No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
UPGRADING OF ELECTRIC POWER SUPPLY
IN
TARAWA ATOLL
IN
THE REPUBLIC OF KIRIBATI

MARCH, 2001

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Kiribati, the Government of Japan decided to conduct a basic design study on the Project for Upgrading of Electric Power Supply in Tarawa Atoll in the Republic of Kiribati and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kiribati a study team from November 13 to December 14, 2000.

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

March, 2001

Kunihiko Saito
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

March, 2001

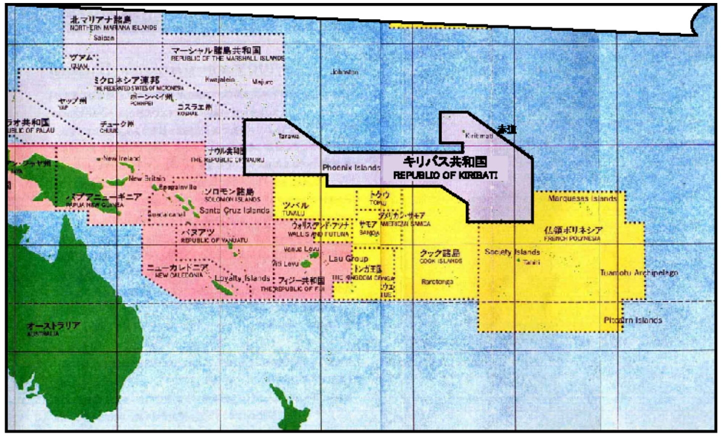
We are pleased to submit to you the basic design study report on the Project for Upgrading of Electric Power Supply in Tarawa Atoll in the Republic of Kiribati.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from Novmber, 2000 to March, 2001. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kiribati and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

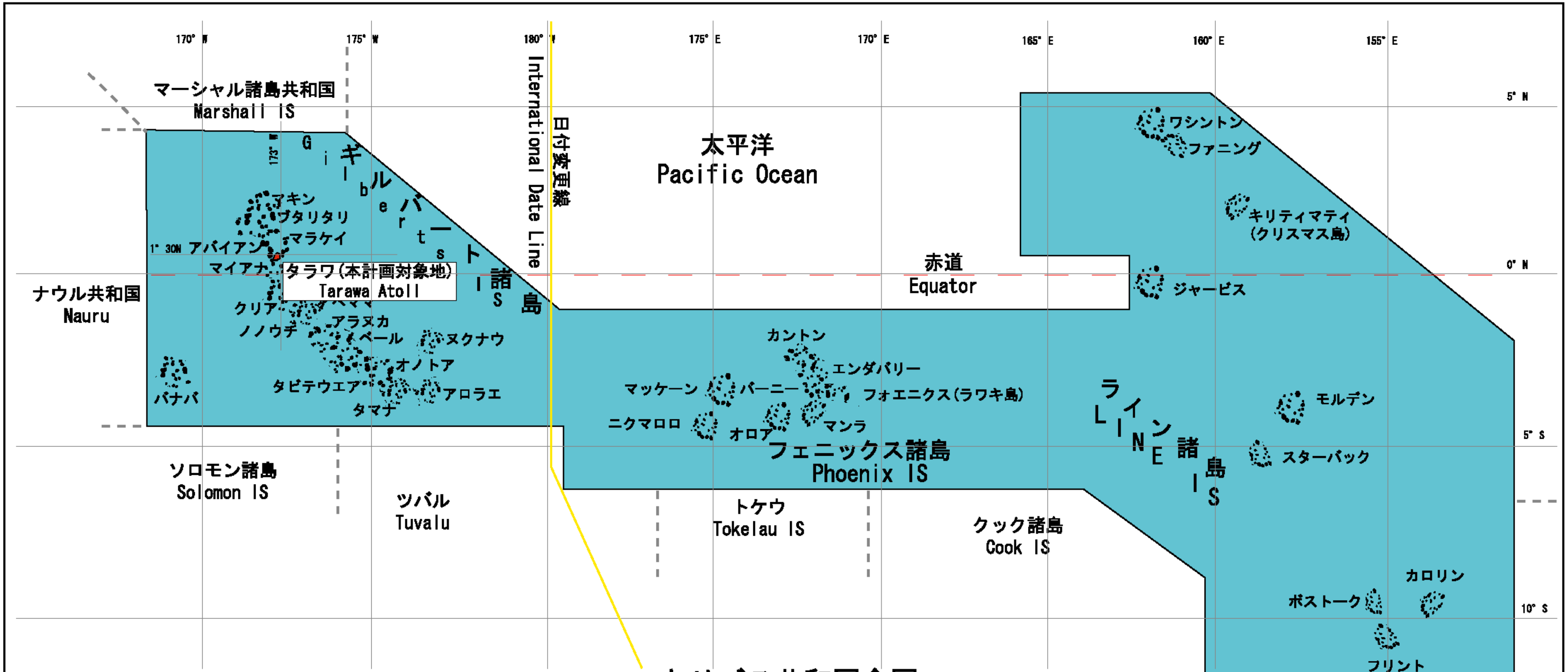
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

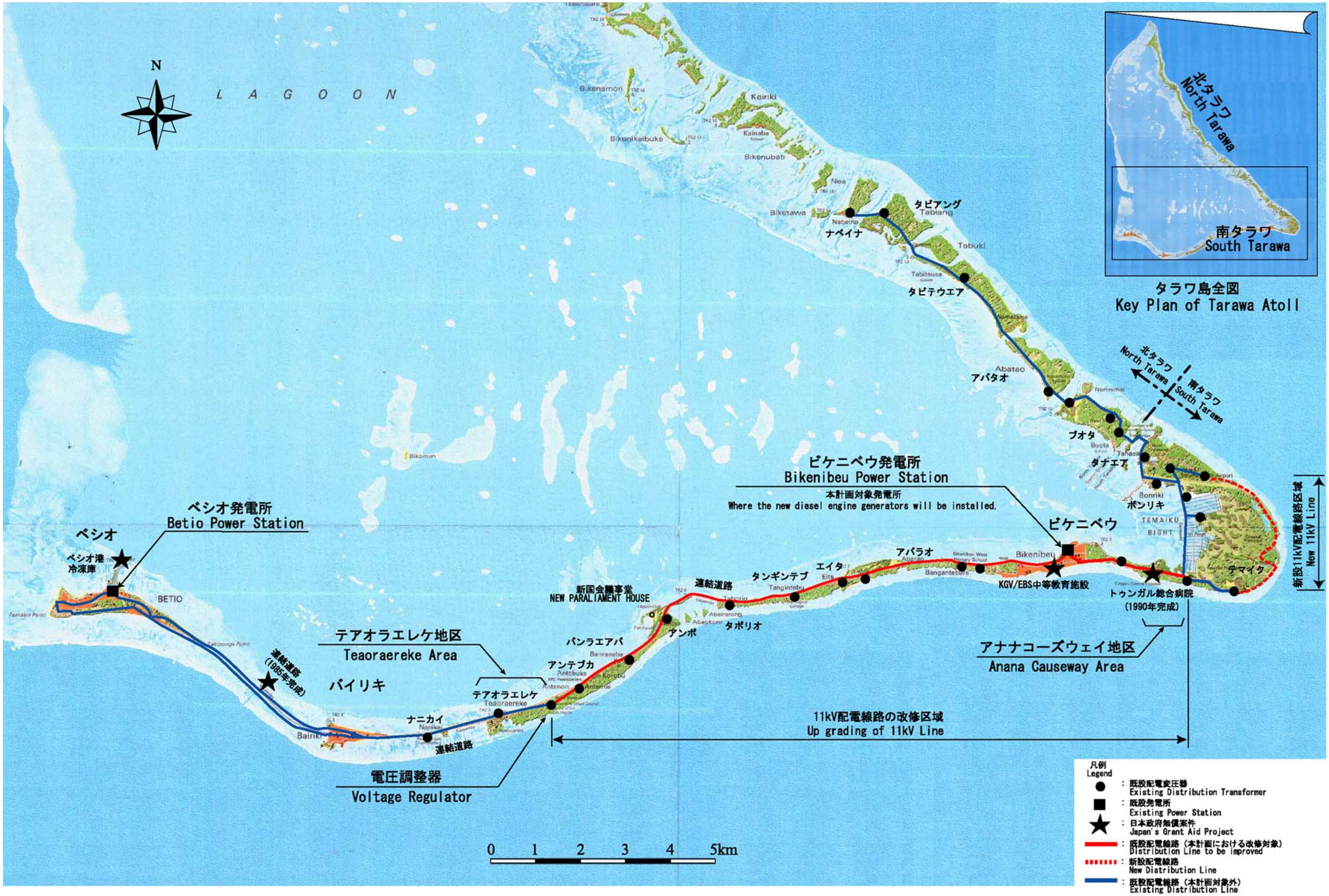
Mitsuhisa Nishikawa
Project Manager,
Basic design study team on the Project for
Upgrading of Electric Power Supply
in Tarawa Atoll in the Republic of Kiribati
Yachiyo Engineering Co., Ltd.



キリバス共和国位置図
Location Map of Kiribati



キリバス共和国全図
Map of Kiribati



タラワ島 11kV 配電網

11kV Distribution Network in Tarawa

THE PROJECT FOR UPGRADING OF ELECTRIC POWER SUPPLY
IN TARAWA ATOLL IN THE REPUBLIC OF KIRIBATI

ABBREVIATIONS

ADB	Asian Development Bank
AIS	Architectural Institute in Japan
AusAID	Australian Agency for International Development
A$	Australian Dollar (1 A$=62 J Yen）
BHN	Basic Human Needs
DEG	Diesel Engine Generator
EEZ	Exclusive Economic Zone
EU	European　Union
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
KOIL	Kiribati Oil Company
MESD	Ministry of Environment and Social Development
MWE	Ministry of Works and Energy
O & M	Operation and Maintenance
OJT	On the Job Training
PUB	Public Utilities Board
SAPHE	Sanitation, Public health and Environment
TSKL	Telecommunication Services of Kiribati Ltd.

CONTENTS

[Appendices]

1. Member List of the Study Team
2. Study Schedule
3. List of Parties Concerned in the Recipient Country
4. Minutes of Discussions
5. Cost Estimation Borne by the Recipient Country
6. Other Relevant Data (if applicable)
7. References

LIST OF FIGURES AND TABLES

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Following its independence in 1979, the Republic of Kiribati (hereinafter referred to as Kiribati) heavily relied on the financial support of the United Kingdom, its former suzerain state. Fiscal aid by the UK for Kiribati's current budget, however, was terminated in 1986, making self-reliant public finance an urgent national task for the country. Kiribati has been attempting to develop its national economy, mainly featuring the development of fisheries by means of the effective exploitation of the marine resources of its huge 200-mile EEZ. Meanwhile, the Eighth (1996 – 1999) National Development Strategy and (2000 – 2003) National Development Strategies have adopted the development, improvement and expansion of social infrastructure to stimulate economic activities as a priority target. Nevertheless, the progress of infrastructure development has been slow even in South Tarawa, which is the economic, industrial and administrative centre of Tarawa, the capital of Kiribati. The slow progress is particularly noticeably in regard to the development of power supply facilities, which are essential for the stable operation of social and public facilities, such as hospitals and schools, and fishing facilities, including cold storages, and also for improvement of the standard of living of the public.

Under these circumstances, the Government of Kiribati made a request to the Government of Japan for the provision of grant aid for the procurement and installation of equipment and materials of new power generating and distribution facilities, which are essential for the implementation of the Power Supply Facilities Upgrading Project in South Tarawa, which is the capital of Kiribati and the country's economic development centre.

[Contents of the Request]

(1) Procurement and Installation of Diesel Generating Units

1) Two (2) sets of diesel engine generators with an output of approximately 1.4 MW each

2) Auxiliary mechanical system required to operate 1) above

- Fuel and lubrication oil supply system, including fuel oil storage tanks and daily tanks
- Oil and water separation system and sludge treatment system
- Cooling water system
- Intake Air and Exhaust Gas system
- Piping, cabling and other materials required for the installation of the above systems

3) Electrical system required for 1) and 2) above and station power source

- Remote control panels, including instrumentation and protective relay panels
- 11 kV high voltage panel
- Auxiliary equipment for the new generating units (station power and DC power supply equipment, etc.)
- Grounding system
- Cabling and other materials required for the installation of the above

(2) Civil Engineering and Building Work at Bikenibeu Power Station necessary for item (1) above

1) Construction work of powerhouse, including building services

2) Foundation work for the main and auxiliary equipment

3) Exterior work, including a rainwater drainage system and oil and water separation system, within the premises

(3) 11 kV Distribution Network Upgrading Work (including Civil Engineering Work)

1) 11 kV distribution line upgrading work (including terminal treatment and connection materials for distribution cables)

- Upgrading of the 11 kV distribution cable from the Bikenibeu Power Station to Teaoraereke where the existing voltage regulator is located (approximately 13.3 km)
- Upgrading of the 11 kV distribution cable from the Bikenibeu Power Station to the existing ring main unit (RMU 31) at Anana Causeway area (approximately 3.1 km)

2) Construction of new 11 kV distribution lines (including terminal treatment and connection materials for distribution cables)

- Construction of a new 11 kV distribution line from the existing ring main unit (RMU 43) at Temaiku to the existing ring main unit (RMU 44) at Bonriki area (approximately 4.9 km)
- Procurement and installation of four sets of distribution substation equipment (including transformers, ring main units and auxiliary materials)

3) Procurement and installation of one set of distribution substation equipment (including transformer, ring main unit and auxiliary materials) at Buota area

4) Procurement and installation of two 11 kV circuit breaker panels

5) Procurement and installation of one set of 11 kV voltage regulator (including the work to remove existing voltage regulator)

(4) Procurement of Spare Parts, Maintenance Equipment and Tools Required for (1) and (3) Above

1) Procurement of consumables and spare parts required for two years operation

2) Procurement of maintenance/repair equipment and tools

3) Procurement of operation and maintenance manuals

Two request letters for the Project have been prepared and submitted by the Kiribati side to the Government of Japan, i.e. "Original Request" and "Revised Request" as outlined below.

① Original Request

The Original Request was issued in March 1999, consisting of two components: (i) procurement and installation of three 1,400 kW generating units and (ii) rehabilitation of the 11 kV distribution network (approximately 53 km). It was hoped that the entire work would be completed in a single fiscal year.

② Revised Request

The Revised Request was issued in December 1999 and changed (i) the number of requested generating units to two (two 2,300 kW generating units) and (ii) the project implementation period to two years (two phases).

Based on the Revised Request, the Study Team had a clear grasp of the background of the request, the current conditions of the existing facilities/equipment, related development plans/projects and the trends of aid for Kiribati by other donors and aid organizations during the field survey and determined the most effective project scale for the urgent improvement of the power supply capacity to formulate the optimal plan ignoring the division of work between Phase 1 and Phase 2. At the same time, it was confirmed through the discussion with the Kiribati side that the contents of the Final Request by the Kiribati side were those defined in the Minutes of Discussions (M/D) agreed by the Kiribati side and the Study Team and that the target year of the Project would be 2004.

The main differences between the Original Request, the Revised Request and the Final Request in the M/D are shown in Table 1-1-1.

Table 1-1-1 Comparison Between Various Requests

No. Item	Original Request		Revised Request		Final Request (at Time of Basic Design Study)
	Component A	Component B	Phase 1	Phase 2	
1. Date of Request or Confirmation	March, 1999		December, 1999		November, 2000
2. Project Areas					
1) Section between Bikenibeu and Teaoraereke	○	—	○	—	○
2) Section between Teaoraereke and Betio	—	○	—	○	—
3) Electrification of Temaiku and Buota	—	—	—	—	○
3. Requested Items					
1) Power House Building Construction					
a) Power House Building	○	—	○	—	○
b) Foundations for Auxiliary Equipment and Exterior Work	○	—	○	—	○
2) Equipment (Procurement and Installation)					
a) Generating Facilities					
-Generator Capacity and Quantity	1,400 kW×3	—	2,300 kW×1	2,300 kW×1	1,400 kW×2
-Step-Up Transformers (6,000 kVA)	○	—	○	—	— (unnecessary)
-Auxiliary Equipment	○	—	○	○	○
b) Rehabilitation/Improvement of 11 kV Distribution Facilities					
-Rehabilitation of 11 kV Cable (Bikenibeu – Teaoraereke)	120 mm^2 (16 km)	—	120mm^2 (16 km)	—	95 mm^2 (13.3 km)
	70 mm^2 (5 km)	—	70 mm^2 (5 km)	—	—
-Rehabilitation of 11 kV Cable (Teaoraereke – Betio)	—	70 mm^2 (30 km)	—	70 mm^2 (30 km)	—
-Rehabilitation of 11 kV Cable (Bikenibeu-Anana Causeway)	—	—	—	—	50 mm^2 (3.1 km)
-Laying of New 11 kV Cable (Temaiku, Bonriki area)	—	—	—	—	25 mm^2 (4.9 km)
-11 kV Circuit Breaker Panel	—	6	—	6	2
-11 kV Distribution Transformer	—	100 kVA×4	—	100 kVA×4	100 kVA×5
		200 kVA×6	—	200 kVA×6	—
-11 kV Ring main unit	—	10	—	10	5
-11 kV Voltage Regulator	—	2,000 kVA×1	—	2,000 kVA×1	—
		3,000 kVA×1	—	3,000 kVA×1	3,000 kVA×1
-SCADA	—	○	—	○	—
-Spare Parts and Maintenance Tools	—	○	—	○	○
-Maintenance Track and Excavator, etc.	—	○	—	○	—
c) Implementation of OJT	○	○	○	○	○
3) Consultancy Service	○	○	○	○	○

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

(1) Objectives of the Project

In its National Development Strategies (2000 – 2003), the Government of Kiribati has promoted the economic growth of the country and the improvement of the life of the people as the two main strategic targets.

The present Project is considered to form part of the attempt to develop social infrastructure which is essential for the improvement of people's lives, the stable operation of social and public facilities and the vitalization of industry in South Tarawa, which is the centre of socioeconomic activities in Kiribati. The immediate objectives of the Project are the construction of generating facilities, the upgrading of a distribution network and the electrification of hitherto unelectrified areas to achieve a highly reliable and stable power supply, which is given high priority in Kiribati.

(2) Outline of the Project

In order to achieve the above objectives, the Project plans to improve the existing power supply facilities in South Tarawa. The implementation of the Project is expected to achieve a stable power supply, which is an important component of the social infrastructure in South Tarawa, and to improve the supply reliability of the power system. The scope of the Japanese grant aid covers the installation of new generating equipment on the premises of the existing Bikenibeu Power Station, upgrading of 16.4 km of 11 kV trunk distribution lines out of the total length of 54 km and the installation of 4.9 km of 11 kV distribution lines to hitherto unelectrified areas.

2.2 Basic Design of the Required Japanese Assistance

2.2.1 Design Policy

(1) Basic Concept

The basic principles for the determination of the basic framework, i.e. scope of the cooperation, site selection and scale of equipment, are described below.

1) Scope of Cooperation

The scope of the cooperation under the Project will be the construction of a new power station (two 1.4 MW generating units), upgrading of 16.4 km of 11 kV trunk distribution lines and the installation of new 11 kV distribution lines for 4.9 km to unelectrified areas.

2) Site Selection

As the efficient use of the available sites of the existing power facilities and land owned by the government is intended, the new power station will be constructed on the premises of the existing Bikenibeu Power Station and the upgraded and new 11 kV distribution cables will be buried along existing cable routes and existing roads respectively.

3) Scale of Equipment

The scale of equipment will be sufficient to secure the reserve power generation and supply capacity and to ensure adequate voltage distribution in 2004, two years after the completion of the Project.

(2) Natural Conditions

1) Temperature and Humidity

The Project Area has a tropical climate with an almost constant temperature throughout the year. The maximum, minimum and mean temperatures in the last 12 years were 34°C, 24°C and 28°C respectively. As the generating equipment to be procured under the Project will be installed inside a building, no special measures will be required vis-à-vis the ambient temperature. No special measure relating to temperature will be required for the distribution equipment which will be installed outdoors as the difference between the maximum and minimum ambient temperatures of 10°C is small. As the design humidity is high (maximum of 100%, minimum of 60% and average of 75%), the adoption of measures to prevent condensation will be necessary to determine the equipment specifications, taking the maximum humidity of 100% into consideration.

2) Wind and Rainfall

While the recorded maximum wind velocity is 21 m/sec, the mean annual wind velocity is 5 – 8 m/sec with a prevailing east wind. The mean annual rainfall of 2,300 mm is relatively high. The maximum hourly rainfall of approximately 5 – 10 mm is low and there is hardly any distinction between the dry season and the rainy season. Rainwater drainage, etc. will be provided for the power station premises so that undrained rainwater will not disrupt the operation and maintenance of the generating equipment. In the case of the distribution equipment, careful planning of the schedule for the excavation work for the laying of the cables will be necessary, taking the maximum rainfall and periods of relatively heavy rainfall from November to April into consideration. Given the occurrence of some 15 thunderstorms a year which is not particularly high, a lightning rod will be installed on the roof of the power house to avoid lightning damage to the generating equipment.

3) Salt Damage

Although the planned site for the new generating units is situated on the coast, the main equipment will be installed inside the building to protect it from salt damage and also to reduce noise pollution in the surrounding area. Such auxiliary facilities as the radiator and fuel tank, etc. to be installed outdoors will receive a salt-resistant coating and other measures for their protection together with the use of corrosion-proof materials.

Of the planned distribution facility to be installed under the Project, as the voltage regulator and circuit breaker panels, etc. will be installed outdoors, highly corrosion-proof materials, such as FRP and coating, will be used. As the distribution cables will be buried underground, any consideration of salt damage is unnecessary. However, attention should be paid to the groundwater level to determine the burying depth.

4) Earthquakes

No earthquakes have been recorded in Tarawa and, therefore, no special consideration will be given to earthquakes.

(3) Social Conditions

The people of Kiribati are predominantly Christian. Public offices are open on weekdays and there are some 13 public holidays a year. Each district has its own community hall where important local issues are discussed and decided. There are no local customs or habits, which could significantly affect the construction schedule. The construction plan for the Project should aim at making power cuts during the distribution line rehabilitation work as short as possible and reducing the adverse impacts of the work on local people as well as on the social activities of communities. The safety of workers as well as local people will obviously be of paramount importance.

(4) Construction and Procurement Conditions

The principle condition for the formulation of the work plan will be the procurement of local materials as much as possible. While coral sand can be locally obtained for use as concrete aggregate for the building construction, the import of such main construction materials as cement and reinforcing bars, etc. will be necessary. Accordingly, careful attention should be paid to the transportation routes and procurement period for these materials from neighboring countries.

The installation work, including the test operation and adjustment, of the planned generating equipment will require a high level of skill and, therefore, a Japanese engineer(s) will be dispatched to Kiribati to provide technical guidance to ensure proper quality control and schedule control.

In the case of the cable laying work, detailed planning of the work, including the advance examination of appropriate routes and depth, etc., will be required as many water supply and sewerage lines as well as telephone cables are buried along the distribution cable routes. Careful planning of the work schedule will also be necessary, as the planned work period will overlap with the implementation period of the SAPHE Project which is in progress by the ADB.

When a major public project is implemented in Kiribati, it is customary to establish a project committee which is led by the project implementation body and which consists of representatives of all government offices involved to establish a consensus. In the case of the present Project, this committee is expected to have representatives of the following offices.

- Ministry of Works and Energy (MWE)
- Public Utilities Board (PUB)
- Ministry of Environment and Social Development (MESD)
- Attorney General Office

Permission for the construction of the planned facilities under the Project, i.e. new generating units and 11 kV distribution lines, will be issued only after examination of the project contents by this committee.

(5) Availability of Local Construction Companies, Equipment and Materials

1) Use of Local Construction Companies

There are not many local construction companies in Kiribati and most of them are small government-affiliated companies, making it difficult to secure a sufficient number of engineers and workers for the smooth implementation of the Project. It will, therefore, be necessary to recruit engineers and workers with sufficient experience of civil engineering, construction and equipment installation work from Japan or a third country as subcontracted engineers/workers of the Japanese Contractor for the Project.

2) Use of Locally Available Equipment and Materials

While coral sand for use as concrete aggregate can be obtained in Kiribati, all other major equipment and materials are imported. It is necessary to consider the import of the cement, reinforcing bar and timber, etc. required for the construction of the planned facilities under the Project from neighboring countries.

All types of generating and distribution equipment available in Kiribati are imported products. Although these products come from various countries, the Kiribati side strongly hopes that Japanese products will be used because of their high quality and performance. In addition, the geographical proximity of Japan will make the establishment of a good after-service system possible.

In view of the above situation in Kiribati, the procurement sources for the generating and distribution equipment to be provided under the Project will be decided taking into consideration (i) the ease of operating and maintaining such equipment by local engineers, (ii) the planned duration for the manufacture of spare parts, (iii) the expected length of delivery and (iv) the availability of an after-service system by the manufacturers to deal with equipment breakdowns.

(6) Operation and Maintenance Capability of Project Implementation Body

Power supply in Kiribati predominantly relies on small diesel generating units which are operated and maintained with Australian assistance. Accordingly, the PUB is believed to possess the basic skills required to operate and maintain the generating and distribution equipment to be provided under the Project. However, as the PUB has no experience of operating the medium capacity (1,400 kW class) diesel generating units to be provided under the Project, it will be necessary for Japanese engineers to conduct OJT during the installation and operation test period to enable local engineers to conduct the effective and efficient operation and maintenance of this equipment thereafter.

Part of the income from electric energy sales will be used to fund the maintenance of equipment, while spare parts to cover a period of two years after the handing over of the new facilities/equipment will be included in the scope of the Project. In regard to OJT, textbooks, which are suitable for the technical level of local engineers, will be necessary.

(7) Grades of Specifications of the Equipment

In consideration of the conditions described above, the following principles will be adopted for the scope of the construction of facilities and the procurement of equipment and materials under the Project and for their technical grades.

1) Scope of Facilities and Equipment

The minimum but necessary configuration (types and quantities) of equipment will be selected in order to achieve the principal objective of the Project, i.e. a stable power supply for local people and social/public facilities in South Tarawa, through the installation of generating units and the provision of distribution equipment, materials and spare parts.

To ensure an economical as well as technically optimal design, the equipment and material specifications will be based on international standards where possible. The types of equipment and parts, etc. will be kept to a minimum to facilitate the interchangeability of equipment and parts, etc.

2) Grades

The specifications of the planned generating and distribution equipment should be the same as those of existing equipment with which the PUB is familiar where possible so that the equipment is not beyond the technical capability of PUB engineers.

The provision of OJT on operation and maintenance by engineers of the manufacturers during installation and operation test period is planned. The main purpose of this OJT will be the training of PUB engineers to the level where they can analyze operation and power supply failure data of the generating units to prepare and implement appropriate responses and can also implement preventive maintenance using the newly acquired technical knowledge and skills in addition to their existing O & M skills.

(8) Procurement method and Construction Period

As the Project will be implemented in accordance with Japan's grant aid scheme, it must be completed within a single fiscal year, making it necessary to simultaneously proceed with the work involving the generating equipment and the work involving the distribution equipment. In addition, the cabling work for the distribution lines must be conducted at multiple sites because of the long length of the planned work. The optimum project implementation schedule must, therefore, be prepared taking such parallel work into consideration. The planned distribution line rehabilitation work will use the existing cable routes to replace existing cables with new cables. As such, this work will have to be continually conducted. In order to avoid any undesirable delay of the work, the Japanese side will conduct the removal of the existing cables.

(9) Environment

The implementation of the Project may have environmental impacts in terms of pollution and impacts on the natural and social conditions. The environmental standards in Kiribati will be referred to in order to assess such impacts. If relevant local standards do not exist, Japanese standards will be referred to.

2.2.2 Basic Plan (Construction Plan/Equipment Plan)

(1) Preconditions

The following conditions have been set to determine the applicable scale and specifications for the Project based on the conditions described earlier.

1) Climatic and Site Conditions

① Design Temperature	:	Maximum of 40°C
② Temperature in diesel generator room	:	Maximum of 40°C
③ Humidity	:	Annual average of 75% (maximum of 100%)
④ Mean annual rainfall	:	Mean annual of 2,300 mm Hourly maximum of 10 mm/hr
⑤ Wind velocity	:	Maximum of 21 m/sec (mean of 5～ 8 m/sec)
⑥ Earthquakes	:	Not considered
⑦ Salt deposit density	:	0.12 mg/cm^2 (32 mm/kV)
⑧ Noise	:	To follow the general noise control regulations in Japan
⑨ Dust	:	Not considered

⑩ Soil bearing capacity : 5 tons/m^2

⑪ Annual number of days with thunderstorms : Average of 15 days

⑫ Elevation : 2.9 m above mean sea level

⑬ Groundwater table : Approximately 30 cm – 150 cm

2) Applicable Codes/Standards and Units

Such international standards as IEC and ISO and the Japanese standards listed below will be applied for the design of the main functions of the equipment to ensure compatibility with existing equipment in Kiribati. As there are no local standards governing for the electrical work, Japanese standards will be used for the electrical installation work. The International System of Units (SI) will be used for the units.

① IEC : applied to electrical products in general

② ISO : applied to industrial products in general

③ JIS : applied to industrial products in general

④ JEC : applied to electrical products in general

⑤ JEM : as above

⑥ JEAC : as above

⑦ JCS : applied to electrical wires and cables

⑧ Technical Standards for Electrical Facilities in Japan : applied to electrical work in general

⑨ AIJ : applied to building work in general

3) Power Supply and Demand Forecast

The power demand situation at two years after the commissioning of the new generating units in the Project Area is forecast based on the following conditions.

① Preconditions

a) The rate of power demand growth tends to be proportional to the trends of the demand and GDP growth rate in the past. The average annual growth rate of the maximum power demand in South Tarawa has been 7.2% for the past 10 years or 11.1% from 1995 to 2000, while the GDP growth rate from 1995 to 1999 was 5.2% a year. The average annual growth rate of the maximum power demand is set at 6% for the Project on the grounds that (i) the high population density of South Tarawa as of the end of 2000 means that not much land is available for further housing development, (ii) the electrification rate of nearly 80% is already high and (iii) the target GDP growth rate of Kiribati at present is 5%.

b) Waiting consumers will be connected to a upgraded and new 11 kV distribution lines under the Project. It is assumed that connection will take place at the end of 2002 in the Buota, Bonriki and Temaiku areas and in 2003 in other areas.

c) The demand factor using for demand forecast is 0.5 for ordinary consumers and 0.7 for public facilities.

d) It is assumed that the commercial operation of the new generating units will commence in January 2003.

e) Arrangements will be made to maintain a steady power supply so that the stoppage of one unit for periodical inspection will not adversely affect the supply and demand balance.

② Examination Results

The power supply and demand forecast based on the above preconditions suggests that the installation of two 1,400 kW generating units will ensure a surplus power supply up to 2004, the target year of the Project. A stable power supply system will be in place, as the stand-by capacity will allow the stoppage of one generating unit for maintenance purposes.

Power balance based on the electric load forecasting and supply is shown in Appendix 5.

4) Environmental Considerations

As Kiribati does not have environmental standards, which are relevant to the generating and distribution equipment to be procured and installed under the Project, the following values are used as the design conditions in view of the relevant standards in Japan and the local situation in Kiribati.

(a) NOx : not higher than 950 ppm (when the residual oxygen concentration is 13%)

(b) SOx : not higher than 250 ppm (when the sulphur content of fuel oil is 1%)

(c) Oily Water : not higher than 30 ppm

(d) Dust : not higher than 100 mg/Nm^3

(e) Noise : not higher than 65 dB (A) at the boundary of the power station, when only the new units are in operation

(f) Vibration : not higher than 65 dB at the boundary of the power station, when only the new units are in operation

5) Facility Layout Plan

① Generating Facilities

The power station building will be located on the coastal side of the premises to make the most efficient use of the existing power station premises, to reduce noise pollution for nearby houses and to secure a fuel oil delivery route for tank lorries. The general layout is shown in Basic Design Drawing TB-G01. The principal conditions for the layout plan are described below.

(a) The existing premises of the Bikenibeu Power Station should be used as efficiently as possible. The elevation of the new generating units should be at least 1.5 m above the maximum tide level to avoid damage due to high tide.

(b) Sufficient room should be provided around the power station building and the fuel oil tanks so that an additional generating facility can be easily installed to meet the demand increase in the future. The construction of a new fuel oil storage facility will necessitate the relocation of the existing entrance. This work will be conducted by the Kiribati side.

(c) Space for maintenance work should be provided inside the powerhouse to facilitate the maintenance of the diesel generators.

(d) The layout plan should incorporate environmental considerations to prevent pollution caused by waste oil and noise, etc.

② Distribution Facilities

The necessity to acquire new land will be minimized by using the sites for the existing distribution equipment and the high voltage underground cable routes. The safety of people living nearby should be of paramount importance. The distribution network Diagram for South Tarawa and the planned 11 kV distribution route maps are shown in Basic Design Drawing TB-D00 and Basic Design Drawings TD-G01 ～ G04 respectively. The main conditions for the distribution facilities are described below.

(a) As the locations of the distribution equipment are near the coast and/or private houses, optimal salt damage prevention measures should be introduced for the selection of the specification and the safety of residents should be given the highest priority for the allocation of the facility. The ease of inspection and maintenance should also be taken into consideration. The design of the distribution equipment should not expose any charging part.

(b) The available land should be efficiently used by means of using those sites where the existing distribution facility is installed. It will be necessary for the Kiribati side to secure land for the installation of new equipment, etc. along the new distribution line routes by the time of the commencement of the Project.

(c) The construction plan for the underground cables will feature measures to prevent any damage to the cables due to an accident during the excavation work for water supply, sewer or telephone lines.

(d) The expected sites for the underground cabling work are often marked by a shallow groundwater level. In these instances, the cable burying depth will not meet the specified depth to avoid immersion by groundwater and, therefore, extra care should be taken to protect the cables from heavy items which could be placed or which pass above.

(2) Outline of Basic Plan

The main components of the Project are outlined in Table 2-2-1 based on the basic design conditions described in 2.2.1.

Table 2-2-1 Outline of Main Components of the Project

<table>
<tr><th>Power Station Construction Plan
(Construction of Power Station)</th><th>Distribution Network Upgrading Plan
(Procurement and Installation of Distribution Equipment and Materials)</th></tr>
<tr><td>At Bikenibeu Power Station in South Tarawa</td><td>Section between Teaoraereke in South Tarawa to Buota in North Tarawa</td></tr>
<tr><td><Construction Work>
• Construction of powerhouse (Approx. 603 m^2)
• Construction of foundations for generators, fuel tanks and auxiliary machinery
• Construction of rainwater storage tank
• Construction of internal roads and outdoor lighting around powerhouse
• Construction of auxiliary facilities for powerhouse</td><td rowspan="2">• Procurement and installation of the following distribution equipment
- Rehabilitation of 11 kV cable from Bikenibeu Power Station to Teaoraereke (approx. 13.3 km)
- Rehabilitation of 11 kV cable from Bikenibeu Power Station to existing distribution switchgear (RMU 31) (approx. 3.1 km);one circuit breaker panel
- New construction of 11 kV distribution line between existing distribution switchgears (RMU 43 and RMU 44) (approx. 4.9 km) and installation of four sets of Distribution transformers and switchgears
- Procurement of one set of distribution switchgear and Distribution transformer for Buota area
- Rehabilitation of one voltage regulator and installation of one circuit breaker panel at Teaoraereke
• Procurement of O&M manuals for distribution equipment</td></tr>
<tr><td><Procurement and Installation of Generating Equipment>
• Procurement and installation of diesel generators (1,400 kW x 2)
• Procurement and installation of auxiliary mechanical systems/equipment for generators
- Fuel oil system (including oil tank)
- Lubricant oil system
- Cooling water system
- Compressed air system
- Intake air and exhaust gas system
- Piping system
- Sludge treatment system (including incinerator)
• Procurement and installation of auxiliary electrical system/equipment for generators
- 11 kV high voltage distribution plan
- 415 V station power panels and DC power system
- Wiring and grounding system
• Procurement of spare parts for generators and auxiliary machinery and of machine tools
• Procurement of O & M manuals for generating equipment (including textbooks for OJT) and implementation of OJT</td></tr>
</table>

(3) Building Plan (Power House)

1) Contents of the Plan

The Bikenibeu Power Station to be constructed under the Project will include the following facilities. The outline of the powerhouse is shown in Basic Design Drawings TB-A01, TB-A02 and TB-A03 respectively.

-	Power house	1	steel-frame, single story building (partly two story) Total floor area: approx. 603 m^2
-	Equipment Foundations	1	set including foundations for fuel tank
-	Rainwater tank	1	5 $m^3 \times 1$ (effective capacity)
-	Septic tank	1	connect to the existing sewerage pipe
-	External work	1	set internal roads, rainwater drainage, outdoor lighting and earth work

2) Site and Facility Layout Plan

As shown in Basic Design Drawing TB-G01, the new powerhouse will be constructed next (southwestern side) to the existing powerhouse. This site covers an area of 106 m ×80 m. The entrance to the site faces a public road while the opposite side faces the sea. Because of the large empty space, it is a suitable site for the new powerhouse. The layout plan should take the prevention of noise pollution for the private houses dotted nearby and the secondary school situated on the opposite side of the public road into proper consideration. The plan should also provide the necessary space for a car park, administrative facilities and future extension of the station.

3) Main Functions of Various Facilities and Building Plan

The following rooms will be planned to ensure the performance of the new station as the base generating station on Tarawa Atoll.

① Generator Room

This room will house two 1,400 kW generators and auxiliary equipment and will accommodate space for easy maintenance work. The approximate dimensions of the generators are a length of 8 m, a width of 3 m and a height of 4 m. The auxiliary equipment will include a fuel oil service tank, compressed air and cooling water, etc. The floor size will be 18 m ×16.5 m to accommodate these adequately. A three-ton overhead crane will be installed to hoist generator components for inspection and repair purposes.

② Electrical Room

This room will house high voltage switchgear panels and low voltage distribution panels. The room will have sufficient size to allow the adequate layout of panels and to conduct inspection and maintenance work.

③ Control Room

The operation and supervising of the generating facilities will be done from this room, the size of which will be large enough to accommodate control panels and protective relay panels, etc. This room will always be manned by at least one operator.

④ Ventilation Room

This room will be responsible for the ventilation of the powerhouse, releasing the heat generated by the generating units to the outside and taking in combustion air. Because of the planned large generating capacity, a mechanical ventilation system using blowers will be employed. The room size must, therefore, be large enough for the installation of the ventilation equipment and must have a sufficient opening area to obtain the supply of fresh air comparable to the required scale of ventilation. The velocity of the intake air should be safe vis-à-vis the equipment and those working in the room.

⑤ Meeting Room

This room will be used for internal or external meetings to discuss technical issues relating to the operation of the power station and will be large enough to accommodate a table seating 5 ～ 6 people. It will also be used for the storage of the O & M manuals and drawings to be provided under the Project so that they can be referred to when necessary.

⑥ Warehouse

The size of the warehouse should be large enough to store tools and electrical spare parts, etc. As the spare parts for the mechanical equipment of the generating units are large, they will be stored in the existing powerhouse.

⑦ List of Main Rooms

(a) Floor Area

Room	Area (m^2)	Building Services
Generator Room	297	Lighting; emergency lighting; ventilation
Control Room	51	Lighting; emergency lighting; AC ventilation
Meeting Room	39	Lighting; AC ventilation
Electrical room	85	Lighting; ventilation
Toilet	6	Lighting; ventilation; sanitary services
Spare Parts Storage	60	Lighting; ventilation
Kitchenette	2	Lighting; ventilation; sanitary services
Ventilation Room	51	Lighting
Staircase, etc.	12	Lighting
Total	603	

(b) Specifications of Main Structural Components

Item	Structural Specifications
Foundations	RC; spread foundations
G. Floor; Cable Pit	RC
First Floor	RC slabs on top of deck plates
Pillars; Beams	Steel-frame with molten zinc plating finish

RC: Reinforced Concrete

(c) Exterior Finishing

Item	Finishing Type
Roof; Walls	Zinc-plated steel plates

(d) Interior Finishing

Room	Place	Finishing Type
Generator Room	Floor	Concrete; trowel finish
	Walls	Glass wool acoustic boards
	Ceiling	As above
Electrical room	Floor	Concrete; trowel finish
	Walls	Glass wool acoustic boards
	Ceiling	As above
Control Room; Meeting Room	Floor	PVC tiling on top of deck plates and concrete slabs
	Walls	Plasterboard on light steel framework; paint finish
	Ceiling	As above
Toilet; Pantry	Floor	Concrete; trowel finish
	Walls	Plasterboard on light steel framework; paint finish
	Ceiling	As above
Warehouse	Floor	Concrete; trowel finish
	Walls	Plasterboard on light steel framework; paint finish
	Ceiling	As above

4) Cross-Section Plan

Given the height of the generators of approximately 4 m and the need to mount a 3 ton crane for maintenance purposes on the ceiling, the ceiling height of the generator room will be approximately 10 m.

5) Structural Plan

① Foundation Type

The ground for the power station consists of elevated coral reef, providing good support for the powerhouse and equipment foundation. Accordingly, spread foundations will be used.

② Main Structure of Building

A steel-frame structure will be employed given the facts that a high floor height is required to secure large space in the powerhouse and that there is no record of any earthquake occurring in the past. The use of such a structure will shorten the required construction period and the lightweight of the building will reduce the load on the foundations. Zinc plating will be applied to the steel surface to prevent salt damage.

6) Building Equipment

The building services equipment for the main rooms is listed in Table 2-3-2.

① Fire Extinguishing System

One ABC fire extinguisher (3 kg type) will be provided in each room (four in the generator room) except for the toilet and corridors. One halogen fire extinguisher will be provided in the electrical room and the control room to deal with electric fires. One 10 kg type fire extinguisher on wheels will be provided near the fuel oil loading pump as part of the fuel oil supply system. A smoke detector will be installed in rooms, which are not continually occupied, and a fire alarm signal will be displayed on the generator control panel.

② Lighting and Receptacles

JIS standards will be used as the standards for the indoor luminous intensity and lighting will, in principle, be provided by either fluorescent lamps or mercury lamps. Meanwhile, halogen lamps will be used for outdoor lighting.

③ Air-Conditioning

For control and meeting rooms, packaged type air-conditioners will be provided.

④ Ventilation

A mechanical ventilation system using blowers will be employed in the generator room to feed combustion air to the diesel engines and to ventilate the room. In the case of the other main rooms, mechanical ventilation using a fan or natural ventilation using louvers, etc. will be considered.

⑤ Rainwater Collection and Feeding System

The water to be used in the building for drinking and miscellaneous purposes will be supplied from an elevated water tank to which rainwater collected from the roof of the building will be pumped via a ground water tank ($1 \times 5\ m^3$). The use of potable water (city water) will also be considered for emergencies. Outline of Rainwater Collection System is shown in Table 2-2-2.

Table 2-2-2 Outline of Rainwater Collection System

Equipment	Procurement Quantity	Specifications
1. Water Tank	1	Outdoor-type (concrete); capacity: 5 m^3
2. Feeding System	1 set	Outdoor storage pump (one pump with control panel); capacity: 20 liters/min

⑥ Crane

The overhead crane to be procured under the Project will be used for maintenance work of the diesel engines. The heaviest item is expected to be a cylinder weighing approximately one ton. This will make it necessary the mounting of a traveling crane with a maximum lifting capacity of 3 tons necessary. It will be operated by the pendant system.

7) Foundations

Foundations will be constructed for the diesel engine generators, auxiliary machinery, electrical equipment and oil tanks, etc. Pits for the plumbing and cables will also be constructed.

(4) Generating Facility Plan (Procurement and Installation)

The generating facility to be procured under the Project will be operated as the base generating units for the power system in South Tarawa. While the generating equipment will be installed inside the powerhouse, sufficient salt damage prevention measures should be considered for some of the auxiliary equipment to be installed outdoors. The necessary facility for the construction of the new generating units will, therefore, be selected based on the following basic requirements and conditions.

1) Basic Requirements

① Generating Method

Diesel engine generators will be selected in consideration of the existing equipment in Kiribati and the easy operation and maintenance of such facilities.

② Control Method

A control room will be established on the first floor of the powerhouse to conduct remote control operation as same as the existing generating units. The starting up and stopping of the diesel engines will, however, be done at locally for the safety operation.

③ Fuel Composition

The fuel currently used by the existing Bikenibeu Power Station is diesel oil, which is imported from Australia and/or Singapore. The use of the same diesel oil for the new generating units is planned and the composition of this diesel oil is shown in Table 2-2-3.

Table 2-2-3 Composition of Diesel Fuel Oil

Item	Unit	Testing Method	Value / Composition
Flash Point	°C	JIS K2265 (PM method)	67.0
Kinetic Viscosity (50°C)	mm^2/s	JIS K2283	2.420
Pouring Point	°C	JIS K2269	-2.5
Residual Carbon	mass %	JIS K2270	<0.01
Moisture Content	mass ppm	JIS K2275 (Carl Fischer method)	332
Ash Content	mass %	JIS 2272	<0.01
Sulphur Content	mass %	JIS 2651	0.80
Density	G/cm^3	JIS K2249	0.8423

④ Composition of Lubricant Oil

Although the recommended composition of lubricant oil may vary from one generator manufacturer to another, lubricant oil with the same specifications as those for that currently used (Mobile No.312) will be used for the new generating units considering easy handling.

⑤ Cooling Water

Although city water, groundwater from a well, rainwater or distilled water may be used as the cooling water for the generating units for the Project. The total hardness of the city water and local groundwater is too high to use for cooling water for the generating units because of the possible accumulation of scales, while the rainwater collected from the roof will contain salt as evidenced by the corrosion of the cooling pipes and radiators of the existing generating units. Accordingly, water obtained from the existing desalination system will be used for the new generating units. The results of analysis of this desalinated seawater show a high level of dissolved solids which can cause deterioration of the cooling effect and other adverse impacts with the accumulation of scale (see Table 2-2-4). A water softener will, therefore, be installed to provide cooling water for the new generating units so that treated water, i.e. water of which the residual solids have been removed, is used to ensure easier maintenance.

The capacity of the cooling water tank should be sufficiently large enough to fill one inspected radiator with cooling water in a single operation. An anti-corrosion agent will be mixed with the water to prevent internal corrosion.

Table 2-2-4 Analysis Results of Desalinated Seawater

Item	Unit	Testing Method	Value
pH		JIS K0102	6.6
Total Hardness	mg/l	"	73
Chlorine ion	"	"	15
Silica (SiO_2)			0.25
Ammonium ion	"	"	0.25
Electric Conductivity	μs/cm	"	1,470
Mg	mg/ℓ	"	14
Fe	"	"	<0.1
Dissolved Solids	"	"	840

Note: The main judgment criteria are as follows.
- When the level of total hardness exceeds 100 mg/ℓ, scaling may occur inside the radiator.
- When the level of chlorine ion exceeds 100 mg/ℓ, corrosion may occur inside the radiator.
- When the level of dissolved solids exceeds 100 mg/ℓ, scaling may occur inside the radiator.

2) Planning Concept

① Engine Output and Generator Capacity

The rated engine generator output required for the Project will be decided based on the following conditions.

(a) The target year of the Project will be 2004, i.e. two years after the completion of the Project (end of 2002) when the first overhauling of the new generating units will be conducted.

(b) The generating capacity should be decided to ensure the availability of a reserve capacity in the target year (2004).

(c) Arrangements should be made to allow the stoppage of the new generators for maintenance purposes.

(d) The minimum annual operating hours will be 8,000 hours based on continuous operation (base load operation).

In consideration of the above conditions, the optimal generator capacity will be 1,400 kW and two generators will be required as described in the power supply and demand forecast (see 2.2.2).

The required engine output and the rated capacity of the generators are calculated below. As the engine specifications vary from one manufacturer to another, the following specifications will be used for general guidance purposes only.

• Engine Output

$$Pe \geq \frac{P}{0.7355 \times \eta_G} = 2{,}115 \text{ PS}$$

Where, Pe : engine output (PS)

P : output at generator terminal (1,400 kW)

η_G : efficiency of generator (assumed to be 90%)

• Generator Capacity

$$P_G = \frac{P}{Pf} = 1{,}750 \text{ kVA}$$

Where, P_G : generator capacity (kVA)
P : output at generator terminal (1,400 kW)
Pf : power factor (0.8, lagging)

Table 2-2-5 Engine Output and Generator Capacity

Item	Output/Capacity
Engine Output Pe (PS)	2,115
Generator Capacity P_G (kVA)	1,750

② Examination of Engine Speed

When diesel generators with a single unit capacity of 1,400 kW are used to meet the base load, it is a common practice for Japanese electricity generating companies to use medium speed diesel generators of 750 rpm or lower in view of economical operation and maintenance. The operation performance of such diesel generators up to the present has been very favorable. The revolution of all existing generators in Kiribati is 750 rpm. Taking the composition of the lubricant oil to be used into consideration, an engine speed of 750 rpm or slower will be selected for the Project.

③ Auxiliary Mechanical Plan

Common equipment will be used as much as possible for the auxiliary mechanical systems to ensure easy operation, maintenance, energy saving and an economical spare parts cost.

(a) Fuel Supply System

i) Number of Fuel Tanks

Two outdoor fuel oil tanks will be installed in view of the following operational reasons. Fuel oil will be supplied to the tanks from a tank lorry using an unloading pump. As the fuel oil may contain water and/or foreign matters, these will be separated inside the tanks through sedimentation. A floating suction in each tank will recover only the separated fuel oil for its supply to the diesel engines. As this separation of water and foreign matters insides the tanks will require standing of the original fuel for approximately three days, two tanks will be required to allow one to be used for actual operation and the other to be used for separation purposes. Because of the use of such a fuel system, no oil-water separator will be installed under the Project. The separated foreign matters resulting from sedimentation will be combusted in an incinerator.

ii) Tank Capacity

The tank capacity is determined based on the fuel consumption volume of the generating unit in 2004, the target year of the Project, and taking the diesel oil storage capacity of the KOIL described below into proper consideration in view of the selection of a sufficient capacity to prevent any restriction of the power supply due to a fuel shortage.

- Storage Capacity of KOIL

The maximum diesel oil storage capacity of the KOIL in 2000 is 1,031 m^3 while the average monthly consumption of diesel oil in the Tarawa area is 700 m^3. The two power stations of the PUB consume 300 m^3/month with private sector-owned vehicles, boats and emergency generators consuming the remaining 400 m^3. Meanwhile, Mobile Oil supplies the KOIL with an amount of diesel oil to reflect the consumption volume every four weeks.

- Fuel Consumption in 2004

The total electric energy generated in 2004 is estimated to be 18 GWh based on an annual growth rate of 6% and the monthly fuel consumption for power generation is calculated by the following expression.

$$V = \frac{18{,}000{,}000 \text{ x } V_1}{1{,}000 \text{ x } 12 \text{ months}} = 393 \text{ k}\ell$$

Where,
V : monthly fuel consumption volume (kℓ)
V1 : fuel consumption per unit output (liter/kWh = 0.262 liter/kWh

Note: The specific gravity of fuel is assumed to be 0.84.

Accordingly, the monthly diesel oil consumption of the PUB in 2004 will be 393 m^3. Assuming the same 6% annual growth rate of diesel oil consumption by vehicles and boats, etc., the total monthly consumption in 2004 will be 898 m^3, accounting for 87% of the total diesel oil storage capacity of the KOIL. Even if there are monthly fluctuations of the consumption volume or a slight delay of the diesel oil delivery, the estimated level of diesel oil consumption should not disrupt the continuous operation of the generating units. The tank capacity to be designed for the Project will, therefore, be equivalent to one month's consumption volume of diesel oil based on the delivery frequency by an oil tanker of every four weeks.

The economical operation of the generating units will require generating shares of 60% and 40% for the Bikenibeu Power Station and the Betio Power Station respectively as indicated by the power current in Appendix 6. This means that the monthly fuel requirement of the new Bikenibeu Power Station (Vb) will be 236 kℓ (Vb = 393 x 0.6). As two fuel tanks will be installed, each tank will have a storage capacity of 118 kℓ. Assuming a margin of some 10%, the nominal capacity of each tank will be 130 kℓ. As these tanks will be installed outdoors, the optimal coating with a high salt resistance performance will be given to the tanks. A fuel oil service tank, which is capable of supplying fuel for up to two hours, will be installed for each generator in the generator room in consideration of a drop of the in-house power and easy maintenance.

The fuel oil will be supplied from a tank lorry to the tanks using an unloading pump, which is capable of unloading one tank lorry (10 kℓ) within 40 minutes. Two pumps will be installed, i.e. one for normal use and one as a reserve pump. The alternate operation system will be employed to ensure good maintenance by averaging the operating hours. The fuel oil system Diagram is shown in Basic Design Drawing TB-M02.

(b) Lubricating Oil System

Each diesel engine will have a built-in lube oil sump tank. The lubricating oil will be changed every 8,000 hours of operation and filter oil cleaner will be installed to reduce the maintenance cost. The lubricant oil will be directly supplied to the tank from the drum using a manual pump at inside the powerhouse. The lubricant oil system Diagram is shown in Basic Design Drawing TB-MO3.

(c) Cooling Water System

As it is difficult to secure continuous water supply on the site, a closed circulation system using a radiator will be adopted to reduce the water consumption as in the case of the existing generating units. A common cooling water storage tank serving two generating units will be provided.

Desalinated seawater will be used as the cooling water after further softening to avoid any adverse impacts on the radiator. The capacity of this cooling water tank will be not less than 3 m^3 to secure the volume of water required during the maintenance period of one generating unit. As this tank will not be used often, it will be installed outdoors. It will be made of FRP with a high salt-resistance performance. The cooling water system Diagram is shown in Basic Design Drawing TB-M04.

(d) Start-Up System

The start-up system for the diesel engines will be pneumatic start-up system using compressed air because of its advantage of gaining a large start-up torque. The compression system can be started by either a regular motor or an emergency engine and will be installed in the generator room. The capacity of the air receiver will be sufficient to start a diesel engine three times. The high humidity level of the local air means that water will tend to accumulate in the air receiver. An automatic water discharge valve will, therefore, be installed to the air receiver. While there are two types of compressed air system distribution, i.e. centralized and scattered distribution, centralized distribution will be adopted for the Project because of the presence of two generators and the need for easy maintenance and energy saving. The compressed air system Diagram is shown in Basic Design Drawing TB-M05.

(e) Intake Air and Exhaust Gas System

This system for the supply of combustion air and for indoor ventilation will be installed inside the powerhouse. Exhaust air from the engine will be influenced to the outside of the powerhouse via a silencer. The system capacity will be sufficient to allow the simultaneous rated operation of the two new generating units. The ventilation system Diagram is shown in Basic Design Drawing TB-M06.

(f) Sludge Treatment System

The existing power station has a simplified oil separation tank. However, as this tank is no longer functioning, there is concern in regard to environmental pollution due to the overflow of waste oil because of mixing by rainwater. A sludge separation tank and an oil separation tank will be installed under the Project to exclusively serve the planned generating units in order to separate waste oil and water. As only the separated water will be discharged, environmental pollution should be avoided. An incinerator will be introduced to dispose of the separated sludge and waste oil in an appropriate manner. As most parts of the system will be installed outdoors, salt-resistant materials will be selected with an additional coating. The sludge disposal system Diagram is shown in Basic Design Drawing TB-M02.

(g) Piping

The piping under the Project consists of the piping for compressed air, cooling water, fuel oil and drain. While the pipes will be laid in trenches or with supports inside the power house for easy maintenance, outdoor pipes will be directly buried underground to ensure the maximum use of the available land. All of the buried pipes will be considered by such protection measures as anti-corrosive jute sheathing, etc. Each pipe will be color-coded for easy maintenance and to avoid miss-operation.

④ Electrical Facility Plan

The main electrical facility to be installed is described below. A single line Diagram for the Bikenibeu Power Station is shown in Basic Design Drawing TB-EO1.

(a) Generator

The generator shall be of a 3-phase, 3 wire method, alternating synchronous generator, horizontal shaft, open protected, salient or cylindrical pole type with removable perforated sheet metal for the cooling air. The generator voltage shall be 11 kV, which is same as existing high voltage and shall be capable of isochronous operation.

Major specification is as follows;

- Rating	:	Continuous
- Capacity	:	more than 1,750 kVA
- Voltage	:	11kV
- Frequency	:	50Hz
- Power factor	:	0.8 (lagging)
- Revolving Speed	:	same as diesel engine

- Excitation : Brush , thyrister type

(b) 11 kV High Voltage Panel

Synchronization of the new generators will be conducted by the panel to be installed in the electrical room on the ground floor of the powerhouse. Its operation will be controlled locally as well as from the control room on the first floor to ensure easy operation and maintenance.

The circuit breaker for this high voltage panel will be a vacuum circuit breaker in view of environmental considerations and will have the following configuration. The generator and 11 kV circuit Diagram is shown in Basic Design Drawing TB-E02.

- two generator panels
- two distribution line panels
- one feeder panel to the existing generating units
- one feeder panel to the local transformer (use of a high voltage fuse instead of a circuit breaker)
- one neutral grounding panel for the generators (common use by two generators)

The rated current and short-circuit current of the bus for the 11 kV high voltage panel will be 800 A and 12.5 kA respectively to allow for the introduction of additional generating units in the future. This high voltage panel and bus must be designed so as to minimize their remodeling when additional generating units are introduced in the future. An automatic re-closing device will not be provided for the circuit breaker of the distribution line panel as all of the high voltage distribution cables will not experience any grounding accidents due to their contact with trees, etc. under severe weather conditions.

(c) Low Voltage Distribution Panel

415 V low voltage distribution panels will be installed in the electrical room together with the 11 kV high voltage panel to supply power to the auxiliary equipment for the two new generating units, auxiliary equipment and power house building. The single line Diagram for the 415 V low voltage circuit is shown in Basic Design Drawing TB-E03.

(d) Local Control Panel

A local control panel will be provided at the side of each generator to monitor the state of engine operation.

(e) DC Power Supply System

A common DC power supply system will be provided as the power source for the control panels and circuit breakers, etc. The voltage will be DC 110 V and a sealed-type maintenance-free battery will be used in view of easy maintenance and will be placed inside the DC battery and charger panel. The rated battery capacity will be sufficient for 30 minutes AC power supply failure because of the availability of an emergency generator.

(f) Station Transformer

This transformer will be used to distribute 11 kV to 415 – 240 V to supply low voltage power to the station auxiliary. This will be installed inside a cubicle in the electrical room for safety reasons. No load for any future generating units will be taken into consideration.

(g) Grounding System

The required grounding system under the Project will consist of the following.

- Grounding to protect the generator circuits (direct grounding system for both the 11 kV and 415 V circuits)
- Grounding to prevent electric shocks from metal surfaces or electrical equipment
- Grounding for the fuel oil tanks (separate from the above two systems)
- Grounding for lightning rods (separate from the above three systems)

(h) Cabling System

The cables inside the powerhouse will be placed inside a cable trench, tray or conduit while the cables outside the power house will be either placed inside a conduit or directly buried underground. Those cables placed inside a cable trench or conduit will not be armored while those directly buried underground will have armor protection. Copper cables will be used in view of good workability and general-purpose cross-linked polyethylene insulated cables will be used for cabling purpose.

(i) Instruments

The accuracy of the instruments to be used for various types of equipment will be 1.0 class for watt-hour meters and fuel oil flow meters and 1.5 – 3.0 class for indicators, such as ammeters, voltmeters and pressure gauges, etc. given the fact that these will be used for public power supply.

3) Outline of Major Equipment

Outline of the major equipment for the generating units to be constructed under the Project are shown in Table 2-2-6.

Table 2-2-6　Outline of Major Generating Facility

Equipment Name	Procurement Quantity	Approximate Specifications
(1) DEG Unit		
1) Diesel Engine	2	Duty : continuous operation Output : 2,115 PS Engine speed : not more than 750 rpm Type : four cycle Cooling system : radiator cooling Fuel oil : diesel oil with service tank With common frame and anti-vibration system
2) Generator	2	Duty : continuous operation Rated output : 1,750 kVA Number of phases : three phase three wire Rated voltage : 11,000 V Speed : not more than 750 rpm Power factor : 0.8 (lagging) Frequency : 50 Hz Coil connection : Y connection (direct ground) Exciter : brushless thyrister type
3) Electrical Equipment		
① Control Panel	1 set	Desk-type; controls generating equipment
② Protective Relay Panel	1 set	Self standing-type for generator and 11 kV high voltage panels
③ 11 kV High Voltage Panel	1 set	11 kV, including vacuum circuit breaker and synchronizer
④ 415 V Low Voltage Power Panel	1 set	415 V; circuit breaker for distribution circuit
⑤ DC Power Supply System	1 set	Lead battery; 110 V, 30 min.
⑥ Station Transformer	1	11 kV/415 ～ 240 V; three phase; 300 kVA or higher
4) Mechanical Systems		
<Fuel Supply System>		
a) Fuel Storage Tank	2	Type : vertical for outdoor installation Capacity : 130 m^3/tank
b) Fuel Oil Supply Pump	2 (1 back-up)	Type : gear pump for indoor installation Capacity : 3 m^3/hr
c) Fuel Unloading Pump	2 (1 back-up)	Type : gear pump for outdoor installation Capacity : 30 m^3/hr
(2) Spare Parts for DEG Units 1) Normal Operation (Consumables) 2) Emergency (Breakdown)	2 years supply (16,000 hrs)	Oil filter elements, lubricating oil filter elements, o- rings and fuel injection nozzles, etc.
(3) Maintenance Tools for DEG Units	1 set	Engine tools, liner pulling tools, etc.
(4) Repair Machinery	1 set	Mechanical work tool set, electrical work tool set, instrument tools and grounding tools, etc.

(5) Distribution Facility Plan (Procurement and Installation)

Under the Project, the Japanese side will also be responsible for the construction of distribution lines totaling approximately 21 km. The equipment and materials to be used for these lines will be selected based on the following conditions and the outline of the planned equipment. The 11 kV master distribution network Diagram for Tarawa Island is given in Basic Design Drawing TB-D00.

1) Basic Conditions

① Electricity Supply System

The electricity supply system for the new distribution lines will be the same as the existing system as described below.

a)	Trunk distribution voltage	:	11 kV, three phase, three wire (maximum voltage: 12 kV)
b)	Branch distribution voltage	:	415 ～ 240 V, three phase, five wire (three phase + neutral line + grounding line)
c)	Frequency	:	50 Hz
d)	Interrupting capacity	:	11 kV system, 12.5 kA (1 sec. sym)
e)	Grounding system	:	direct grounding
f)	Basic insulation level (BIL)	:	11 kV system; 95 kV, AC 38 kV
g)	Surface leakage distance	:	20 mm/kV (for indoor facility)
h)	DC control voltage	:	DC 110 V
i)	Allowable voltage fluctuation	:	415 ～ 240 V system ±5 % DC 110 V system +5 ～ -10 %

② Electrical Equipment

The following conditions will apply for electrical equipment, taking the existing systems and climatic conditions into consideration.

a)	Phase identification	:	IEC standards (red, yellow, blue and black)
b)	Insulator	:	ceramic, white
c)	Fouling category	:	IEC standards (heavy pollution area)

d) Distribution panel protection grade and sheet thickness

Application	Sheet Thickness	Protection Grade
Outdoor	> 2.3 mm	IP43 or higher
Indoor	> 1.6 mm	IP20 or higher

e) 11 kV distribution capacity

Cable Size (sq)	Distribution Capacity (MW)
25	2.0
50	3.0
90	4.5

f) Control method: local control

2) Basic Concepts

The planned distribution lines will form part of the trunk distribution network in South Tarawa and almost of the high voltage cables will be buried near water supply, sewerage and telephone lines along main roads. As the distribution equipment will be installed near residential areas, safety should be of paramount importance in the planning.

In regard to the selection of the equipment and materials required for the construction of the distribution lines, ease of operation and maintenance following the completion of the construction work and safety should be carefully taken into consideration. In order to shorten the equipment installation period to minimize power cuts and disruption to traffic during the work period, bypass high voltage cables will be used temporally.

Given the fact that the distribution equipment to be newly installed under the Project will be located near private houses and/or general structures, the distribution equipment will be fenced with a common grounding system for both the equipment and fence in order to ensure safety and to minimize any adverse impacts of accidents caused by electrical equipment. The equipment design, etc. will incorporate adequate measures to prevent salt damage in view of the vulnerability of the installation sites to salt damage.

As there is no alternative but to use the existing routes for the laying of the new cables because of the limited availability of land, the work to remove the existing high voltage cables will be included in the Project in order to improve the work efficiency, to shorten the construction period and to reduce any adverse impacts on local lives by the work, including the necessity to block traffic.

3) Distribution Substation

The planned distribution substations will step down 11 kV high voltage to 415 – 240 V low distribution voltage and each substation will consist of a ring main unit with a 11 kV / 415 – 240 V transformer. The outdoor specifications will apply to these substations, which will be located within 9 m of the center of the existing road in order to minimize the land acquisition.

The transformer capacity of these distribution substations will be 100 kVA in consideration of the number of waiting consumers, the load situations of the existing distribution network and an increase of the load in the future. The circuit configuration of the new ring main unit, considering easy maintenance, will be the same as that of the existing one, consisting of load-break switches for incoming and outgoing lines and a disconnecting switch with fuse for the distribution transformer. The PUB is familiar with the maintenance of the equipment manufactured by BS Standard and BS or similar will be used as the standards for the ring main units to be used under the Project. Moreover, for the prevention of salt damage, the charging system will be sealed together with the use of highly salt-resistant paint and materials.

4) Voltage Regulator

The voltage regulator to be procured under the Project will be essential equipment to link the Bikenibeu Power Station with the Betio Power Station in South Tarawa in order to secure a stable power supply, an adequate distribution voltage and the economical operation of the power system. As the maintenance of an adequate distribution voltage in the face of an ever-changing load is essential, this voltage regulator will be equipped with an automatic voltage regulation system to minimize the complexity of voltage regulating operation. The tap value will be 2.5% in view of the relatively frequent load fluctuations and voltage regulations can be conducted within ±10% of the rated voltage.

The voltage regulator capacity will be 3,000 kVA, taking the maximum power demand and current in the target year of the Project and the standard capacity of the voltage regulator into consideration. The design will allow the future provision of remote control operation. An oil pit and an oil-separating tank will be installed to prevent the outflow of insulating oil as an environmental protection measure. The removal of the existing voltage regulators will be included in the scope of the Project to shorten the required period of construction work by ensuring the quick completion of the related work.

5) High Voltage Circuit Breaker Panel

High voltage circuit breaker panel to be procured under the Project have important functions to protect the distribution lines properly. Under the Project, one panel will be installed at the Bikenibeu Power Station side of the new voltage regulator and another will be installed at the power source side of the existing RMU 31 in the Anana causeway area where the distribution system will form a loop with the new cables. As in the case of the existing panel, instruments capable of measuring the voltage, current, watt and electric energy (watt-hours) will be installed.

6) High Voltage Cables

All of the high voltage cables will be 11 kV cables and will be directly buried underground. Because of the limited land availability, the laying routes will be the same as existing routes. New routes will run within 9 m of the center of the road as in the case of existing routes.

The cable size will be sufficient to maintain power distribution at an allowable voltage drop for consumers when the operation of the Betio Power Station is stopped for the maintenance in the target year of the Project. All of the cables will use a three core copper conductor with armor considering easy installation work.

All of the terminal equipment will be indoor-type and will be the same as the existing terminal equipment to ensure interchangeability of the spare parts.

Most of the cable connection boxes used for the existing ring main units is of an old type, which use a compound insulation material. Because of their poor maintainability, they are hardly used at present. For the connection of the cables under the Project, an insulation material with heat shrinkable properties will be used in view of its excellent workability and maintainability.

The size and length of the high voltage cables based on the above conditions are given below.

Cable Laying Section	Cable Size (mm)	Cable Length (m)
1. Rehabilitation of Existing Lines		
1) Bikenibeu PS – Voltage Regulator (Teaoraereke)	95	13,260
2) Bikenibeu PS – Existing Ring main unit (RMU 31)	50	3,050
2. Construction of New Lines		
1) Existing Ring main unit (RMU 43) – New Ring main unit (RMU 55)	25	1,110
2) New Ring main unit (RMU 55) – New Ring main unit (RMU 56)	25	650
3) New Ring main unit (RMU 56) – New Ring main unit (RMU 57)	25	805
4) New Ring main unit (RMU 57) – New Ring main unit (RMU 58)	25	1,300
5) New Ring main unit (RMU 58) – Existing Ring main unit (RMU 44)	25	1,010

All of the distribution lines subject to upgrading under the Project are currently in use. In order to minimize any adverse impacts by the implementation work for the existing underground cables on consumers by reducing the frequency and duration of power cuts, re-routing distribution lines using 11 kV cables will be set up during the implementation work to ensure the continuous power supply. For this purpose, re-routing 11 kV cables and accessories will be procured. These cables will be single core 25 mm^2 cables with good workability and will have armor for safety during the period of temporary use.

The new cables to be procured for the upgrading will replace the existing cables and will be laid after the removal of the existing cables. It will be necessary for a series of work, i.e. excavation, removal of the existing cables, laying of the new cables and refilling, to be continuously conducted in view of safety and prompt completion in accordance with the planned schedule and the removal of the existing cables will be conducted by the Japanese side.

7) Low Voltage Distribution Lines

The cables for the 415/240 V low voltage distribution lines to be connected to consumers will be procured by the Kiribati side and, therefore, are not included in the scope of procurement under the Project.

8) Outline of Major Distribution Facility

Outline of the major distribution facility to be procured under the Project are listed in Table 2-2-7.

Table 2-2-7 Outline of Major Distribution Facility

Equipment Name	Procurement Quantity	Specifications
1. Distribution Substation	5 sets	
- Ring main unit	5	Waterproof, free-standing, 11 kV
- Distribution Transformer	5	Outdoor-type, 11 kV/415 – 240 V, 100 kVA
- Substation Wiring Materials	5 sets	Grounding materials, fencing materials and accessories
2. Voltage Regulator	1	Outdoor-type, 11 kV, 3,000 KVA with automatic voltage regulating system, ±10% (9 taps)
3. Circuit Breaker Panel	2	Waterproof, free-standing, 11 kV, 630 A
4. High Voltage Cable		
- For Rehabilitation	13,260 m	11 kV, copper conductor, three core, 95 mm^2 with armour
	3,030 m	11 kV, copper conductor, three core, 50 mm^2 with armour
- For New Lines	4,865 m	11 kV, copper conductor, three core, 25 mm^2 with armour
5. Spare Parts	2 years supply	
- For Normal Operation	1 set	Fuses and lamps, etc.
6. Maintenance Tools	1 set	Voltammeter, relay tester and insulation resistance tester, etc.
7. Repair Tools	1 set	

2.2.3 Basic Design Drawing

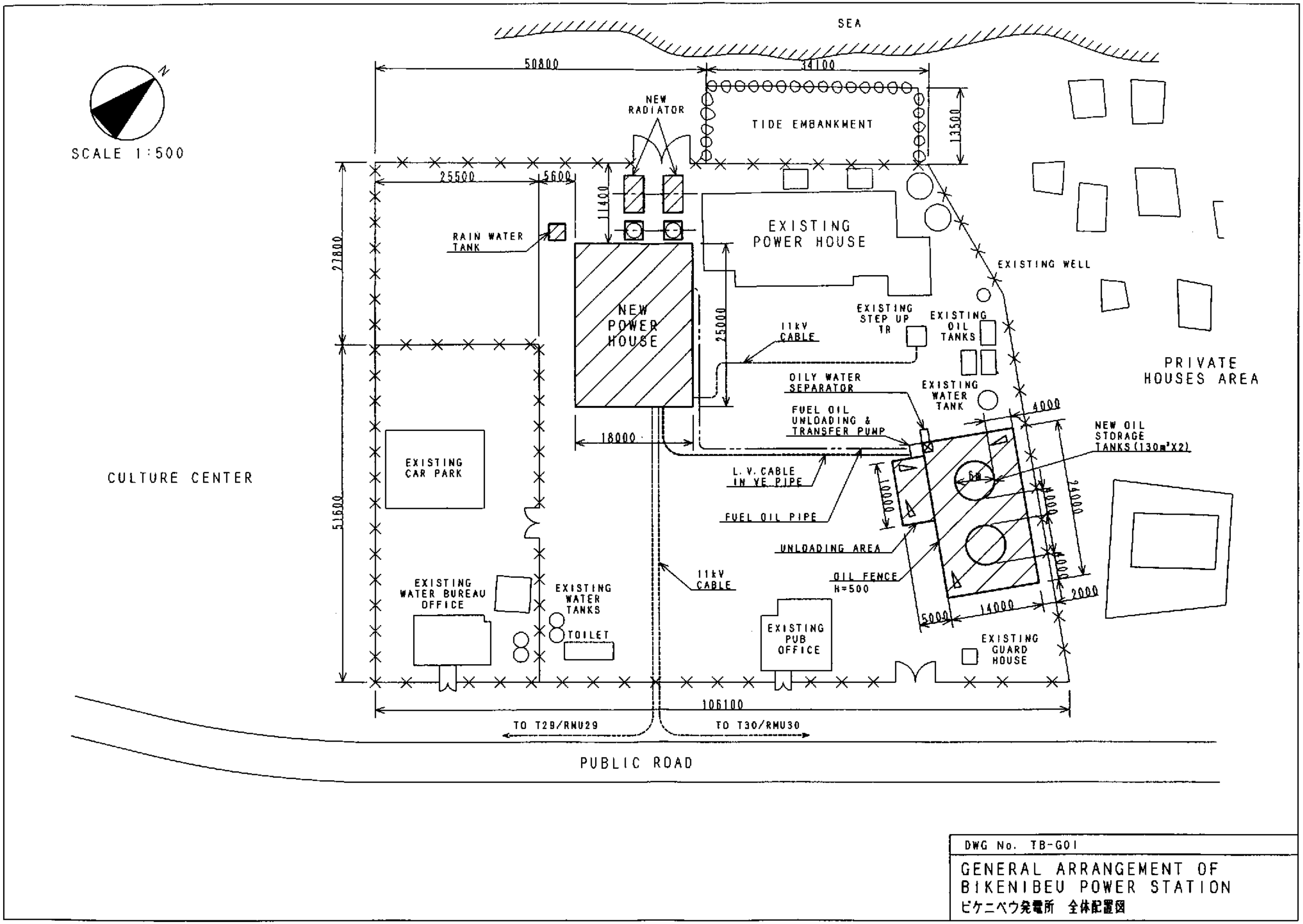
The following basic design drawings have been prepared for the Project.

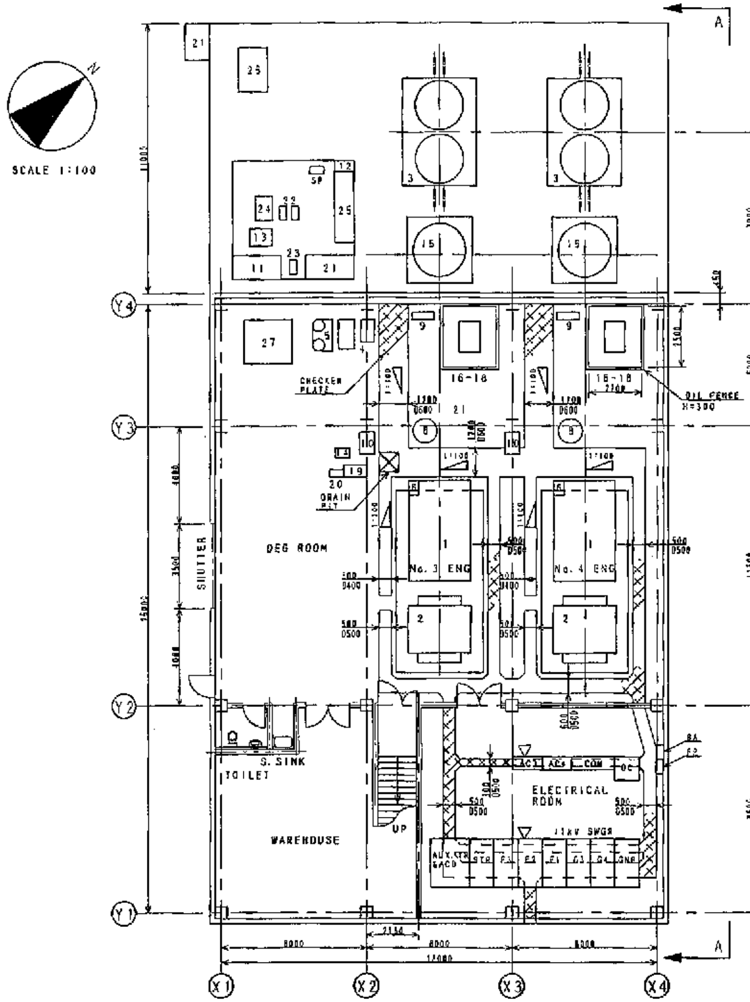
< Power Station Construction Plan >

TB-G01	General Arrangement of Bikenibeu Power Station
TB-G02	Arrangement of Bikenibeu New Power House
TB-E01	Single Line Diagram of Bikenibeu Power Station
TB-E02	Single Line Diagram for DEG and 11 kV Circuit
TB-E03	Single Line Diagram for Low Voltage System
TB-M01	Key Flow Diagram
TB-M02	Flow Diagram of fuel Oil System with Sludge Treatment System
TB-M03	Flow Diagram of Lubricant Oil System
TB-M04	Flow Diagram of Cooling Water System
TB-M05	Flow Diagram of Compressed Air System
TB-M06	Flow Diagram of Intake Air and Exhaust Gas System
TB-A01	Finishing Schedule
TB-A02	New Power House Plan
TB-A03	New Power House Elevation

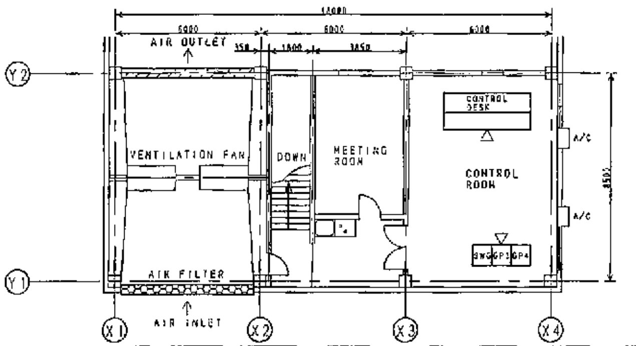
< Distribution Network Upgrading Plan >

TB-D00	11 kV Distribution Network in Tarawa
TD-E01	Tarawa New Power System Diagram
TD-E02	Single Line Diagram for Voltage Regulator, RMU and CB Panel
TD-G01	11 kV Distribution System (Betio – Bairiki)
TD-G02	11 kV Distribution System (Bairiki – Ambo)
TD-G03	11 kV Distribution System (Ambo – Bangantebure)
TD-G04	11 kV Distribution System (Bangantebure – Tenaea)
TD-G10	Layout of Voltage regulator
TD-G11	Layout of Distribution Transformer and Ring main unit
TD-G12	Layout of Existing RMU 31 and New 11 kV Circuit Breaker Panel

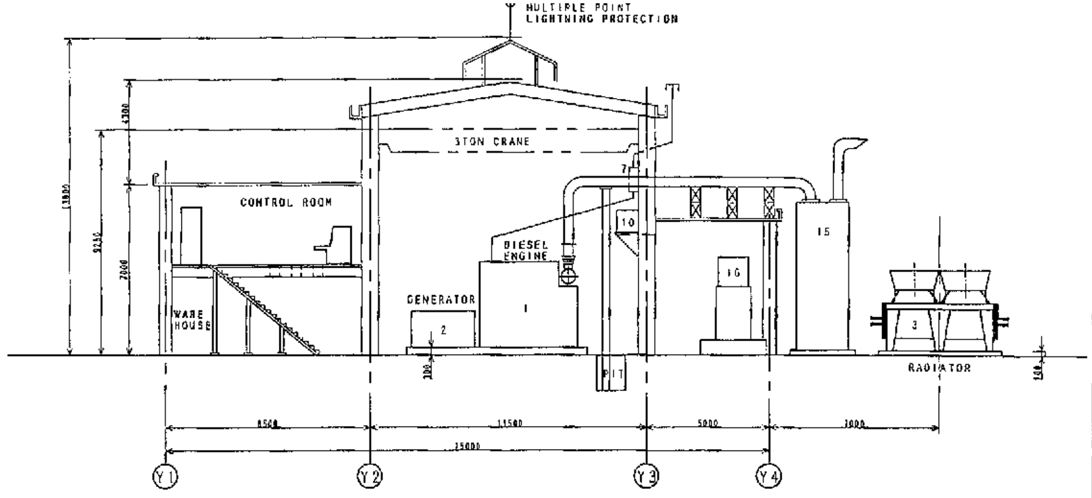

SEA
SCALE 1:500
N
50800
34100
13500
NEW RADIATOR
TIDE EMBANKMENT
25500
5600
11400
27800
RAIN WATER TANK
EXISTING POWER HOUSE
NEW POWER HOUSE
25000
EXISTING WELL
EXISTING STEP UP TR
EXISTING OIL TANKS
11kV CABLE
PRIVATE HOUSES AREA
OILY WATER SEPARATOR
EXISTING WATER TANK
FUEL OIL UNLOADING & TRANSFER PUMP
4000
NEW OIL STORAGE TANKS (130m³X2)
18000
L.V. CABLE IN VE PIPE
6m
10000
24000
4000
4000
4000
CULTURE CENTER
EXISTING CAR PARK
FUEL OIL PIPE
51600
UNLOADING AREA
OIL FENCE H=500
11kV CABLE
2000
14000
5000
EXISTING WATER BUREAU OFFICE
EXISTING WATER TANKS
TOILET
EXISTING PUB OFFICE
EXISTING GUARD HOUSE
106100
TO T29/RMU29
TO T30/RMU30
PUBLIC ROAD
DWG No. TB-G01
GENERAL ARRANGEMENT OF BIKENIBEU POWER STATION
ビケニベウ発電所 全体配置図



1^{ST} FLOOR PLAN



2^{ND} FLOOR PLAN



A-A SECTION

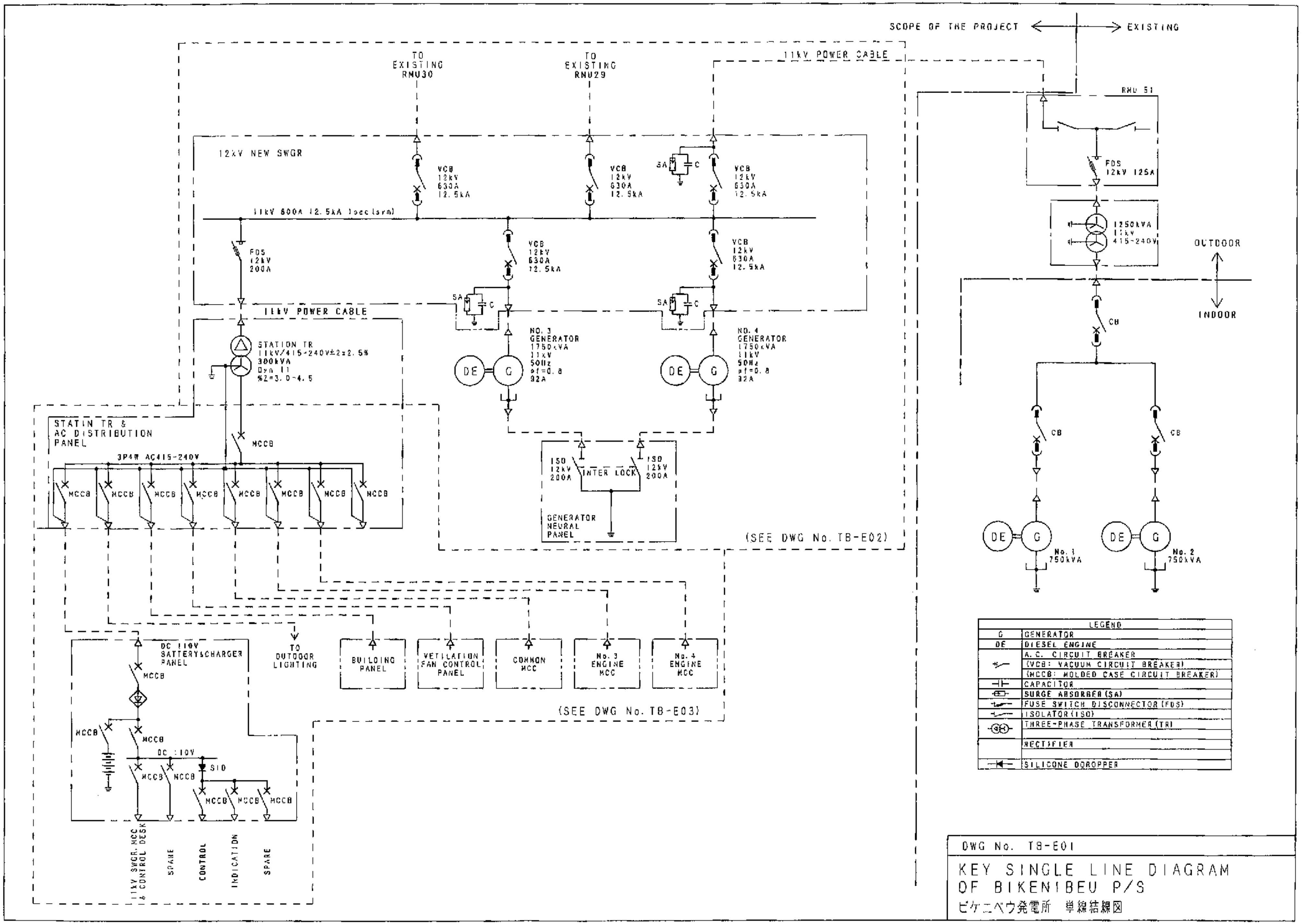
NOTES

No.	NAME
1	DIESEL ENGINE
2	GENERATOR
3	RADIATOR
4	AIR COMPRESSOR
5	AIR RECEIVER
6	ENGINE STOP CONTROL BOX
7	MIST GAS SILENCER
8	BY-PAS FILTER
9	COOLER WATER PUMP
10	COOLING WATER EXPANSION TANK
11	COOLING WATER TANK
12	OILY CHECK TANK
13	PRESSURIZING PUMP
14	DRAIN DISCHARGE PUMP
15	EXHAUST GAS SILENCER
16	F.O. SERVICE TANK
17	F.O. FLOW METER
18	F.O. AIR SEPARATOR
19	WASTE OIL TANK
20	WASTE OIL DISCHARGE PUMP
21	OILY WATER SEPARATOR TANK
22	SLUDGE DISCHARGE PUMP
23	OILY WATER PUMP
24	SLUDGE TANK
25	OILY WATER SEPARATOR
26	INCINERATOR
27	WATER SOFTNER

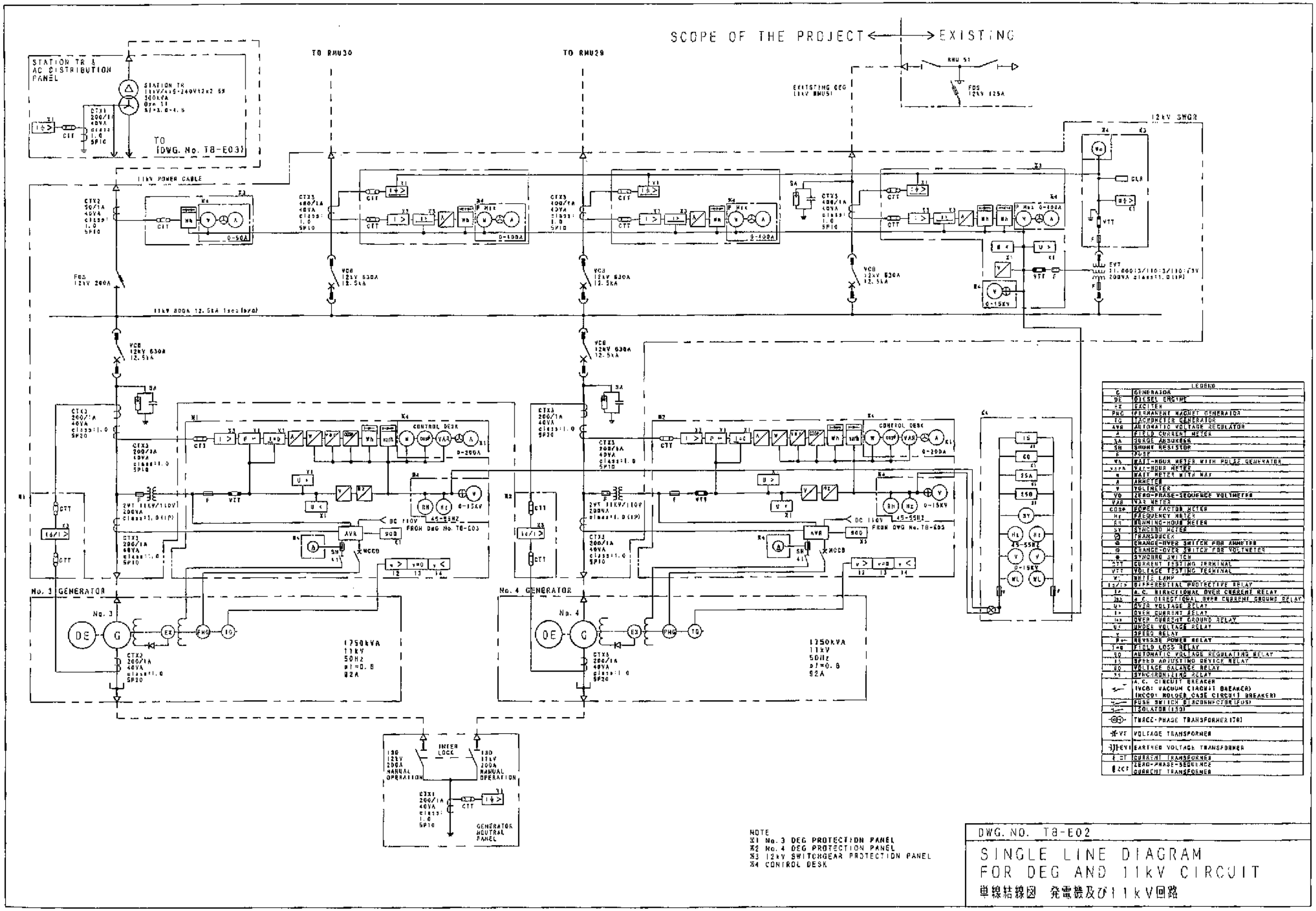
PANEL LEGEND	
GNP	GENERATOR NEUTRAL PANEL
G3	No. 3 GENERATOR CB PANEL
G4	No. 4 GENERATOR CB PANEL
F1	11kV FEEDER PANEL No. 1
F2	11kV FEEDER PANEL No. 2
F3	11kV FEEDER PANEL No. 3
STR	STATION FEEDER PANEL
AUX. TR	STATION TRANSFORMER
ACD	AC DISTRIBUTION PANEL
COM	COMMON MCC
AC3	No. 3 ENGINE MCC
AC4	No. 4 ENGINE MCC
DC	DC 110V BATTERY AND CHARGER PANEL
FP	VENTILATION FAN CONTROL PANEL
BA	BUILDING PANEL
SP	SLUDGE TREATMENT PANEL
GP3	No. 3 DEG PROTECTION PANEL
GP4	No. 4 DEG PROTECTION PANEL
SWG	11kV SWITCHGEAR PROTECTION PANEL
CONTROL DESK	CONTROL DESK

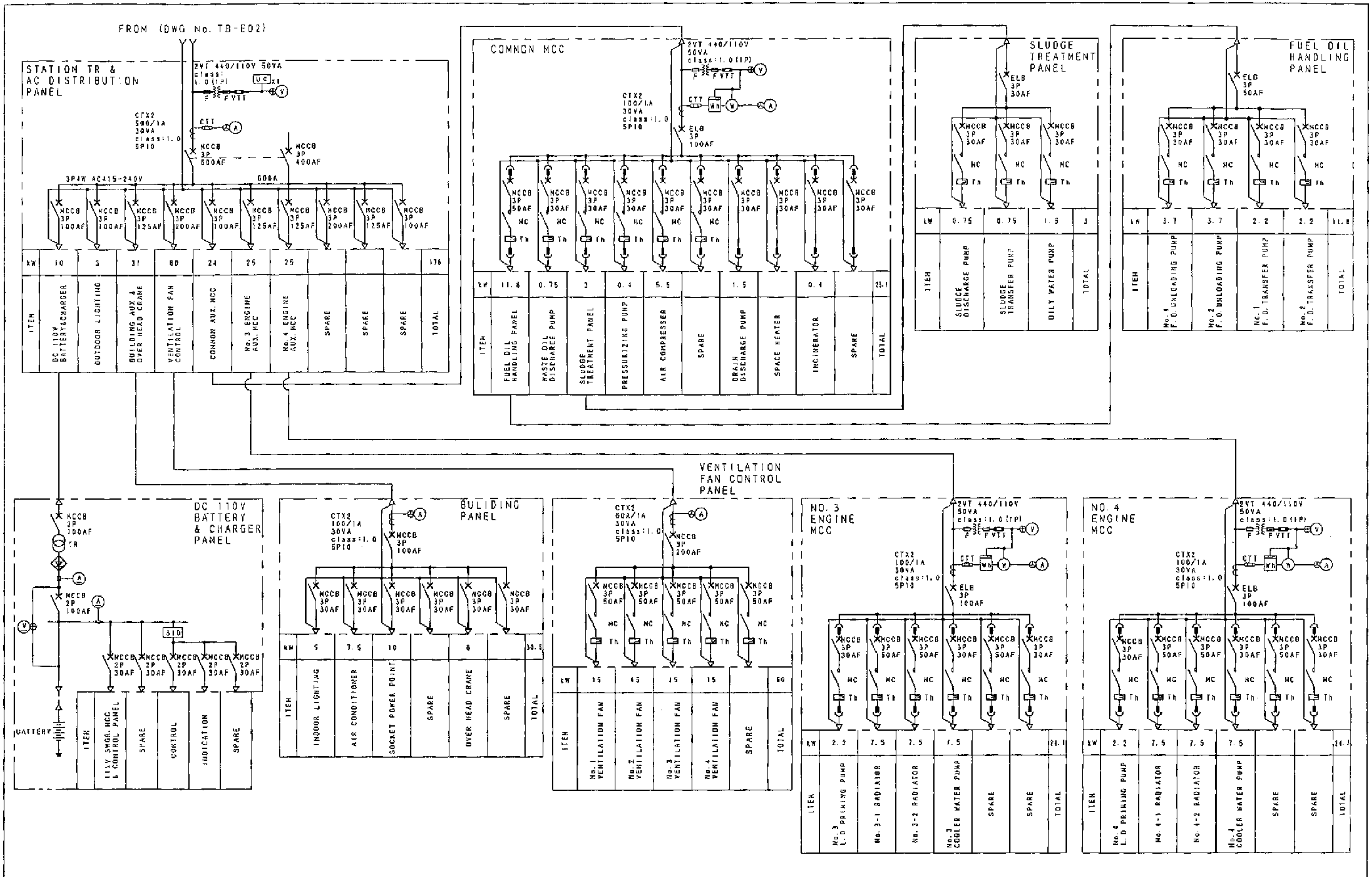
DWG. NO. TB-G02

ARRANGEMENT OF
BIKENIBEU NEW POWER HOUSE
新設ビケニベウ発電所建屋 配置図



SCOPE OF THE PROJECT
EXISTING
TO EXISTING RMU30
TO EXISTING RMU29
11kV POWER CABLE
RMU 51
12kV NEW SWGR
VCB 12kV 630A 12.5kA
11kV 600A 12.5kA 1sec(sym)
FDS 12kV 200A
FDS 12kV 125A
1250kVA 11kV 415-240V
OUTDOOR
INDOOR
CB
SA
C
11kV POWER CABLE
STATION TR 11kV/415-240V±2x2.5% 300kVA Dyn 11 %Z=3.0-4.5
NO. 3 GENERATOR 1750kVA 11kV 50Hz pf=0.8 92A
NO. 4 GENERATOR 1750kVA 11kV 50Hz pf=0.8 92A
DE
G
No. 1 750kVA
No. 2 750kVA
STATIN TR & AC DISTRIBUTION PANEL
3P4W AC415-240V
MCCB
ISO 12kV 200A
INTER LOCK
GENERATOR NEURAL PANEL
(SEE DWG No. TB-E02)
DC 110V BATTERY&CHARGER PANEL
DC 110V
SID
TO OUTDOOR LIGHTING
BUILDING PANEL
VETILATION FAN CONTROL PANEL
COMMON MCC
No. 3 ENGINE MCC
No. 4 ENGINE MCC
(SEE DWG No. TB-E03)
11kV SWGR, MCC & CONTROL DESK
SPARE
CONTROL
INDICATION
SPARE
LEGEND
G GENERATOR
DE DIESEL ENGINE
A.C. CIRCUIT BREAKER (VCB: VACUUM CIRCUIT BREAKER) (MCCB: MOLDED CASE CIRCUIT BREAKER)
CAPACITOR
SURGE ABSORBER (SA)
FUSE SWITCH DISCONNECTOR (FDS)
ISOLATOR (ISO)
THREE-PHASE TRANSFORMER (TR)
RECTIFIER
SILICONE DOROPPER
DWG No. TB-E01
KEY SINGLE LINE DIAGRAM OF BIKENIBEU P/S
ビケニベウ発電所 単線結線図


SCOPE OF THE PROJECT
EXISTING
STATION TR & AC DISTRIBUTION PANEL
TO (DWG. No. T8-E03)
TO RMU30
TO RMU29
EXISTING DEG 11kV RMU51
12kV SWGR
11kV POWER CABLE
No. 3 GENERATOR
No. 4 GENERATOR
1750kVA
11kV
50Hz
92A
CONTROL DESK
INTER LOCK
GENERATOR NEUTRAL PANEL
LEGEND
G GENERATOR
DE DIESEL ENGINE
EX EXCITER
PMG PERMANENT MAGNET GENERATOR
TG TACHOMETER GENERATOR
AVR AUTOMATIC VOLTAGE REGULATOR
A FIELD CURRENT METER
SA SURGE ABSORBER
SH SHUNT RESISTOR
F FUSE
Wh WATT-HOUR METER WITH PULSE GENERATOR
varh VAR-HOUR METER
W WATT METER WITH MAX
A AMMETER
V VOLTMETER
VO ZERO-PHASE-SEQUENCE VOLTMETER
VAR VAR METER
COSφ POWER FACTOR METER
Hz FREQUENCY METER
RH RUNNING-HOUR METER
SY SYNCHRO METER
TRANSDUCER
CHANGE-OVER SWITCH FOR AMMETER
CHANGE-OVER SWITCH FOR VOLTMETER
SYNCHRO SWITCH
CTT CURRENT TESTING TERMINAL
VTT VOLTAGE TESTING TERMINAL
WL WHITE LAMP
DIFFERENTIAL PROTECTIVE RELAY
A.C. DIRECTIONAL OVER CURRENT RELAY
A.C. DIRECTIONAL OVER CURRENT GROUND RELAY
OVER VOLTAGE RELAY
OVER CURRENT RELAY
OVER CURRENT GROUND RELAY
UNDER VOLTAGE RELAY
SPEED RELAY
REVERSE POWER RELAY
FIELD LOSS RELAY
AUTOMATIC VOLTAGE REGULATING RELAY
SPEED ADJUSTING DEVICE RELAY
VOLTAGE BALANCE RELAY
SYNCHRONIZING RELAY
A.C. CIRCUIT BREAKER
(VCB: VACUUM CIRCUIT BREAKER)
(MCCB: MOLDED CASE CIRCUIT BREAKER)
FUSE SWITCH DISCONNECTOR (FDS)
ISOLATOR (ISD)
THREE-PHASE TRANSFORMER (TR)
VT VOLTAGE TRANSFORMER
EVT EARTHED VOLTAGE TRANSFORMER
CT CURRENT TRANSFORMER
ZCT ZERO-PHASE-SEQUENCE CURRENT TRANSFORMER
NOTE
※1 No. 3 DEG PROTECTION PANEL
※2 No. 4 DEG PROTECTION PANEL
※3 12kV SWITCHGEAR PROTECTION PANEL
※4 CONTROL DESK
DWG. NO. T8-E02
SINGLE LINE DIAGRAM
FOR DEG AND 11kV CIRCUIT
単線結線図 発電機及び11kV回路



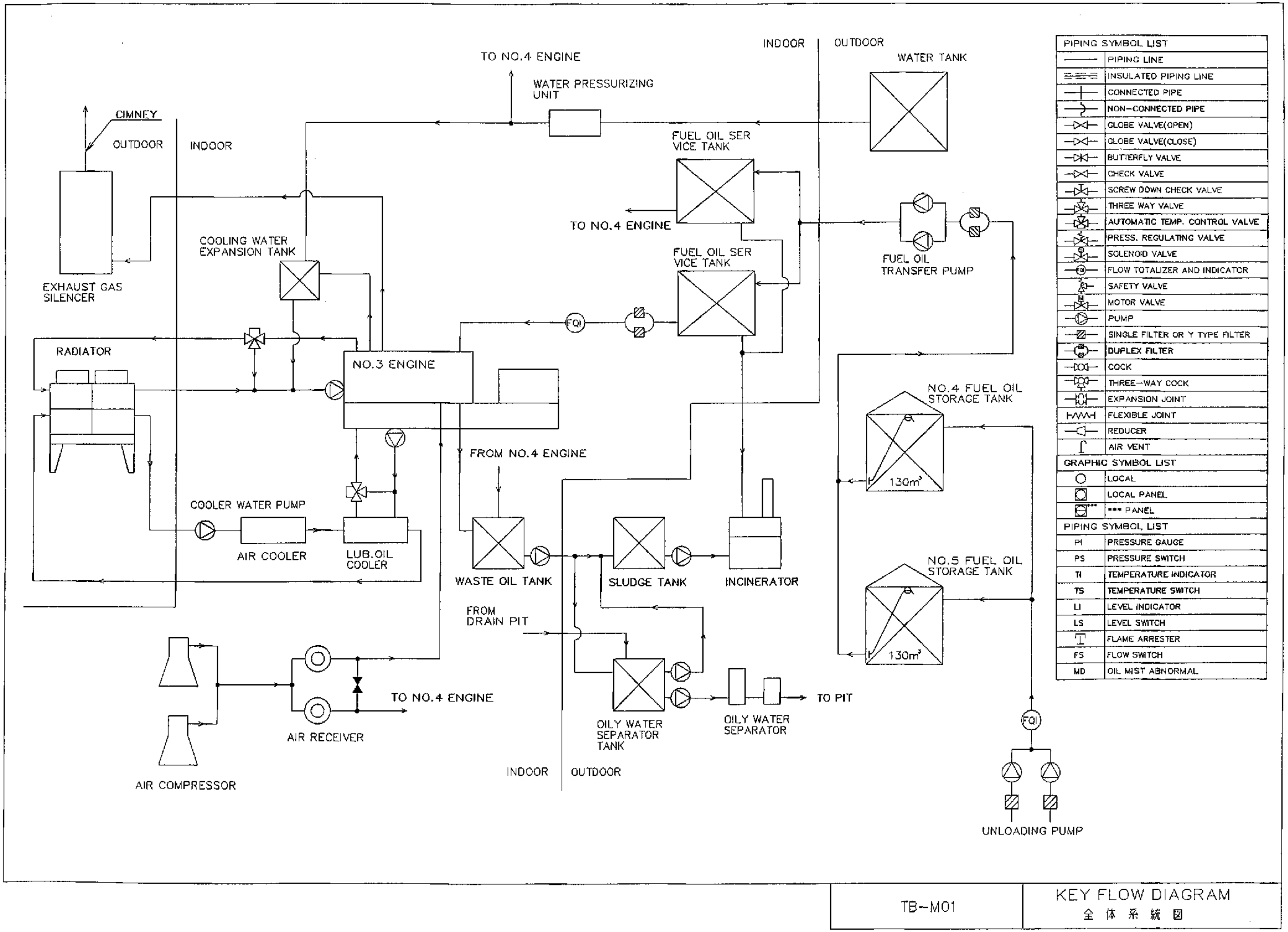
-47-

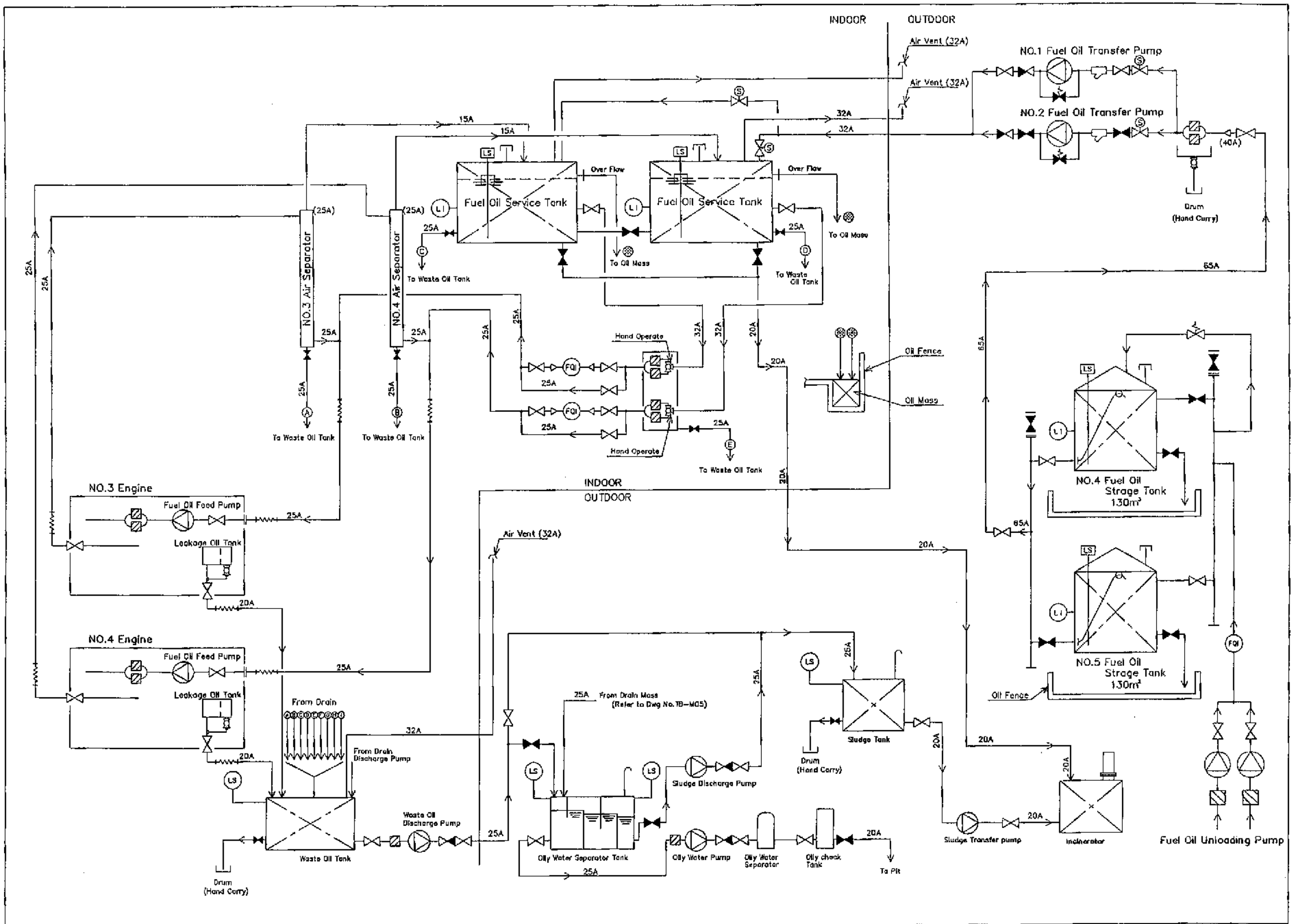
REMARKS:
ALL GROUPED ALARMS SHALL BE LED TO THE CONTROL DESK AS A MINIMUM.

DWG No. TB-E03

SINGLE LINE DIAGRAM FOR LOW VOLTAGE SYSTEM

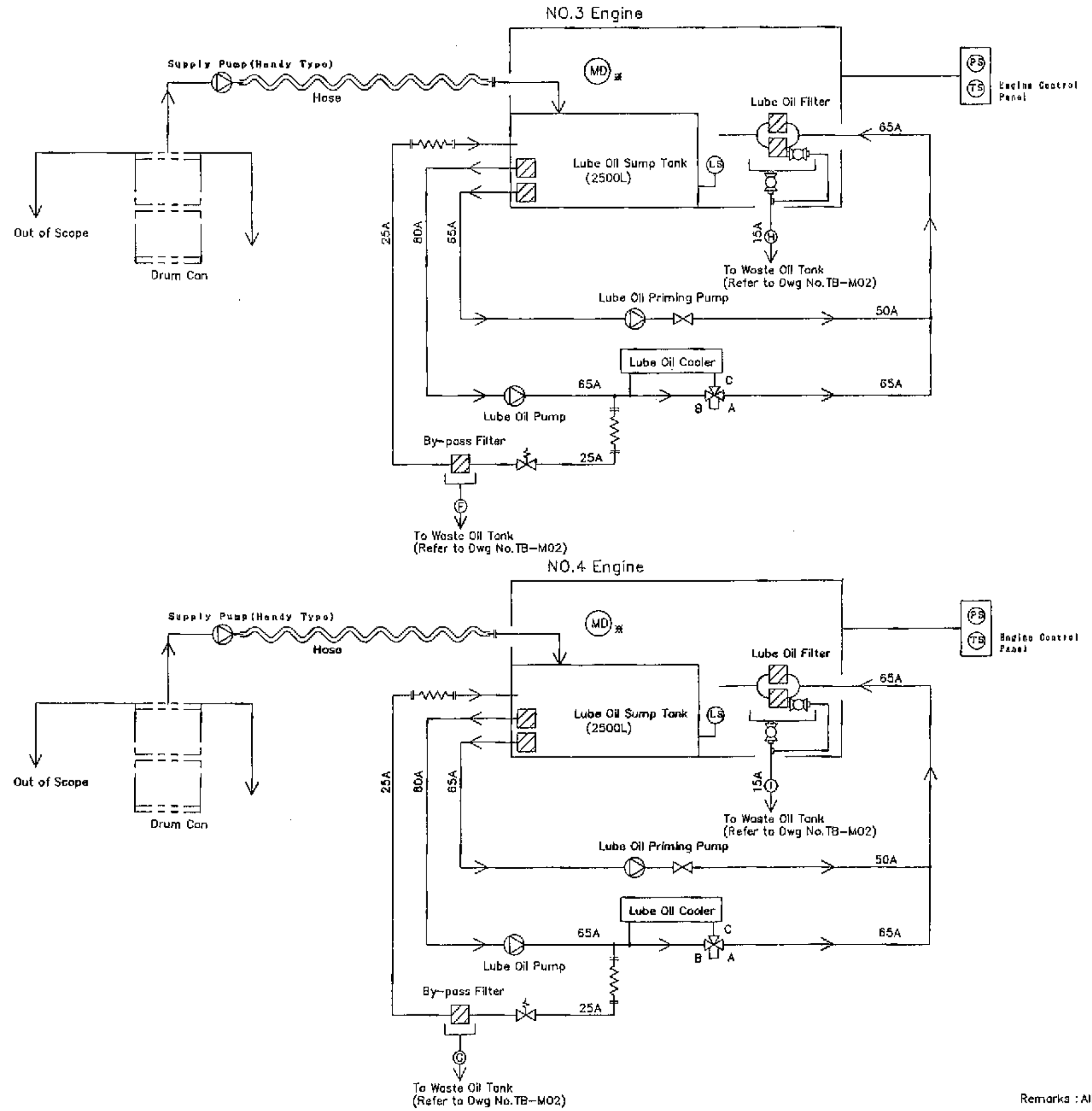
単線結線図 415V低圧回路


TO NO.4 ENGINE
WATER PRESSURIZING UNIT
INDOOR
OUTDOOR
WATER TANK
CIMNEY
OUTDOOR
INDOOR
FUEL OIL SER VICE TANK
TO NO.4 ENGINE
COOLING WATER EXPANSION TANK
EXHAUST GAS SILENCER
FUEL OIL SER VICE TANK
FUEL OIL TRANSFER PUMP
FQI
RADIATOR
NO.3 ENGINE
NO.4 FUEL OIL STORAGE TANK
130m³
FROM NO.4 ENGINE
COOLER WATER PUMP
AIR COOLER
LUB.OIL COOLER
WASTE OIL TANK
SLUDGE TANK
INCINERATOR
NO.5 FUEL OIL STORAGE TANK
130m³
FROM DRAIN PIT
TO NO.4 ENGINE
AIR RECEIVER
OILY WATER SEPARATOR TANK
OILY WATER SEPARATOR
TO PIT
FQI
AIR COMPRESSOR
INDOOR
OUTDOOR
UNLOADING PUMP
PIPING SYMBOL LIST
PIPING LINE
INSULATED PIPING LINE
CONNECTED PIPE
NON-CONNECTED PIPE
GLOBE VALVE(OPEN)
GLOBE VALVE(CLOSE)
BUTTERFLY VALVE
CHECK VALVE
SCREW DOWN CHECK VALVE
THREE WAY VALVE
AUTOMATIC TEMP. CONTROL VALVE
PRESS. REGULATING VALVE
SOLENOID VALVE
FLOW TOTALIZER AND INDICATOR
SAFETY VALVE
MOTOR VALVE
PUMP
SINGLE FILTER OR Y TYPE FILTER
DUPLEX FILTER
COCK
THREE-WAY COCK
EXPANSION JOINT
FLEXIBLE JOINT
REDUCER
AIR VENT
GRAPHIC SYMBOL LIST
LOCAL
LOCAL PANEL
*** PANEL
PIPING SYMBOL LIST
PI PRESSURE GAUGE
PS PRESSURE SWITCH
TI TEMPERATURE INDICATOR
TS TEMPERATURE SWITCH
LI LEVEL INDICATOR
LS LEVEL SWITCH
FLAME ARRESTER
FS FLOW SWITCH
MD OIL MIST ABNORMAL
TB-M01
KEY FLOW DIAGRAM
全体系統図



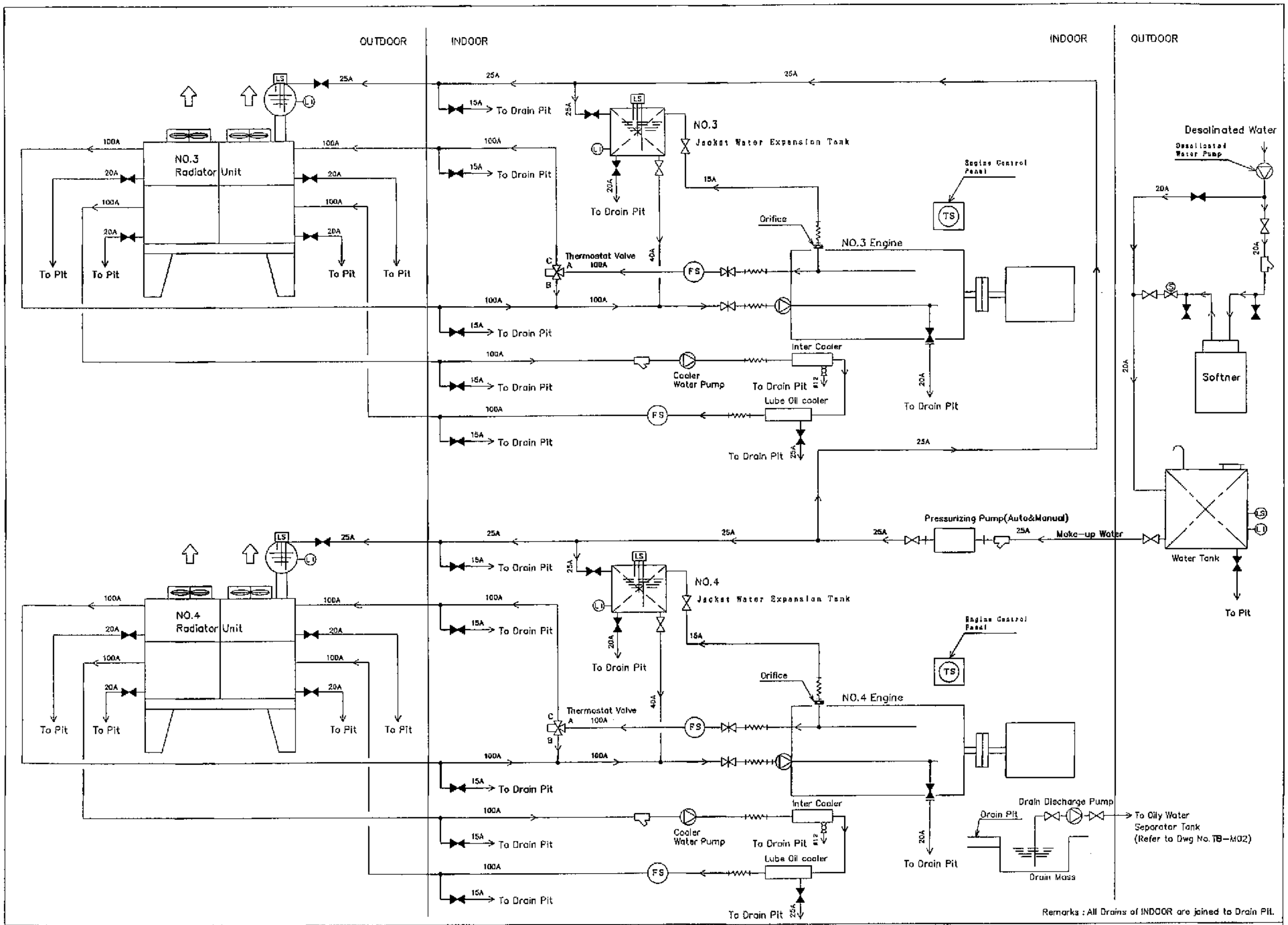
TB-M02

FLOW DIAGRAM OF FUEL OIL SYSTEM
WITH SLUDGE TREATMENT SYSTEM
燃 料 油 系 統 図

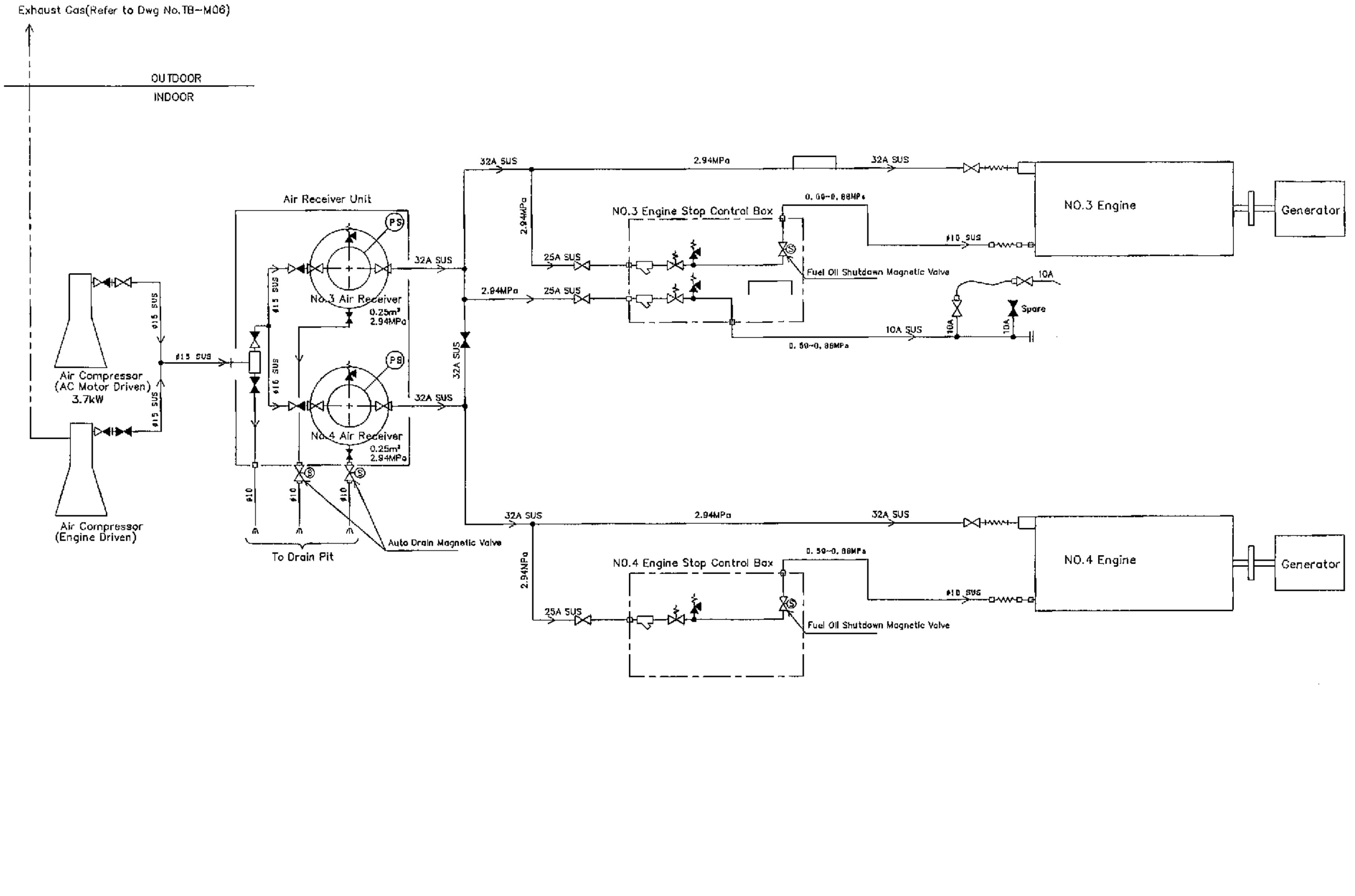


Remarks : All facilities are located in the power house.

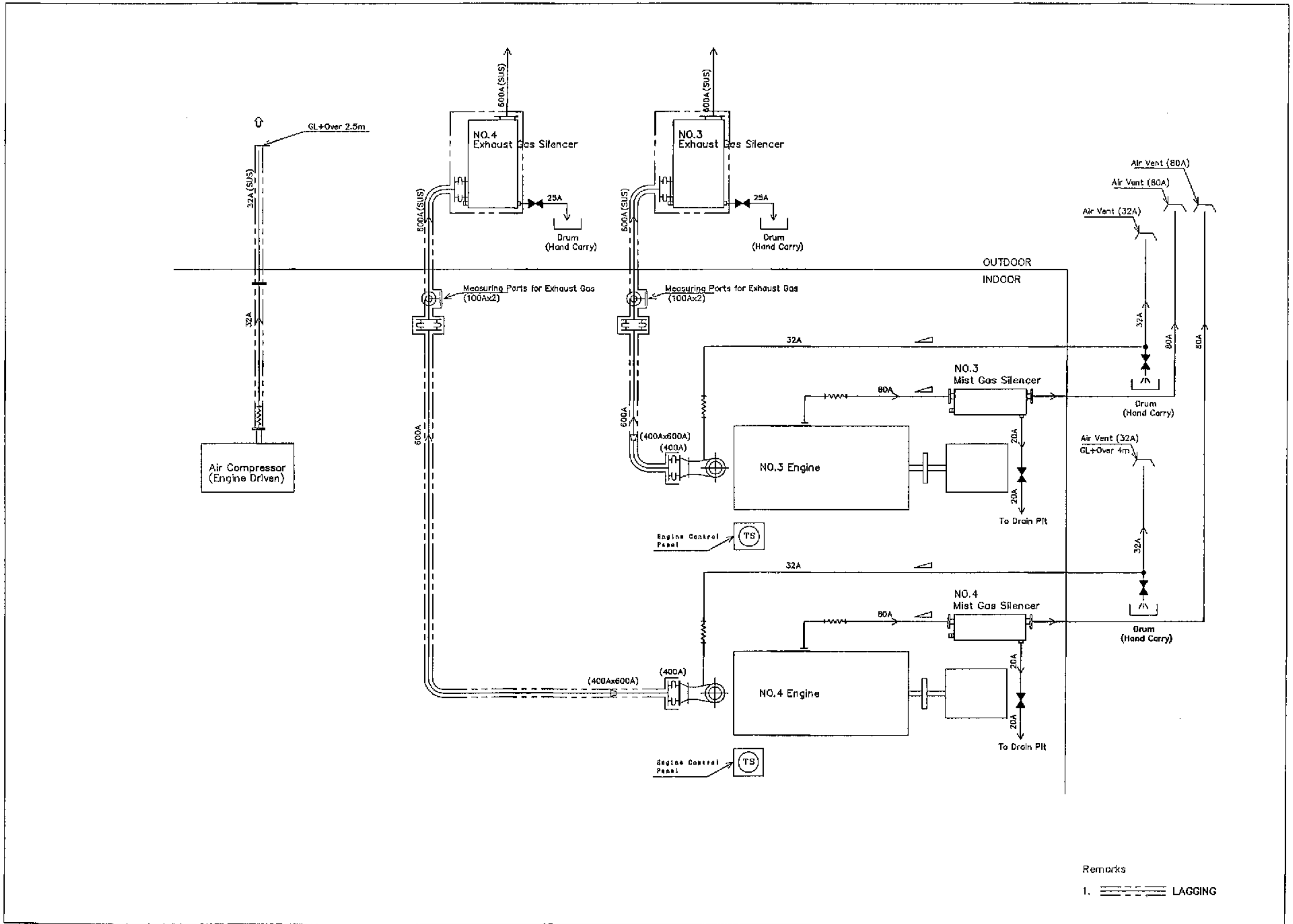
TB-M03	FLOW DIAGRAM OF LUBRICANT OIL SYSTEM 潤 滑 油 系 統 図



TB-M04 FLOW DIAGRAM OF COOLING WATER SYSTEM
冷却水系統図



TB-M05	FLOW DIAGRAM OF COMPRESSED AIR SYSTEM 圧 縮 空 気 系 統 図



TB-M06	FLOW DIAGRAM OF INTAKE AIR AND EXHAUST GAS SYSTEM 吸 排 気 系 統 図

1.DATA

SITE AREA	3,000.00m2
BUILDING AREA	450.00m2
TOTAL BUILDING AREA	603.00m2
UNDER GROUND	R.C. CONSTRUCTION
UPPER GROUND	STEEL STRUCTURE

2.EXTERIOR FINISHING

ROOF	SHELL (RIBBED) ROOF h=150mm ACID-RESISTANT HIGH-POLYMER CLAD STEEL SHEET t=0.8mm
EXTERIOR WALL	RIBBED WALL CLADDING h=38mm ACID-RESISTANT HIGH-POLYMER CLAD STEEL SHEET t=0.8mm
BASEBOARD	CONCRETE, PAINT FINISH
EXTERIOR	·CONCRETE FOUNDATION ·CONCRETE PAVING PREMISES ROAD ·OUTDOOR LIGHT ·DRANAGE WORK

3.INTERIOR FINISHING

ITEM	FINISHING/SPECIFICATION	
DEG ROOM	FLOOR	CONCRETE STEEL TROWEL FINISH/OILPROOF PAINT FINISH
	WALL	GLASSWOOL ACOUSTIC BOARD t=50mm SOUND PROOF CEMENT BOARD t=12.8mm
	CEILING	GLASSWOOL ACOUSTIC BOARD t=50mm SOUND PROOF CEMENT BOARD t=12.8mm
ELECTRICAL ROOM	FLOOR	CONCRETE STEEL TROWEL FINISH/DUSTPROOF PAINT FINISH
	WALL	CEMENT BOARD
	CEILING	ROCKWOOL SYSTEM CEILING BOARD (630x1,200)
CONTROL ROOM	FLOOR	DECKPLATE RC FLOOR, POLYVINYL TILE
	WALL	CEMENT BOARD, PAINT FINISH
	CEILING	ROCKWOOL SYSTEM CEILING BOARD (630x1,200)
TOILET	FLOOR	CONCRETE STEEL TROWEL FINISH
	WALL	CEMENT BOARD, PAINT FINISH
	CEILING	CEMENT BOARD, PAINT FINISH
STAIRCASE	FLOOR	GALVANIZING Ch·PLATE t=4.5mm
	WALL	CEMENT BOARD, PAINT FINISH
	CEILING	ROCKWOOL SYSTEM CEILING BOARD (630x1,200)
CORRIDOR	FLOOR	DECKPLATE RC FLOOR, POLYVINYL TILE
	WALL	CEMENT BOARD, PAINT FINISH
	CEILING	ROCKWOOL SYSTEM CEILING BOARD (630x1,200)
WAREHOUSE	FLOOR	CONCRETE STEEL TROWEL FINISH/DUSTPROOF PAINT FINISH
	WALL	CEMENT BOARD, PAINT FINISH
	CEILING	–

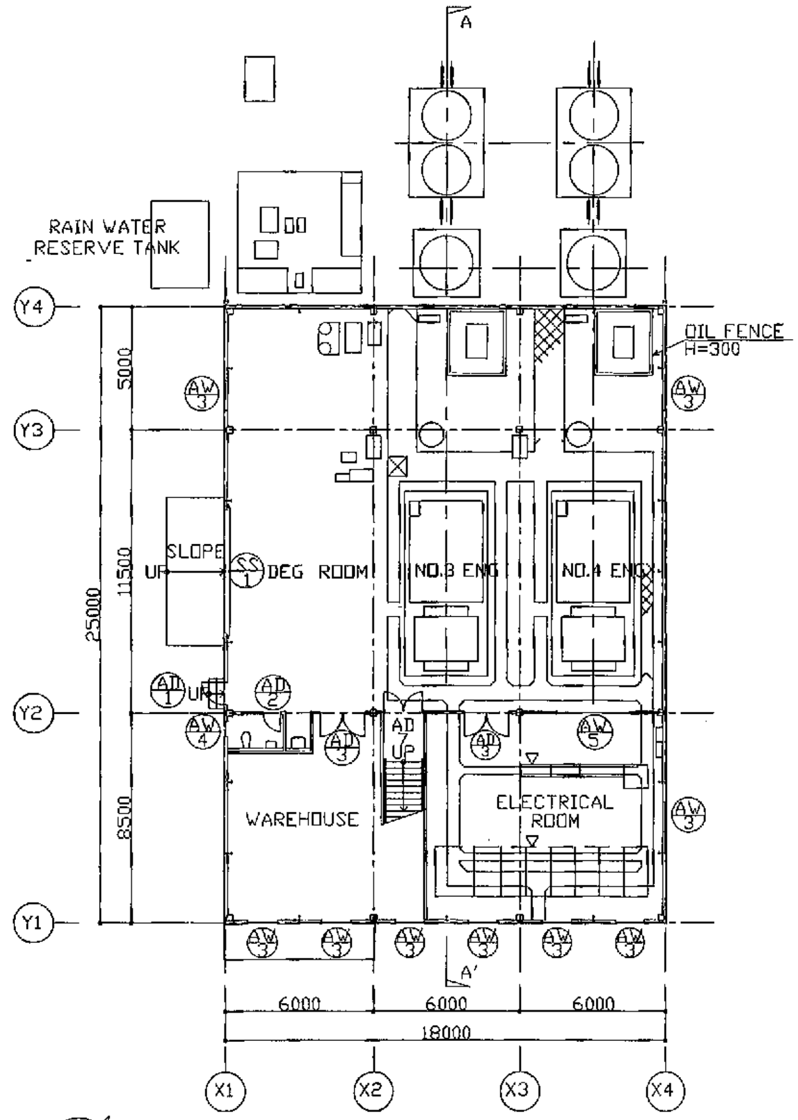
4.DOORS AND WINDOWS SCHEDULES

	ITEM	QUANTITY	SIZE (WxH)	REMARK
SS 1	STEEL SHUTTER	1	5,000x4,500	·ELECTRIC SHUTTER ·SMOKEPROOF TYPE ·PAINT FINISH
AW 1	ALUMINIUM WINDOW	4	1,200x1,200	·HORIZONTAL SLIDING ·CLEAR FLOAT GLASS, t=5mm
AW 2	ALUMINIUM WINDOW	2	1,800x1,200	·HORIZONTAL SLIDING (DOUBLE SASH) ·CLEAR FLOAT GLASS, t=5mm
AW 3	ALUMINIUM WINDOW	6	1,200x600	·TOP-HINGED OUTSWINGING ·TINTED GLASS, t=5mm
AW 4	ALUMINIUM WINDOW	1	600x600	·TOP-HINGED OUTSWINGING ·PATTERN GLASS, t=5mm
AW 5	ALUMINIUM WINDOW	1	3,000x1,200	·FIX (DOUBLE SASH) ·CLEAR FLOAT GLASS, t=5mm
AD 1	ALUMINIUM DOOR	1	900x2,000	
AD 2	ALUMINIUM DOOR	1	700x2,000	
AD 3	ALUMINIUM DOOR	2	1,800X2,000	
AD 4	ALUMINIUM DOOR	1	900x2,000	·AIR TIGHT
AD 5	ALUMINIUM DOOR	1	900x2,000	·CLEAR FLOAT GLASS, t=5mm
AD 6	ALUMINIUM DOOR	1	1,800x2,000	·CLEAR FLOAT GLASS, t=5mm
AD 7	ALUMINIUM DOOR	1	1,600x2,000	·CLEAR FLOAT GLASS, t=5mm
AG 1	ALUMINIUM LOUVER	1	5,000x1,200	
AG 2	ALUMINIUM LOUVER	2	9,000x1,200	

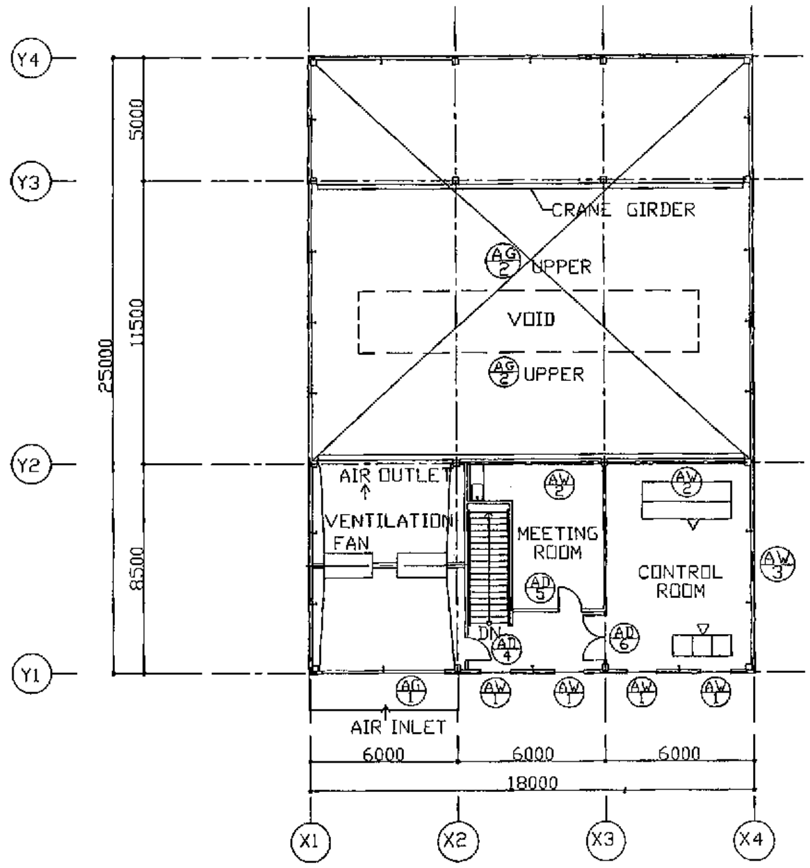
TB–A01

発電建屋仕上表
NEW POWER HOUSE FINISHING SCHEDULE

BIKENIBEU NEW POWER HOUSE

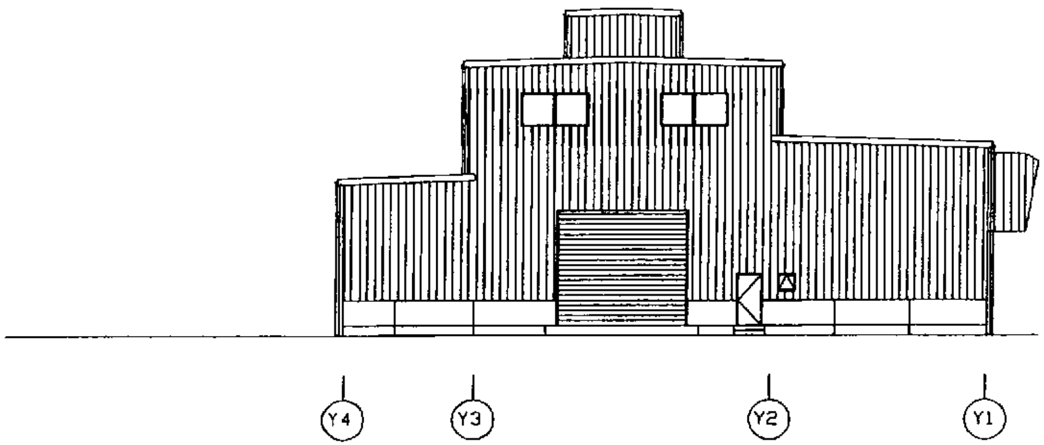


1st FLOOR PLAN 1/100

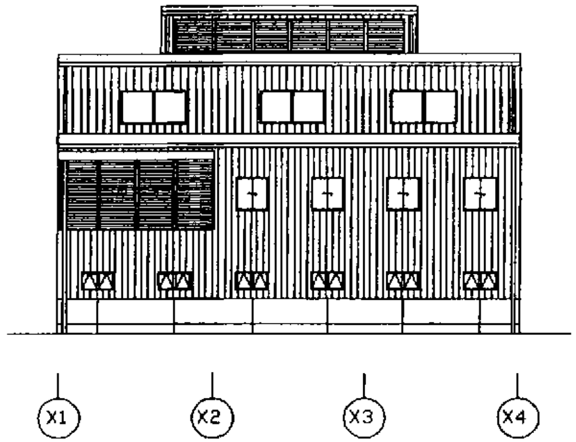


2nd FLOOR PLAN 1/100

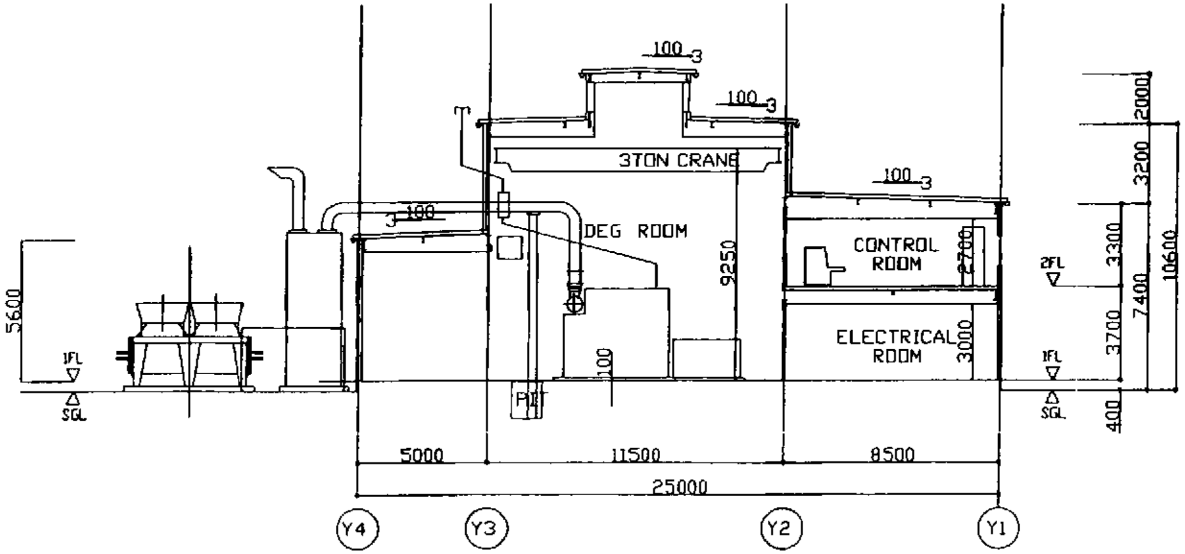
TB-A02
NEW POWER HOUSE PLAN
BIKENIBEU NEW POWER HOUSE



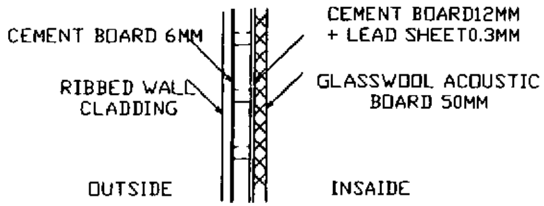
SOUTH ELEVATION 1/100



EAST ELEVATION 1/100



A-A' SECTION 1/100



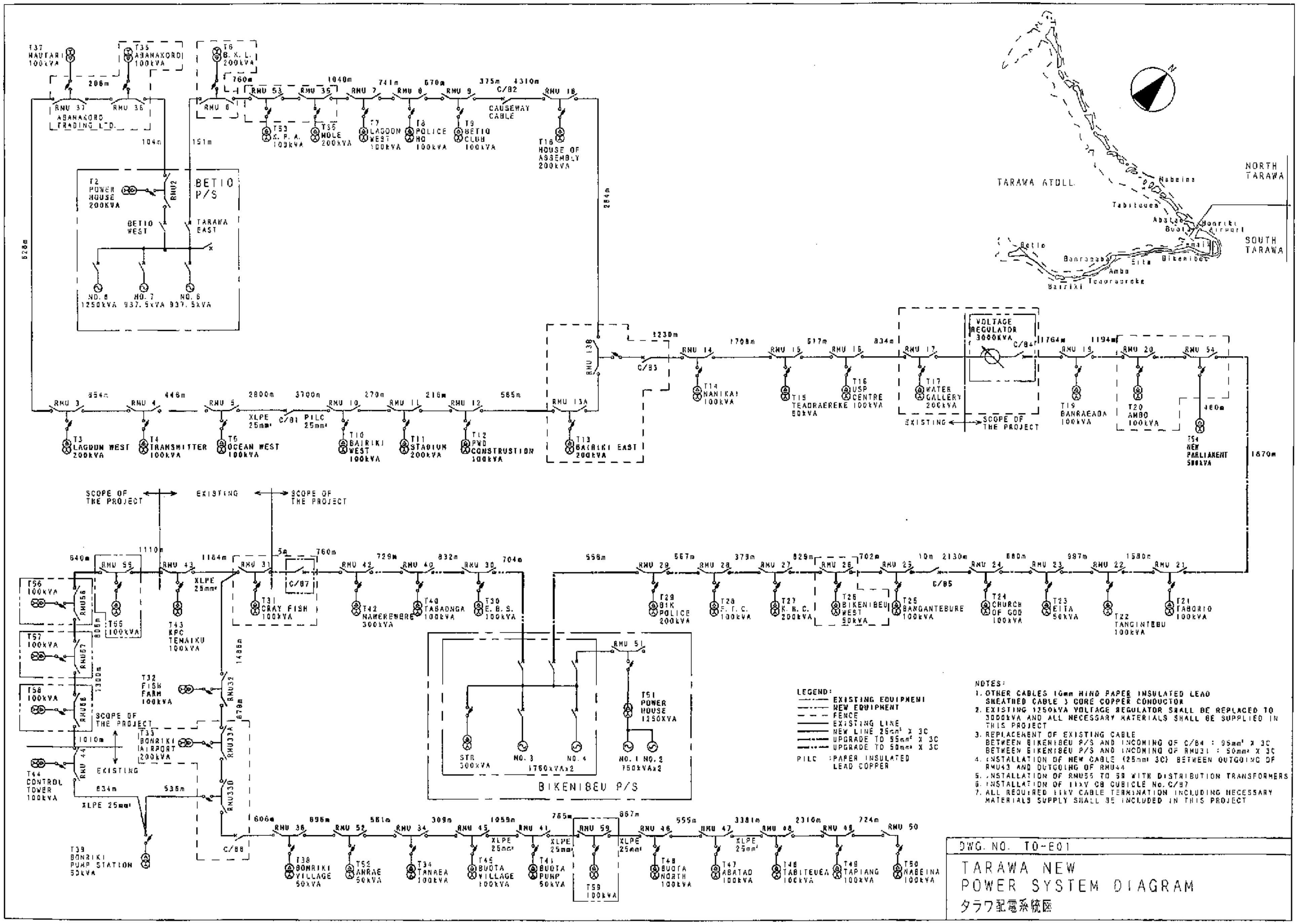
DETAIL OF SOUNDPROOF WALL

2F FLOOR

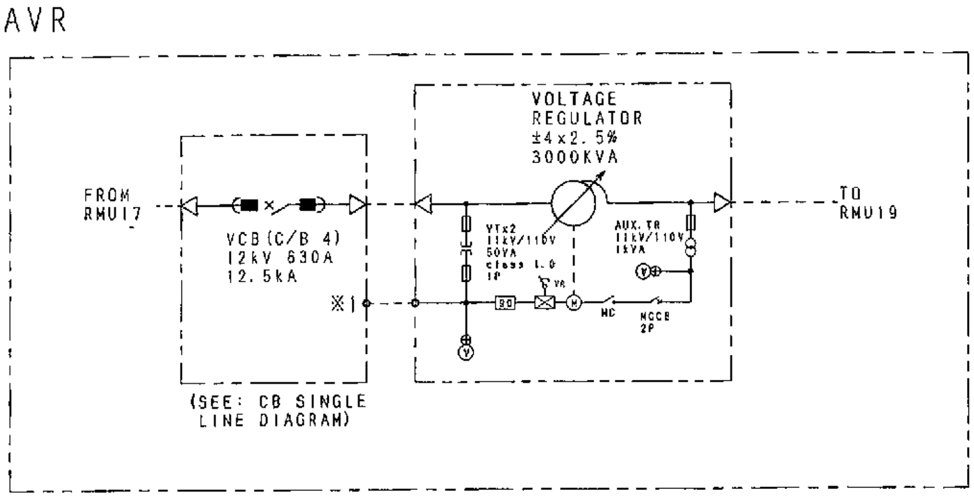
GALVANIZED V DECK SHEET

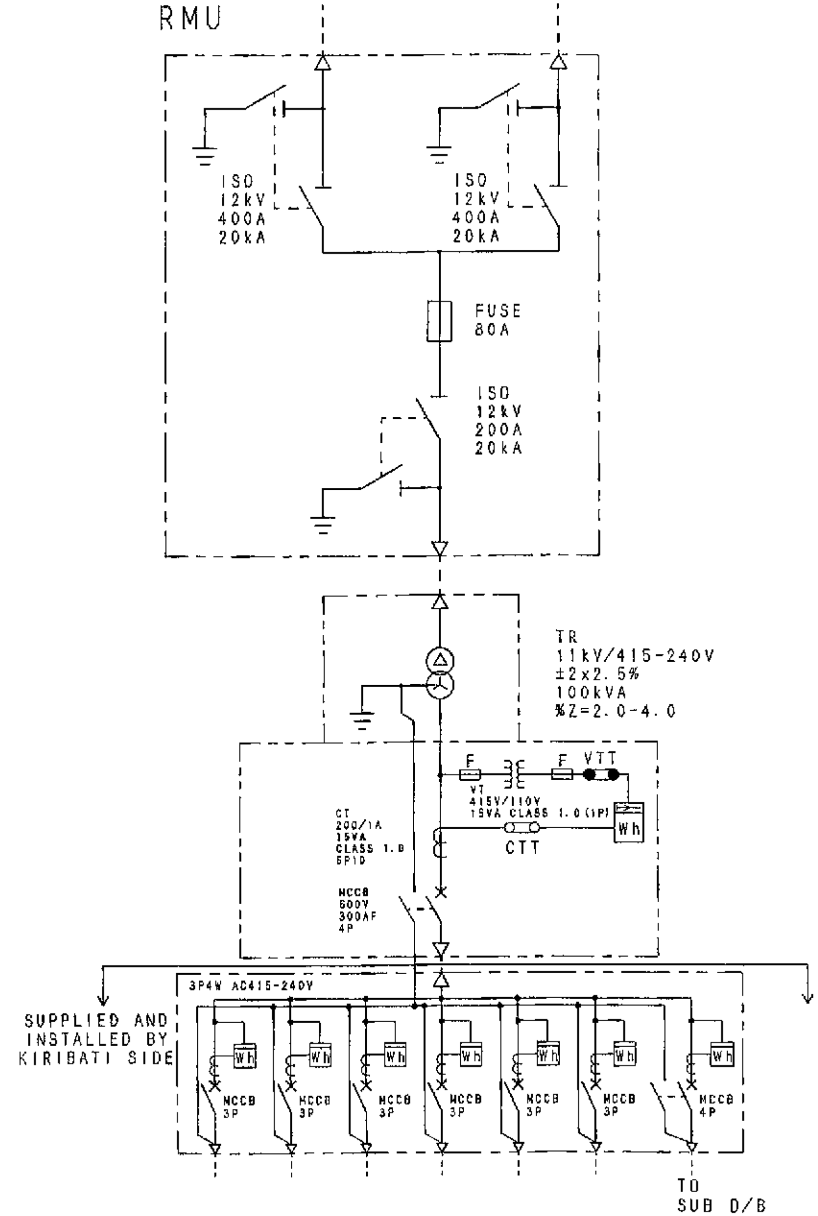
TB-A03
NEW POWER HOUSE ELEVATION
BIKENIBEU NEW POWER HOUSE

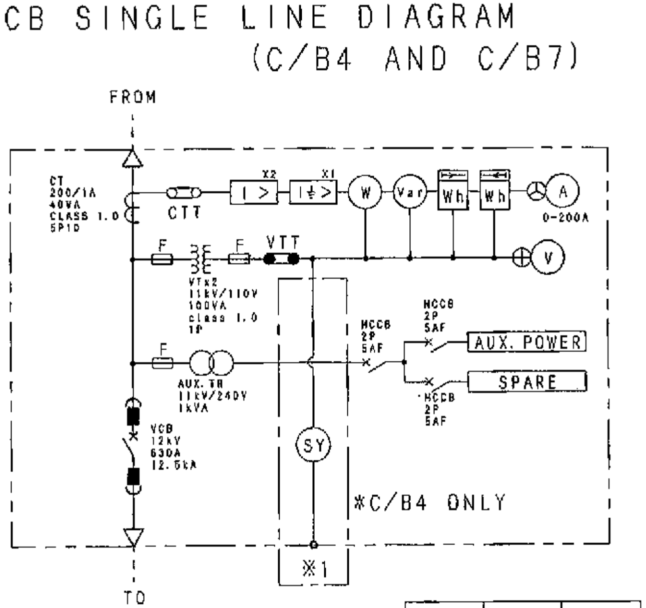
DWG. NO.TB-D00 タラワ島 11kV 配電網全体計画図
11kV Distribution Network in Tarawa



DWG. NO. TO-E01
TARAWA NEW POWER SYSTEM DIAGRAM
タラワ配電系統図
TARAWA ATOLL
NORTH TARAWA
SOUTH TARAWA
BETIO P/S
BIKENIBEU P/S
LEGEND:
EXISTING EQUIPMENT
NEW EQUIPMENT
FENCE
EXISTING LINE
NEW LINE 25mm² X 3C
UPGRADE TO 95mm² X 3C
UPGRADE TO 50mm² X 3C
PILC :PAPER INSULATED LEAD COPPER
NOTES:
1. OTHER CABLES 16mm HIND PAPER INSULATED LEAD SHEATHED CABLE 3 CORE COPPER CONDUCTOR
2. EXISTING 1250kVA VOLTAGE REGULATOR SHALL BE REPLACED TO 3000kVA AND ALL NECESSARY MATERIALS SHALL BE SUPPLIED IN THIS PROJECT
3. REPLACEMENT OF EXISTING CABLE
BETWEEN BIKENIBEU P/S AND INCOMING OF C/84 : 95mm² X 3C
BETWEEN BIKENIBEU P/S AND INCOMING OF RMU31 : 50mm² X 3C
4. INSTALLATION OF NEW CABLE (25mm² 3C) BETWEEN OUTGOING OF RMU43 AND OUTGOING OF RMU44
5. INSTALLATION OF RMU55 TO 59 WITH DISTRIBUTION TRANSFORMERS
6. INSTALLATION OF 11kV CB CUBICLE No. C/87
7. ALL REQUIRED 11kV CABLE TERMINATION INCLUDING NECESSARY MATERIALS SUPPLY SHALL BE INCLUDED IN THIS PROJECT







	FROM	TO
C/B4	RMU17	AVR
C/B7	RMU42	RMU31

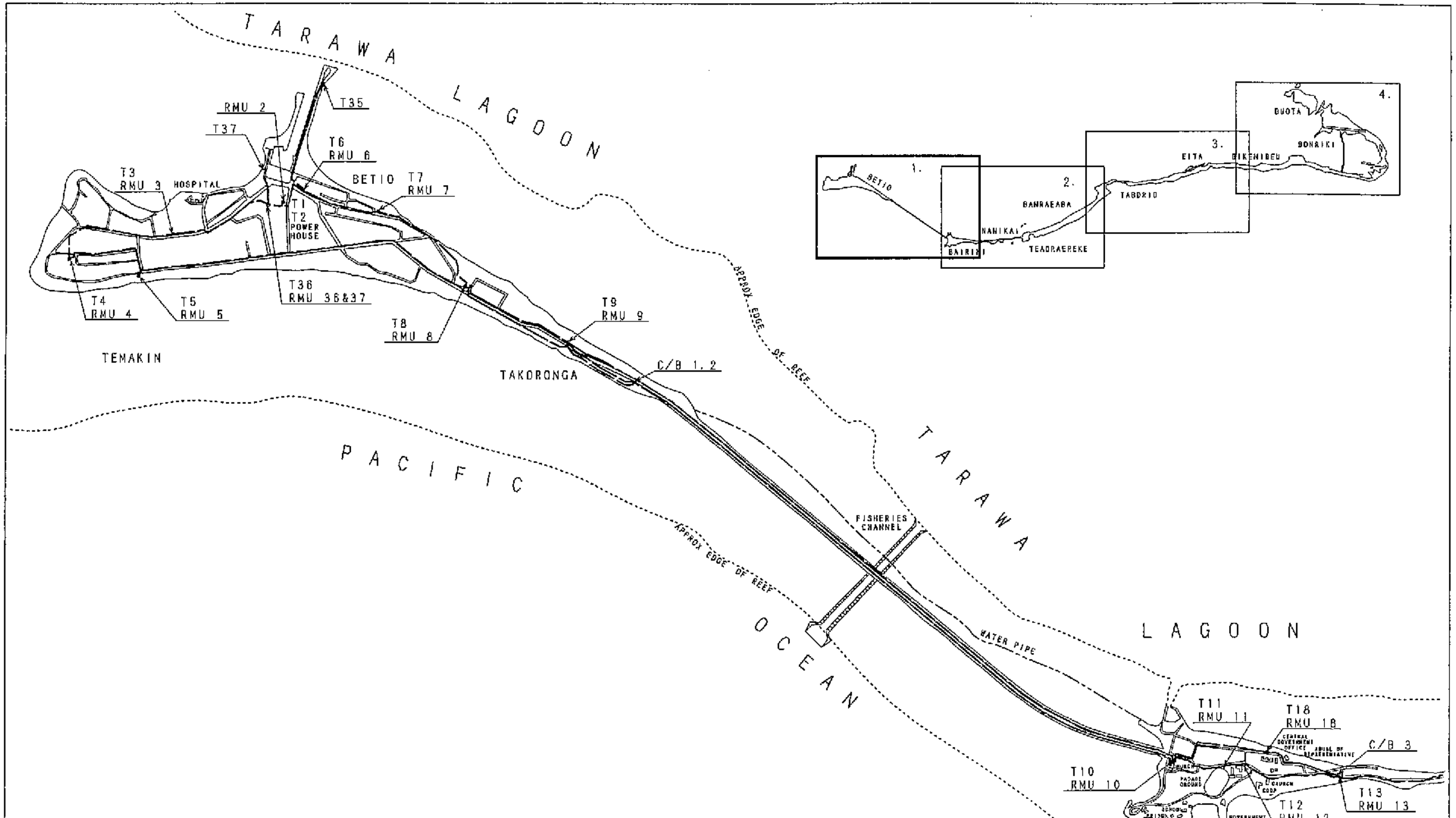
NOTE

----- MECHANICAL INTERLOCK

DWG No. TD-E02

SINGLE LINE DIAGRAM FOR VOLTAGE REGULATOR, RMU AND CB CUBICLE

単線結線図 電圧調整機、配電用開閉器盤及び遮断器盤



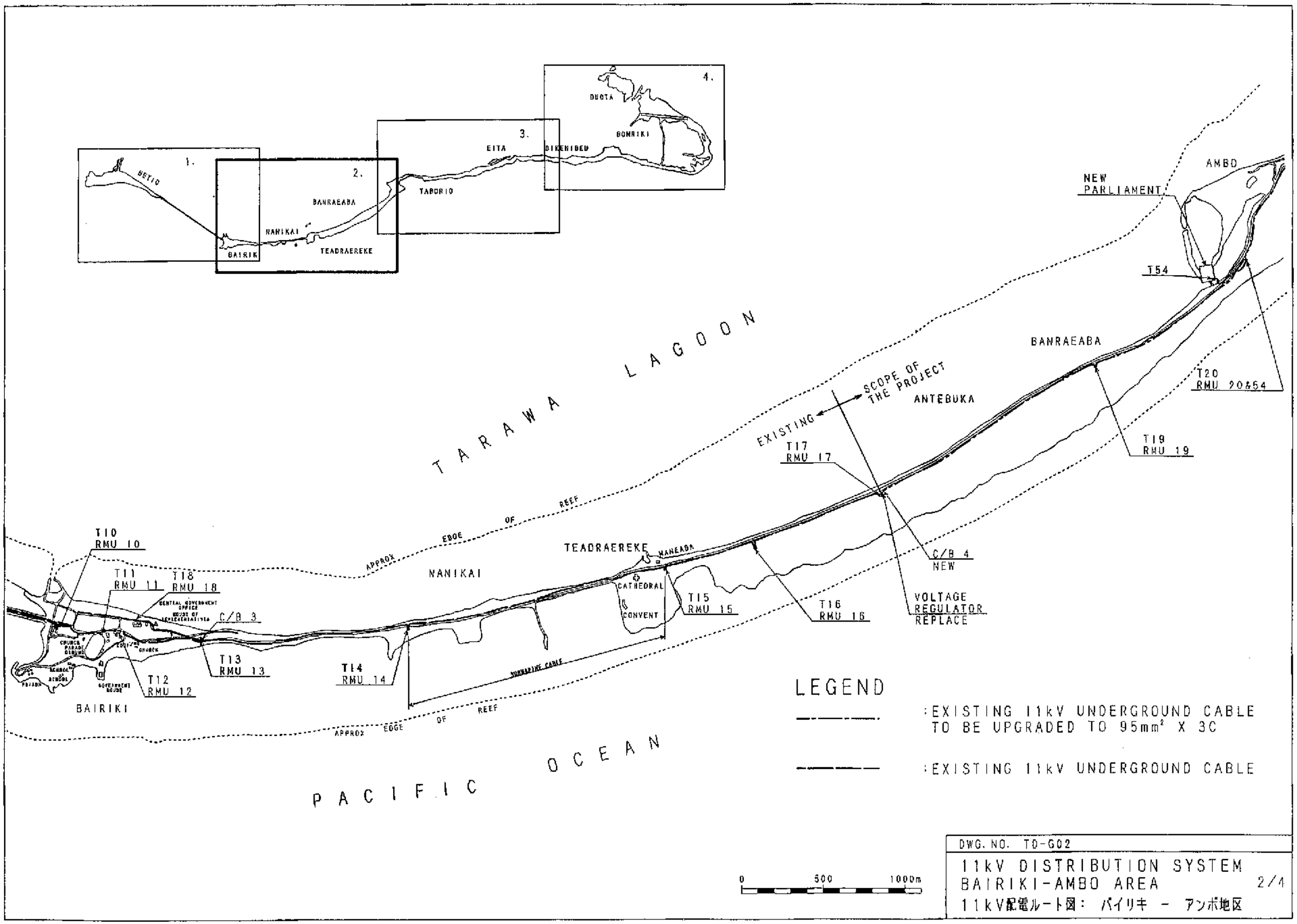
LEGEND

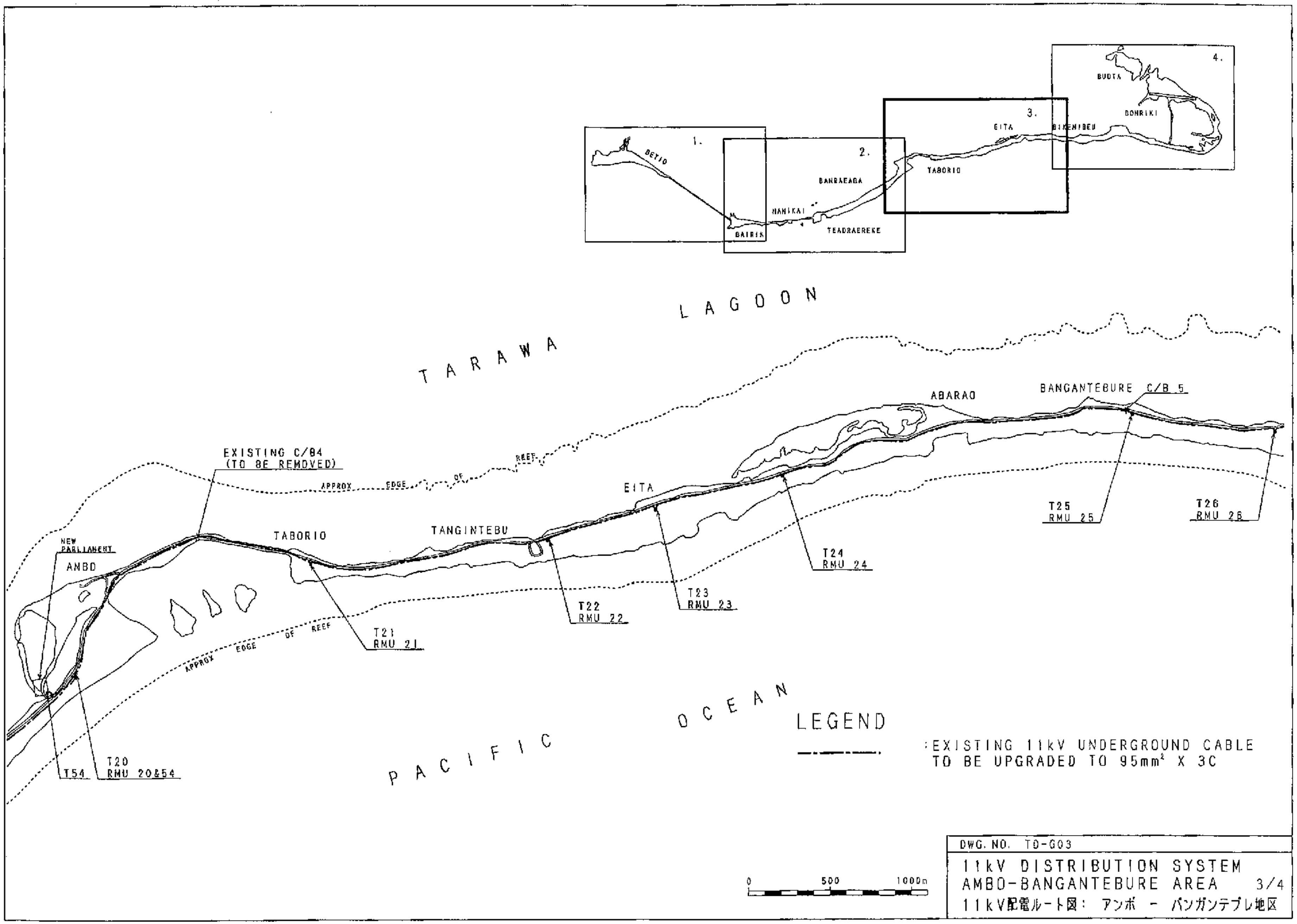
━━━━━ :EXISTING 11kV UNDERGROUND CABLE

0 500 1000m

DWG. NO. TD-G01

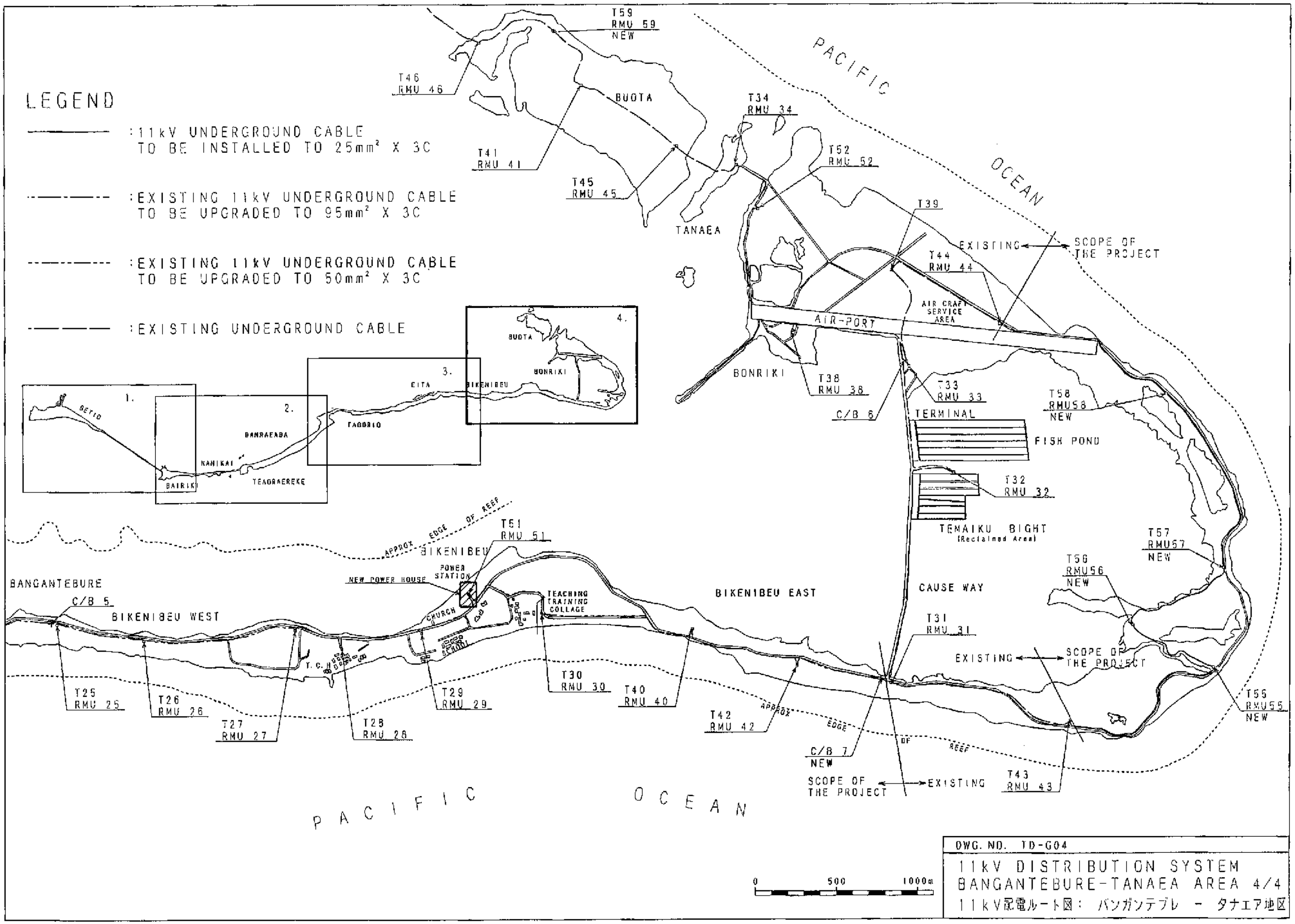
11kV DISTRIBUTION SYSTEM
BETIO-BAIRIKI AREA 1/4
11kV配電ルート図： ベシオ － バイリキ地区

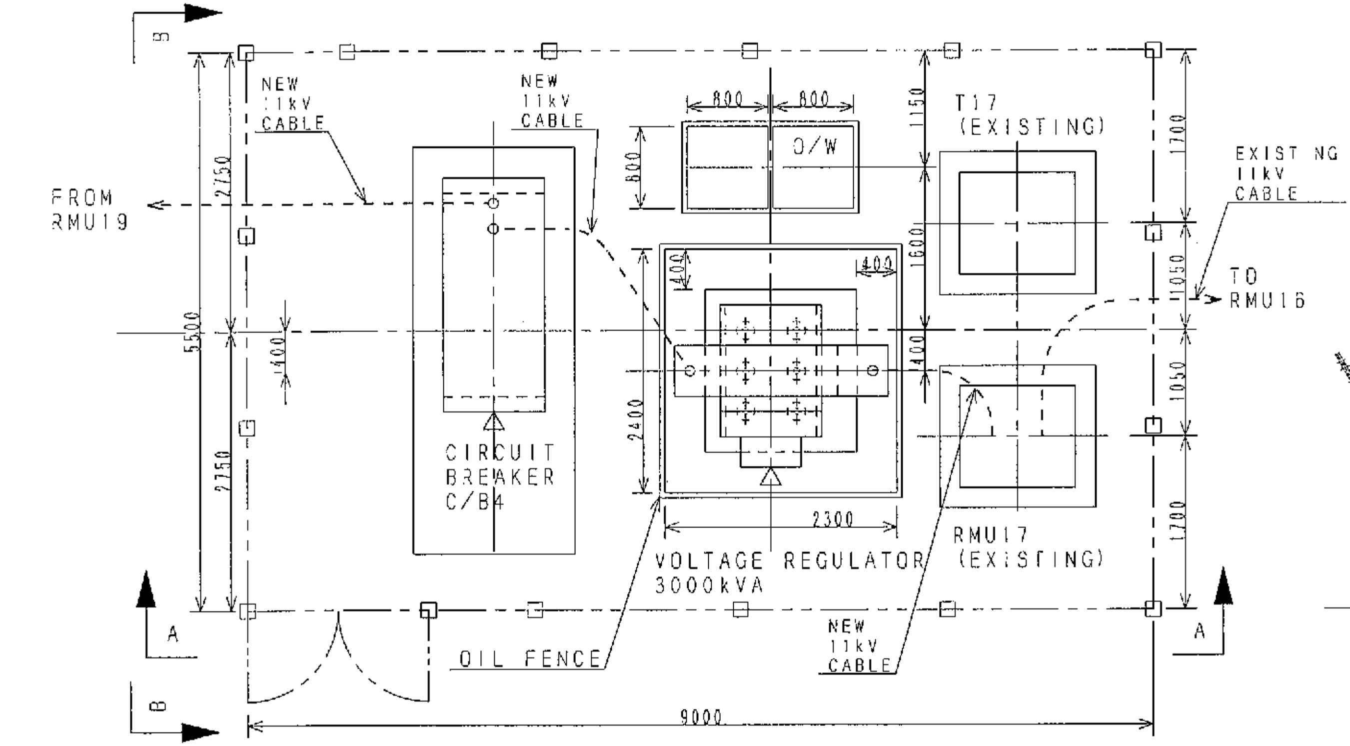

1.
2.
3.
4.
BETIO
BAIRIKI
NANIKAI
BANRAEABA
TEADRAEREKE
TABORIO
EITA
BIKENIBEU
BONRIKI
TARAWA LAGOON
PACIFIC OCEAN
APPROX EDGE OF REEF
AMBO
NEW PARLIAMENT
T54
BANRAEABA
T20
RMU 20&54
ANTEBUKA
SCOPE OF THE PROJECT
EXISTING
T17
RMU 17
T19
RMU 19
C/B 4
NEW
VOLTAGE
REGULATOR
REPLACE
TEADRAEREKE
MANEABA
CATHEDRAL
CONVENT
T15
RMU 15
T16
RMU 16
T10
RMU 10
T11
RMU 11
T18
RMU 18
CENTRAL GOVERNMENT OFFICE
HOUSE OF REPRESENTATIVES
C/B 3
T12
RMU 12
T13
RMU 13
T14
RMU 14
SUBMARINE CABLE
CHURCH
PARADE GROUND
SCHOOL
PRISON
GOVERNMENT HOUSE
LEGEND
:EXISTING 11kV UNDERGROUND CABLE
TO BE UPGRADED TO 95mm² X 3C
:EXISTING 11kV UNDERGROUND CABLE
0
500
1000m
DWG. NO. TD-G02
11kV DISTRIBUTION SYSTEM
BAIRIKI-AMBO AREA
2/4
11kV配電ルート図： バイリキ － アンボ地区



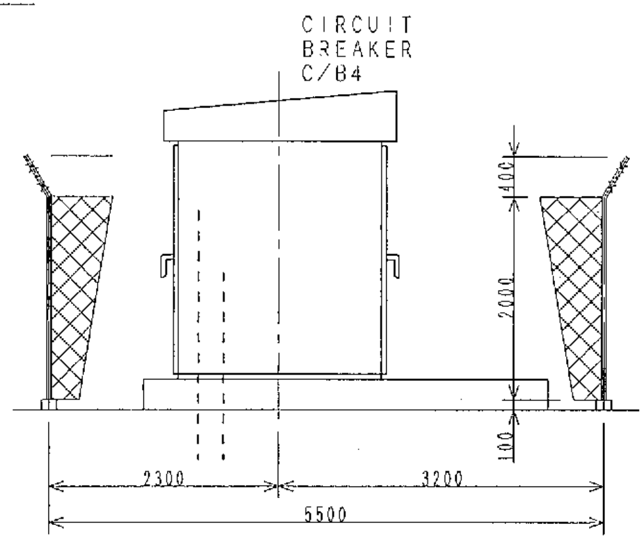
DWG. NO. TD-G03

11kV DISTRIBUTION SYSTEM
AMBO-BANGANTEBURE AREA 3/4
11kV配電ルート図： アンボ － バンガンテブレ地区

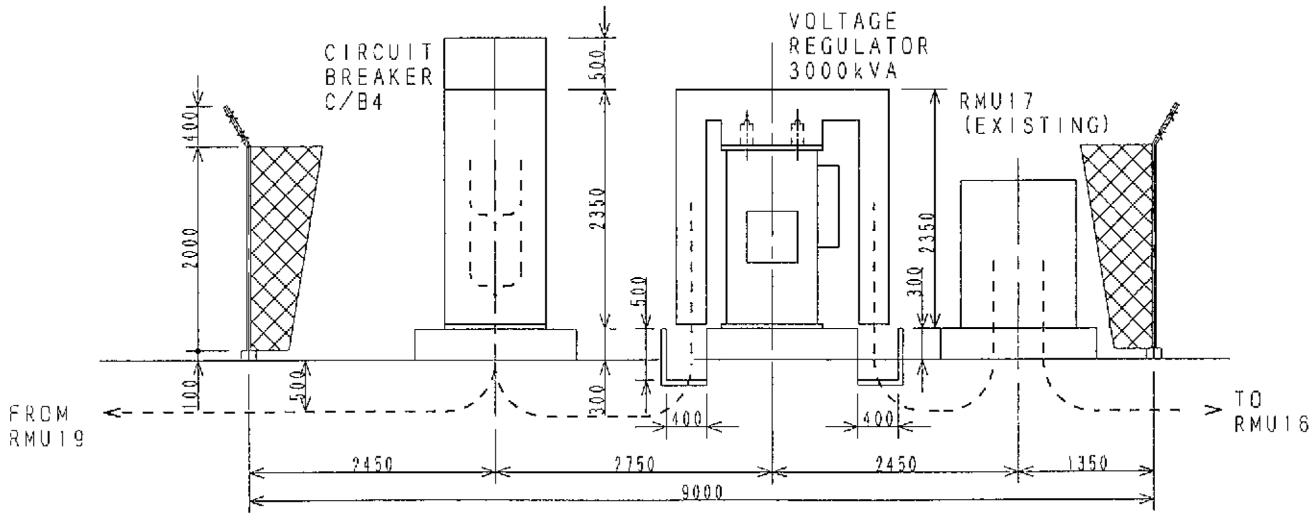

LEGEND
:11kV UNDERGROUND CABLE TO BE INSTALLED TO 25mm² X 3C
:EXISTING 11kV UNDERGROUND CABLE TO BE UPGRADED TO 95mm² X 3C
:EXISTING 11kV UNDERGROUND CABLE TO BE UPGRADED TO 50mm² X 3C
:EXISTING UNDERGROUND CABLE
PACIFIC OCEAN
BUOTA
TANAEA
BONRIKI
AIR-PORT
AIR CRAFT SERVICE AREA
TERMINAL
FISH POND
TEMAIKU BIGHT (Reclaimed Area)
CAUSE WAY
BIKENIBEU EAST
BIKENIBEU WEST
BIKENIBEU
BANGANTEBURE
NEW POWER HOUSE
POWER STATION
TEACHING TRAINING COLLAGE
CHURCH
SCHOOL
APPROX EDGE OF REEF
EXISTING
SCOPE OF THE PROJECT
T59 RMU 59 NEW
T46 RMU 46
T41 RMU 41
T45 RMU 45
T34 RMU 34
T52 RMU 52
T39
T44 RMU 44
T38 RMU 38
T33 RMU 33
C/B 6
T58 RMU58 NEW
T32 RMU 32
T57 RMU57 NEW
T56 RMU56 NEW
T55 RMU55 NEW
T31 RMU 31
T43 RMU 43
C/B 7 NEW
T42 RMU 42
T40 RMU 40
T30 RMU 30
T29 RMU 29
T28 RMU 28
T27 RMU 27
T26 RMU 26
T25 RMU 25
C/B 5
T51 RMU 51
1. 2. 3. 4.
BETIO
BAIRIKI
NANIKAI
BANRAEABA
TEAORAEREKE
TABOBIO
EITA
BIKENIBEU
BONRIKI
BUOTA
0 500 1000m
DWG. NO. TD-G04
11kV DISTRIBUTION SYSTEM
BANGANTEBURE-TANAEA AREA 4/4
11kV配電ルート図： バンガンテブレ － タナエア地区



PLAN



B-B SECTION



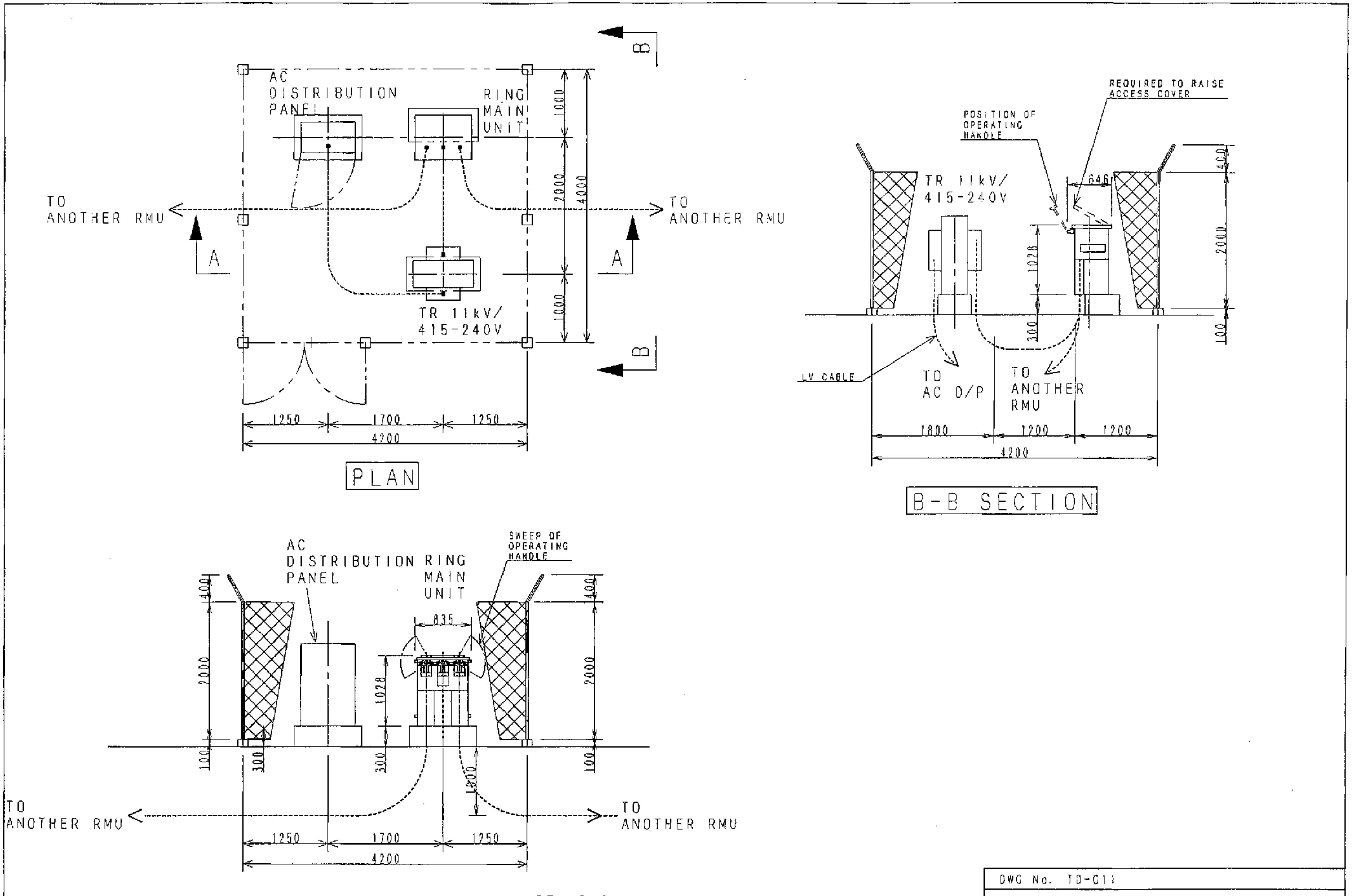
A-A SECTION

Remarks:
O/W:OIL/WATER SEPARATOR

DWG No. TD-G10

LAYOUT OF
VOLTAGE REGULATOR
電圧調整器配置図

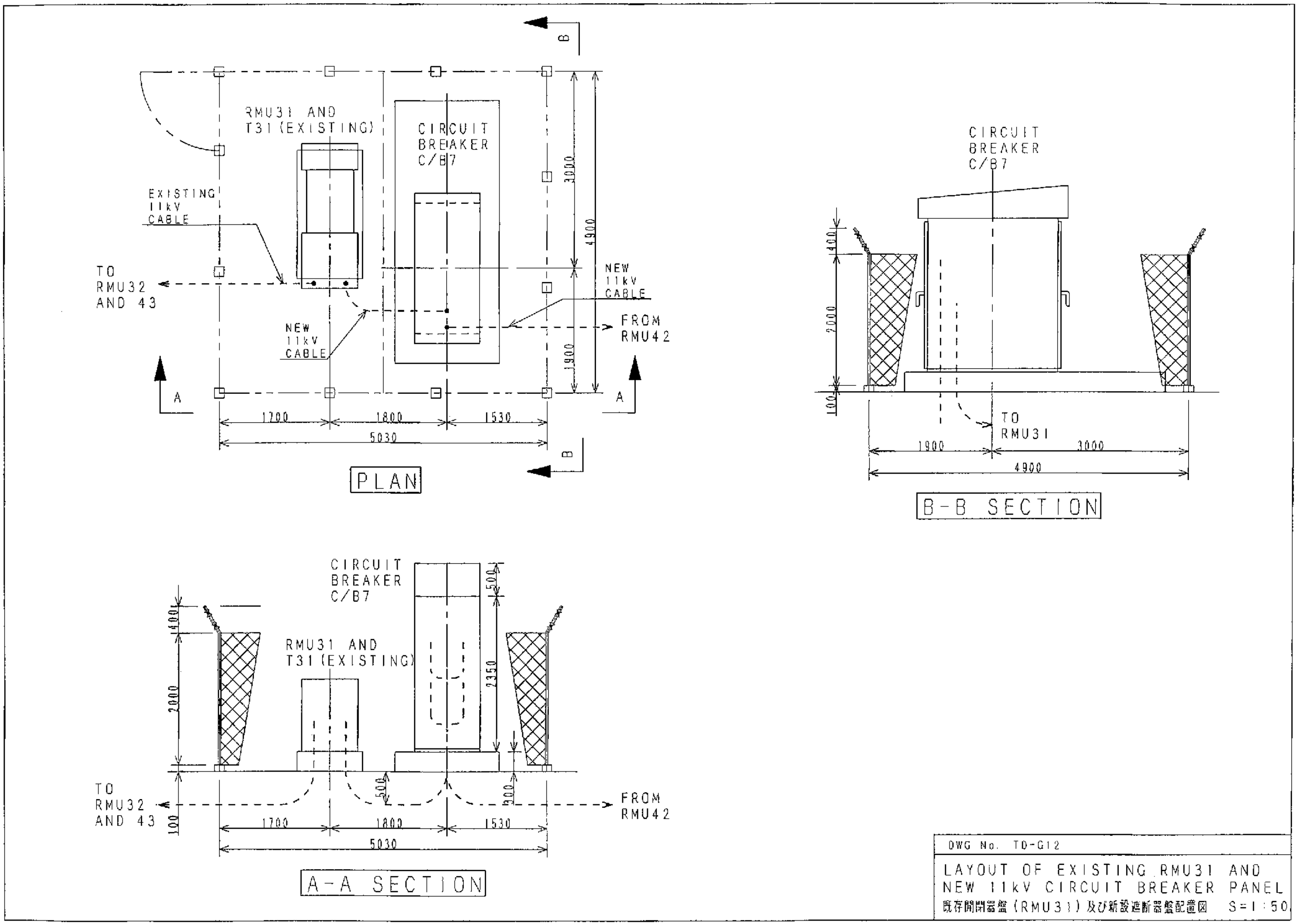
S=1:50



A-A SECTION

REMARKS:
AC DISTRIBUTION PANEL SHALL BE SUPPLIED AND INSTALLED BY KIRIBATI SIDE.

DWG No. TD-G11
LAYOUT OF DISTRIBUTION TRANSFORMER AND RING MAIN UNIT
配電用変圧器及び開閉器盤配置図 S=1:50


B
RMU31 AND
T31 (EXISTING)
CIRCUIT
BREAKER
C/B7
EXISTING
11kV
CABLE
3000
4900
1900
TO
RMU32
AND 43
NEW
11kV
CABLE
FROM
RMU42
NEW
11kV
CABLE
A
A
1700
1800
1530
5030
B
PLAN
CIRCUIT
BREAKER
C/B7
400
2000
100
TO
RMU31
1900
3000
4900
B-B SECTION
CIRCUIT
BREAKER
C/B7
500
RMU31 AND
T31 (EXISTING)
400
2000
2350
500
900
TO
RMU32
AND 43
FROM
RMU42
100
1700
1800
1530
5030
A-A SECTION
DWG No. TD-G12
LAYOUT OF EXISTING RMU31 AND
NEW 11kV CIRCUIT BREAKER PANEL
既存開閉器盤（RMU31）及び新設遮断器盤配置図 S=1:50

2.2.4 Implementation Plan/Procurement Plan

2.2.4.1 Implementation Policy/Procurement Policy

The Project will be implemented within the framework of the grant aid system of the Government of Japan. Accordingly, the Project will only be implemented after it's approval by the Government of Japan and the formal Exchange of Notes between the Government of Japan and the Government of Kiribati. The basic issues and special points for consideration for the implementation of the Project are described below.

(1) Project Implementation Body

The organization responsible for the implementation of the Project on the Kiribati side is the Ministry of Works and Energy (MWE) while the Public Utilities Board (PUB) of Kiribati will be in charge of the actual implementation of the Project. The PUB is responsible for all aspects of public electricity services in Kiribati, ranging from studies and planning to construction, operation and maintenance.

The Kiribati side should appoint a person in the PUB to be responsible for the Project through close communications and consultations with the Japanese Consultant and Contractor to ensure the smooth implementation of the Project. The selected person will be required to explain the contents of the Project to staff of the Bikenibeu Power Station and related government officials in Kiribati. He will also fully explain the Project to local people who live around the Project areas to obtain their understanding and will provide guidance for local people in view of their safety during the construction period and their cooperation with the Project to ensure its smooth progress.

(2) Consultant

In order to construct the necessary facilities and to procure and install the necessary equipment for the Project, the Japanese Consultant will conclude a consultancy agreement with the PUB and will conduct the detailed design and supervision of the site work for the Project. The Consultant will also prepare the tender documents and will execute the prequalification and tender on behalf of the PUB, i.e. the project implementation body.

(3) Contractor

The Contractor, which will be a Japanese firm or company selected by the Government of Kiribati by means of open tender in accordance with Japan's grant aid system, will conduct the construction of the planned power house building, etc. and the procurement and installation of the new equipment, etc. As it is deemed necessary for the Contractor to provide after-care in terms of the supply of spare parts and the repair of breakdowns in regard to the new equipment, the Contractor must give proper consideration to the establishment of a post-Project liaison system.

(4) Necessity to Dispatch Japanese Engineers

The planned generating facility construction work and distribution line upgrading work are combination of civil and building work and installation work for generating and distribution equipment, both of which will be simultaneously conducted. This complexity will make it necessary to dispatch a site manager from Japan to provide consistent management and guidance on schedule control, quality control and work safety. In regard to the power house construction work, including the foundation work, the local shortage of skilled engineers in this field will make it essential for the Contractor to dispatch Japanese engineers to Kiribati to ensure proper quality control and schedule control. Moreover, the planned installation of the generating and distribution equipment will demand wide-ranging knowledge and expertise in regard to the equipment functions and configuration. Accordingly, the equipment manufacturers will be required to dispatch experts at appropriate times to supervise the installation, test operation and adjustment of the new equipment.

In general, the likelihood of equipment breakdown can be illustrated by the bathtub curve which is classified into three periods, i.e. initial breakdown period, accidental breakdown period and abrasion breakdown period. A proper response to necessary repairs in the initial breakdown period during which the number of breakdowns is comparatively high is very important to ensure the long life of equipment. Accordingly, the dispatch of electrical and mechanical engineers will be considered within the period of the E/N to assist the work to repair initial breakdowns.

2.2.4.2 Implementation Conditions/Procurement Conditions

(1) Conditions of Construction Industry in Kiribati

1) While it is possible to employ laborers in Kiribati for construction work, there are not many skilled workers or engineers with specialist knowledge and technical expertise regarding schedule, quality and safety control, etc. This will make it necessary for the Japanese Contractor to dispatch engineers and/or skilled workers to Kiribati when deemed appropriate.

2) As it will be difficult to recruit local engineers capable of installing and tuning the medium size generating units to be provided under the Project, the dispatch of Japanese engineers is planned to supervise such work as well as the schedule control as referred to in 2.2.4.1-(4).

3) As the minimum construction equipment and other machinery required for the site construction work and inland transportation and installation of equipment under the Project are available in Kiribati, they will be procured locally.

(2) Special Points to Note for Construction Planning

1) The rainy season in Tarawa lasts from November to April. Appropriate measures, including the planning of shelter from rain and rainwater drainage, should be introduced for the excavation work and the 11 kV high voltage cable laying work during this period. In addition, it will be necessary for the schedule plan to take the rainy season into consideration.

2) The installation of the generating units should commence as soon as the main construction work of powerhouse has been completed and the mechanical and electrical equipment work should be simultaneously conducted to minimize the work duration.

3) The planning of the implementation of the existing 11 kV distribution line rehabilitation work should include measures to minimize any adverse impacts on the lives of islanders due to power cuts and traffic restrictions, etc., including the introduction of a temporary bypass line.

4) The excavation work for the existing 11 kV cables should be carefully conducted to avoid any damage to the existing underground water supply, sewerage and telephone lines. The schedule should be planned so as to avoid overlapping with the SAPHE Project.

5) The generator installation work and finishing work for the power house building is likely to be simultaneously conducted to strictly meet the contracted completion date and, therefore, special attention must be paid to work safety because of the likelihood of the simultaneous implementation of the construction and installation work on different levels with some workers working above others.

6) In the case of any additional work, such as the cutting of existing trees, being found necessary, the scope of the required work and its timing, etc. must be agreed by the PUB in advance. The agreed scope of work and timing, etc. must then be strictly observed.

7) In the case of the use of groundwater being found necessary as water for concrete, the water quality in terms of the salt content and other aspects must be controlled to ensure the required quality of the concrete and other relevant items.

2.2.4.3 Scope of Works

The division of work between the Japanese side and the Kiribati side under the Project is shown in Table 2-2-8.

Table 2-2-8 Division of Work between Japanese Side and Kiribati Side

Work Item	Japanese Side	Kiribati Side
1. Generating Units		
1) DEGs	Supply and installation	
2) Auxiliary Mechanical Equipment for DEGs	Supply and installation	
3) Auxiliary Electrical Equipment for DEGs	Supply and installation	
4) Fuel Oil, Cooking Water and Compressed Air Systems	Supply and installation	
5) Grounding System	Supply and installation	
6) Maintenance Tools	Supply only	Storage
7) Repair Equipment	Supply only	Storage
8) Spare Parts	Supply only	Storage
9) O & M Manuals	Supply and explanation	Storage and study
10) OJT	Implementation	Attendance
11) Cleaning of Construction Site, etc.		Implementation
2. Distribution Facilities		
1) New 11 kV Voltage regulator	Supply and installation	
2) Existing 11 kV Voltage regulator	Removal	Storage
3) New 11 kV Ring main units and Distribution Transformers	Supply and installation	
4) Existing 11 kV Ring main units (RMU 19, 23, 44) and Distribution Transformers		Relocation
5) New Distribution Circuit Breaker Panel	Supply and installation	
6) Existing Circuit Breaker Panel (CB 4)		Removal for storage
7) New 11 kV Cables with Connecting and Terminal Treatment Materials	Supply and installation	
8) Removal of existing 11 kV Cables	Removal	Storage
9) Low Voltage Cables with Accessories		Procurement and installation
10) Installation Apparatus and Fencing Materials	Supply and installation	
11) Maintenance Tools	Supply only	Storage
12) Spare parts	Supply only	Storage
13) O & M Manuals	Supply and explanation	Storage
14) OJT	Implementation	Attendance
15) Preparation and Cleaning of Construction Site		Implementation
16) Removal of Trees and Other Obstacles		Implementation
3. Power House		
1) Premise Road	Design and construction	
2) Power House Building	Design and construction	
3) Rainwater Supply System for Power House Building	Design and construction	
4) Fuel Tank Foundations and Oil Retaining Wall	Design and construction	
5) Rainwater Drainage System	Design and construction	
6) Furniture and Curtains		Procurement and installation
7) Materials for Temporary Electrical, Water Supply and Telephone Work	On premises only	
8) Charges for Temporary Electrical, Water Supply and Telephone Services	Payment	
9) Fuel Oil and Lubricant Oil up to No-Load Test for Generating Units	Supply	
10) Fuel Oil and Lubricant Oil after No-Load Test of Generating Units		Procurement

2.2.4.4 Work Supervision/Procurement Supervision Plan

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

(1) Supervision Principles

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

1) Schedule Control

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

① Quantity of the work conducted (including the volume of manufactured equipment by the manufacturers)

② Confirmation of the preparations for the temporary work and construction machinery

③ Quantity of the equipment and materials delivered (for generating and construction purposes)

④ Work efficiency and actual number of engineers, technicians and workers at work

2) Safety Control

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

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

② Enforcement of the safety control rules and regular confirmation

③ Prevention of accidents to workers by means of the periodical inspection of the construction machinery

④ Introduction of traveling routes for work vehicles and construction machinery, etc. and the thorough enforcement of slow driving on the site

⑤ Enforcement of welfare measures and days-off for workers

(2) Project Implementation Regime

The project implementation regime, i.e. relationship between the parties involved in the implementation of the Project, including at the work supervision stage, is shown in Fig. 2-2-1.

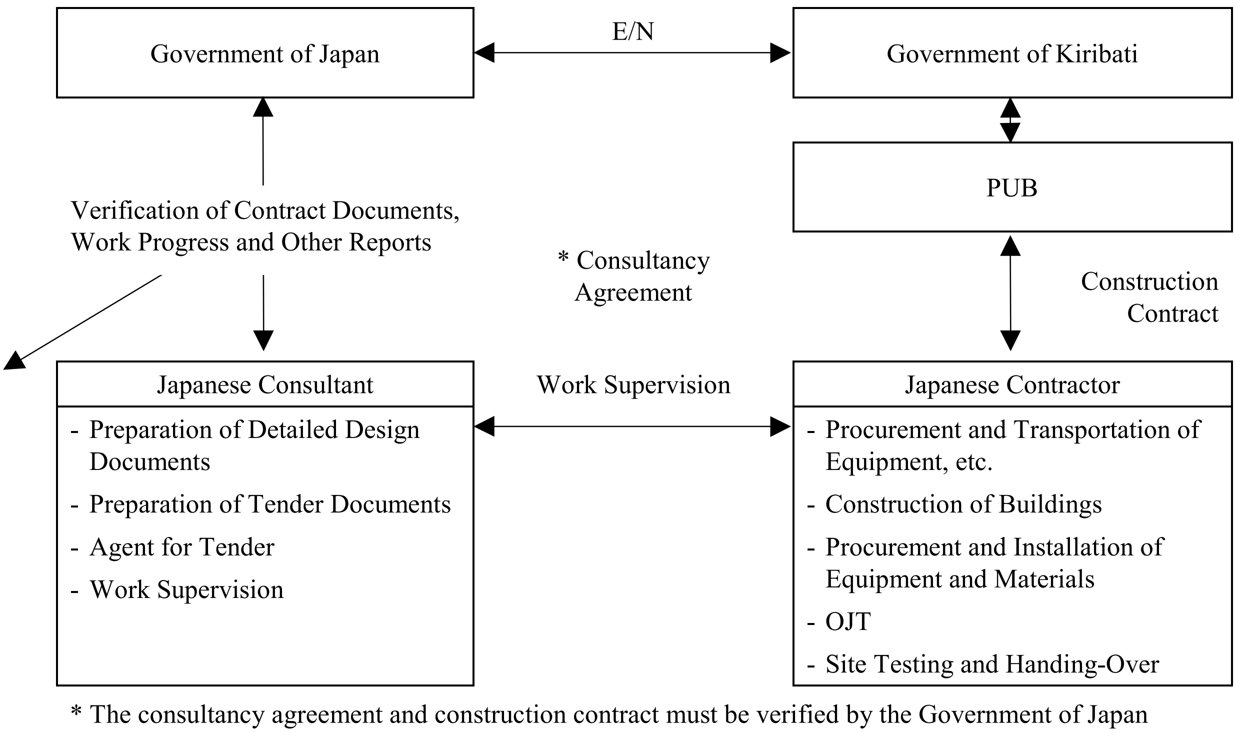


Fig. 2-2-1 Project Implementation Regime

(3) Work Supervisors

The Contractor must be capable of providing appropriate technical guidance for local construction companies in Kiribati in view of the smooth implementation of the construction work and equipment procurement and installation work as described in the detailed design documents within the planned work period. Moreover, it is desirable that the Contractor dispatches a site supervisor to Kiribati with previous experience of similar projects to ensure the high quality of the work to be conducted. Given the size and contents of the Project, the appointment of the following full-time on-site supervisors by the Contractor is deemed essential.

Site Manager (1) : general management of on-site work

In addition to the above, the further dispatch of engineers will be required in accordance with the work progress. The subject areas for expert supervision will include equipment installation and test running/adjustment.

2.2.4.5 Quality Control Plan

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

① Checking of the shop drawings and specifications for equipment

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

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

④ Checking of the installation manuals, on-site test running, inspection and test manuals and working drawings for the equipment

⑤ Checking of the test running, adjustment and inspection manuals

⑥ Supervision of the site installation of the equipment and attendance at the test running and inspection

⑦ Comparison between the building work drawings and the completed work

2.2.4.6 Procurement Plan

The planned equipment and materials for construction and procurement under the Project are not produced in Kiribati except for concrete aggregate. 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 such substation equipment as ring main units, those made in a third country (New Zealand) are commonly used in Kiribati. This equipment has been well maintained by the maintenance staff of the PUB who are quite familiar with the operation and maintenance of the said equipment. Consequently, this equipment will be procured from a DAC country under the Project.

The planned equipment and material supply sources for the Project are shown in Table 2-2-9 based on a comparative analysis of possible sources from the viewpoints of (i) reliability in terms of standards, specifications, quality, production and supply, (ii) ease of operation and maintenance and (iii) availability of after-services for spare parts supply and breakdown repair, etc.

Table 2-2-9 Equipment and Material Supply Sources

Equipment/Materials	Supply Source		
	Kiribati	Japan	Third Country
Diesel Fuel Oil, Lubricating Oil, Cooling Water	○		
Sand	○		
Cement	○		
Gravel	○		
Structural Steel		○	
Building Finishing Materials		○	
DEG Units (Diesel Engines, Generators and Electrical/Mechanical Equipment, Plumbing Materials and Power Cables, etc.)		○	
Spare Parts for Above		○	
Maintenance Tools for Above		○	
Distribution Equipment			
• Voltage regulator		○	
• Distribution Transformers		○	
• Distribution Circuit Breaker Panels		○	
• Ring Main Unit			○
• Distribution Cables, etc.		○	
Construction Machinery (Backhoe, Dump Truck, Truck Crane, Generator, Water Pump and Others)		○	

2.2.4.7 Implementation Schedule

According to Japan's grant aid scheme, the Project will be implemented in accordance with the following schedule.

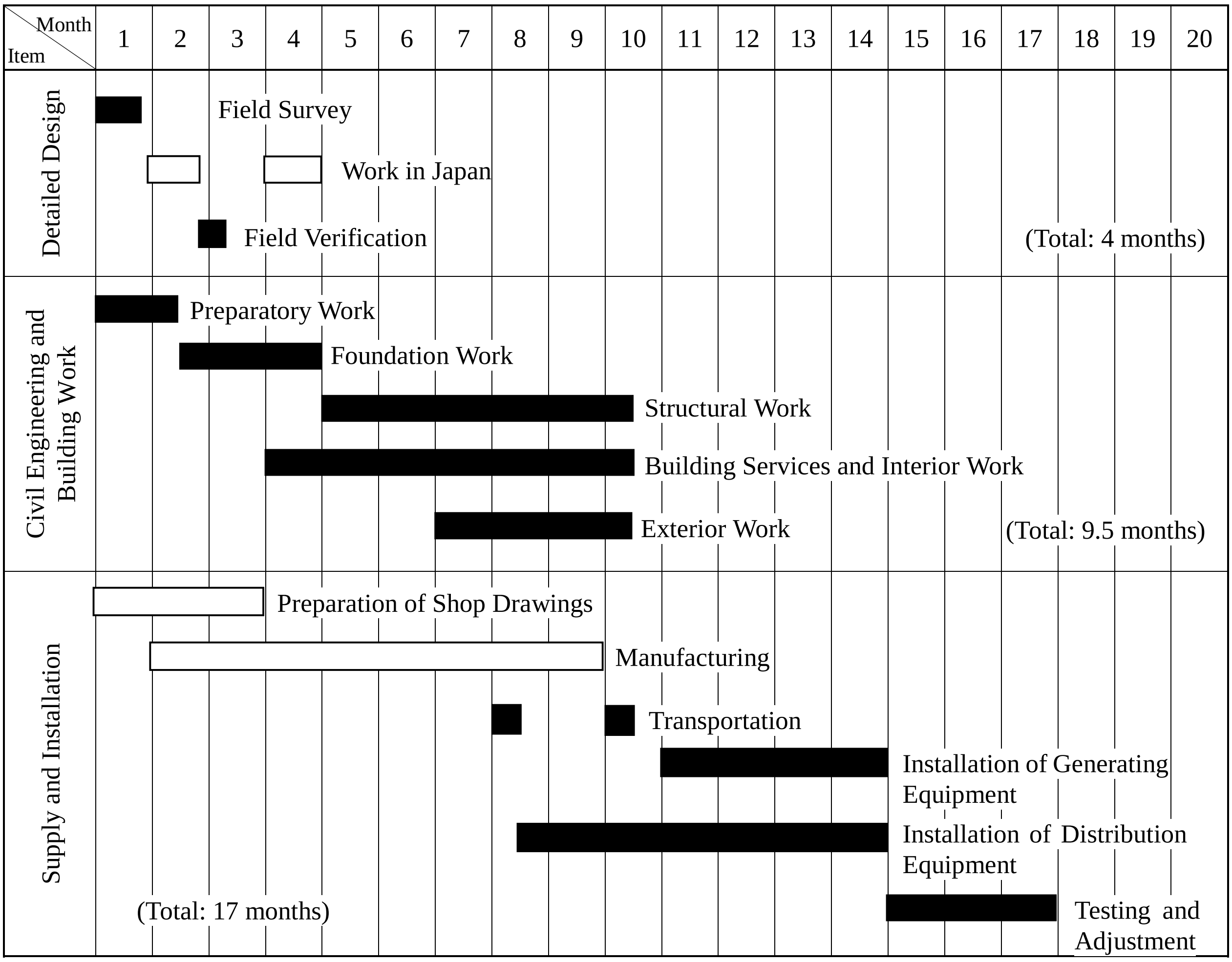


Fig. 2-2-2 Project Implementation Schedule

2.3 Obligations of Recipient Country

In the course of the implementation of the Project, the Government of Kiribati will be responsible for conducting the following works or providing the following items in addition to the scope of work the Kiribati side described in 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 new power house and oil tank yard 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 Kiribati.

(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 Kiribati 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 Kiribati 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 procure and install the 415 V distribution equipment and materials in accordance with the implementation schedule which meets the relevant requirements of Japan's grant aid scheme.

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

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

(14) To complete the entrance gate relocation work at the power station prior to the commencement of the work by the Japanese side.

(15) To ensure and complete the necessary procedures to use land for the temporary 11 kV distribution line and the securing of the said land.

(16) To take necessary measures and coordination regarding the laying of the new 11 kV distribution lines and to coordinate with other projects.

(17) To remove all obstacles on the planned distribution line route and new substation area.

2.4 Project Operation Plan

(1) Maintenance Plan

1) Maintenance System

Among the equipment to be provided under the Project, the generating units are the most important equipment in regard to maintenance. The proper operation and maintenance of these units and the proper maintenance of their 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 units 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.

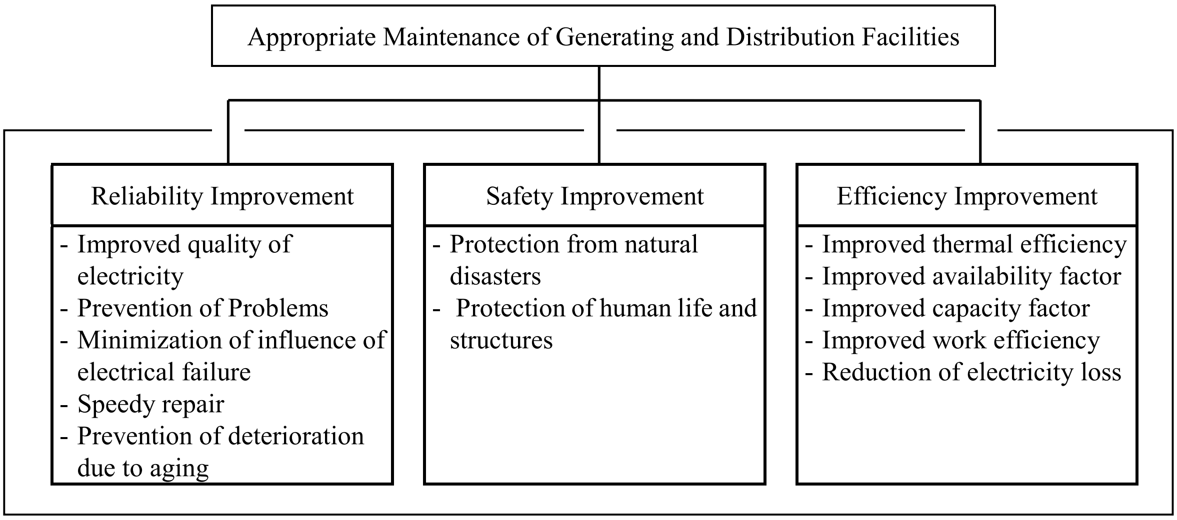


Fig. 2-4-1 Basic Concept of Maintenance of Generating and Distribution Facilities

It will be necessary for the PUB to prepare an operation plan for the Bikenibeu and Betio Power Stations in accordance with their respective load patterns to ensure economical operation.

2) Personnel Training Plan

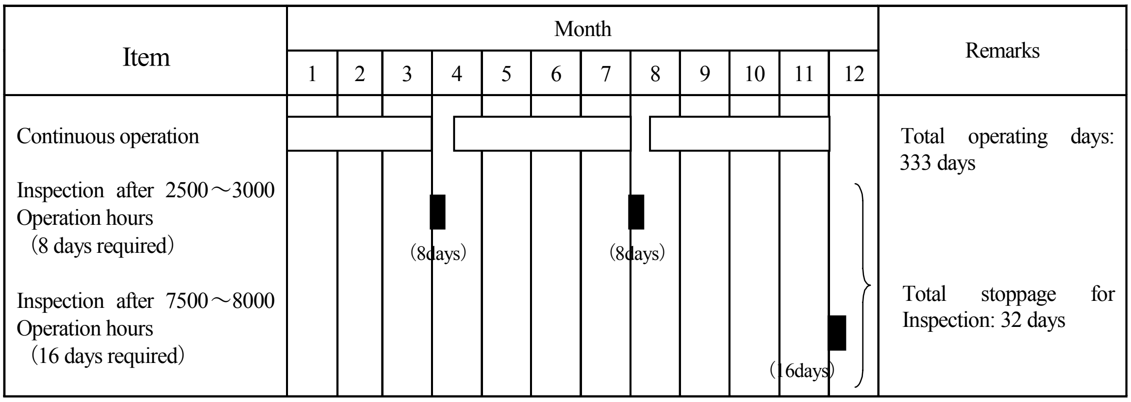
For the successful outcome of the Project, it will be necessary for the Kiribati side to conduct adequate operation and maintenance of all of the equipment using the O&M techniques transferred to the Kiribati side through OJT to be provided by the engineers to be dispatched by the Contractor during the installation work and 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) Operating Plan for New Generating Units

The planned new generating units 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 availability 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 units while Fig. 2-4-2 shows the annual operation programme for the same units 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 units will be suspended for approximately 32 days/year as shown in Fig. 2-4-2. Power supply by the No. 8 unit of the Betio Power station and the standby generating units should be operated during this period to compensate for the loss of power supply by the new generating units.



Note: Based on an annual availability factor of 90%.

Fig. 2-4-2 Annual Operation Programme for New Generating Units

(3) Periodical Inspection Items

1) Generating Facility

The standard items for the periodical inspection of the planned generating units are shown in Table 2-4-1. The Kiribati side will be required to prepare an operation and maintenance plan for the planned generating units in accordance with the O & M manuals to be submitted by the manufacturers with a view to establishing an economical operation programme for these units 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 heat 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 rotor if necessary - Overhauling, inspection and replacement of lubricating oil pump attached to engine if necessary
Generator	Daily Inspection	- Visual inspection of all sections and checking of abnormal sound and temperature
	Monthly Inspection	- Checking of abnormal vibration - Checking of lubricating oil flow and oil leakage from bearings - Necessary cleaning of components
	Annual Inspection	- Measurement of insulation resistance and inspection of lead wires and terminals - Visual inspection of accessories, including space heater - Visual inspection of bearings and cleaning if necessary

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 circuit breakers and ring main units

(4) Fuel Oil Procurement Plan

The estimated fuel (diesel oil) consumption to operate the two new generating units (1,400 kW each) is approximately 5,800 m^3/year based on an assumed availability factor of 90%.

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

(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 PUB 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 Kiribati 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.

(6) Operating Balance of New Generating Units

The PUB currently charges A$ 0.35/kWh for ordinary households and A$ 0.42/kWh for commercial and industrial premises, averaging A$ 0.39 kWh. The estimated operating income and expenditure of the new generating units based on this tariff are shown in Table 2-4-4. As the table shows, if the annual capacity factor drops below 60%, it will be difficult for the power station to sustain self-financing operation. However, if the annual capacity factor exceeds 60%, the overall balance is expected to produce a profit. In view of such a prospect, the PUB should properly maintain the generating units, establish the state of load and implement the optimal operating program for the generating facilities in order to achieve an economical (profitable) operating rate.

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 s pare 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 discharge 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 Equipments and Auxiliaries	
(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 12kV 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
12) Tripping and Closing Coil for Circuit Breaker	1 set

I-2. Spare Parts for Distribution Line

Item	Q'ty
(1) Consumable Spare Parts	
1) Fuse Elements for Low Voltage Circuit	200% for each type
2) Lamps or Bulbs for Indicator	200% for each type
3) Silica gel for Voltage Regulator	3 kg
4) 11 kV Cable for Temporary connection route (11 kV XLPE 1C x 25 sq mm) with cable termination kit	2 km x 3 sets, 1km x 3 sets

II. Maintenance Tools and Instruments

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

III. Repair tools

Item	Q'ty
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. Common Use for Generator and Distribution Line Equipments	
(1) Earthing Equipment Set (3Phase Set)	2 sets

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effect

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

(1) Direct Effect

Current Situation and Problems	Improvement Measures Under the Project (Grant Aid Portion)	Project Effects and Degree of Improvement
1. The generating units of the existing Betio and Bikenibeu Power Stations are nearly 30 years old. The general deterioration and difficulty of obtaining general-purpose spare parts have resulted in a huge decline of the available capacity. The inadequate maintenance has led to an average fuel consumption rate of 0.339 liters/kWh, indicating poor operation efficiency.	Construction of a new power station (New Bikenibeu Power Station: 2×1,400 kW) to provide urgent reserve supply capacity up to the target year of the Project (2004)	Establishment of a reserve supply capacity up to 2004 will enable the implementation of proper maintenance work according to the increasing of generating capacity and improvement of the fuel consumption rate by an average of 5%.
2. The existing 11 kV distribution lines are mainly 20 – 30 years old and their small cable size causes a large voltage drop, resulting in a large distribution loss of more than 20%.	Rehabilitation of some 16 km of the total 54 long existing 11kV trunk distribution network	The improved power supply reliability of the distribution network will establish a power supply system with few power cuts or breakdowns and the distribution loss will improve to some 10%. Power supply will become available for some 350 waiting consumers.
3. The two existing power stations in the Project Area are independently operated without a system link, resulting in the poor quality of electricity, low supply reliability and several power shut down.	Replacement of the existing voltage regulator (1,250 kVA currently out of use) at Teaoraereke by a new 3,000 kVA unit	Connection between the two existing power stations will enable flexible operation between the two, reducing the frequency and duration of power cuts. An appropriate distribution voltage will be secured.
4. There are some 700 waiting consumers in South Tarawa. Despite their strong hope to receive power supply, no new connection	New construction of some 5 km of 11 kV distribution lines and four distribution substations in Temaiku and the construction of one new distribution substation in Buota	Some 350 waiting consumers in Temaiku, Bonriki and Buota will be electrified.
5. The power supply to the Bonriki Pump Station, which is the water source for the water supply system in South Tarawa, and to the international airport is unstable	Creation of an 11 kV distribution loop in Temaiku with the construction of a some 5 km long 11 kV distribution line in the area	A stable power supply to the international airport and the new pump station will be secured.

Current Situation and Problems	Improvement Measures Under the Project (Grant Aid Portion)	Project Effects and Degree of Improvement
6. While a water supply and sewerage facility improvement program is currently in progress in South Tarawa under the SAPHE Project, the power supply capacity to the new equipment to be installed under the Program is insufficient.	Installation of new generating units (two x 1,400 kW) at the Bikenibeu Power Station	A stable power supply will be secured for some 30 water pumps for the elevated water tanks and drainage pumps to be installed between Bikenibeu and Betio.

(2) Indirect Effect

Current Situation and Problems	Improvement Measures Under the Project (Grant Aid Portion)	Project Effects and Degree of Improvement
1. Power facilities in South Tarawa are unreliable due to the lack of a stable power supply capacity, causing adverse impacts on the lives of local people and the operation of public facilities.	Construction of a new power station (New Bikenibeu Power Station: 2 x 1,400 kW) and rehabilitation and new construction of the 11 kV distribution network	The stable and reliable operation of public facilities (hospitals, schools, public offices and churches, etc.) serving some 83,000 people will become a reality. The new installation of street lamps, etc. will improve the security of local people and the expanded hours for activity will stimulate economic activities.
2. While many users currently have an independent generators, the lack of expert involvement in the operation and maintenance of such generators is creating a hazardous situation in terms of personal accidents and environmental pollution, etc.	Installation of new generators (2 x 1,400 kW) at the Bikenibeu Power Station	The operation and maintenance of the power generating facilities will be centralized to the PUB, reducing the likelihood of personal accidents and environmental pollution involving independent generators.
3. Waste lubricant oil, etc. from the Betio and Bikenibeu Power Station leak beyond the premises, causing environmental deterioration around these stations.	Installation of new generators (2 x 1,400 kW) at the Bikenibeu Power Station	The shortening of the operating hours of the existing power stations will reduce the amount of waste oil. In addition, it will become possible to prepare appropriate measures to prevent environmental pollution.

3.2 Recommendations

It will be necessary for the Kiribati side to conduct the following tasks to ensure the realization and continuation of the effects of the Project.

(1) It will be necessary for the Kiribati side to fully note the SAPHE Project and others of which the work periods overlap with that of the planned upgrading of the existing

distribution lines and to regularly establish the progress situation and schedules of these projects to avoid any conflict between these projects and the Project.

(2) While the stand-by power supply capacity up to the year 2004 will be secured with the completion of the Project, it will be necessary for the Government of Kiribati to periodically review the likelihood of a further increase of the power demand after 2004 and to formulate a plan to increase the power supply capacity accordingly. In addition, it will also be necessary for the Government of Kiribati to secure the necessary budget for the procurement of new equipment.

(3) The Kiribati side should urgently formulate a rehabilitation plan for those 11 kV lines of which the rehabilitation is not included in the Project in order to further reduce the distribution loss and to improve the power supply reliability. At the same time, appropriate energy conservation measures should be prepared and implemented.

(4) It will be necessary for the PUB to record the generating efficiency and other performance of each of the new and existing generating units to assist the formulation of an economical operation program. The PUB should also establish the actual load for each Distribution transformer to select the transformer capacity and size of low voltage distribution cable to suit the load.

(5) A gradually increasing power tariff where the unit charge increases with a higher level of consumption should be introduced to provide an incentive for large consumers to reduce their power consumption while providing a low rate for poor households.

(6) The introduction of a subsidy scheme or preferential measures for poor households and social welfare facilities should be considered in regard to the sharing of the distribution line installment cost by consumers to facilitate electrification as soon as possible.

(7) The optimal tap value for the Distribution transformers should be selected for each installation site to improve the quality of the power supplied and to reduce the distribution loss.

The Project will be implemented more smoothly and its effects will be further enhanced if the above tasks are achieved by the Kiribati side. As the AUSAID plans to provide technical assistance for the operation and maintenance of the existing power facilities for a period of two years from April, 2001, not only the maintenance skills but also the management capability of the PUB are expected to further improve.