to ensure the smooth progress of the Project and the post-project maintenance of the newly installed equipment. Moreover, the manager will raise the issue of safety during the construction work.

(2) Consultant

A Japanese consultant will conclude a consulting services agreement with the Government of East Timor to execute the detailed design and work supervision to ensure that the procurement and installation of equipment under the Project proceeds to satisfactory completion. The Consultant will also prepare the tender documents and conduct the prequalification and tender on behalf of the EDTL which is the project implementation body.

(3) Contractor

A Japanese contractor selected by the East Timor side through open tender in accordance with the framework of Japan's grant aid scheme will conduct the procurement and installation of the planned equipment. As it is necessary for the contractor to provide post-project after-care, including the supply of spare parts and arrangement of repair work, etc. at the expense of the East Timor side, the contractor must establish a communication system regarding the said after-service.

(4) Necessity for Dispatch of Engineers

The planned work to renew the generating unit and to rehabilitate the distribution lines under the Project will be combined work, consisting of foundation work and generating as well as distribution equipment installation work. The dispatch of a site manager to be responsible for the supervision of and guidance on the entire work will be essential to ensure schedule, quality and safety control. Given the fact that there is a shortage of engineers who can control the entire works of the Project and other types of equipment, it will be necessary for the Contractor to dispatch Japanese engineers for the purposes of schedule, quality and safety control.

Engineers with wide knowledge of the equipment functions and configurations and with excellent skills will be required for the installation of the planned generating and distribution equipment under the Project. Accordingly, it will be necessary for the equipment manufacturers to dispatch specialist engineers in time for the installation, test operation and adjustment of the main equipment.

In general, equipment breakdowns can be classified into three types, i.e. initial breakdowns, accidental breakdowns and breakdowns due to wear, and tend to form a bath tub curve. A proper response to and repair of initial breakdowns which tend to occur in a relatively large number after the commencement of operation are particularly important to preserve the equipment life. Accordingly, the dispatch of electrical and mechanical engineers within the period specified by the E/N will be planned to support repair work to deal with initial breakdowns.

2.2.4.2 Implementation Conditions

(1) Situation of Local Construction Industry

1) In East Timor, while it is possible to recruit ordinary workers for installation work, there are not many skilled workers and engineers with specialist skills regarding schedule, quality and safety control. Accordingly, it will be necessary for the Japanese contractor to prepare for the dispatch of a Japanese engineer(s) as well as skilled worker(s) as and when such dispatch is judged to be required.

2) As the recruitment of local engineers capable of installing and adjusting the medium-scale generating unit to be procured under the Project is quite difficult, the dispatch of engineers, including an expert on schedule control, from Japan as described in 2.2.4.1-(4) is planned.

3) As the minimum range of construction machinery required for the inland transportation and installation of the equipment can be procured in East Timor, local procurement is planned.

(2) Important Points to Note for Implementation Plan

1) The rainy season in East Timor lasts from October to March. If the excavation work and 20 kV high voltage equipment installation work is planned to be conducted during this period, suitable measures, such as rain cover and storm water drainage, should be considered in addition to careful planning of the implementation timing of such work.

2) The installation work for the new generating unit will commence immediately after the completion of the equipment foundation work in parallel with the mechanical and electrical equipment installation work to shorten the overall work period.

3) The plan for the rehabilitation of the existing 20kV distribution network must include measures to minimize the adverse impacts of necessary power cuts on the lives of the public and the work plan for the work involving live wiring must feature work safety. In this way, any adverse impacts on the lives of the public caused by power cuts and traffic control due to roadside work, etc. can be minimized.

4) In the case of the generating unit installation work, the DEG installation work and equipment foundation work may concurrently be in progress to strictly adhere to the

contracted work schedule. It is even possible that this work will take place simultaneously, making on-site safety control essential.

5) If the cutting of existing trees is found to be necessary, the planned scale of cutting must be confirmed with the EDTL in advance. The agreed cutting scale must then be strictly adhered to.

6) In the case of the use of groundwater for the preparation of concrete, the water quality, including the salt content, must be checked and controlled to ensure the proper quality of the concrete.

2.2.4.3 Scope of Work

The respective scopes of the procurement and installation work for the Japanese side and the East Timor side are shown in Table 2-2-10.

Table 2-2-10 Work Share Between Japanese and East Timor Sides

Work Item	Japanese Side	East Timor Side
1. Generating Facility		
1) DEG	Procurement and installation	-
2) Mechanical auxiliary equipment	as above	-
3) Electrical auxiliary equipment	as above	-
4) Water and oil treatment system	as above	-
5) Grounding system	as above	-
6) Maintenance tools	Procurement only	Storage
7) Rain water drainage system	Design and construction	-
8) Spare parts	as above	Storage
9) Operation and maintenance manuals	Procurement and explanation	Storage and study
10) OJT	Execution	Attendance
11) Clearing of construction site	-	Execution
12) Fuel oil, compressed air and cooling water system	Modification of existing pipe and design and installation of new system	Preparation and arrangement of connecting points on existing No.5 unit
13) Materials for electricity, water and telephone extension for the work	Only those on site	Preparation and arrangement of connecting points on power plant
14) Payment of electricity, water and telephone bills associated with the work	Payment	-
15) Fuel and lubricating oil up to no-load test of generating unit	Procurement	-
16) Fuel and lubricating oil after no-load test of generating unit	-	Procurement
2. 20kV distribution network		
1) New 20 kV/400 – 230 V distribution transformers, arresters, main distribution panels, distribution materials and concrete poles	Procurement and installation	-
2) Existing 20 kV/400 – 230 V distribution transformers, arresters, main distribution materials and concrete poles	Removal	Storage or disposal
3) New 20 kV recloser, wiring materials and concrete poles	Procurement and installation	-
4) Existing 20 kV recloser, wiring materials and steel poles	Removal	Storage or disposal
5) Maintenance tools	Procurement only	Storage
6) Spare parts	Procurement only	Storage
7) Operation and maintenance manuals	Procurement and explanation	Storage and study
8) OJT	Implementation	Attendance
9) Preparation and clearing of planned sites	-	Execution
10) Removal of trees and other obstacles	-	Execution
11) Power cut planning	Planning	Execution
12) Electricity, water and telephone bills associated with the work	Payment	-

2.2.4.4 Consultant Supervision

In accordance with the Japan's grant aid scheme and based on the purposes of the Basic Design Study, the Consultant will establish a project team, which will be consistency involved in the detailed design and supervision stages to ensure the smooth progress of all of the work and dispatch at least one engineer permanently at the project site to conduct schedule, quality and safety control. The Consultant will also dispatch other engineers in line with the progress of the equipment installation work, on-site testing and adjustment and handing-over test with a view to supervising such work to be conducted by the contractor. In addition, the Consultant will conduct the pre-shipment inspection of the equipment manufactured in Japan to prevent the occurrence of any problems after the delivery of the equipment to the project site.

(1) Basic Principles for Work and Procurement Supervision

The basic principle for the Consultant supervision is the provision of supervision and guidance of the contractor to ensure (i) the progress of the work within the specified period, (ii) the delivery and quantity of the equipment and materials indicated in the contract and (iii) the safety control of the work. The main important points for work and procurement supervision are further explained next.

1) Schedule Control

The consultant will demand that the contractor abide by the time limit for the work specified in the agreement and will conduct weekly as well as monthly work progress checks. If the consultant believes that it is possible that the completion of the work may be delayed, he will remind the contractor of the possible delay and will demand the submission and implementation of a plan to rectify the situation so that the systems and equipment will be properly delivered in time to the East Timor side.

Comparison of the planned schedule and actual progress will mainly be based on the following.

① Checking of the progress (including manufacturing progress at the plants)

② Checking of the time for equipment loading onto the ship

③ Checking of the situation of preparations for the temporary work and construction machinery

④ Checking of the actual delivery of the equipment (generating and distribution equipment and materials and construction materials)

⑤ Checking of the planned input and actual input of engineers, skilled workers and laborers

2) Safety Control

The Consultant will discuss and cooperate with the representative of the contractor to enforce safety control to prevent any site accidents involving workers or a third party during the construction period.

The main important points for safety control are listed below.

① Preparation of safety control rules and appointment of a safety manager

② Strict enforcement of the safety control rules and regular checks

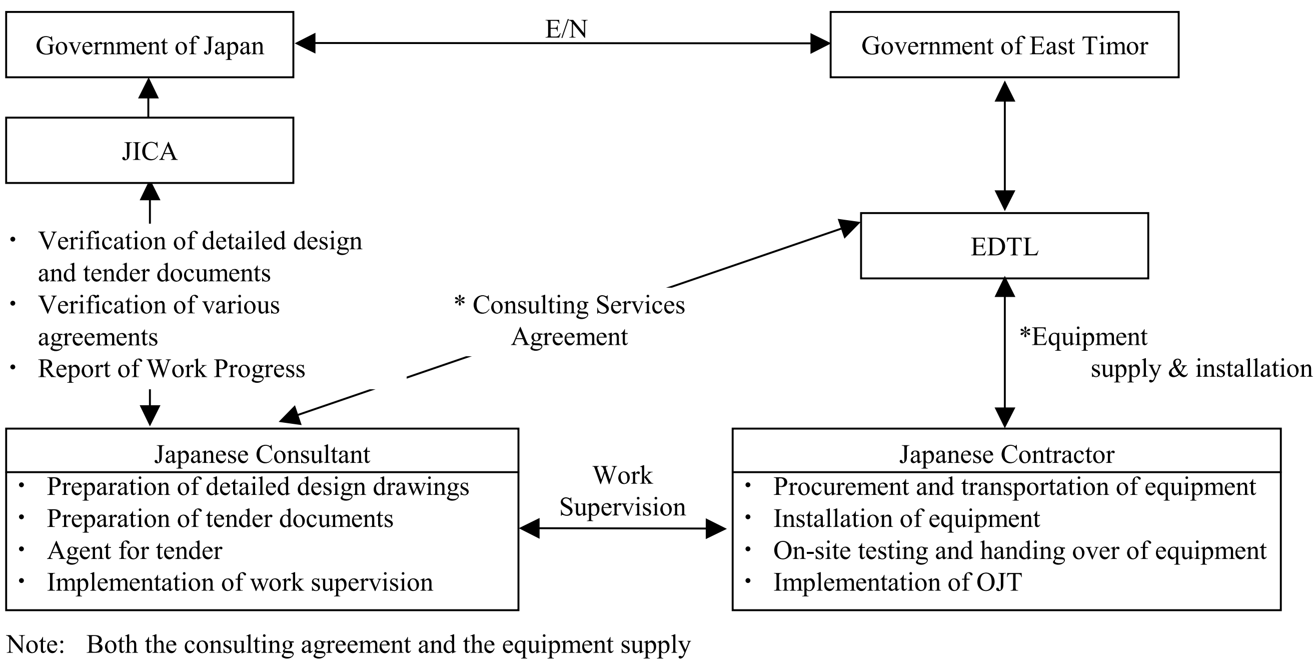
③ Prevention of accidents by means of conducting regular checks of the construction machinery

④ Establishment of traveling routes for the work vehicles and construction machinery and the strict enforcement of slow driving

⑤ Preparation of welfare measures for workers and the strict enforcement of days off

(2) Project Implementation System

The relationship between the parties to the Project at various stages of the Project is shown in Fig. 2-2-1.



Note: Both the consulting agreement and the equipment supply contract must be verified by the Government of Japan

Fig. 2-2-1 Project Implementation Regime

(3) Work Supervisors

The contractor must be capable of providing appropriate technical guidance for the local subcontractor so that the procurement and installation of the equipment can be completed according to the schedule to meet all of the requirements of the detailed design documents. Moreover, the dispatch of a work supervisor(s) with experience of similar projects by the contractor is desirable to ensure high quality. Given the scale and contents of the Project, the contractor should dispatch the following supervisor to be permanently stationed at the project site.

Site manager (1) : supervision and management of the installation work and OJT

In addition to the site manager, it will be necessary for the contractor to dispatch engineers specializing in equipment installation, testing and adjustment, etc. when such engineers are required at the site.

2.2.4.5 Quality Control Plan

Supervision of the quality in regard to the following items will be conducted to ensure that the equipment and materials to be used for the Project meets the quality specified in the contract documents (technical specifications and detailed design documents). If the check results suggest that the required quality may not be achieved, the Consultant will immediately instruct that the contractor make the necessary correction, alteration or modification.

① Checking of the shop drawings and specifications for the equipment

② Checking of the factory inspection and factory test reports

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

④ Checking of the working drawings and installation manuals for the equipment

⑤ Checking of the manuals for the test running, adjustment and inspection of the equipment

⑥ Supervision of the on-site equipment installation work and witnessing of the test operation, adjustment and inspection

⑦ Checking of the completed work against the working drawings for the equipment/systems

2.2.4.6 Procurement Plan

The planned equipment and materials for construction and procurement under the Project are not produced in East Timor except aggregate for concrete and are imported from abroad. Although some imported items (cement, reinforcing bars and forms, etc.) are available in the local market, it will be difficult to guarantee the punctual delivery or quality of other items which will, therefore, be procured in Japan and/or a third country.

In regard to the recloser as part of the distribution equipment to be procured under the Project, those made in a third country (Sweden) are commonly used in East Timor. As the operation and maintenance staff of the EDTL are familiar with a particular brand of product which is not manufactured in Japan, procurement of the recloser from a third country (DAC country) is considered for the Project.

The planned equipment and material supply sources for the Project are shown in Table 2-2-11 based on a comparative analysis of possible sources from the viewpoints of (i) standards, specifications, quality, production and reliability of supply, (ii) ease of operation and maintenance and (iii) availability of after-services for spare parts supply and breakdown repair, etc.

Table 2-2-11 Equipment and Material Supply Sources

Equipment/Material	Supply Source		
	East Timor	Japan	Third Country
Fuel oil; lubricating oil; cooling water	O		
Sand	O		
Cement	O		
Gravel	O		
Steel materials		O	
Diesel generating unit (diesel engine; generator; electrical systems; mechanical systems; piping materials; cables)		O	
Spare parts for the above		O	
Maintenance tools for the above		O	
Distribution equipment			
- Distribution transformers with arresters		O	O
- Recloser		O	O
- Main distribution panels		O	O
- Concrete poles		O	O
- Distribution materials		O	O
Vehicles with bucket and truck with a crane		O	O

2.2.4.7 Implementation Schedule

The following implementation schedule is planned based on Japan's grant aid scheme.

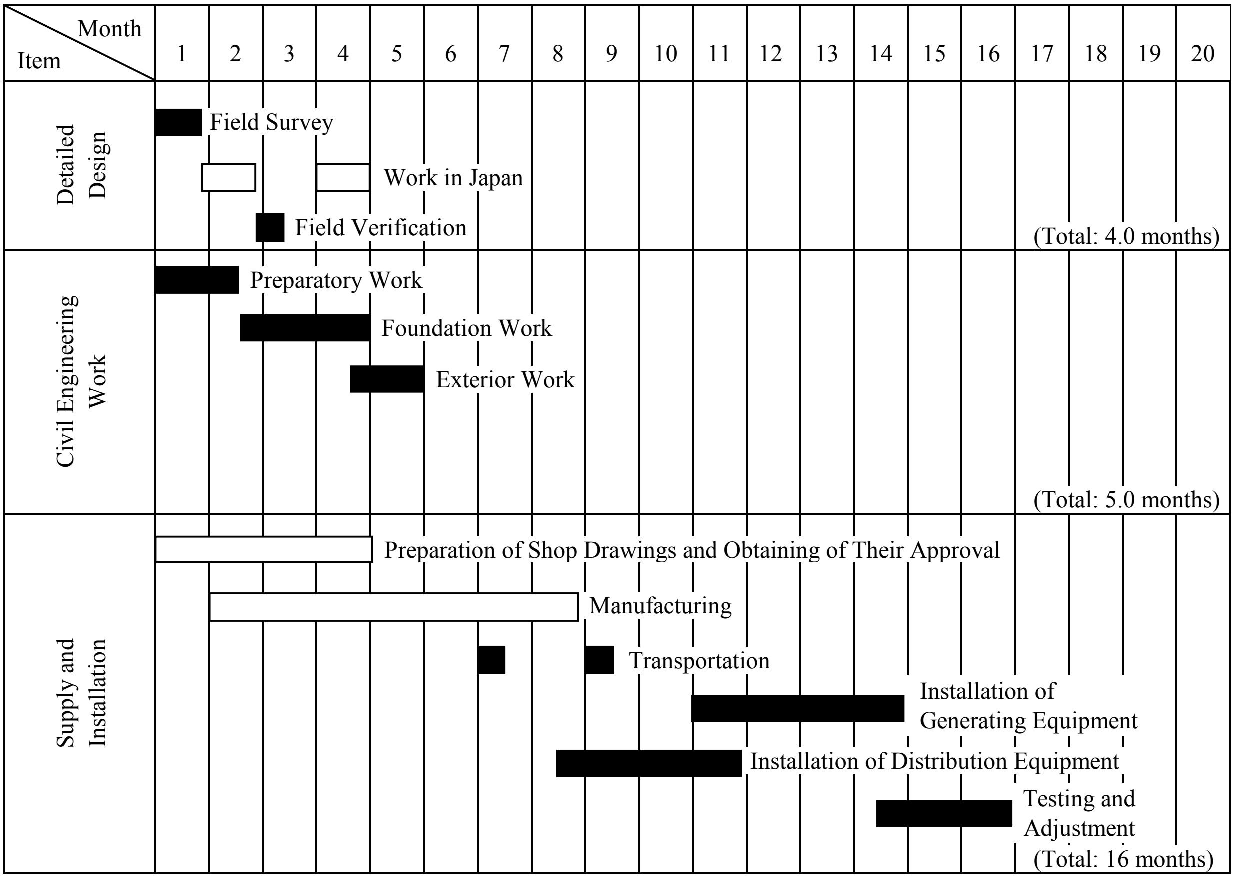


Fig. 2-2-2 Project Implementation Schedule

2.3 Obligations of Recipient Country

In the course of the implementation of the Project, the government of East Timor will be responsible for conducting the following works or providing the following items in addition to the scope of work of the East Timor side described in the item "2.2.4.3: Scope of works".

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

(2) To secure and provide cleared embanked and leveled land as well as access roads for the project sites prior to the commencement of the construction work under the Project.

(3) To ensure speedy unloading, customs clearance and tax exemption of the goods for the Project at the port and/or airport of disembarkation and internal transportation in East Timor.

(4) 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 East Timor and stay therein for the performance of their work.

(5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in East Timor with respect to the supply of the products and services under the verified contracts.

(6) To bear commissions to a Japanese bank for banking services based on the banking arrangements.

(7) To bear all expenses other than those to be borne by the Grant aid necessary for the implementation of the Project.

(8) To assign exclusive counterpart engineers and technicians for the Project in order to transfer operation and maintenance techniques under the Project and to witness and confirm the construction/installation work and quality of equipment and materials when inspection is conducted.

(9) To take necessary measures and responsibility for the stoppage of electricity during the construction/installation period if necessary.

(10) To use and maintain properly and effectively all equipment and materials provided with Japanese Grant aid.

(11) To provide proper disposal sites for the excavated soil, waste water and waste oil discharged during the construction period.

(12) To remove all obstacles on the planned distribution line routes.

(13) To clear the planned site for the new generating unit at the Comoro Power Station prior to the commencement of the Project.

(14) To complete all necessary procedures relating to the installation of the new generating unit and rehabilitation of the 20 kV distribution equipment and coordination with other projects.

(15) To prepare the reports required in accordance with local environmental standards and to complete all related procedures before commencement of the Project.

2.4 Project Operation Plan

2.4.1 Maintenance Plan

(1) Maintenance System

Among the equipment to be provided under the Project, the generating unit is the most important equipment in regard to maintenance. The proper operation and maintenance of this unit and the proper maintenance of its operating environment will be essential to ensure a stable power supply which responds to daily demand fluctuations. In order to maintain the proper performance and functions of the planned generating unit to ensure a stable supply of power, the implementation of appropriate preventive maintenance designed to improve the reliability, safety and efficiency of the generating and distribution facilities is essential. Fig. 2-4-1 shows the basic concept of such maintenance.

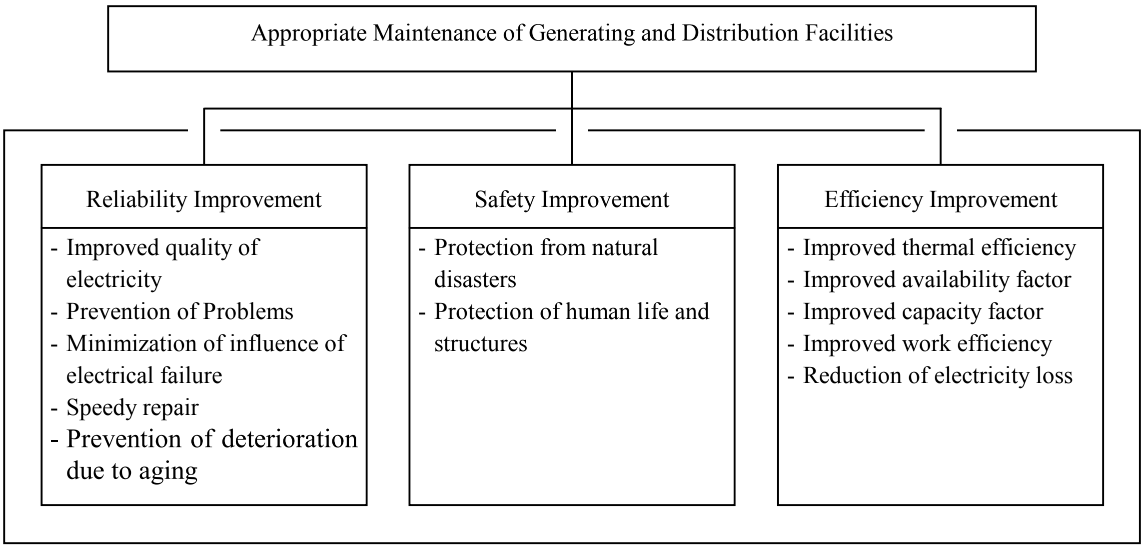


Fig. 2-4-1 Basic Concept of Maintenance of Generating and Distribution Facilities

It will be necessary for the EDTL to prepare an operation plan for the Comoro Power Stations in accordance with their respective load patterns to ensure economical operation.

(2) Personnel Training Plan

For the successful outcome of the Project, it will be necessary for the East Timor side to conduct adequate operation and maintenance of all of the equipment using the O&M techniques transferred to the East Timor side through OJT to be provided by the engineers to be dispatched by the Contractor during the installation, the test operation and adjustment period and also in accordance with the O&M manuals provided by the Contractor. The subject persons of OJT will be engineers and technicians. A total of 10 persons, i.e. five mechanical and five electrical engineers/technicians, are planned to receive OJT.

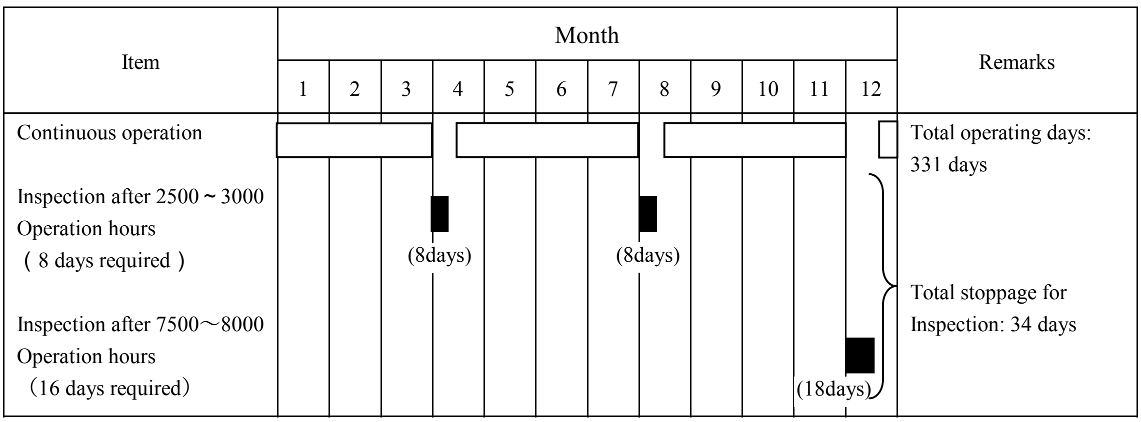
2.4.2 Operating Plan for New Generating Unit

The planned new generating unit will provide for the base load operation as described in 2.3.2 and the adoption of the following operating conditions is deemed appropriate in view of their specifications, etc.

- Annual utilization factor : 90% or higher
- Annual operating hours : approximately 8,000 hours

Table 2-4-1 shows the periodical inspection items required for the proper operation of the new generating unit while Fig. 2-4-2 shows the annual operation program for the same unit for the first year based on the operating conditions mentioned above, taking the periodical inspection items into consideration. It is expected that the operation of the new generating unit will be suspended for approximately 34 days/year as shown in Fig. 2-4-2.

It will be necessary to actively use Unit No. 3 and Unit No. 4, both of which are operating to cover the base load, and some of the other generating units designed to cover the peak load at the Comoro Power Station to ensure a sufficient supply of power during these inspection periods.



Note: Based on annual rate of operation of 90%.

Fig. 2-4-2 Annual Operation Program for New Generating Unit

2.4.3 Periodical Inspection Items

(1) Generating Facility

The standard items for the periodical inspection of the planned generating unit are shown in Table 2-4-1. The East Timor side will be required to prepare an operation and maintenance plan for the planned generating unit in accordance with the O & M manuals to be submitted by the manufacturers with a view to establishing an economical operation program for this unit 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 2-4-1 Standard Periodical inspection Items of Generating Facility

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 - Visual checking of various sections
	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 and 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 and 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 rotator 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

(2) Distribution Facility

① Periodical Inspection of Distribution Equipment

The standard periodical inspection items for the distribution equipment to be procured and installed under the Project are shown in Table 2-4-2. As the table shows, the inspection of the distribution equipment is classified as (i) "patrolling inspection" which is conducted daily using human senses to check any abnormal heating and sound, etc. of the equipment, (ii) "standard inspection" to check energized sections beyond the daily patrolling inspection, including the fastening conditions of bolts, etc. of the equipment and the cleanliness of or damage to the surface of insulated items, etc. and (iii) "detailed inspection" to check the proper functioning of the interlocking mechanism between equipment and the accuracy of instruments, etc.

Standard inspections are conducted every one or two years while detailed inspections are conducted approximately every four years.

The regular replacement of certain parts at the time of either standard inspection or detailed inspection is desirable based on confirmation of the characteristics as well as frequency of use of such parts. These include the fuses, measuring instruments and relays, etc. installed inside the distribution panels and others which are liable to performance deterioration, including the insulation performance, abrasion of the contact points and changes of the characteristics.

Table 2-4-2 Standard Periodical inspection Items for Distribution Facility

Subject	Inspection Item (Method)	Patrolling Inspection	Standard Inspection	Detailed Inspection
Equipment Outlook	Condition of indicators and indication lamps	○	○	
	Abnormal sound or odor	○	○	
	Thermal discoloration of terminals	○	○	
	Cracks, damage or staining of bushing and insulator	○	○	
	Rust on casings and frames	○	○	
	Abnormal temperature (thermometer)	○	○	
	Fastening of bushing terminals (mechanical check)	○	○	
Operating Apparatus and Control Panels	Correct indication by various instruments	○	○	○
	Reading of operation counters		○	○
	Condensation, rust and damage inside console and panels		○	○
	State of oil supply and cleaning		○	○
	Fastening of cable terminals	○	○	○
	State of Open-Close indications		○	○
	Air leakage and oil leakage		○	○
	Pressure before and after operation (air pressure, etc.)		○	○
	Working of instruments		○	○
	Rust, deformation and/or damage to springs	○	○	○
	Abnormality of fastening pins		○	○
	Auxiliary contactors and relays		○	○
	DC control power source	○		
Measurement/Testing	Measurement of insulation resistance		○	○
	Measurement of contact resistance			○
	Breaking of heater cable		○	○
	Operation check of relays		○	○

② Periodical inspection of Distribution Lines

One of the most important consumer services is the maintenance of distribution lines by means of detecting breakdowns and damage through regular patrolling and immediate repair. The major check items for patrolling inspection are listed below.

(a) Contact between distribution equipment and trees, etc.
(b) State of fencing and locks
(c) Operating state of distribution panel and transformer

As almost all of the distribution equipment will be installed high above the ground, two trucks with a crane and two trucks with a bucket will be procured to facilitate the inspection and maintenance of the distribution equipment. The main specifications of these vehicles are given below.

(a) Truck with crane

- With a 3 ton crane
- Loading capacity: 4 tons
- 4 WD

(b) Truck with a bucket

- Maximum height above the ground: 12 m
- 4WD

2.4.4 Fuel Oil Procurement Plan

The estimated fuel (diesel oil) consumption to operate the new generating unit (4.0 MWx1) is approximately 6,300 m^3/year based on an assumed annual capacity factor of 80 %.

The EDTL will be required to prepare and implement a practical fuel oil procurement plan to ensure the steady operation of the said generating unit.

2.4.5 Spare Parts Procurement Plan

The spare parts for the generating and distribution facilities consist of those to replaced aged parts (consumables) and emergency spare parts, which are required at the time of a breakdown, etc. Accordingly, the EDTL should procure and prepare these spare parts in accordance with the periodical inspection cycle (see Table 2-4-1 and 2-4-2).

Two years spare parts to cover 16,000 hours of operation during which the periodical inspection cycle will be completed will be included in planned under the Project. The main procurement items based on the periodical inspection items are shown in Table 2-4-3. The East Timor side will be responsible for appropriating the necessary budget for the procurement of additional spare parts (amounting to some 6% of the Project cost in two years) by the end of the second year following the completion of the Project in order to continue periodical maintenance work.

Table 2-4-3 Spare Parts and Maintenance Tools to be Provided Under the Project

I-1. Spare parts for diesel generating equipment

Item	Q'ty
1. Diesel Engine and Auxiliary Equipment	
(1) Consumable spare parts	
1) Fuel oil filter element	2 sets
2) Lubricating oil filter element	2 sets
3) Cylinder cover packing	12 sets
4) Air cooler packing	4 sets
5) Exhaust gas valve	
Valve seat	2 sets
Valve guide	2 sets
Valve rotator	2 sets
6) Intake air valve	
Valve guide	2 sets
Sleeve	2 sets
Valve seat	2 sets
O ring	2 sets
Valve rotator	2 sets
7) Turbo charger	
Bearing	4 sets
Thrust bearing	4 sets
8) Piston	
Piston ring	4 sets
Oil ring	4 sets
O ring	4 sets
9) Fuel oil injection pump	
Plunger	4sets
Deflector	4sets
O ring	4sets
10) Fuel oil injection nozzle	
Nozzle tip	6 sets
O ring	6 sets
(2) Emergency spare parts	
1) Fuel oil injection block complete	For 2 cylinders
2) Cylinder cover complete	For 1 cylinder
3) Fuel oil injection nozzle complete	For 1 cylinder
4) Fuel oil injection pump complete	For 1 cylinder
5) Jacket cooling water pump complete	1 set
6) Lubricating oil filter for turbo charger	2 sets
7) Lubricating oil by-pass filter element	2 sets
8) Pre-filter for turbo charger	2 sets
9) Starting valve complete	1 set
10) Waste oil discharge pump complete	1 set
11) Sludge transfer pump complete	1 set
12) Sludge discharge pump complete	1 set
13) Spare parts for auxiliary pump	200 %
14) Instrument	
Pressure gauge	One of each kind
Thermometer	One of each kind

2. Electrical Equipment and Auxiliary Equipment	
(1) Consumable Spare Parts	
1) Fuse Elements for Control Circuit	200% for each type
2) Lamps or Bulbs for Indicator	200% for each type
3) Fluorescent Lamp for Panels	200% for each type
(2) Spare Parts for Emergency Condition	
1) Printed circuit board for AVR	1 set
2) Complete Set of 20kV Circuit Breaker	1 set
3) Auxiliary Relay	1 pc for each type
4) Timer	1 pc for each type
5) Molded Case Circuit Breaker (MCCB)	1 pc for each type
6) Earth Leakage Breaker (ELB)	1 pc for each type
7) Electro-Magnetic Contactor	1 pc for each type
8) Electrical Meter for Panels (Voltage, Ampere, etc.)	1 pc for each type
9) Thermal Relay	1 pc for each type
10) Fuse for Voltage Transformer	1 pc for each type
11) Fuse for High Voltage Equipment	1 pc for each Type

I-2. Spare Parts for Distribution Line

Item	Q'ty
(1) Consumable Spare Parts	
1) Fuse Elements for Low Voltage Circuits	200 %
2) Lamps or Bulbs for Indicator	200 %
3) Silica gel for Transformers	3 kg

Ⅱ. Maintenance Tools and Instruments

Item	Q'ty
A. For Generating Unit	
1. For Diesel engine	
(1) Special tools for maintenance	1 set
(2) Remover for Cylinder liner	1 set
(3) Thermometer (Radiation type)	1 set
(5) Ear pad	10 sets
2. Common Use for Generator and Distribution Line Equipments	
(1) Circuit Tester (Analog meter)	1 set
(2) Tool set for Electrical Maintenance	1 set
(3) Power Analyzer (A, V, W, Wh)	1 set
(4) Relay Testing Set (Single Phase)	1 set
(5) Slide Transformer (0～250 V, 0～50 A)	3 sets
(6) Ampere Meter (50 mV)	1 set
(7) Insulation Tester (500 V, 1000 MΩ)	1 set
(8) Insulation Tester (2,500 V, 100 GΩ)	1 set
(9) Portable Sound Level Meter	1 set
(10) Portable Illumination Meter (Lux Meter)	1 set
(11) Portable Vibrometer	1 set
(12) Insulating Oil Test Set	1 set
(13) Portable Earth Resistance tester (0～100Ω, 0～30V)	1 set
(14) DC Dielectric Strength Test Set (DC30kV, 10mA)	1 set
(15) Phase Rotation Meter	1 set
(16) Voltage Detector for Low Voltage Circuit	1 set
(17) Voltage Detector for 20kV Circuit	1 set
(18) Digital Multimeter	1 set
(19) AC/DC Clamp meter	1 set
(20) Clamp Meter for Power Factor	1 set
B. For 20kV distribution network	
(1) Circuit Tester (Analog meter)	1 set
(2) Tool set for Electrical Maintenance	1 set
(3) Power Analyzer (A, V, W, Wh)	1 set
(4) Insulation Tester (500 V, 1000 MΩ)	1 set
(5) Insulation Tester (2,500 V, 100 GΩ)	1 set
(6) Portable Sound Level Meter	1 set
(7) Portable Vibrometer	1 set
(8) Insulating Oil Test Set	1 set
(9) Portable Earth Resistance tester (0～100Ω, 0～30 V)	2 sets
(10) DC Dielectric Strength Test Set (DC 30 kV, 10 mA)	1 set
(11) Phase Rotation Meter	1 set
(12) Voltage Detector for Low Voltage Circuit	1 set
(13) Voltage Detector for 20 kV Circuit	1 set
(14) Digital Multimeter	1 set
(15) AC/DC Clamp meter	1 set
(16) Clamp Meter for Power Factor	1 set

III. Repair tools

Item	Q'ty
A. Generating Unit	
1. Diesel engine	
(1) Tool set (mechanical)	1 set
(2) Measuring device	1 set
(3) Chain block	1 set
(4) Wire rope	1 set
2. Generator and Electrical Installation	
(1) Earthing equipment set (3 phase set)	1 set
B. Distribution System	
1. Truck with a bucket	2 sets
2. Truck with a 3 ton crane	2 sets
3. Earthing equipment for maintenance work (for 3 phase)	2 sets

2-5 Estimated Project Cost

2-5-1 Estimated Cost for Subject Project for Japanese Cooperation

This cost estimation is provisional and would be further examined by the Government of Japan for the approval of the Grant. In the case of the Project's implementation under the Japan's grant aid Scheme, the total project cost is estimated to be approximately ¥765 million. The financial undertaking by each side is estimated below based on the work share described earlier and the estimation conditions shown below.

(1) Cost to be Borne by Japanese Side

Item	Amount (¥ million)
(1) Procurement and Installation Cost	695
1) Comoro Power Station	(496)
2) 20 kV Dili distribution network	(199)
(2) Consultant Fee	67
Total	762

(2) Cost to be Borne by East Timor Side

The main cost items to be borne by the East Timor side are shown in Appendix 5.

(3) Estimation Conditions

1) Date of estimation : June, 2003

2) Foreign exchange rate : US$ 1 = ¥119.7 (TTS average from April to June, 2003)

3) Construction period : The construction will be completed in one phase and the planned periods of the detailed design, construction work and equipment procurement are those shown in the Work Schedule

4) Other : The Project shall be implemented in accordance with the Japan's Grant Aid Scheme.

2-5-2 Operation and Maintenance Cost

As of July, 2003, the EDTL charges US$ 0.16/kWh for ordinary households and US$ 0.20/kWh for public, commercial and industrial facilities. Table 2-5-1 shows the estimated operating income and expenditure for the new generating unit when the current tariff is applied to power supply by this generating unit. It is clear from the table that self-financing operation, including the procurement of spare parts, by the new generating unit is feasible if the annual capacity factor of this generating unit (4.0 MW generator) is approximately 52% or higher.

However, if the annual operating rate drops below 51%, the profit and loss is expected to be deficit as shown in Table 2-5-1. The East Timor side must, therefore, clearly understand the local situation to ensure economical, i.e. profitable, operation together with appropriate maintenance and must also prepare and implement an optimal operating plan for the new generating unit. As overhaul will be required every 8,000 – 10,000 hours of operation, the overhaul cost must be included in the maintenance cost by properly assuming the operating hours of the new generating unit.

Table 2-5-1 Estimated Profit and Loss of New Generating Unit

No.	Item	Unit	Annual Capacity Factor (%)			
			51	52	60	70
I.	Conditions					
1.	Installed Capacity (1 x 4.0 MW)	kW	4,000	4,00	4,000	4,000
2.	Annual Operating Hours	hr	4,468	4,555	5,256	6,132
3.	Generated Energy	MWh	16,083	16,399	18,922	22,075
4.	Station Service Power Consumption	MWh	423	492	568	662
5.	Distribution Loss	MWh	804	820	946	1,104
6.	Energy Sold (3 - 4 - 5)	MWh	14,797	15,087	17,408	20,309
II.	Income					
	Income from Energy Sold	US$	2,367,500	2,413,900	2,785,300	3,249,500
III.	Expenditure					
1.	Fuel Cost (I-3.)×(3)×(5)	US$	1,465,200	1,493,900	1,723,700	2,011,000
2.	Lubricating Oil Cost (I-3.)×(4)×(5)	US$	27,400	27,900	32,200	37,600
3.	Personnel Cost	US$	27,000	27,000	27,000	27,000
4.	Spare Parts Procurement Cost	US$	375,000	375,000	375,000	375,000
5.	Head Office Expenses	US$	236,700	236,700	236,700	236,700
6.	Depreciation Cost	US$	250,000	250,000	250,000	250,000
7.						
	Total Expenditure	US$	2,381,300	2,410,500	2,644,600	2,937,300
IV.	Balance	US$	-13,800	3,400	140,700	312,200
V	Unit Generating Cost	US$/kWh	0.148	0.147	0.140	0.133

< Estimation Conditions >

(1) The unit generating cost is set at US$ 0.16/kWh based on the actual performance of the EDTL in 2003.

(2) The station service power consumption is assumed to be 3% of the generated energy while the distribution loss is assumed to be 5% of the distributed energy.

(3) The fuel cost is based on a unit price of US$ 0.378/litre as of the end of March, 2003.

(4) The lubricating oil cost is based on a unit price of US$ 1.065/litre as of the end of February, 2003.

(5) The consumption rates of fuel and lubricating oil are assumed to be as follows.
- Fuel : 0.241 liter/kWh
- Lubricating oil : 0.0016 liter/kWh

(6) The personnel cost is based on 15 employees, representing one-third of the total manpower of the Comoro Power Station, including operating, maintenance and administrative staff members, and the average wages at the EDTL for 2003 are used.

(7) The spare parts procurement cost is assumed to be 3% of the equipment cost for the generating unit in question.

(8) The head office expenses are assumed to be 10% of the total income.

(9) The depreciation cost is calculated using the straight line method based on an operating life of the generating unit of 15 years and a nil residual value.

(10) A foreign exchange rate of US$ 1 = ¥120 is used.

CHAPTER 3　PROJECT EVALUATION

CHAPTER 3 PROJECT EVALUATION

3.1 Project Effects

The implementation of the Project is expected to have the following effects.

(1) Direct Effects

Current Situation and Problems	Improvement Measures Under the Project	Project Effects and Degree of Improvement
1. Dili, the capital, suffers from planned power cuts on a daily basis.	The installation of a 4.0 MW generating unit will provide a sufficient reserve supply capacity to allow the planned outage of a key generating unit for maintenance purposes up to the target year (2008).	The availability of a reserve supply capacity up to 2008 will enable the implementation of appropriate maintenance of the generating units, including the existing units.
2. The distribution transformers connected to the 20 kV Dili distribution network is operating under an excess load, raising a question of safety for the lives of the public. At the same time, there is concern in regard to an increase of power cuts due to sudden system and/or equipment faults.	Out of the existing distribution transformers, those operating under the condition of an excess load will be renewed together with the replacement of the highly corroded steel poles with new concrete poles.	The reliability of the power supply by the distribution network will be improved to establish a power supply regime with less frequent power cuts and breakdowns. A reduction of the distribution loss from the current level is also anticipated.
3. Because of the malfunctioning of the automatic recloser installed on the 20 kV distribution network, the breakdown of a feeder line affects a wide area. Manual operation of the switch to repair a breakdown takes a long time, resulting in a relatively long power cut duration.	New automatic recloser will be installed with the additional function of automatic switching.	The introduction of automatic recloser at seven sites will minimize the power cuts and will also shorten the time required to restore the power supply.

(2) Indirect Effects

Current Situation and Problems	Improvement Measures Under the Project	Project Effects and Degree of Improvement
1. The existing generating units at the Comoro Power Station have not been properly overhauled for regular inspection as recommended by the manufacturer.	Procurement of one new 4.0 MW generating unit	Reserve power supply capacity to allow the planned outage of the main generating units for overhauling purposes up to 2008, the target year of the Project
2. Many users currently operate their own generators. However, as no specialist is involved in the operation and maintenance of these generators, operation is prone to personal injury accidents and environmental destruction, etc., causing a very dangerous situation.	Procurement of one new 4.0 MW generating unit	The operation and maintenance of the generating units will be centralized to the EDTL, reducing the frequency of accidents and alleviating environmental destruction, etc. due to the operation of privately owned generating units.
3. Frequent power cuts take place, partly because of planned power cuts, causing adverse impacts on the lives of the public and on the stable operation of public facilities, etc.	Procurement of one new 4.0 MW generating unit	A stable power supply is anticipated.
4. The present distribution losses in 20 kV Dili distribution network is about 10 % which is high value.	Installation of new distribution transformers with low power loss	Reduction of the transforming and distribution losses can be expected to result in a reduction of the generating cost.
5. Fuel consumption of Comoro power station is about 221 g/kWh which is too high.	Procurement of one new 4.0 MW generating unit	Reduction of fuel consumption is expected.

3.2 Recommendations

The East Timor side should pay careful attention to the following points for the realization and continuance of the project effects.

(1) The East Timor side must be fully aware of any new infrastructure development projects, such as rehabilitation projects for the existing generating units and distribution network of other donors, to avoid any overlapping between such projects and the present Project.

(2) The East Timor side should operate the new generating unit which capacity factor shall be more than 80 %.

(3) The East Timor side should establish adequate operation and maintenance systems based on the management Contract.

(4) Although the implementation of the Project will secure a reserve power supply capacity up to 2008, it will be necessary for the East Timor side to review the power demand in subsequent years for the purpose of formulating a plan to increase the power supply capacity after the completion of the Project. Accordingly, the East Timor side will be required to prepare a sufficient budget for the procurement of new equipment.

(5) The East Timor side should formulate an early rehabilitation plan for the facilities of the 20 kV distribution networks which will not be rehabilitated under the Project to reduce the distribution loss and to establish the reliability of power supply. The East Timor side should also prepare and implement energy saving measures.

(6) The East Timor side should record the generating efficiency, etc. for each new and existing unit for the purpose of ensuring their economic operation and should also establish the actual load for each distribution transformer with a view to selecting an appropriate transformer capacity and low voltage distribution cable size for the established load.

(7) The introduction of an incremental power tariff whereby the unit price increases in accordance with the consumption level should be considered as such a tariff will encourage energy saving regarding power consumption on the part of large users while reducing the burden of the power bill on the part of the poor.

(8) The optimal tap value should be selected for each distribution transformer depending on the conditions of each site to improve the quality of the power supplied and also to reduce the distribution loss.

The Project will be implemented more smoothly and will achieve additional positive effects with the improvement or satisfactory development of the above points.