BASIC DESIGN STUDY REPORT ON THE DAR ES SALAAM POWER SUPPLY SYSTEM EXPANSION PROJECT IN THE UNITED REPUBLIC OF TANZANIA DECEMBER, 1996

MINISTRY OF ENERGY AND MINERALS
TANZANIA ELECTRIC SUPPLY CO.,LTD.
THE UNITED REPUBLIC OF TANZANIA

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PREFACE

In response to a request from the Government of the United Republic of Tanzania the Government of Japan decided to conduct a basic design study on the Dar es Salaam Power Supply System Expansion Project and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to Tanzania a study team from July 25, to August 19, 1996.

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

December, 1996

Kimio Fujita
President
Japan International Cooperation Agency

December, 1996

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Dar es Salaam Power Supply System Expansion Project in the United Republic of Tanzania.

This study was conducted by EPDC International Ltd., under a contract to JICA, during the period from July 17, 1996 to January 31, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tanzania and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

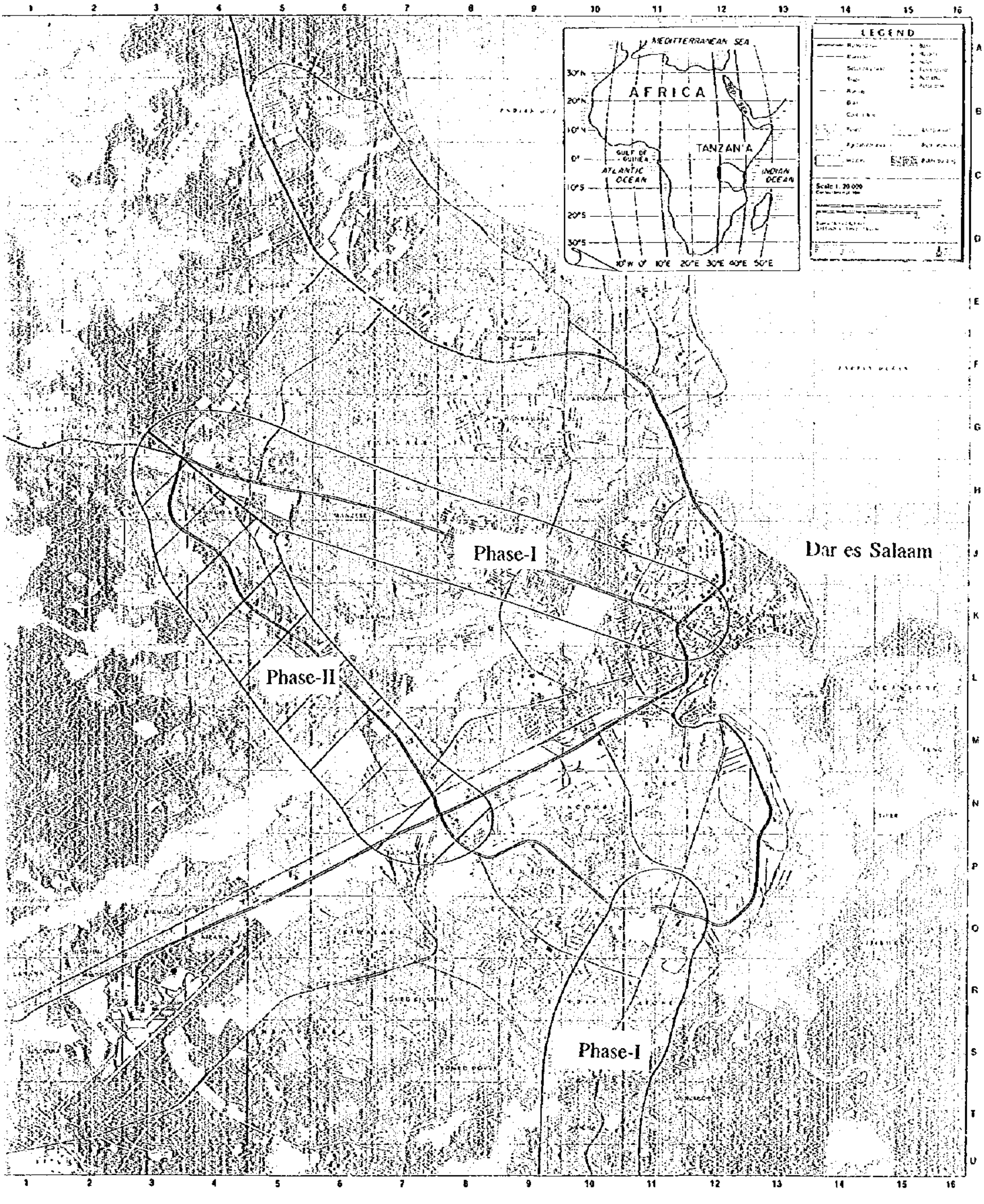
Finally, we hope that this report will contribute to further promotion of the project.

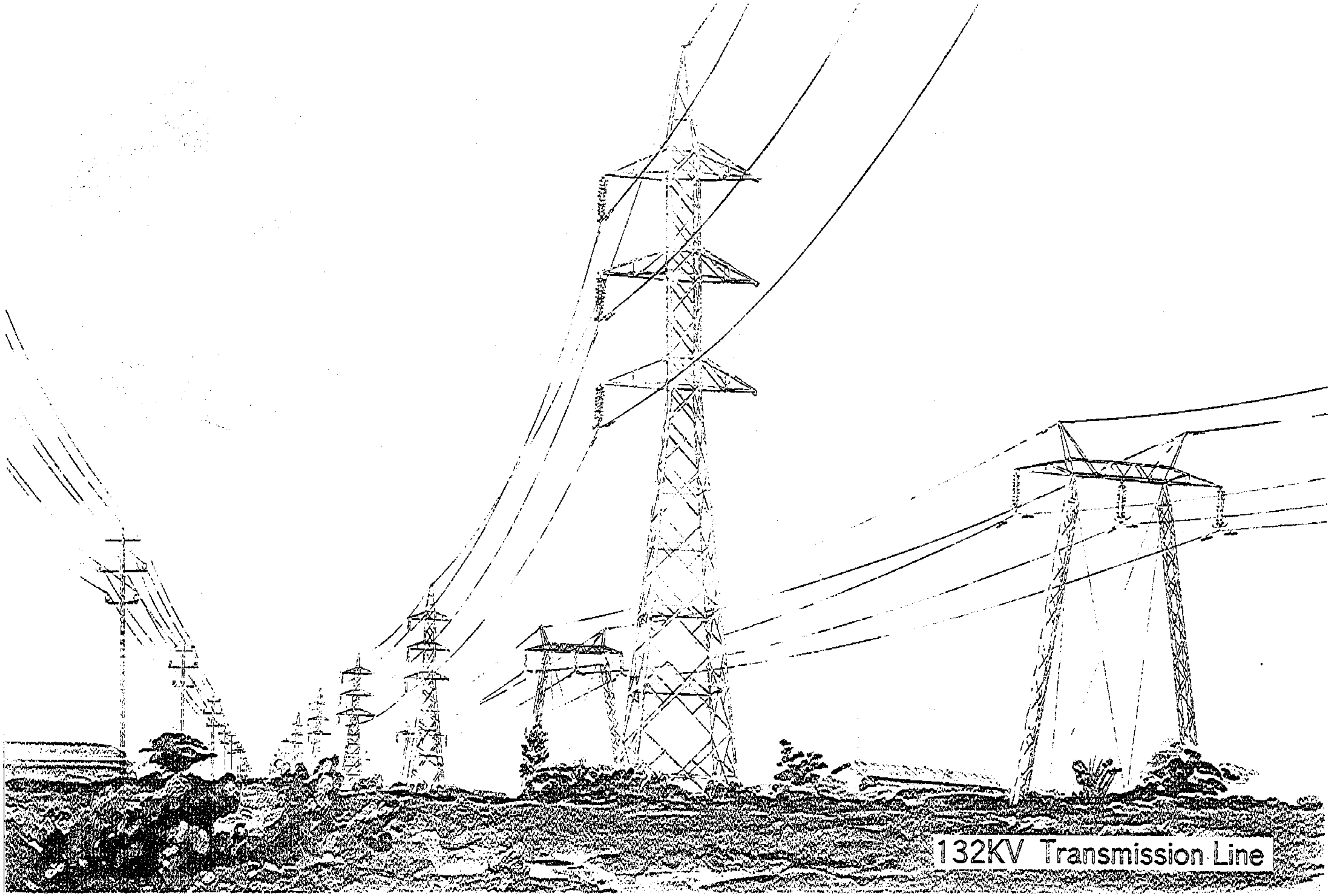
Very truly yours,

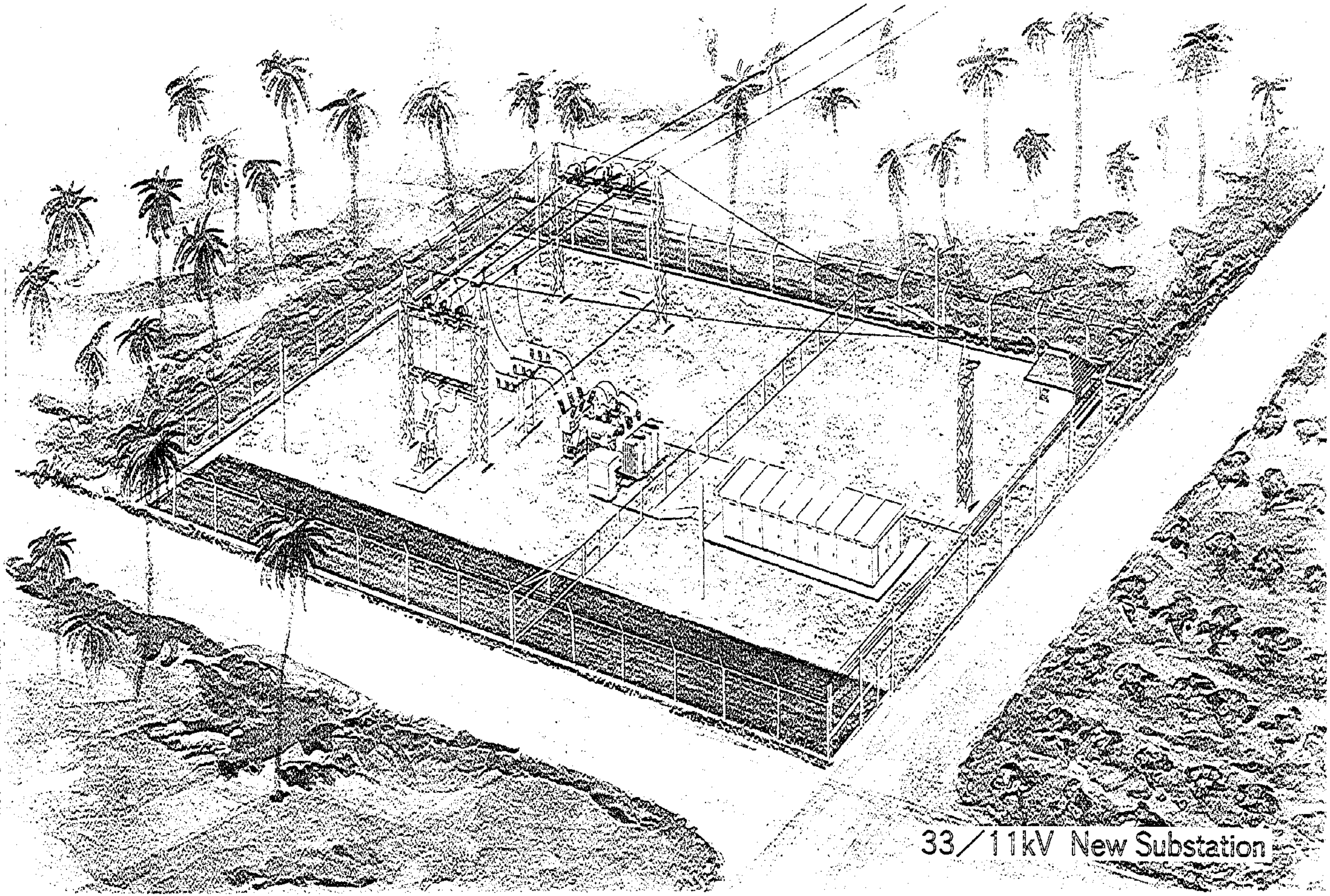
H. Kitazawa

Hitoshi Kitazawa
Project manager,
Basic design study team on the Dar es Salaam
Power Supply System Expansion Project
EPDC International Ltd.

Location Map




132KV Transmission Line


33／11kV New Substation

Abbreviations

Abbreviations

Agencies

MEM	:	Ministry of Energy and Minerals
MOF	:	Ministry of Finance
TANESCO	:	Tanzania Electricity Supply Company Limited
EMB	:	Embassy
JICA	:	Japan International Cooperation Agency
IMF	:	International Monetary Fund
IDB	:	Inter-American Development Banks
EIB	:	Europian Investment Bank
NORAD	:	Norgian Agency for Development Cooperation
ADF	:	African Development Bank
IPP	:	Indepedent Power Producer
KFW	:	Kreditanstalt für Wiederaufbau
SIDA	:	Canadian International Development
ERPs	:	Economic Recovery Programms
ODA	:	Overseas Development Administration
ADB	:	Asian Development Bank

Term

E/N	:	Exchange of Notes
GDP	:	Gross Domestic Products
GNP	:	Gross National Products
OJT	:	On Job Training
LLDC	:	Least Developed Country
SCADA	:	System Control and Data Aquisition
IEC	:	International Electrotechnical Commission
BS	:	British Standards
UK	:	United Kingdom
F/S	:	Feasibility Study
S/S	:	Substation
JIS	:	Japanese Industrial Standards
ASTM	:	American Society of Mechanical Engineers
ACSR	:	Aluminum Cable Steel Reinforced
MCM	:	Meter Circular Mil
JCS	:	Japan Cable Manufacturer Association Standards
XLPE	:	Crosslinked Polyethylene
LBS	:	Load Break Switch
LV	:	Low Voltage
US$	:	United States dollar
T.sh	:	Tanzania Shillings
G/T	:	Gas Turbine

Unit

kW	: Kilowatt	$= 10^3 W$
kWh	: Kilowatt hour	$= 10^3 Wh$
MW	: Megawatt	$= 10^3 kW$
MWh	: Megawatt hour	$= 10^3 kWh$
GWh	: Gigawatt hour	$= 10^6 kWh$
Hz	: Hertz (cycles per second)	
H.W.L	: High Water Level	
L.W.L	: Low Water Level	
kVA	: Kilovolt Ampere	$= 10^3 VA$
MVA	: Megavolt Ampere	$= 10^3 kVA$
kV	: Kilovolt	$= 10^3 V$
kA	: Kiloampere	$= 10^3 A$

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(Appendices)

Chapter 1 Background of the Project

Chapter 1 Background of the Project

1-1 Background

Tanzania, with an area of 945,100 km^2 (about 2.5 times as large as Japan), is located in the tropics at the eastern part of Africa facing on the Indian Ocean. The United Republic of Tanzania was established uniting Tanganyika and Zanzibar in April 1964 after colonial period by Germany (1885-1916) and the United Kingdom (1919-1961).

Since independence in 1961, the country has been under a unique agriculture-oriented socialist regime. In the 1980's when the world faced the oil crisis, she was also depressed and barely maintaining herself with assistance by foreign countries.

Then with the financial aids by the World Bank and IMF, she implemented a structural adjustment programme associated with an economic development plan, which has recently given rise to a sustainable direction to go for social and economic development.

The present population is about 28 million (1994) and the annual per capita GNP is still as low as $90 (1993), she unfortunately being regarded as an LLDC country.

The electric industry in Tanzania including generation, transmission, distribution and supply is now fully managed by a semi-governmental company, Tanzania Electric Supply Company Limited (TANESCO).

The total installed capacity of power generation is about 500 MW of which 370 MW has been produced by hydropower plants. The remaining 130 MW has been produced by diesel or gas turbine driven thermal power plants.

Major cities including Dar es Salaam throughout the country are interconnected with 220 kV or 132 kV transmission lines.

The Tanzanian government is now developing a hydropower plant (200 MW) at Kihansi responding to quick increase in electricity demand resulted from increasing social and economic activities. Other power development projects include a gas turbine plant (37.5 MW) and a diesel plant (100 MW) in Dar es Salaam. These two plants will fire natural gas that will be supplied via a pipeline (under construction) from the Songo Songo gas field.

The largest city in Tanzania, Dar es Salaam is consuming about half of the total generation in the country, and the number of consumers in the city is about 124,000. As mentioned above, the generation capacity has been increased, but the distribution facilities have been left not expanded nor rehabilitated because of shortage of funds (no financial aids obtained from foreign countries due to the worldwide economic depression in the early 1980's). As a result, the distribution systems for the city have been significantly deteriorated causing voltage drop, power loss and lower supply reliability.

In 1984, the Japanese government conducted a feasibility study called Dar es Salaam Electric Power Distribution Network Project (F/S). Based on the results of this F/S, the government inplemented three grant aid projects in 1986, 1987 and 1991 respectively for rehabilitation and expansion of the distribution systems for Dar es Salaam. In 1992, Japanese government conducted an additional survey on Dar es Salaam Power Supply System Expansion Project, and prepared the Short Term Master Plan (1993-1997) and Long Term Master Plan (1993-2007) . The report of this study was submitted to the Tanzanian government in March 1994.

Based on this report, the Tanzanian government requested the Japanese government in March 1995 a grant aid for expansion of three existing substations and construction of five new substations. However, since the quick increase in electricity demand required urgent expansion of distribution facilities, it was decided to use finance from the World Bank for four distribution substations (1-expansion and 3-new construction) that were considered to be urgently completed. Following this, in November 1995, the Tanzanian government again requested the Japanese government to have a revised grant aid for the remaining four substations as follows:

1-2 Contents of the Request

(1) Ilala substation
- (a) Adding transformers : 132/33kV 45MVA x 1
  33/11kV 15MVA x 1
- (b) Constructing a 132 kV Ubungo-Ilala transmission line: 7.0 km
- (c) Constructing 11 kV distribution lines: 0.1 km

(2) Factory Zone III substation
- (a) Adding transformers : 132/33kV 45MVA x 2
- (b) Constructing a 132 kV Ubungo-FZ III transmission line: 8.6 km

(3) Kariakoo substation

(a) Constructing a new substation: 33/11kV 15MVA x 1

(b) Constructing a 33 kV Ilala-Kariakoo transmission line: 2.1 km

(c) Constructing 11 kV distribution lines: 4.1 km

(4) Mbagala substation

(a) Constructing a new substation: 33/11kV 15MVA x 1

(b) Constructing a 33 kV Kurasini-Mbagala transmission line: 8.5 km

(c) Constructing 11 kV distribution lines: 3.9 km

(5) Common items

(a) Working vehicles and tools: 1 set

(b) Others including communication facilities: 1 set

1-3 Present Problems

The Survey on Dar es Salaam Power Supply System Expansion Project describes the major problems and their causes in the Dar es Salaan distribution systems as follows.

(1) Voltage drop: Insufficient size of transformers and conductors

(2) Increasing power loss: Insufficient size of transformers and conductors, poor insulation and improper use

(3) Increasing outages: Aged distribution and substation facilities, improper connection of conductors, and no switches to isolate fault sections caused by tree-contact or other accidents

The March 1994 report recommended that these problems be solved by proper repair, expansion and maintenance and proposed a short term master plan that describes an urgent expansion project appropriate for expected demand in future.

The project will increase the total distribution capacity by 120 MVA, and his expansion of distribution facilities and the planned new construction of 132/33kV transmission systems will eliminate most of the problems identified above.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2-1 Objectives of the Project

In Tanzania, electricity is placed under the control of the Ministry of Energy and Minerals (MEM) under which Tanzania Electric Supply Company Ltd.(TANESCO)is operating the transmission and distribution networks.

After the independence of the United Republic of Tanzania in 1961, she had been repeating economic and social development plans - the first three-year plan (1961/62-1963/64) followed by three five-year plans-, and then the first and second Economic Recovery Programmes (ERPs) to overcome the oil crises since 1986. Now, she has been annually setting forth the plans called Rolling Plan & Forward Budget for planning, determining and reviewing the national budgets.

The latest Rolling Plan & Forward Budget (1995/96-1997/98) characterized by the macroscopic goals of the GDP growth of 5% and inflation rate of less than 10% announced giving higher priority to the rehabilitation of the existing electric facilities to motivate investment for generation and transmission facilities.

Many countries including Japan have been aiding TANESCO since 1981 to restore the old, ill-kept electric facilities. For example, Japan helped TANESCO rehabilitate the distribution facilities for Dar es Salaam city with a grant aid of 3.9 billion yen. However, since they had been left too heavily burdened for years without repair or maintenance for lack of founds, they still need additional rehabilitation projects. In 1993, a master plan defining the goals of rehabilitating and reinforcing the electric facilities was established by a technical cooperation by Japan.

The Master Plan indicated that frequent outages attributable to aged facilities and larger load should be eliminated by reinforcing the existing transmission and distribution facilities and constructing new substations.

The five-year Master Plan recommends to expand or construct eight substations in Dar es Salaam city to eliminate outages, satisfy the quickly increasing demand and electrify the waiting consumers. The project for expanding two existing substations and newly constructing two substations in Dar es Salaam city for which a Japanese government grant aid has been requested is the major part of the Master Plan and objective of the electric power supply expansion project in association with other projects that will be financially supported by the World Bank and NORAD.

The TANESCO's plan is shown in Figs. 2-1-1 and 2-1-2.

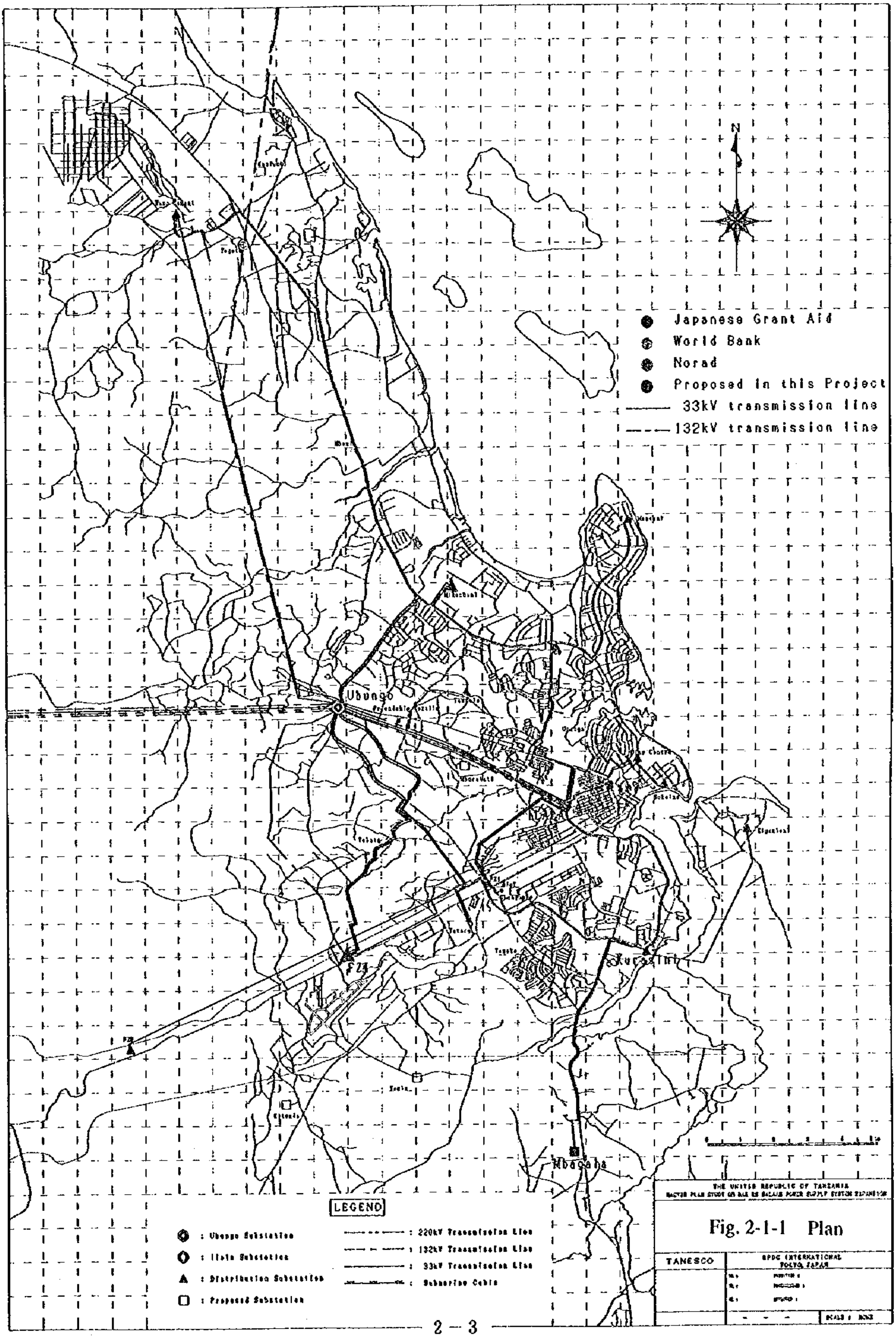

N
Japanese Grant Aid
World Bank
Norad
Proposed in this Project
33kV transmission line
132kV transmission line
Ubungo
Kurasini
F24
Mbagala
LEGEND
TANESCO

Fig. 2-1-1 Plan

220KV, 132KV AND 33KV SINGLE LINE DIAGRAM.

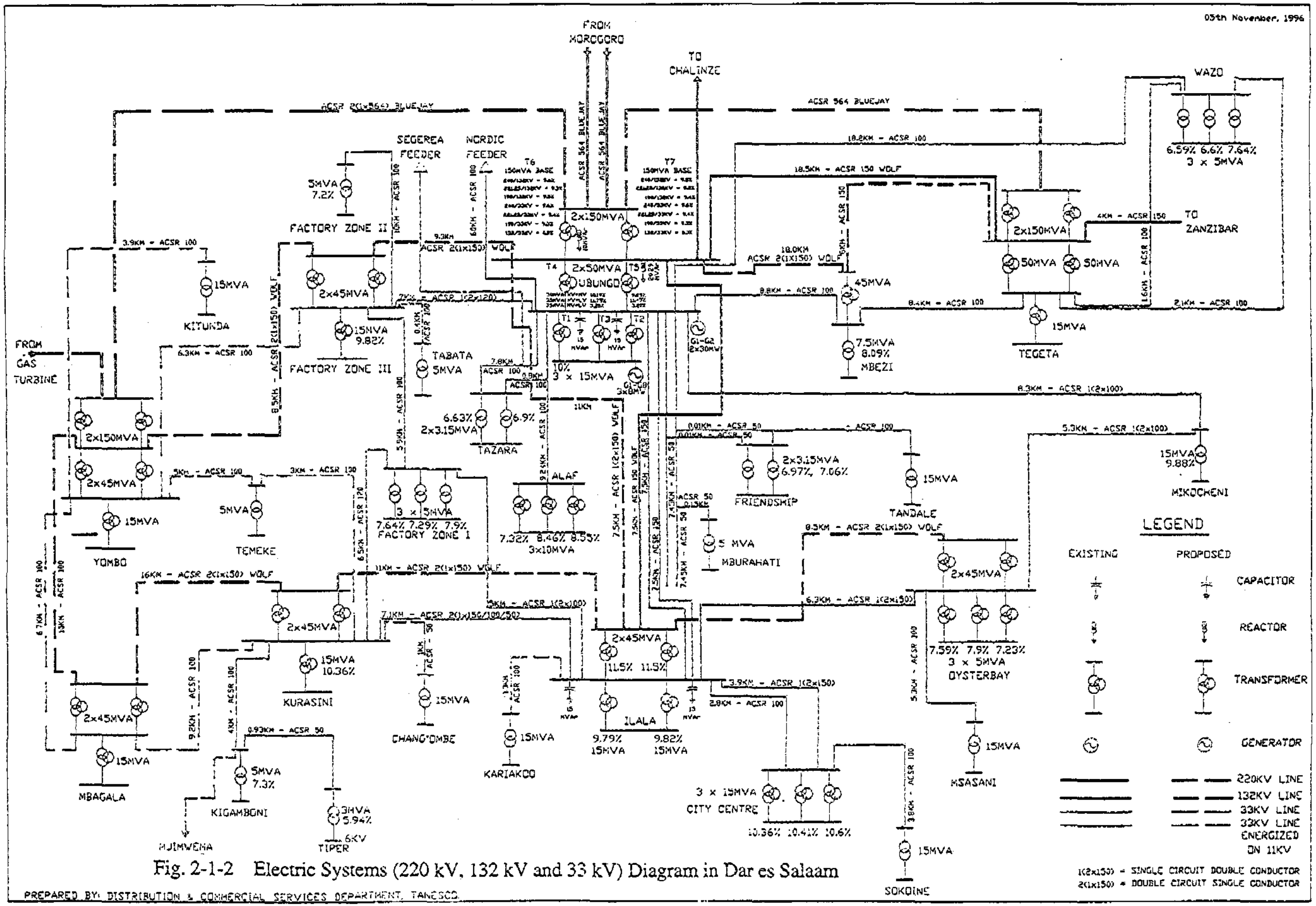


Fig. 2-1-2 Electric Systems (220 kV, 132 kV and 33 kV) Diagram in Dar es Salaam

2-2 Basic Concept of the Project

This project consists of the following works.

1. Expansion of the Ilala substation

   (1) Adding transformers:

   a. 132/33 kV 45 MVA x 1

   b. 33/11 kV 15 MVA x 1

   (2) Constructing a 132 kV transmission line

   Ubungo - Ilala: 7.0 km (7.5 km)

   (3) Constructing a 11 kV distribution line: 0.1 km (1.5 km)

2. Expansion of the Factory Zone-III (FZ-III) substation

   (1) Adding transformers: 132/33 kV 45 MVA x 2

   (2) Constructing a 132 kV transmission line

   Ubungo - FZ-III: 8.6 km (9.3 km)

3. New Construction of the Kariakoo Substation

   (1) Installing a transformer: 33/11 kV 15 MVA x 1

   (2) Constructing a 33 kV transmission line

   Ilala - Kariakoo: 2.1 km (1.3 km)

   (3) Constructing a 11 kV distribution line: 4.1 km (1.6 km)

4. New Construction of the Mbagala Substation

   (1) Installing a transformer: 33/11 kV 15 MVA x 1

   (2) Constructing a 33 kV transmission line

   Kurasini - Mbagala: 8.5 km (9.2 km)

   (3) Constructing a 11 kV distribution line: 3.9 km (1.6 km)

5. Common items

(1) Vehicles and tools

(2) Others

Note: Figures in ( ) show a value confirmed by the survey.

2-2-1 Expansion of the Ilala substation

(1) The Ilala substation (s/s) comprising two main transformers of 132/33 kV (45 MVA) has been supplying most of the loads (distribution substations including Ilala, City Centre, Kurasini, Sokoine, Factory Zone-I, Kigamboni and Airport) in Dar es Salaam . Total capacity of the main transformers installed in these distribution substations is 140 MVA. The present average load of the 132/33 kV Ilala substation is about 75 MVA that is within the total installed capacity of 90 MVA (45 x 2), though the peak load of 94 MVA is exceeding the installed capacity. Therefore, one 45 MVA transformer should be added as early as possible.

The 33/11 kV transformers having an installed capacity of 30 MVA (15 x 2) are also being operated at almost full load of 27 MVA. Moreover, there are more than 12,000 waiting consumers in the Ilala area (as shown table 2-2-1). To eliminate this inconvenience, the Ilala substation should be reinforced.

Since the Ilala substation is covering the largest portion of the loads in Dar es Salaam, the expansion works should be planned and implemented with great care. Outages by implementation of this project will significantly affect the large portions of all the residential, commercial and industrial consumers. Important it is thus to carefully study how to minimize service interruption during the works.

As mentioned in the above, the two 132/33 kV (45 MVA) main transformers are now being operated at 83% of full load (90 x 0.83 = 75 MVA). Even one of the two transformers is not allowed to stop for many hours. We therefore recommend to add one main transformer first, and then rehabilitate the primary side bus bars while continuing the operation of two of the three transformers alternately using a temporary 132 KV bus bar. The secondary side bus bars should be divided into two groups and then rehabilitated group by group while continuing the service using the group that is not under rehabilitation. It will take about three months to complete this rehabilitation. Any accidents that may prolong the work period should in no case be allowed. The existing 33 kV bus bars are too aged to be used as they are and the present allowable current is 1,000A at most. The present installed capacity (15 MVA x 2) will not allow further increase in demand. The 33 kV bus bars should thus be replaced with aluminum pipes in order to increase the current capacity to about 2,500 A.

(2) The Ubungo-Ilala 132 kV transmission line constructed in 1963 is now suffering from many problems troubles, shortage of capacity (as small as 100 MVA), longer outages (more than 40 minutes per month in average) and lowering supply reliability. To remove these problems, the new transmission line envisaged by the Master Plan should be constructed urgently.

The new transmission line will be constructed in the same right of way of the ex-33 kV interconnection line as determined by the discussion with TANESCO. The line length is 7.5 km according to the survey by TANESCO.

Table 2-2-1 Number of Waiting Consumers in Dar es Salaam

Area	Number of consumers	Remarks
Temeke Region		
Mtoni Kijichi	384	
Yombo Vituka	1,044	
Yombo Kilakala	287	
Mbagala Mangaya	138	
Mbagala Kibondemaji	685	
Mbagala ST. Antony	265	
Mbagala Rangi Tatu	64	
Mbagala Kongowe	140	
Tuamoyo Kigamboni	141	
Tungi Kigamboni	137	
Kinondoni North		
Mbezi Beach	756	
Kunduchi Mtongani	325	
Kunduchi RTD	495	
Oyster Bay, Msasani & Masaki	384	
Boko	1,310	
Tegeta	1,190	
Kinondoni South		
Mpigi Magohe	450	
Mbezi Makabe	300	
Kimara Kingongo	475	
Ilala		
Tabata	5,775	
City Centre	351	
Kariakoo	6,499	
TOTAL	21,595	

by TANESCO Sept. 1996

The construction of the new line will accompany installation of 132 kV switchgears at the Ubungo and Ilala substations and construction of 25 self supporting type double-circuit towers though they will be used with a single circuit for the time being. The existing single-circuit towers will be withdrawn when the second circuit is installed.

Since the planned Ubungo-Ilala transmission route has some areas where the ground is weak, the design of the tower and its foundation should be subject to geologic surveys, and limited construction term to avoid the seasons when the underground water level is high.

(3) The 11 kV distribution lines will be constructed by TANESCO as determined in the discussion with TANESCO. It was confirmed that the construction will use equipment and materials for the construction of 11 kV feeders , connection lines between the substation equipment and the 11 kV overhead distribution line coming to the boundary of the substation premises, and underground cable lines; and the total length of these lines measures 1.5 km.

2-2-2 Expansion of the Factory Zone-III substation

(1) The 33/11 kV (1.5 MVA) substation was constructed in 1986 by Japanese grant aid. This substation is receiving power from the Ubungo substation via a 33 kV transmission line to supply to residential consumers within the area and industrial consumers along the Nyerere Road including the Dar es Salaam Airport.

The Factory Zone-I (oldest s/s), Factory Zone-II and Factory Zone-III substations, all of which have been connected to the 33 kV Ilala transmission system, are covering most of the loads in the area including railway, airport, industrial and residential users.

After the four-year load shedding, delay in power development and a long drought, the demand is now quickly increasing, which resulted in the operation of the 33 kV transmission system at almost full capacity.

The 11 kV and 33 kV lines connected to the distribution substations in Dar es Salaam are now suffering from frequent faults: of 1,042 faults in the latest term of one year, 255 were caused by over current or grounding of the 33 kV transmission lines. In average, three circuit failures every day due to over current or grounding. It is apparent that the system has been heavily deteriorated and burdened beyond the capacity.

The Dar es Salaam area has been covered by several 132 kV substations: Ubungo substation that receives power from the hydropower stations located in the northern & western mountainous area and the Ubungo gas turbine plant; Tegeta substation (50 MVA x 2) for the northern part; and Ilala substation (45 MVA x 2) for the central part. The southwestern part of the Dar es Salaam area is yet to be covered by 132 kV system.

According to the master plan, it has been planned to have a ring of 132 kV system that covers the whole parts of Dar es Salaam city and reinforce the existing Factory Zone-III substation by upgrading to 132 kV for the surrounding 33 kV distribution substations. This project is just in line with the master plan.

Judging from the load forecast that the present 33 kV transmission system will be overloaded by 1999, it is the most recommendable plan to step up the primary voltage of the Factory Zone-III transmission system to 132 kV. After this up grading, the secondary (33 kV) side of the main transformers will be connected to three substations Factory Zone-I, Factory Zone-II and Factory Zone-III, and new substations Tabata, Temeke and Chang'ombe that will be funded by the World Bank and NORAD. In this case, new transformers totaling 90 MVA (45 x 2) should be added to lower the operation factor to 60-70% (total capacity will be more than 130 MVA).

(2) The planned route for the new transmission line between Ubungo and Factory Zone-III substation is subject to land acquisition. TANESCO already surveyed the cost for compensation to the landusers during the stay of our mission. It was confirmed that the total length of the line is 9.3 km. Since the route includes such areas as those having weak ground, the design and construction of the transmission facilities should be subject to careful investigations.

2-2-3 New construction of Kariakoo substation

(1) The Kariakoo area is the biggest and most active commercial zone containing large residential areas in Dar es Salaam. The district has been connected to the City Centre substation via one 11 kV feeder and the Ilala substation via three 11 kV feeders. The demand in this district has been large enough to fully occupy one substation.

As shown in Table (2-2-1), the number of waiting consumers in this district is more than 6,500. They should be electrified by newly installing a substation.

The 33/11 kV side of the Ilala substation could not accommodate additional loads because it has been already operated at almost full capacity. It is recommended that the substation be expanded and part of the loads (consumers) be shifted to other substations. Constructing a new substation will absorb the increasing load and allow the Ilala and City Centre substations to shift some loads to other substations.

According to a demand forecast, adding one main transformer (15 MVA) will absorb the increasing demand for the coming 7-8 years.

However, further increase in the number of transformers should also be included in the future expansion plan. The construction site for the new substation that was finally proposed by TANESCO has proved to be conditionally available according to our mission survey (see Fig. 2-2-1).

TANESCO promised to move the three acacia trees outside the premises (19 m x 33 m) in preparation for future expansion of the substation (though they do not have to be moved at this project stage for installing only one transformer).

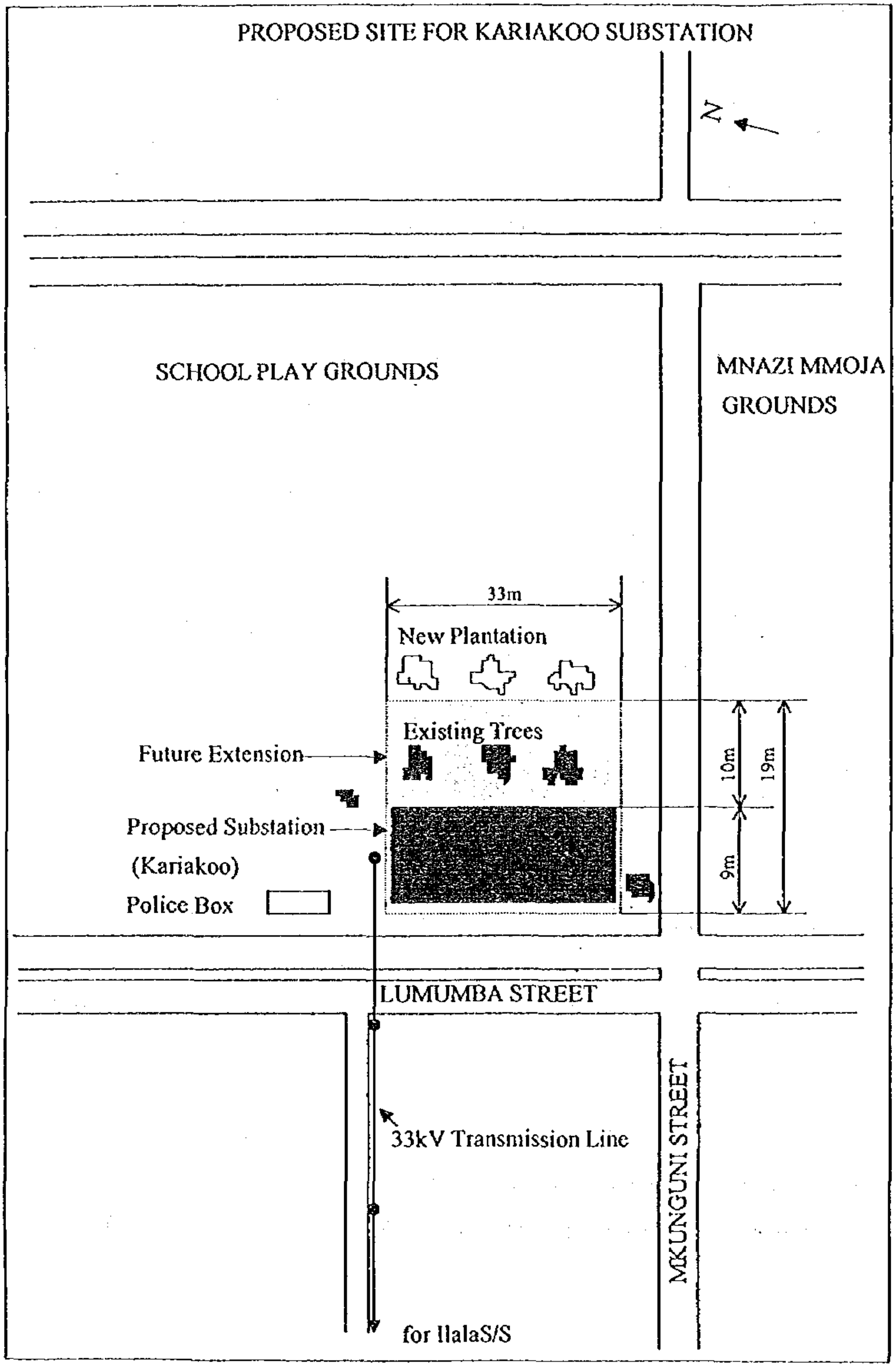


Fig. 2-2-1 Proposed Site for Kariakoo Substation

(2) Constructing a 33 kV transmission line

Of the existing 132 kV substations, nearest to the new Kariakoo substation is the Ilala substation. It was confirmed that the proposed Ilala-Kariakoo roadside transmission route passing through Kariakoo city measures 1.3 km.

Since most parts of this route will go along a street, there may be some difficulties in acquiring the space for the transmission line poles. TANESCO's efforts to acquire a neccessay route are expected.

The construction work for the transmission line other than the 11 kV distribution systems will be implemented by the Japan side as determined in the negotiations with TANESCO.

(3) The 11 kV distribution systems will be constructed by TANESCO. It was confirmed that the material and equipment required for the construction of the 11 kV distribution systems corresponds to the amount required for a total length of 1.6 km.

2-2-4 New construction of Mbagala substation

(1) This area is located at the southern part of Dar es Salaam city. This district is extending along a trunk road leading to Kilwa about 300 km south of Dar es Salaam. Large residential areas are spreading behind the road. Further development is expected in future.

The number of waiting consumers in this district (Temeke) is as shown in Table (2-2-1) more than 1,680 (excluding the Yombo and Kigamboni areas that have been connected to the Kurasini substation).

The northbound Wazohill distribution system (13.5 km) and the southbound Kilwa Road distribution system (8.5 km) had been suffering from large voltage drop and power loss attributable to their longer distance and larger demand. At present, the Wazohill system has been shortened to less than 3 km thanks to the new Tegeta substation (NORAD), so that the voltage characteristic has been significantly improved. The Kilwa Road distribution system is still suffering from large voltage drop and power loss. The master plan proposed that a new 33/11 kV (15 MVA) distribution substation be constructed adjacent to the planned lot for a glass factory in Mbagala in order to relieve the Kilwa Road system from heavy burden.

Based on the results of our survey indicating that the supply from the Kurasini substation to the Mbagala area will not change significantly, we recommend that a 15 MVA transformer be added in preparation for future increase in demand.

Our preliminary reinvestigations on the construction site for the new substation revealed that the presently planned construction site will be at about the middle of the Southern distribution system after the planned extension. We therefore recommend that the presently planned site be used.

(2) Constructing a 33 kV transmission line

Our site survey confirmed that the planned route for the 33 kV transmission line between Kurasini and Mbagala is 9.3 km long. In course of the survey, we studied an alternative route that partly goes along the Tazara railway. However, since the railway authorities did not accept it, we recommend the original route that goes southbound along the Nelson Mandela road and Kilwa road.

The route may have to have roundabouts and underground cables in some areas where there are such trees and/or structures as those obstructing a straightforward or on-the-ground course. TANESCO's efforts to acquire a prudent route are expected.

2-2-5 Common items

(1) Vehicles and tools required for the construction of 11 kV distribution lines that is within the scope of TANESCO's work were confirmed as follows.

- 5-ton truck with a 3-ton crane x 1 unit
- 1-ton double cabin pickup x 1 unit
- Tools x 1 set

(2) Others

The TANESCO's SCADA system consists of two systems for 132 kV transmission and 33/11 kV distribution respectively. The former system has been under the control of the Ubungo dispatching office, while the latter has been under the control of the Ilala dispatching office. The expansion to be implemented by this project should be compatible with both the existing two systems. The SCADA system in Dar es Salaam are shown Fig. 2-2-2.

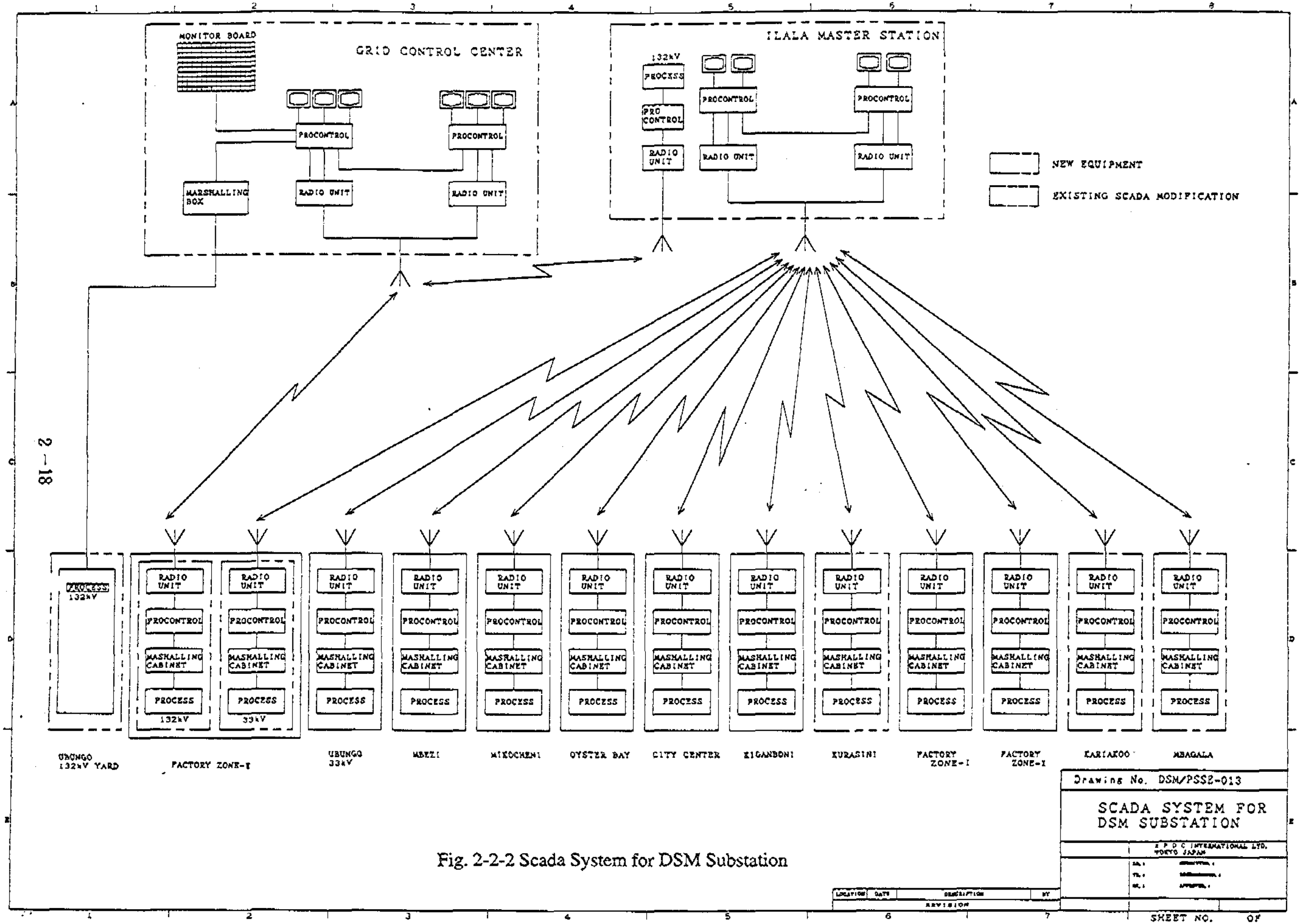


Fig. 2-2-2 Scada System for DSM Substation

2-3 Basic Design

The basic design of this project should follow the principles shown below.

- During a term of about 10 years after this project, the equipment and materials used throughout the project shall not have to be replaced.

- Equipment and materials for substations and transmission lines to be newly installed by this project shall be the same as those used for the existing facilities as far as practicable in order for easier maintenance (e.g. circuit breakers shall be of an oil-immersed type), and shall be such that no special techniques or knowledge is required for installation or maintenance.

2-3-1 Design Concept

Design and working plans for this project shall satisfy the following requirements and conditions.

(1) Natural conditions

a. Foundation, installation of substation equipment and construction of 132 kV and 33 kV transmission lines shall be designed in consideration of the weak ground condition during rainy seasons: heavy rain in March through June; and light rain in November and December.

b. The ambient temperature for design purposes shall be 30°C maximum and 18°C minimum (monthly mean) and design condition for temperature change shall be normal design.

c. Constructing a transmission system shall not cause large-scale removal of trees or other environmental destruction.

d. Salt contamination:

Environmentally, the region where the work will take place is a coastal area, subject to an overall medium relative humidity, which can give rise to condensation. On shore winds are frequently salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulations.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, polluted, salty, corrosive and humid coastal atmosphere.

(2) Social conditions

a. Constructing a transmission system in or near a residential area shall be designed in consideration of maximum safety of the general public.

b. The project includes transportation of heavy equipment and materials. The implementation plan shall ensure that such work can be done safely and properly.

c. The routes for new transmission lines shall be along a trunk road as far as practicable in order to facilitate the transportation and installation of equipment and materials. Even where the route is not along a trunk road, transportation of a small lot of equipment or materials shall be possible.

(3) Construction cost and local contractors

The following notes learned from the Reinforcement project of Power Distribution Network in Dar es Salaam (Phase III) implemented in 1992 shall be considered.

a. Local construction firms are capable of performing general construction works.

b. Local labour is good in terms of both the skill level and quantity.

c. Local producers of general materials such as aggregate and cement are available.

(4) Using local equipment and materials

Wooden poles and aluminum bare conductors are planned to be imported from the third countries.

(5) Management by the implementation agency

a. Technical standards and practices for this project shall be the same as those currently used by TANESCO to support the sustainable promotion of standardization.

b. TANESCO has been satisfactorily managing for years several projects of about the same scale. Therefore, TANESCO's financial status and technology level are likely good enough to implement this project.

(6) Grade of facilities and equipment

The following notes shall be observed.

a. Equipment and facilities to be newly installed shall not be beyond the TANESCO's current technical level, and the design of these newly installed equipment or facilities shall be about the same level as those for existing facilities: avoid sophisticated or sensitive equipment, and such equipment as those too much advanced compared to the existing equipment in order to facilitate correct management and maintenance.

b. Equipment and facilities to be newly installed shall be economical, rigid and simple in consideration of the socio-economic status of the country but subject to satisfaction of the requirements from TANESCO.

(7) Implementation Schedule

The project will be implemented in two stages. In the first phase, Ilala, Kariakoo and Mbagala substations will be implemented and Factory Zone III in the second phase. Construction work of the 11 kV distribution lines should be completed by TANESCO during the first phase.

(8) Condition for FZ III Line

The construction of FZ III line will be reconsidered after completion of the following procedures according to the Minutes of Discussion in November 1996.

a) Topographic survey of the route
b) Geological investigation for the foundation
c) Completion of payment for compensation and prevention of people's further settlement in the Project area.

(9) Design conditions

The design of the substation and transmission line facilities for this project shall be based on the technical standards and practices currently used by TANESCO and those widely accepted in Japan.

Equipment and materials shall satisfy the IEC and JIS standards except that some shall satisfy ANSI (USA) or BS (UK) standard.

a. Natural conditions

Elevation:	Less than 1,000 m
Ambient temperature:	10°C to 40°C (average 32°C)

b. Safety factors

Determined per the current national standard of Tanzania as follows.

Supporting structure : 3

Foundation of a supporting structure	:	2
Electric wire (and anchor)	:	2.5
Insulator	:	2.5
Arm	:	2.5
Guy wire	:	2.5

c. Conductor temperature

Average temperature	:	32°C
Allowable highest temperature	:	90°C

d. Wind pressure

Supporting structures for overhead systems shall be designed with a wind velocity of 38.3 m/sec. Overhead wires shall be designed with a wind pressure of 92 kg/m^2. Steel towers shall be designed with a wind pressure of 266 kg/m^2. Wooden poles shall be designed with a wind pressure of 75 kg/m^2.

e. Height of overhead transmission lines above the ground

Overhead conductors shall be installed at the height above the ground defined below.

Item	132kV	33kV	11kV
General	6.7m	5.5m	5.5m
Traversing a road			
Along a vehicle road	8.0m	6.7m	6.0m
Along a non-vehicle road		6.0m	5.5m
Along a railway	9.0m	9.0m	9.0m
Above a telephone line		1.8m	1.8m

(10) Basic design principles

Substation facilities, transmission facilities and distribution facilities shall be capable of accommodating the expected demand increase and system expansion in future, and shall facilitate the improvement in voltage stability and supply reliability. Newly installed equipment and facilities shall be compatible with the existing ones. In addition, the following requirements shall be satisfied.

a. Maintaining the supply reliability

- Main transformers shall be equipped with an on-load tap changer to keep the voltage stable.
- Faults of a transmission system are caused by deficient facilities (improper installation or manufacture), incorrect maintenance (deterioration of oil or other parts, or overload), natural disaster (typhoon or flood causing mechanical damage) or contact by trees or small animals. To reduce these faults and improve the supply reliability, the equipment and facilities shall be designed based on the following requirements.
- 33 kV transmission lines shall be equipped with section switches to isolate and minimize outage sections in case of a fault or maintenance work.
- Transformers, section switches and electric cables shall be equipped with arresters.

b. Voltage fluctuation

Normal voltage fluctuation on the systems for general consumers shall be less than $\pm$5%. Our latest survey (measurement during about 10 days in July 1996) recorded a voltage fluctuation of $\pm$10%.

c. Supply System to LV customers

The supply system shall be per direct transformation from 11 kV to 400/230V.

(11) Insulation

a. The insulation system shall be capable of coordinating the insulation level of all the equipment and lines in the whole frequency range between lightning surge and power frequency. The insulation system shall be designed based on the following requirements.

- Protect the electric system from internal abnormal voltages (switching surge, persistent abnormal voltage, etc.) by utilizing the insulation performance of the electric equipment themselves.
- Protect the electric system from external abnormal voltages (lightning surge) by utilizing the insulation performance of overhead ground wires, arcing horns or arresters.

b. Insulator type, and number of insulators to form a string

The insulation system shall be designed based on a requirement that flashover due to internal abnormal voltage shall be avoided. The internal abnormal voltage shall be determined by a generally acceptable criterion as defined below.

- Grounding system: Effective grounding system
- Persistent abnormal voltage multiplier: 0.8Um

(Um: maximum system voltage of the electric system)

- Abnormal switching voltage multiplier: 2.8Um

The withstand strength of an insulator shall be determined based on a wet flashover voltage for abnormal switching voltage and a power-frequency wet flashover voltage for persistent abnormal voltage.

The required insulation strength and electric characteristics of an insulator is per the following tables.

a) Required insulation strength against switching surge

Nominal voltage	(kV)	132	33	11
Maximum system voltage, Um	(kV)	145	36	12
Ground voltage wave height, $\sqrt{2}/\sqrt{3}$Um	(kV)	118	29.4	9.8
Switching surge multiplier, n		2.8	2.8	2.8
Switching surge voltage, $\sqrt{2}/\sqrt{3}$Um x n	(kV)	329	82.3	27.4
Insulation deterioration factor		1.1	1.1	1.1
Insulator strength required	(kV)	392	90.5	30.2

b) Required insulation strength against persistent abnormal voltage

		132	33	11
Nominal voltage	(kV)	132	33	11
Maximum system voltage, Um	(kV)	145	36	12
Abnormal voltage multiplier, n		0.8	0.8	0.8
Persistent abnormal voltage	(kV)	115	28.8	9.6
Insulation deterioration factor		1.1	1.1	1.1
Insulator strength required	(kV)	127	32	11

c) Electric characteristics of insulator

	Standard surge 50% flashover voltage (kV)	Switching surge 50% flashover voltage (kV)	(Wet) withstand voltage (kV)	Power-frequency 50% flashover voltage (kV)	(Wet) withstand voltage (kV)	
Suspension insulator						
1-piece type	150	85	75	45	40	1966
2-piece series connected type	240	155	140	80	70	1896
3-piece series connected type	330	225	205	115	105	
4-piece series connected type	410	295	265	150	135	
5-piece series connected type	495	360	325	190	170	
33 kV pin insulator	290	-	-	95	-	
11 kV pin insulator	105			35		

(Note) (1) 250 mm suspension insulators shall satisfy Insulation Design Instruction for Overhead Systems(October 1996)(hereinafter called 1996 Instruction).

(2) 33 kV pin insulators shall be per BS 137.

Insulators shall be per the following table that has been determined based on the required strength as shown in the tables above. 250 mm series-connected suspension insulators shall be of a 3-piece type that includes one piece as spare for maintenance purposes.

	33 kV pin insulator	250 mm suspension insulator
33 kV through-wire insulator	1	-
33 kV strain insulator	-	3-piece type

c. Standard ground insulation distance

The standard ground insulation distance shall correspond to the length of a gap in which flashover will occur by 50% of the reference shock wave (positive polarity) flashover voltage of the insulator string.

Nominal voltage	132kV	33kV	11kV
Number of insulators		3	2
50% shock FOV of the insulator string		330kV	240kV
Equivalent bar gap	87cm	52 cm	36cm
Standard insulation distance		55 cm	35cm

d. Minimum insulation distance

The minimum insulation distance shall correspond to the minimum clearance with which the electric system or equipment can withstand either the switching surge or persistent abnormal voltage.

Nominal voltage	(kV)	132	33	11
Maximum system voltage, Um	(kV)	145	36	12
Ground voltage wave height	(kV)	118	29.4	9.8
Switching surge multiplier		2.8	2.8	2.8
Switching surge wave height value	(kV)	329	82.3	27.4
Withstand voltage required	(kV)	362	99	33
Clearance required	(cm)	76	19	7
Minimum insulation distance	(cm)	75	25	10

e. Insulation distance for abnormal status

The minimum insulation distance for abnormal status (e.g. lateral swing due to the maximum wind velocity) shall be determined based on the wet withstand voltage when being subjected to the maximum system voltage (Um).

Nominal voltage	(kV)	132	33	11
Maximum system voltage, Um	(kV)	145	36	12
Ground voltage wave height	(kV)	83.1	20.8	6.9
Withstand voltage required	(kV)	91.5	22.9	7.6
Minimum insulation distance for abnormal status	(cm)	34	8	3

f. Line-to-line minimum clearance

Nominal voltage	(kV)	132	33	11
Maximum system voltage, Um	(kV)	145	36	12
Ground voltage wave height	(kV)	117.6	29.4	9.8
Line surge multiplier			4.5	6.4 per 1996 Instruction
Line surge voltage	(kV)		132.3	62.7
Line withstand voltage required	(kV)		145	69
Minimum line clearance	(cm)	130	30	12
Actual line				

g. Basic impulse insulation level (BIL) and arresters

BIL values shall be per IEC standards.

BIL Values and Arresters

Nominal voltage		132kV	33kV	11kV
Maximum system voltage	(kV)	145	36	12
Arrester voltage rating	(kV)	126	36	12
MCOV	(kV)*	97.8	28.0	9.3
MCOV x $\sqrt{3}$(kV)	(kV)	169.4	48.5	16.1
Safety factor (Um/MCOV)		1.17	1.35	1.34
Limit voltage (kV) at 20 kA		379	109	36.2
BIL	(kV)	650	170	90
Safety factor (BIL/Limit voltage)		1.72	1.56	2.5

*) Max. Continuous Operating Voltage

h. Lightning protection

Lightning protections shall be principally the same as that for the existing facilities near the project site in light of the fact that these existing facilities have been free from lightning strokes.

Substations and 132 kV transmission systems shall be equipped with arresters and overhead ground wires. All load switches on the 33 kV and 11 kV distribution lines shall be equipped with an arrester to protect from external abnormal voltages such as lightning surges.

2-3-2 Basic Design

1. Overall Plan

(1) Project Site Conditions

1) Substations

i) The site of the Ubungo s/s where the 132 kV and 33 kV facilities will be installed is within a plain area. There is a space available for installing additional equipment.

ii) The site of the Ilala s/s where the 132 kV, 33 kV and 11 kV facilities will be installed is narrow so that the planning and implementation of the work should be subject to careful investigations on service interruption period and the safety of the labour.

iii) The site of the Factory Zone-III s/s where the 33 kV and 11 kV facilities will be installed is wide enough to accommodate additional equipment. However, the planning and implementation of the work should be subject to careful investigations on the safety of the labour and general public, since there is residential quarters and a railway near the site.

iv) The site for a new 33/11 kV substation Kariakoo is on a plain but at the center of a town, so that the planning and implementation of the work should be subject to careful investigations for the security of the social and natural environment, especially with greatest care for preservation of trees.

v) The site of the Kurasini s/s where the 33/11 kV facilities will be installed is within a plain area. There is a space available for installing additional equipment.

vi) The site for a new 33/11 kV substation Mbagala is within the site of a glass factory located at the southern end of the central part of Mbagala. The site is plain and wide enough to accommodate all the planned equipment.

2) Transmission systems

i) 132 kV lines

- Ubungo s/s to Ilala s/s

The existing 40 m wide right-of-way for the existing 33 kV and 132 kV transmission systems is available for the construction of a 132 kV transmission system. The right-of-way is wide enough to be used also for transportation and storage of equipment and materials. The soil condition is good as a whole, except that the wet land partly distributing on the route will require a temporary space/facility for transportation and pre-assembly of some equipment and structures.

- Ubungo s/s to Factory Zone-III s/s

This is a new route. The right-of-way is yet to be acquired, though the desired route has been determined. This new transmission system may use a larger number of angled towers subject to the route of the right-of-way acquired. The route will run on a large hill near the Ubungo s/s where the soil condition is good for easier construction and transportation, and pass through a wet land near the Factory Zone-III s/s where the timing of the construction work should be subject to considerations on the rainy seasons.

ii) 33 kV

- Ilala s/s to Kariakoo s/s

  The planned route traverses a small valley near the Ilala s/s and then goes along a road leading to the Kariakoo s/s by way of a dense population area. Note that a 11 kV line has been running along the road at the north side: the new 33 kV line will run at the south side of the road.

- Kurasini s/s to Mbagala s/s

  The planned route for the 33 kV line runs along the Nelson Mandela road and the Kilwa road. Near the railway crossing on the Kilwa road, the existing 11 kV line must be moved away to install the new 33 kV line. In the Mbagala area, the construction work should be subject to preservation of the townscape: avoid removal of trees as far as practicable.

3) Distribution lines

i) 11 kV

- Ilala s/s: This is a connection cable between the newly installed cubicle and the overhead line outside the premises. Most part of the cable route is located within the premises of the substation.

- Kariakoo s/s: This is a new feeder that connects the existing distribution line. This will run along town roads like the 33 kV line.

- Mbagala s/s: This is a connection to the new s/s. The construction of this connection will accompany movement of part of the existing 11 kV feeder. All the lines will use a roadside route.

(2) Infrastructure needed for project implementation

1) Substation

Access to the substation sites is good enough to transport heavy equipment and materials (note: roads developed for the construction of existing substations, and town-connecting roads constructed thereafter have been maintained).

The new Kariakoo s/s will be located along a trunk road. The new Mbagala s/s will also be located along a road that is available for transportation of equipment and materials.

2) Transmission line

i) The Ubungo-Ilala route will be in the 40 m wide right-of-way for the existing 33 kV and 132 kV transmission lines. Access to the right-of-way for transportation of equipment and materials has been developed. Construction of steel towers in the wet area will require developing an access road.

ii) The Ubungo-FZ-III transmission line will use a new route that will run in rural, sparsely populated areas where the access to the construction site is poor. Some existing roads should be redeveloped. Some access ways to the tower sites should be widened.

iii) 33 kV transmission lines should be located along existing roads for easier transportation of equipment and materials. Construction should be subject to giving special considerations to the public safety and environmental preservation.

3) Distribution line

See the description in 2) ii) above.

(3) Site suitability

1) Substation

i) The Kariakoo s/s construction site is likely the best option: it is near the demand center; it has the shortest distance to the Ilala s/s; and it is convenient for operation and maintenance.

ii) The Mbagala s/s construction site is also the best option: it will facilitate reducing voltage drop on the existing 11 kV transmission line connecting the 33/11 kV Kurasini s/s to the remote southern demand areas; and it will effect the TANESCO's current project for southbound extension of a transmission line.

2) Transmission and distribution lines

i) 132 kV

- Ubungo s/s - Ilala s/s

  The planned route is the best option in every aspect: shortest distance to the Ilala s/s that is located at the center of demand; the existing right-of-way is available; easier maintenance after construction; and the compensation (to land owners) and construction costs are cheaper.

- Ubungo s/s - Factory Zone-III s/s

  This route is also the best option: it runs along the perimeter of the developing (demand increasing) areas in Dar es Salaam; shortest but most effective route; it runs on a soft hill that has roads available for transportation of equipment and materials (except the wet area near the Factory Zone-III s/s); some of the roads are subject to widening, but they will be effective also for maintenance of the electric facilities after construction.

ii) 33 kV

- Ilala s/s - Kariakoo s/s

  The planned route is also the best option because of the shortest connection between the two substations.

- Kurasini s/s - Mbagala s/s

  The planned route is the shortest among construction-possible options, and convenient for security patrol during construction and for maintenance after construction, because it runs along existing roads.

iii) 11 kV

These distribution lines to connect distribution substations to consumers will be constructed by TANESCO. These lines will run along roads in esidential and commercial quarters.

(4) Drawings

Locations of the existing and new substations are shown in Figs. 2-3-1 through 2-3-6.

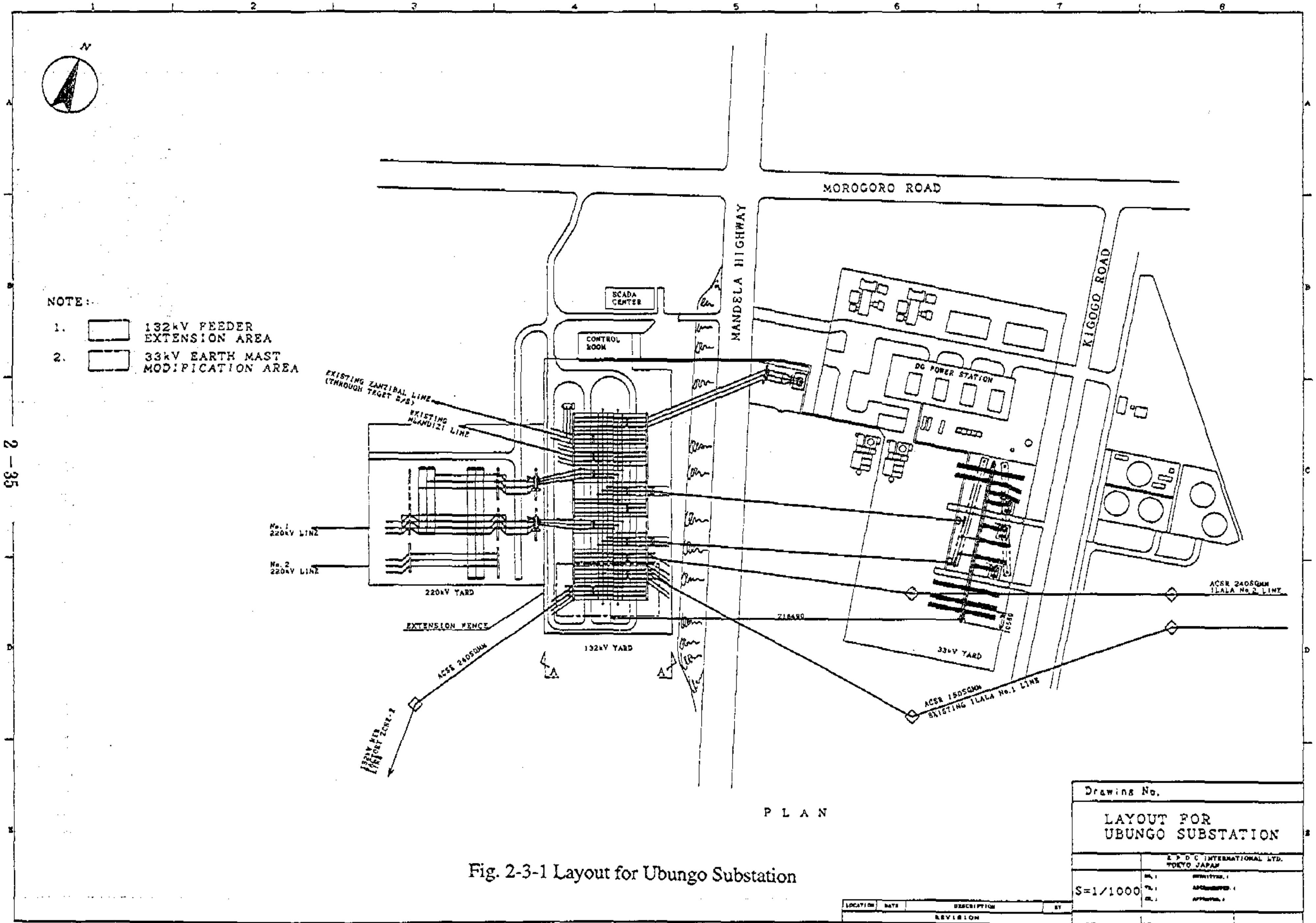
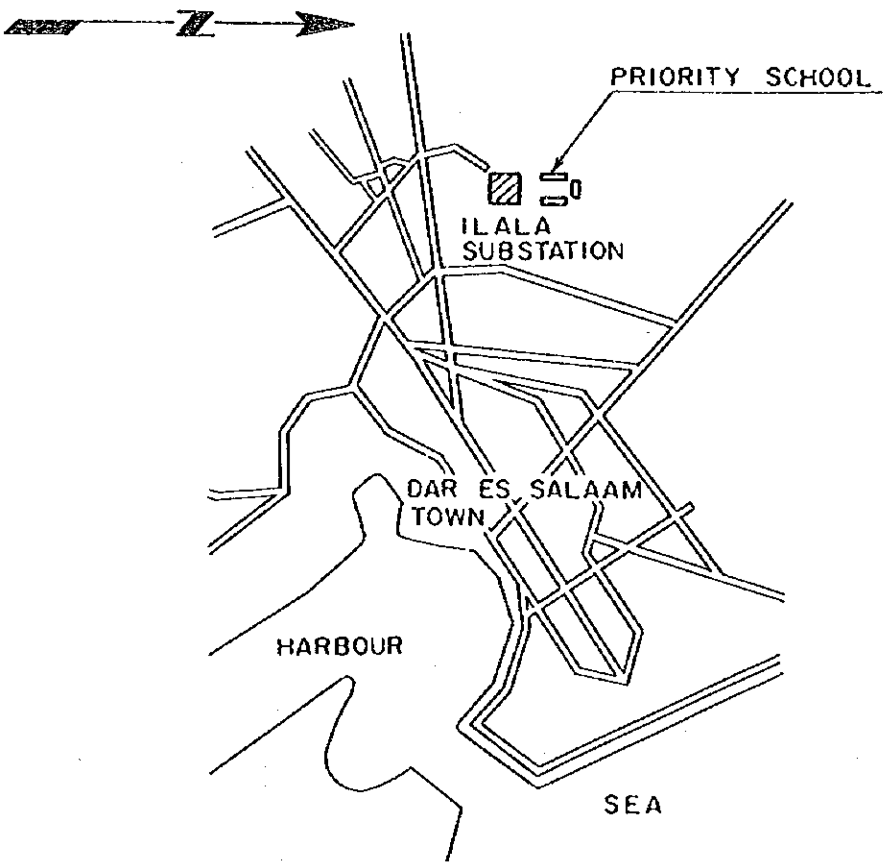


Fig. 2-3-1 Layout for Ubungo Substation



Drawing No.	
LOCATION MAP FOR ILALA SUBSTATION SITE	
TANESCO	E.P.D.C. INTERNATIONAL LTD TOKYO JAPAN
	DR.: SUBMITTED.:
	TR.: RECOMMENDED.:
	CK.: APPROVED.:
	- - -

Fig. 2-3-2 Location Map for Ilala Substation Site

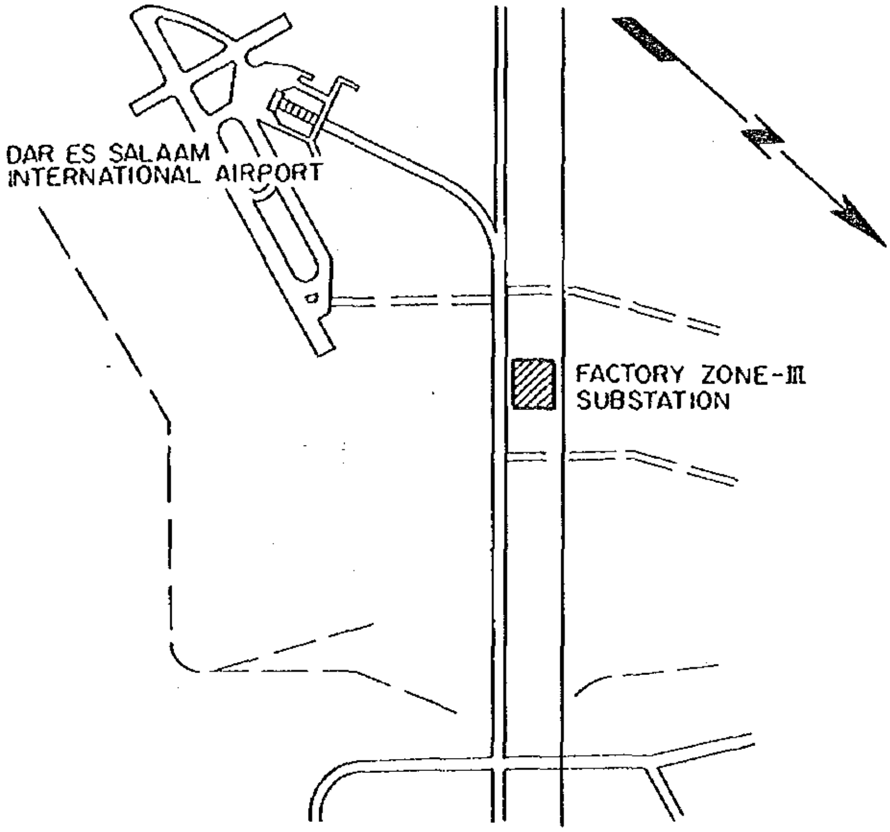
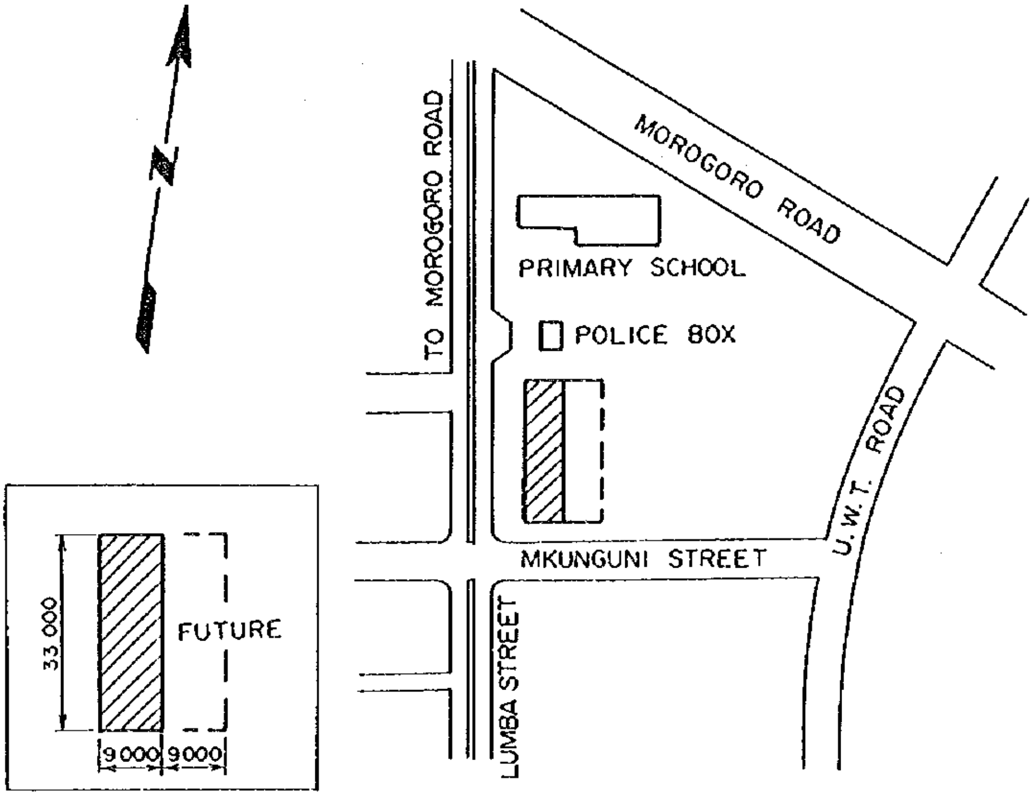


Fig. 2-3-6 Location Map for Factory Zone-III Substation

Drowing No.	
LOCATION MAP FOR FACTORY ZONE-III SUBSTATION	
TANESCO	E.P.D.C. INTERNATIONAL LTD TOKYO JAPAN
	DR.: SUBMITTED:
	TR.: RECOMMENDED:
	CK.: APPROVED:
	- - -



Drawing No.

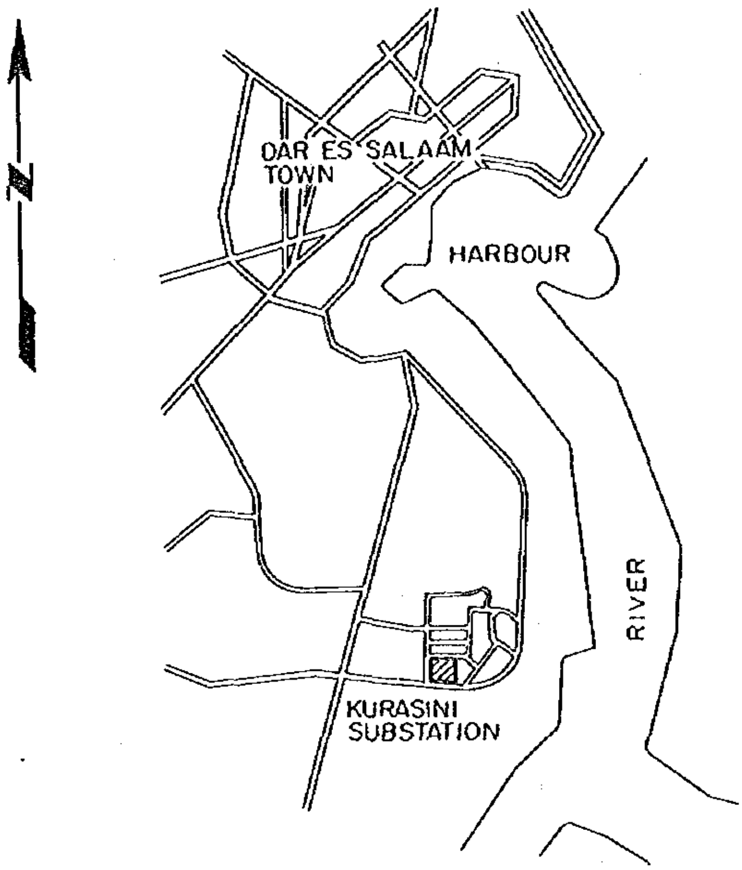
LOCATION MAP FOR KARIAKOO SUBSTATION

TANESCO

E.P.D.C. INTERNATIONAL LTD TOKYO JAPAN

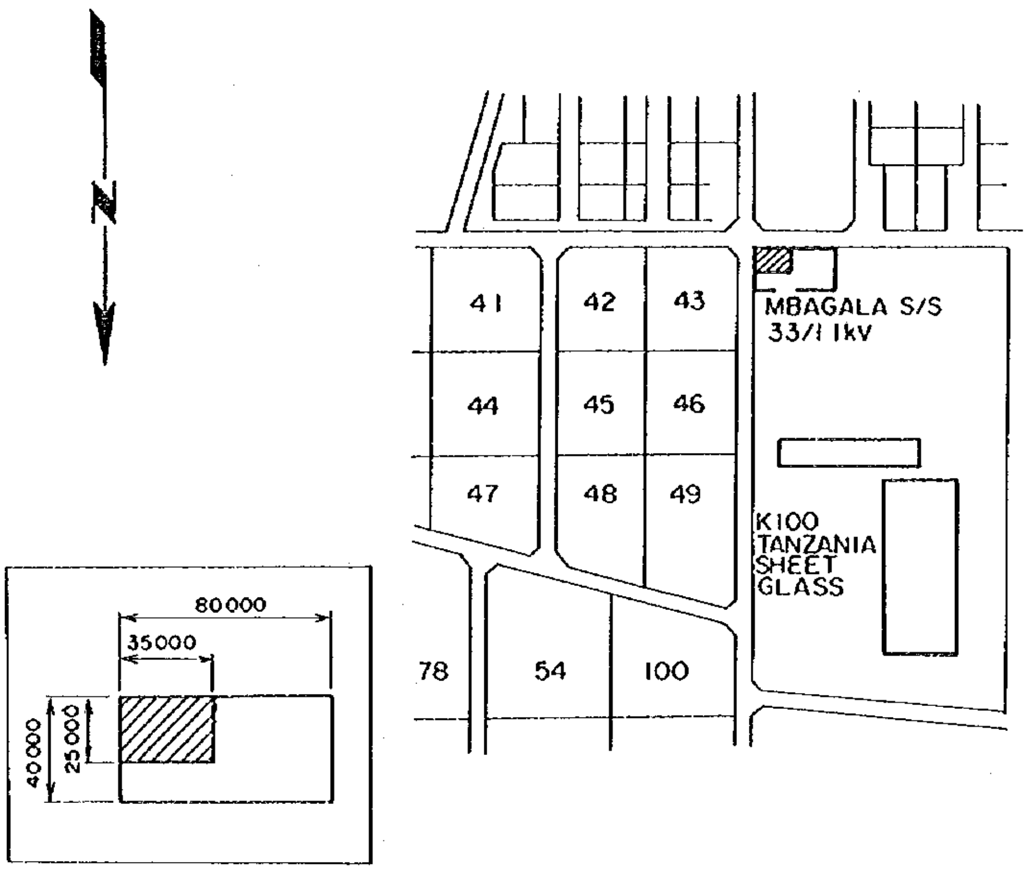
DR.: SUBMITTED.
TR.: RECOMMENDED.
CK.: APPROVED.

Fig. 2-3-3 Location Map for Kariakoo Substation



Drawing No.		
LOCATION MAP FOR KURASINI SUBSTATION		
TANESCO	E.P.D.C. INTERNATIONAL LTD TOKYO JAPAN	
	DR.:	SUBMITTED:
	TR.:	RECOMMENDED:
	CK.:	APPROVED:

Fig. 2-3-4 Location Map for Kurasini Substation



Drawing No.		
LOCATION MAP FOR MBAGALA SUBSTATION		
TANESCO	E.P.D.C. INTERNATIONAL LTD TOKYO JAPAN	
	DR:	SUBMITTED:
	TR:	RECOMMENDED:
	CK:	APPROVED.:

Fig. 2-3-5 Location Map for Mbagala Substation

2. Equipment and Materials: Outline Specifications

(1) *Outline specifications of the major equipment and materials are shown below.* Major equipment and materials for substations and transmission systems should be per the following specifications.

Items	Name of Equipment	Specifications	Number	Unit	Remarks
1.Ilala Substation	Transformer	132/33kV 45MVA	1	Set	
	Transformer	33/11kV 15MVA	1	Set	
	Switch gear	132/33 11kV	1	Lot	
	Transmission line materials	132kV ACSR	7.5	km	for Ubungo-Ilala
	Distribution line materials	11Kv ACSR	1.5	km	
2.Factroy Zone III Substation	Transformer	132/33kV 45MVA	2	Set	
	Switch gear	132//33kV	1	Lot	
	Transmission line materials	132kV ACSR	9.3	km	for Ubungo-F·Z III
3. Kariakoo Substation	Transformer	33/11kV 15MVA	1	Set	
	Switch gear	33/11kV	1	Lot	
	Transmission line materials	33kV ACSR	1.3	km	for Ilala-Kariakoo
	Distribution line materials	11kV ACSR	1.6	km	
4.Mbagala Substation	Transformer	33/11kV 15MVA	1	Set	
	Switch gear	33/11kV	1	Lot	
	Transmission line materials	33kV ACSR	9.2	km	for Kurasini-Mbagala
	Distribution line materials	11kV ACSR	1.6	km	
5.Common Items	Vehicles and Tools	Track 5ton (3ton with crane)	1	Set	
		Working vehicle (1ton)	1	Set	
		Tools	1	Lot	
	Others	Radio system UHF	1	Lot	

(2) Technology level, and maintenance and management of major equipment

Technology level required is normally proportional to the voltage rating. This project will use a highest voltage of 132 kV. Since TANESCO has been successfully operating 220 kV substations, it has proved to be able to handle 132 kV equipment and materials.

TANESCO has been properly maintaining 33 kV and 11 kV equipment, so that its technology level is satisfactory.

(3) Spare parts and consumable

No special spare parts or consumable for substation and transmission equipment will be used by this project.

This project will not use rotating machinery: any equipment used in this project will not contain normally rotating or moving parts. So, no special spare parts or consumable are required.

Spare parts for a vehicle is assumed to be about 10% of the price of the vehicle according to past records.

(4) Procurement from local manufacturers and third country

Pole transformers of small capacity made in Tanzania are available for this project.

Such materials as those not subject to complex processing, e.g. wooden poles and aluminum bare conductors can be imported from neighbouring countries at lower cost.

(5) Layout drawings for the existing and new substations and skeleton (single line) diagrams are shown in Figs. 2-3-7 through 2-3-20.

3. Specifications of major equipment

(1) Substation and transmission equipment should be per the following specifications in accordance with the basic requirements.

1) Substations

i) Ubungo s/s

The existing Ubungo s/s should be additionally fitted with a switch for each of the two 132 kV transmission systems leading to the Ilala s/s and Factory Zone-III s/s respectively.

ii) Ilala s/s

The existing Ilala s/s should be additionally fitted with a switch for the new 132 kV transmission system from the Ubungo s/s, and the existing bus bars should be improved in connection with the addition of the 132/33 kV (45 MVA) and 33/11 kV (15MVA) transformers.

iii) Factory Zone-III s/s

The existing 33/11 kV Factory Zone-III s/s should be additionally fitted with 132/33 kV (45 MVA) transformers and switches for the new 132 kV transmission system from the Ubungo s/s.

iv) Kurasini s/s

The existing Kurasini s/s should be additionally fitted with a switch for the new 33 kV transmission system that will connect the Kurasini s/s to the Mbagala s/s.

v) Kariakoo s/s and Mbagala s/s

These new distribution substations each should be fitted with a 33/11 kV (15 MVA) main transformer.

2) Specifications of the substation equipment

i) Special specifications for transformer

- Neutral grounding system

As shown in the skeleton (single line) diagrams, all the existing 220 kV, 132 kV, 33 kV and 11 kV circuits are using the direct neutral grounding system for all the transformers.

The same grounding system should be used for new transformers in consideration of compatibility with the existing protective systems, etc.

- Connection

  The grounding system for electric systems and the phase difference between the primary and secondary windings of a transformer should be the same as those currently used for the existing facilities in consideration of their use at another substation in future. Therefore, the 人-人-△ connection should be used for all transformers (the tertiary winding should be of an incorporated type).

- LTC, etc.

  Transformer LTCs should have the same tap distance as those of existing transformers. They should be fitted to the high-voltage side for reason of economy. This specification will enable parallel operation with an existing transformer in future.

ii) Operational Control

- The new substations should use the simple monitoring system as defined below. Note that the existing substations are using the same system.

- The simple monitoring system is normally applied for 100 kV or above (less than 10 MVA) substations. This system is based on occasional monitoring, patrolling and/or operation at the site: the operating personnel does not have to be permanently stationed at the substation.

- On-load tap control should comprise LTCs and LDCs like the existing distribution substations.

- The new substations under occasional monitoring by the simple monitoring system should have remote alarming devices. They should have alarm indicators at the Ilala s/s that is the permanent station of the operating personnel. The alarming system should comprise a UHF communication device.

- The 11 kV feeder cubicles to be placed in the new substations should contain a current recorder for load monitoring for each of the circuits in addition to normal instruments.

iii) Number of banks

A variety of methods have been used for evaluating the optimum number of banks. Assuming that the demand at the substation is constant, the sum of the construction costs for transmission and distribution lines does not depend on the number of banks. If a transformer fails, the loads connected to the transformer should be covered by the remaining (sound) banks. Considering a backup function with a smaller number of banks, the total installed capacity of the substation should be larger because the overload capacity of each transformer is not infinite. However, it is also true that substations comprising a smaller number of larger banks are cheaper. We recommend a two-bank system resulting from giving considerations to the above-mentioned general features and for convenience of future expansion.

iv) Transformer capacity per unit

To select the rating of each transformer, it is necessary to forecast the demand density after 10 years or later. When the demand scale is given, the optimum rating of a transformer can be given when the total cost for construction of transmission, substation and distribution facilities is the smallest. There are 5, 7.5, 10 and 15 MVA transformers currently used in Tanzania. We recommend that 15 MVA transformers be used as a standard in Dar-es-Salaam.

v) Bus bar system

The existing distribution substations are using the single bus bar system. This system is available for either one-circuit T-branch receiving or one-circuit π-branch receiving. The new distribution substations should use the same bus bar system.

vi) Protective relays

- For the existing substations

The current protective system is good. However, the protective relays should have the following temperature-proof and dust-proof measures.

- The entrances and openings should be airtight to avoid entry of dust.

- An air conditioning equipment should be furnished to avoid high temperature and large temperature difference.

Especially, distribution substations located near a coast should urgently take these measures.

- For new substations

The same protective system as those for the existing substations should be applied for all of transmission lines, bus bars and transformers. The current system is approximately the same as those widely used in Japan.

Protective relays should be of an electromagnetic type for easier maintenance (note: the existing substations are using this type).

The protective systems and relays should be per the following specifications.

a) Protection for transmission and distribution lines

Voltage \ Fault (Protection)	Main protection: Short-circuit	Main protection: Ground fault	Subordinate protection: Short-circuit	Subordinate protection: Ground fault
132 kV transmission line	DZ x 3	DG	OC x 3	OCG
33 kV transmission line	OC x 3	OCG	-	-
11 kV transmission line	OC x 2	OCG	-	-

DZ: Short-circuit distance relay
DG: Ground directional relay
OC/OCG: Overcurrent/ground overcurrent relay

b) Protection for buses

Voltage	Protection	Remarks
132kV	Voltage differential relay	132 kV substation
33kV	Overcurrent relay	132 kV substation
11kV	Overcurrent relay	33 kV substation

33 kV bus bars in a distribution substation should be protected by the protective system for the 33 kV transmission lines.

c) Protection for transformers

Voltage	Electrical protection							Mechanical protection
	Short-circuit			Ground fault				
	High-voltage winding	Low-voltage winding	Tertiary winding	High-voltage winding	Low-voltage winding	Tertiary winding		
220/132kV	OC *3	OC *3	-	OCG	OCG	-	RDf *3	Pr T (Winding) (Oil temperature)
LTC	-	-	-	-	-	-	-	PR
132/33kV	OC *3	OC *3	-	OCG	OCG	-	RDf *3	Pr T (Winding) (Oil temperature)
LTC	-	-	-	-	-	-	-	Pr
33/11kV (5 MVA or above)	-	OC *3	-	OCG	OCG	-	RDf *3	Pr T (Winding) (Oil temperature)
LTC	-	-	-	-	-	-	-	Pr
33/11kV (Less than 5 MVA)	-	OC *2	-	-	OCG	-	RDf	Pr T (Winding) (Oil temperature)
LTC	-	-	-	-	-	-	-	Pr

RDf: Ratio differential relay
Pr: Pressure relay
T: Temperature relay
LTC: On-load tap changer

vii) Communication system

- Outline of the proposed communication system

  The communication system for the new Kariakoo and Mbagala substations should be such that the existing system can be utilized to the largest extent for reason of economy.

- Compatibility with the existing communication system

  The new substation monitoring system (including SCADA) that should communicate with the Ilala s/s can be realized by expanding the existing communication system. This way is the best option in view of installation space, operation and maintenance.

- Economy

  The SCADA system used by the Ilala s/s should be expanded by adding some software and hardware devices in order to cover the new substations. Note that this expansion of the system does not need installation of new equipment. The cost for this expansion that will occur only in the new substations, not in the existing substations, is small.

viii) Connecting feeder lines to a transformer

The secondary feeder will use the single bus system. The secondary bus of each of the two transformers can be separated. Combined use of these two connecting systems will enable effective and optimum load-switching in case of a transformer fault.

The number of feeders should be determined depending on the forecast demand at each substation.

ix) Connecting a transmission line to a transformer

There are several methods for connecting a transmission line to a transformer depending on the use of a circuit breaker and disconnector. The new substations should use the line CB & transformer CB system that is available for either T-branch or π-branch receiving. This system comprising connections via a circuit-breaker for both the primary side of the transformer and receiving line is available for either the T-branch or π-branch receiving.

x) Specifications of major equipment (substation)

The specifications of the major equipment for the existing and new substations are shown below.

a) Main transformer

Standard : JEC 2200-1978 Transformer

JEC 186-1972 On Load Tap Changer

Capacity	45,000kVA	15,000kVA
Rating	Continuous	Continuous
No. of phases	3	3
Frequency	50Hz	50Hz
Cooling system	Oil-immersed, self-cooled	Oil-immersed, self-cooled
Voltage rating (Primary/Secondary)	132000V / 33000V	33000V / 13000V
Tap voltage(HV)	10% 17Tap	10% 17Tap
Insulation grade	120/ 30A	30/ 10A
Connection Primary Secondary	 Tertiary	 Tertiary
Angular displacement	0°	0°
Polarity	Depolarizing	Depolarizing
Weather-proof	Outdoor use	Outdoor use
Tap changer	On-load tap changing	On-load tap changing
Altitude	Less than 1,000 m	Less than 1,000 m

b) Circuit-breaker

Standard : JEC 2300-1985 Circuit-breaker

Voltage rating	145kV	36kV	36kV		36kV	36kV
Insulation grade	120	30A	30A		30A	30A
Current rating	800A	600A	800A		1,200A	2,000A
Frequency rating	50Hz	50HZ	50HZ		50Hz	50Hz
Rated breaking current	25kA	12.5kA	12.5kA		12.5kA	12.5kA
Rated breaking time	3 cycles	5 cycles	5 cycles		5 cycles	5 cycles
Rated input operating voltage	DC 100V	DC 100V	DC 30A		DC 100V	DC 100V
Rated pull-off voltage	DC 100V	DC 100V	DC 30A		DC 100V	DC 100V
Standard operating responsibility	A 0-(1minute)-CO-(3minutes)-CO	A 0-(1minute)-CO -(3minutes)-CO				
Weather-proof	Outdoor use					
Altitude	Less than 1,000 m					
Ambient temperature, highest	40°C					
Substitution				Only Kurasini s/s		

Voltage rating	12kV	12kV	12kV
Insulation grade	10B	10A	10A
Current reting	1200A	600A	1,200A
frequency rating	50Hz	50Hz	50Hz
Rated breaking current	25kA	25kA	25kA
Rated breaking time	5 cycles	5 cycles	5 cycles
Rated input operating Voltage	DC 100V	DC 100V	DC 100V
Rated pull-off voltage	DC 100V	DC 100V	DC 100V
Standard operating resposibility	B CO-(15 seconds)-CO		
Weather-proof	Indoor cubicle		Outdoor cubicle
Altitude	Less than 1,000 m		
Ambient temperature,highest	40		
Substation	Hala	Feeder(except Hala)	TR Secondary (except Hala)

c) Disconnector

Standard : JEC 2310-1990 AC Disconnector

Voltage rating	145kV		36kV	36kV	36kV	36kV
Insulation grade	120		30A	30A	30A	30A
Current rating	1,200A		600A	800A	1,200A	2,000A
Short-time current rating (standard)	25kA		12.5kA	12.5kA	12.5kA	12.5kA
Weather-proof	Outdoor use					
Altitude	Less than 1,000 m					
Ambient temperature, highest	40℃					
Operation	Motor operated	Manual	Manual	Manual	Manual	Manual
Substation	Only Ubungo					

Accessories : With or without grounding devices

d) Current Transformer

Standard : JEC 1217-1985 Current Transformer

Voltage Rating	132Kv				33Kv	
Type	Independent	Independent	BCT	BCT	BCT	BCT
Insulation grade	120	120	-	-		-
Primary current	800-400	800-400	400-200	400-200	600-200	1200-600
Secondary current	1A	5A	5A	5A	5A	1A
Load rating	40VA	40VA	15VA	15VA	5VA	1VA
Over-current intensity	40	40	40	40	40	40
Class	1P	1P	1P	1P	1P	1P
Substation	ILALA UBUNGO	FZ III	ILALA TR	FZ III TR	FZ III KARIAKOO MBAGALA CB	ILALA TR

Voltage Rating	33Kv					
Type	BCT	BCT	BCT	BCT	BCT	BCT
Insulation grade	-	-	-	-		-
Primary current	1200-600	400-200	400-200	400-200	800-400	800-400
Secondary current	1A	1A	1A	1A	1A	5A
Load rating	25VA	25VA	15VA	15VA	15VA	25VA
Over-current intensity	40	40	40	40	40	40
Class	1P	1P	1P	1P	1P	1P
Substation	ILALA CB	ILALA CB	ILALA CB	ILALA KURASINI CB	FZ III TR	FZ III CB

e) Potential Transformer

Standard : JEC 1201-1985 Potential Transformer

Voltage rating	$\frac{132kV}{\sqrt{3}}$ / $\frac{110kV}{\sqrt{3}}$
Frequency rating	50Hz
Responsibility rating	120
	200 / 100VA
Class	1P -3G

f) Arrester

Standard : JEC 203-1978 Arrester

Voltage rating	126kV	42kV	14kV
Frequency rating	50Hz		
Nominal discharge current	10kA		
Altitude	Less than 1,000 m		
Ambient temperature, highest	40℃		
Grounding system	Direct neutral grounding		

g) Enclosed Switchboard

Standard : JEM 1153 Enclosed Switchboard

Voltage rating	11kV	
Weather-proof	Indoor use	Outdoor use
Altitude	Less than 1,000 m	
Ambient temperature, highest	40℃	
Type	PW	PW
Bus current	1,200A	1,200A
Rated short-circuit current	25kA	25kA
Substation	ILALA	KARIAKOO MBAGALA

PW : Compartment

h) Substation Equipment List

Table 3-3-1 shows the major equipment to be added in accordance with this expansion plan.

Table 3-3-1 Equipment List

Major Equipment			Substation									Remarks
			Ubungo s/s	Ilala s/s		Factory Zone-III		Kurasini s/s	Kariakoo s/s	Mbagala s/s		
Main Transformer	Capacity	Max		45	15	45			15	15		
	No. of Phases			3	3	3			3	3		
	Frequency	Hz		50	50	50			50	50		
	Voltage Rating	kV		132/33	33/11	132/33			33/11	33/11		
	Connection Method			Y Y Δ	Y Y Δ	Y Y Δ			Y Y Δ	Y Y Δ		
	Tap Changer			On-load tap changing	Same as left	Same as left			On-load tap changing	Same as left		
	No. of Units			1	1	2			1	1		
Circuit Breaker	Voltage Rating	kV	145	145	36	145	36	36	36	36		
	Current Rating	A	800	800	600/800	800	1200	1200	1200	1200		
	Breaking Current Rating	kA	25	25	12.5	25	12.5	12.5	12.5	12.5		
	No. of Units		2	4	1/1	3	2	1	1	1		
	Voltage Rating	kV			36	1	36					
	Current Rating	A			1200/2000		600					
	Breaking Current Rating	kA			12.5		12.5					
	No. of Units				1/1		2			1		
Disconnector	Voltage Rating	kV	145	145	36	145	36	36	36	36		
	Current Rating	A	1200	800	1200/800/2000	800/1200	600/1200	800	800	800		
	No. of Units		6		1/2/2	2/1	2/2	1	0	1		
	Voltage Rating	kV	145	145	36	145	36	36	36	36		
	Current Rating	A	1200	800	800	1200	600	800	800	800		
	Accessories		E.S	E.S	E.S	E.S	E.S	E.S	E.S	E.S		
	No. of Units		2	1	1	1	1	1	1	1		
Current Transformer (only for the main circuits)	Voltage Rating	kV	132	132	33	132	33	33	33	33		
	Insulation Grade	A	120	120/BCT	BCT	120/BCT	BCT	BCT	BCT	BCT		
	Current Rating		800/1	400/1	2000/1,1200/1 800/1,400/1	800/5, 400/5	1200/5, 600/5	800/1	600/5	800/5		
	No. of Units		6	3/3	15	3/3	12	3	3	3		
(One unit = Three-phase) P.T. or P.D.	Voltage Rating	kV	$\frac{132}{\sqrt{3}}/\frac{110V}{\sqrt{3}}/\frac{110V}{\sqrt{3}}$	Same as left	$\frac{33}{\sqrt{3}}/\frac{110V}{\sqrt{3}}$	$\frac{132}{\sqrt{3}}/\frac{110V}{\sqrt{3}}/\frac{110V}{\sqrt{3}}$	$\frac{33}{\sqrt{3}}/\frac{110V}{\sqrt{3}}$					
	Insulation Grade		120	120	30A	120	30A					
	Responsibility	VA	200/100	200/100	200	200/100	200					
	No. of Units		7	3	3	3	3					
11 kV Feeder Enclosed Switchboard	No. of Units		-	-	Indoor use x 8	-	-	-	Outdoor use x 8	Outdoor use x 8		

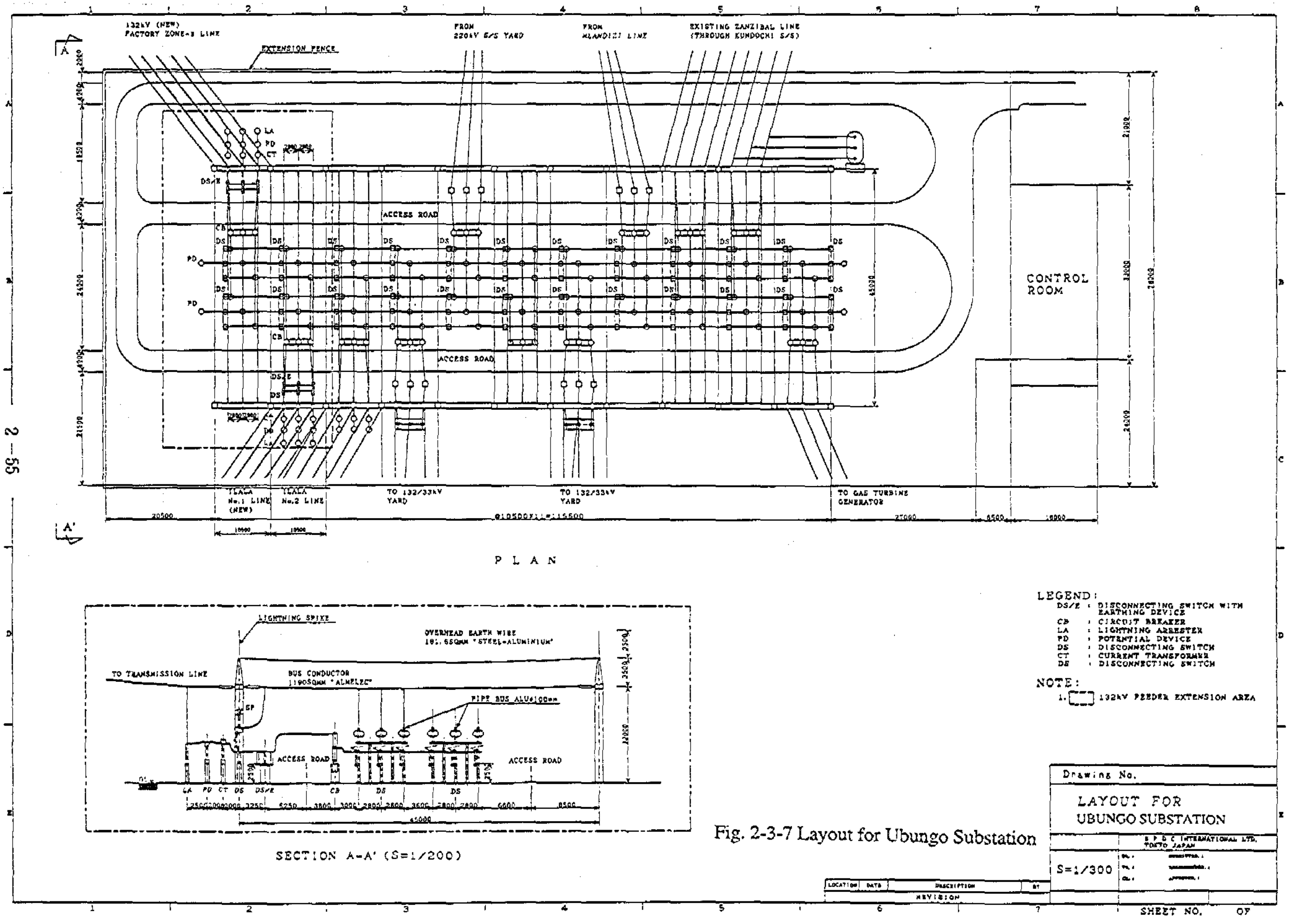


Fig. 2-3-7 Layout for Ubungo Substation

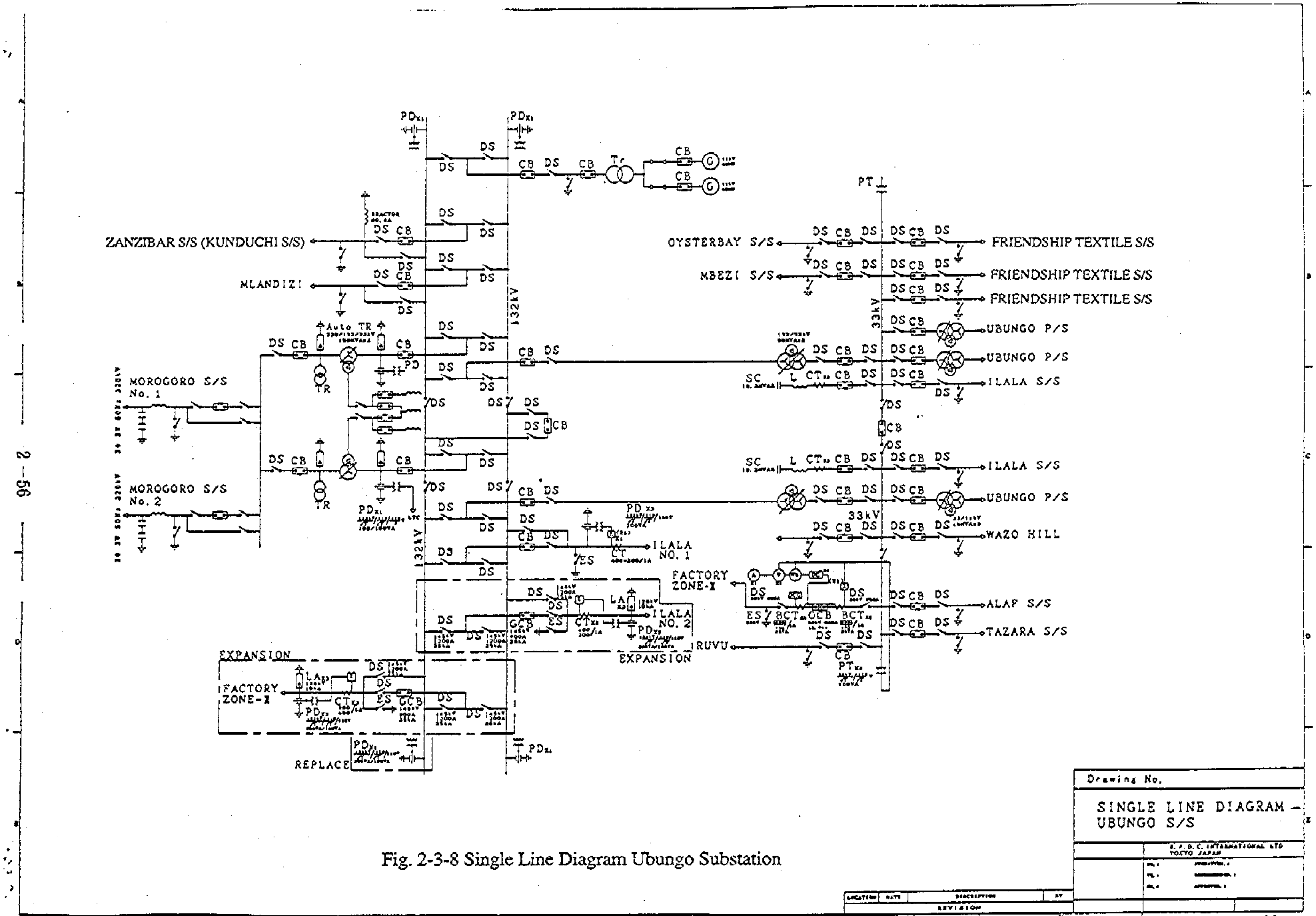


Fig. 2-3-8 Single Line Diagram Ubungo Substation

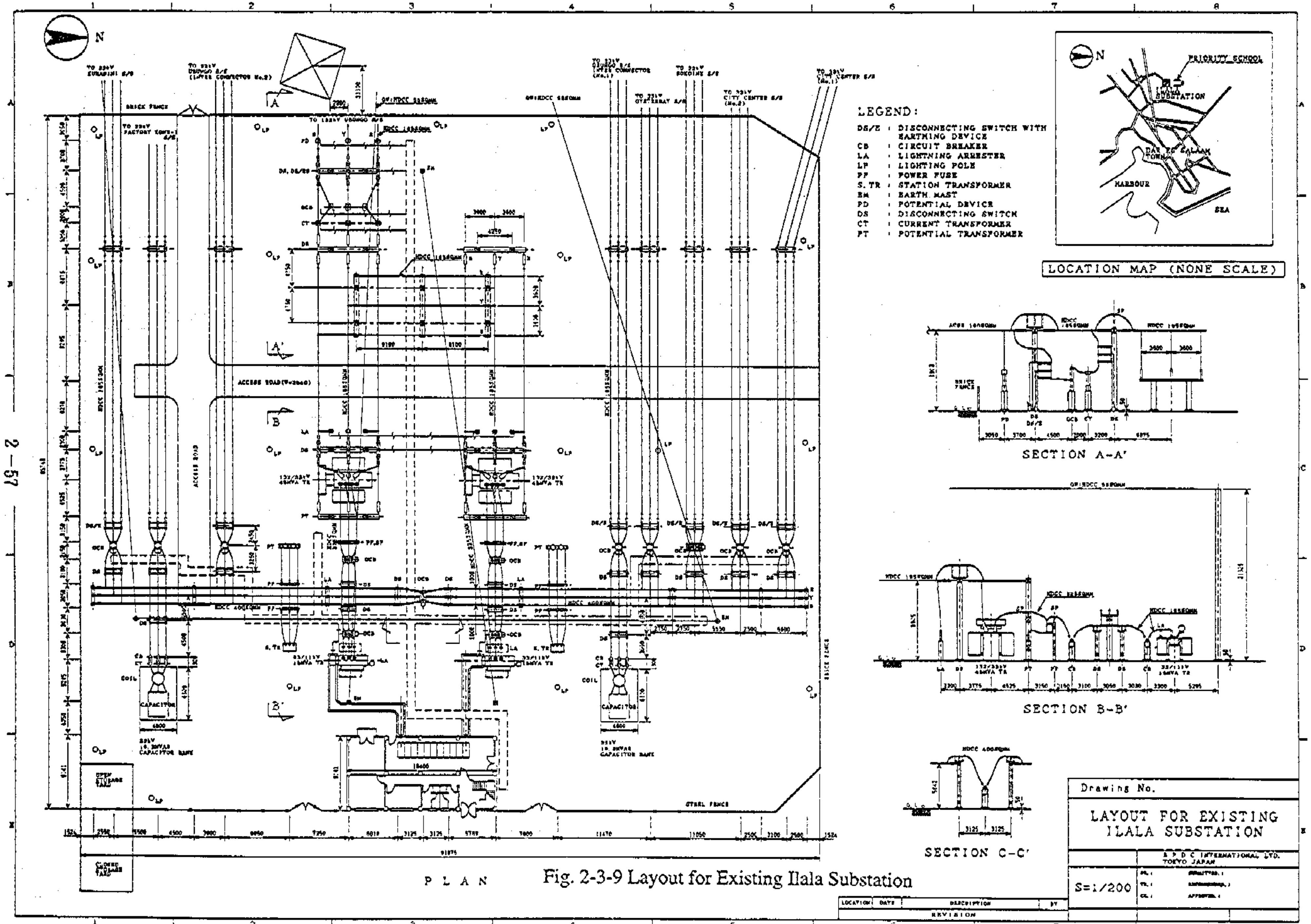


Fig. 2-3-9 Layout for Existing Ilala Substation

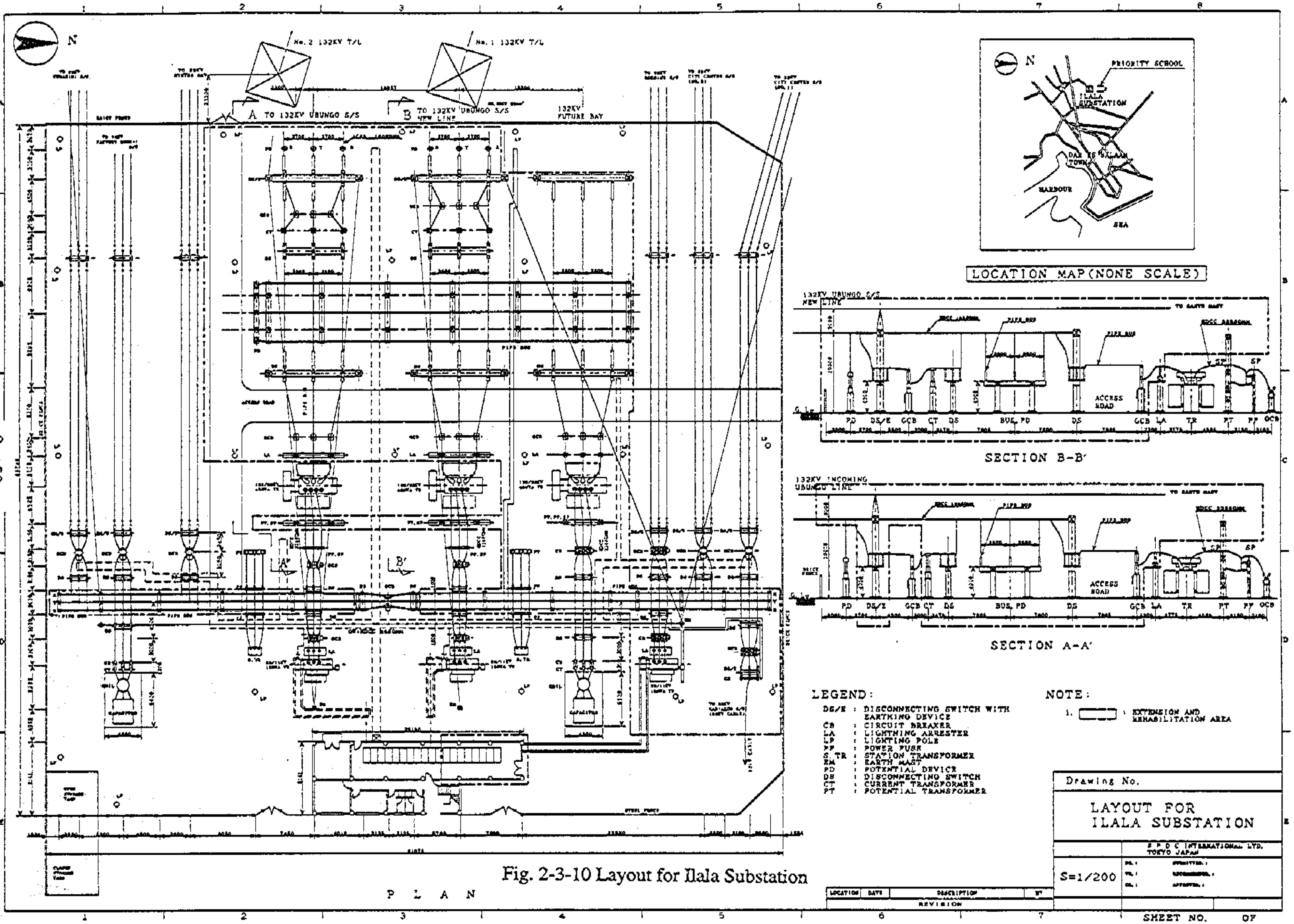


Fig. 2-3-10 Layout for Ilala Substation

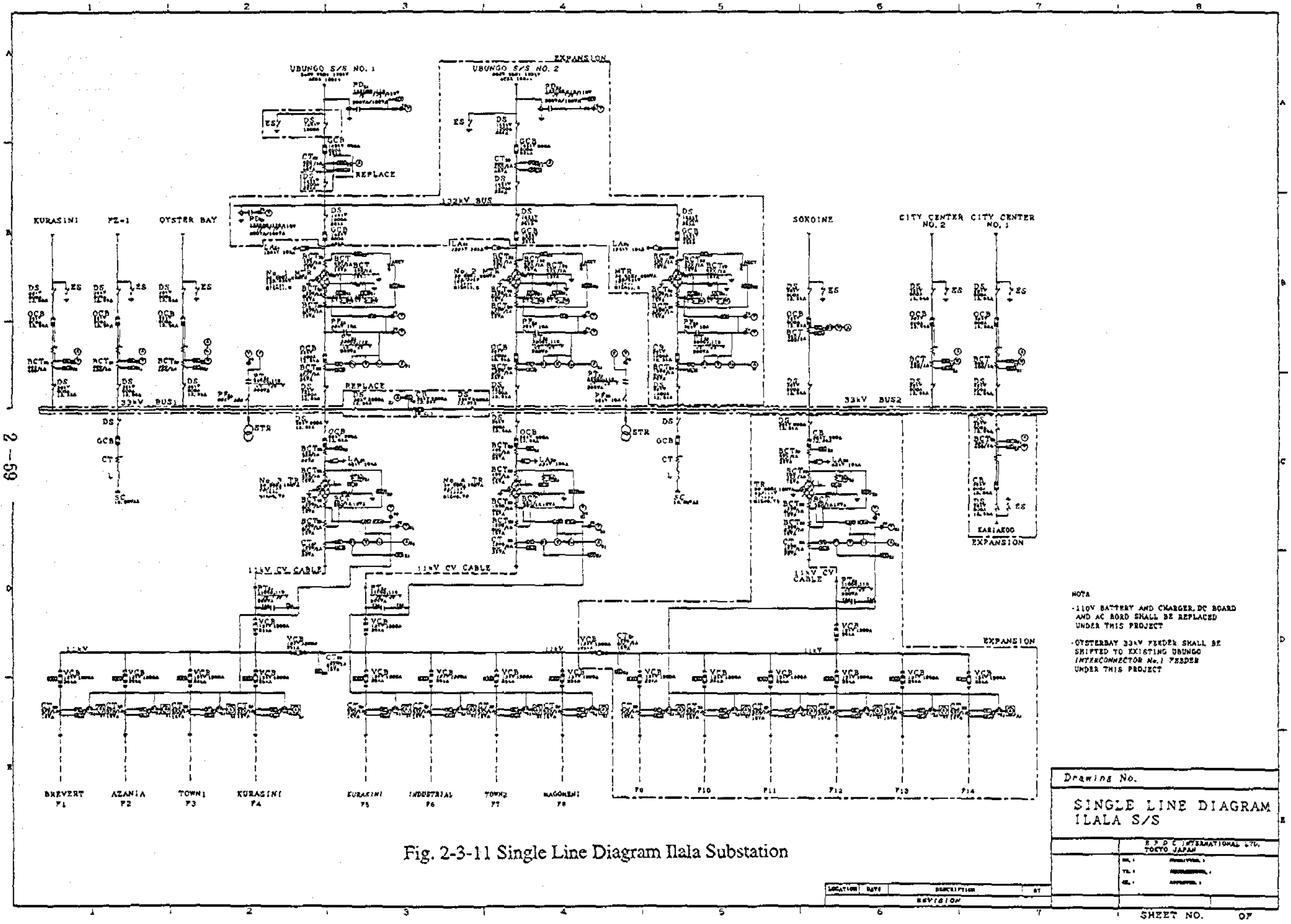


Fig. 2-3-11 Single Line Diagram Ilala Substation

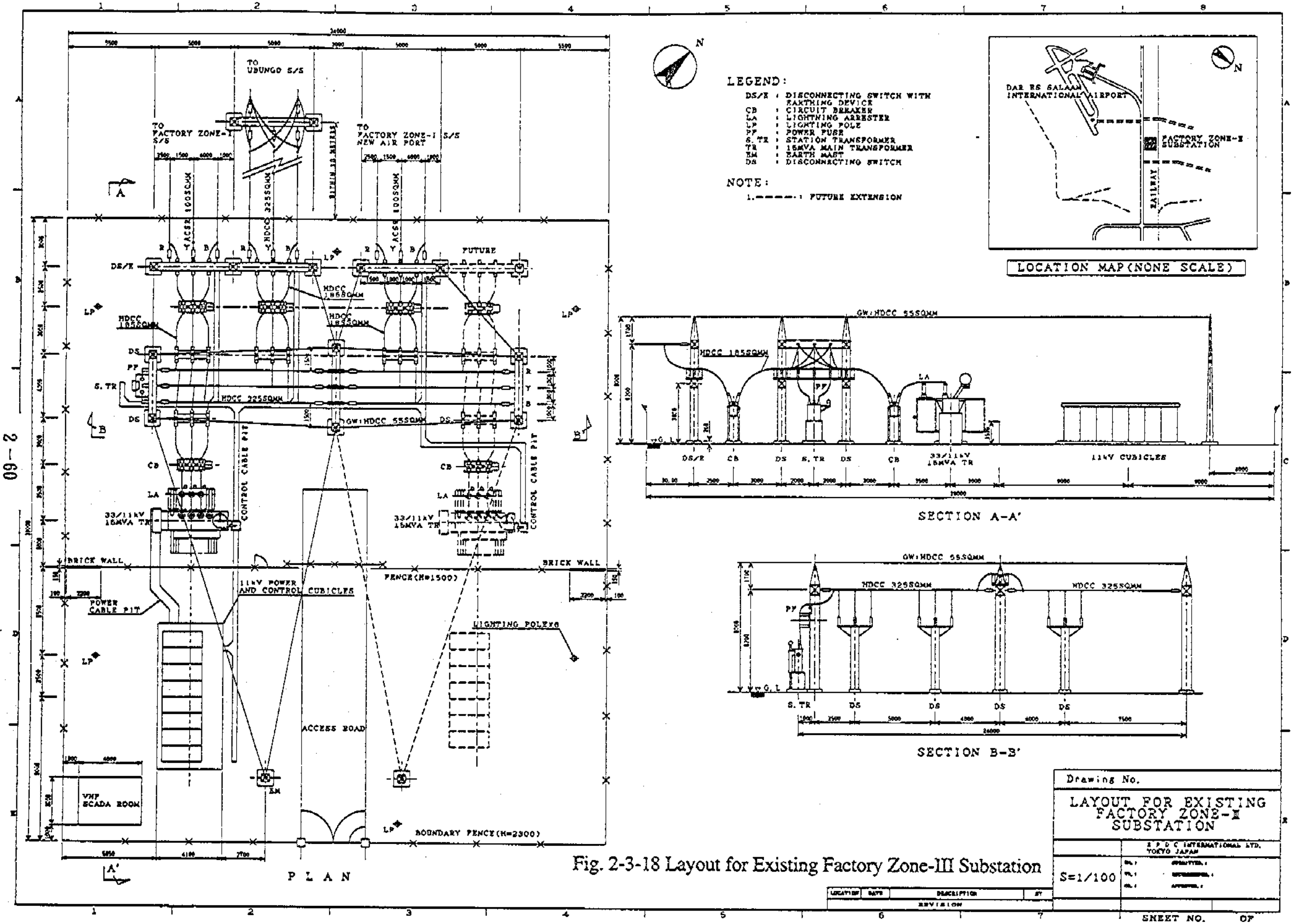


Fig. 2-3-18 Layout for Existing Factory Zone-III Substation

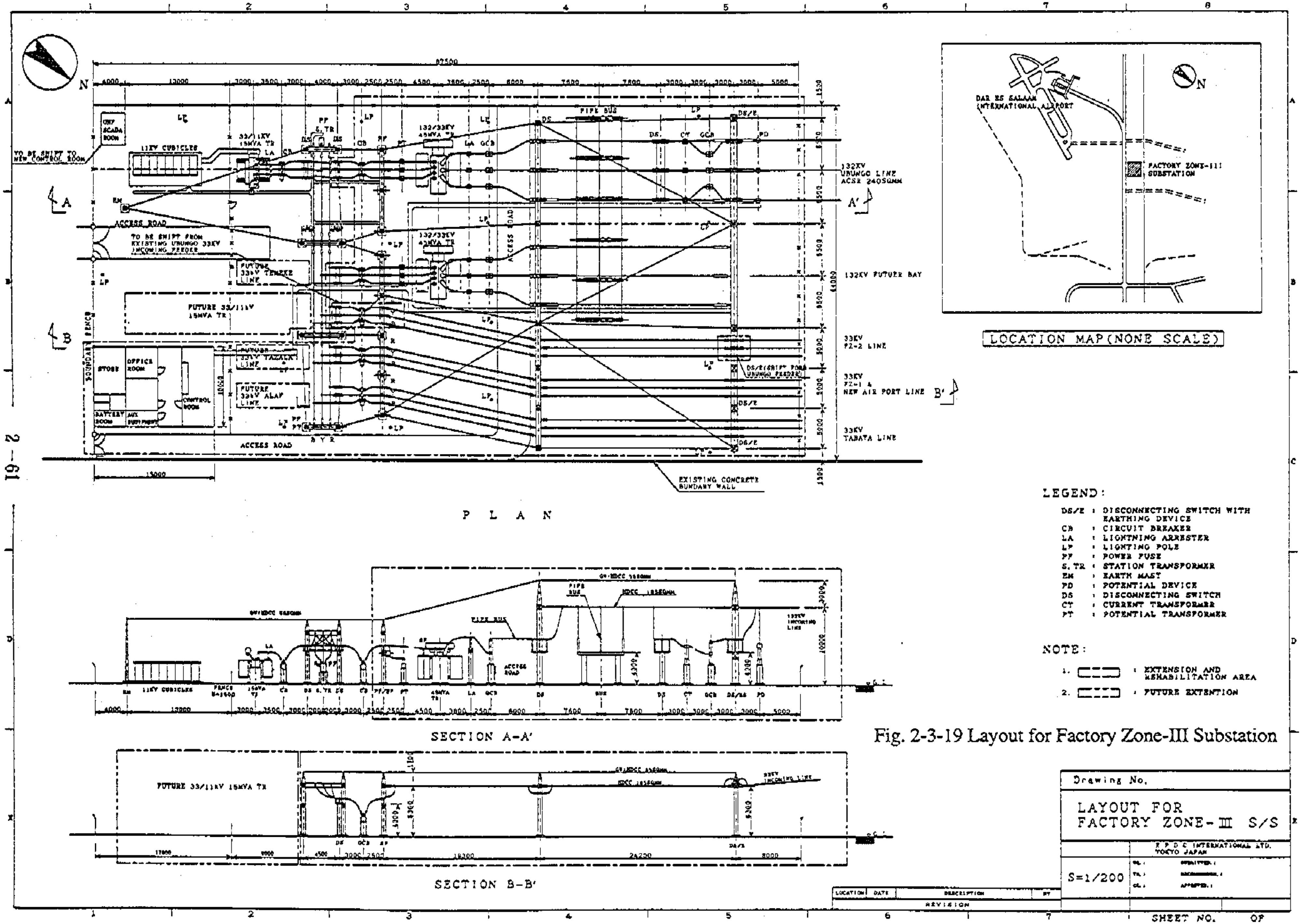


Fig. 2-3-19 Layout for Factory Zone-III Substation

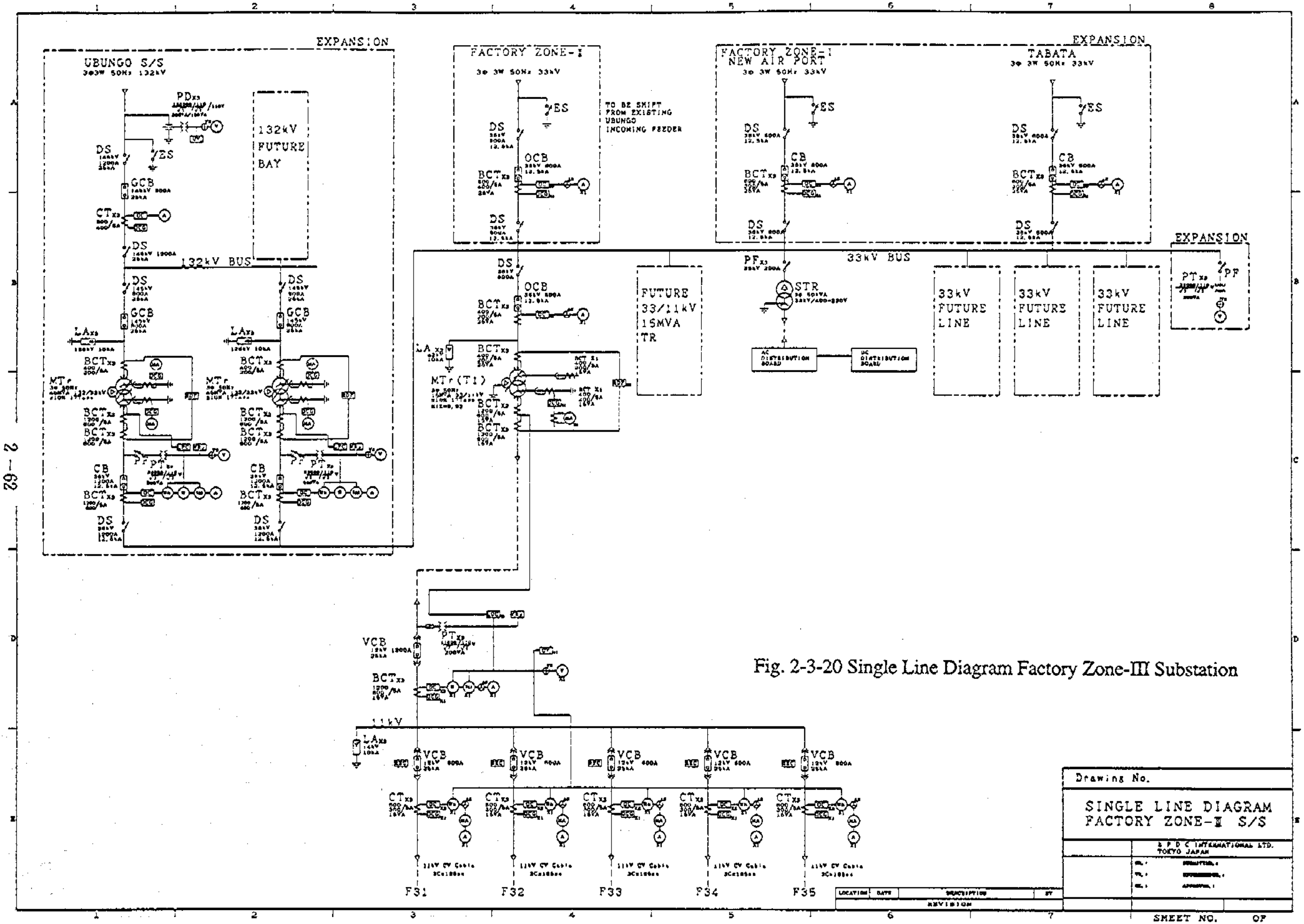


Fig. 2-3-20 Single Line Diagram Factory Zone-III Substation

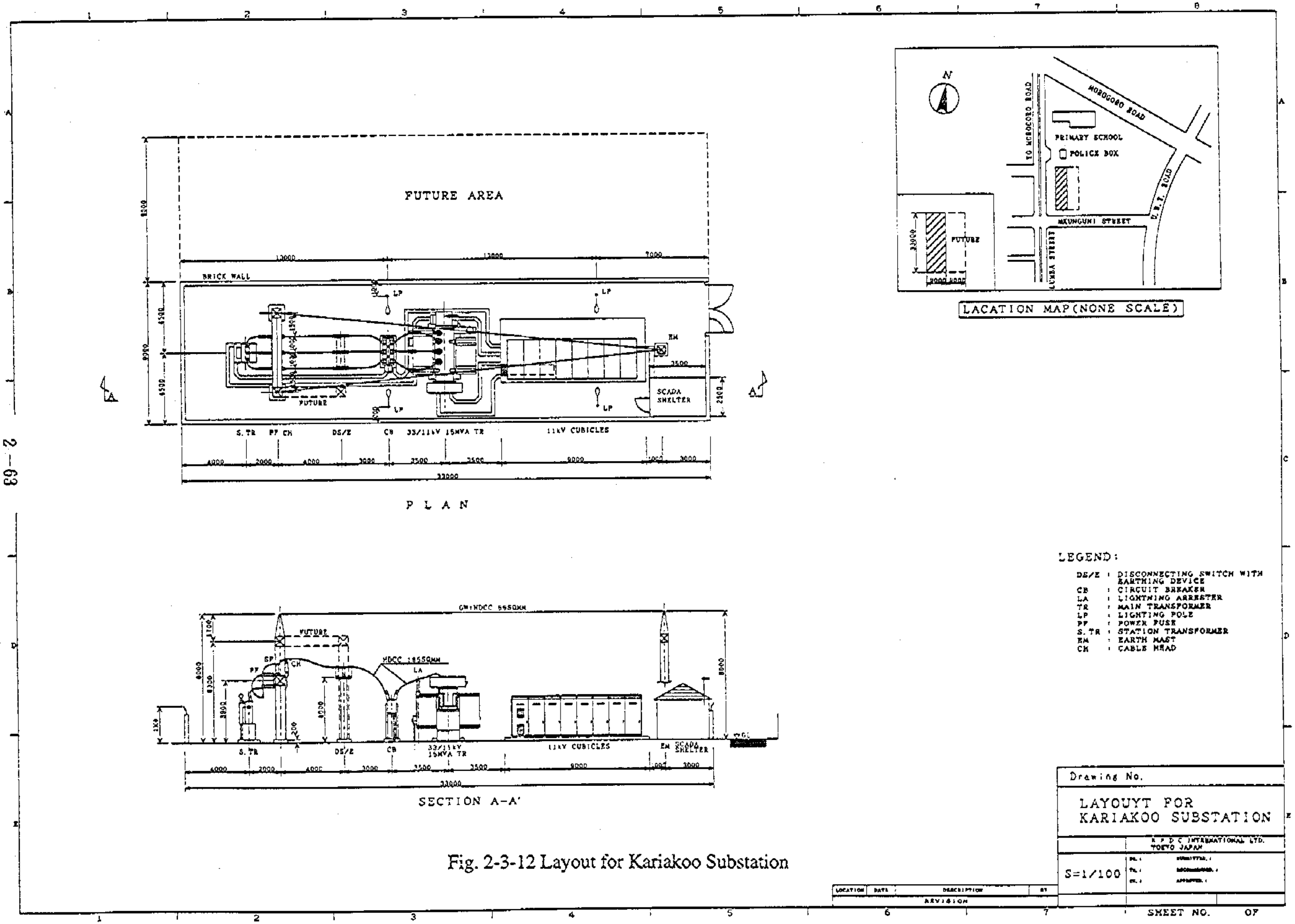


Fig. 2-3-12 Layout for Kariakoo Substation

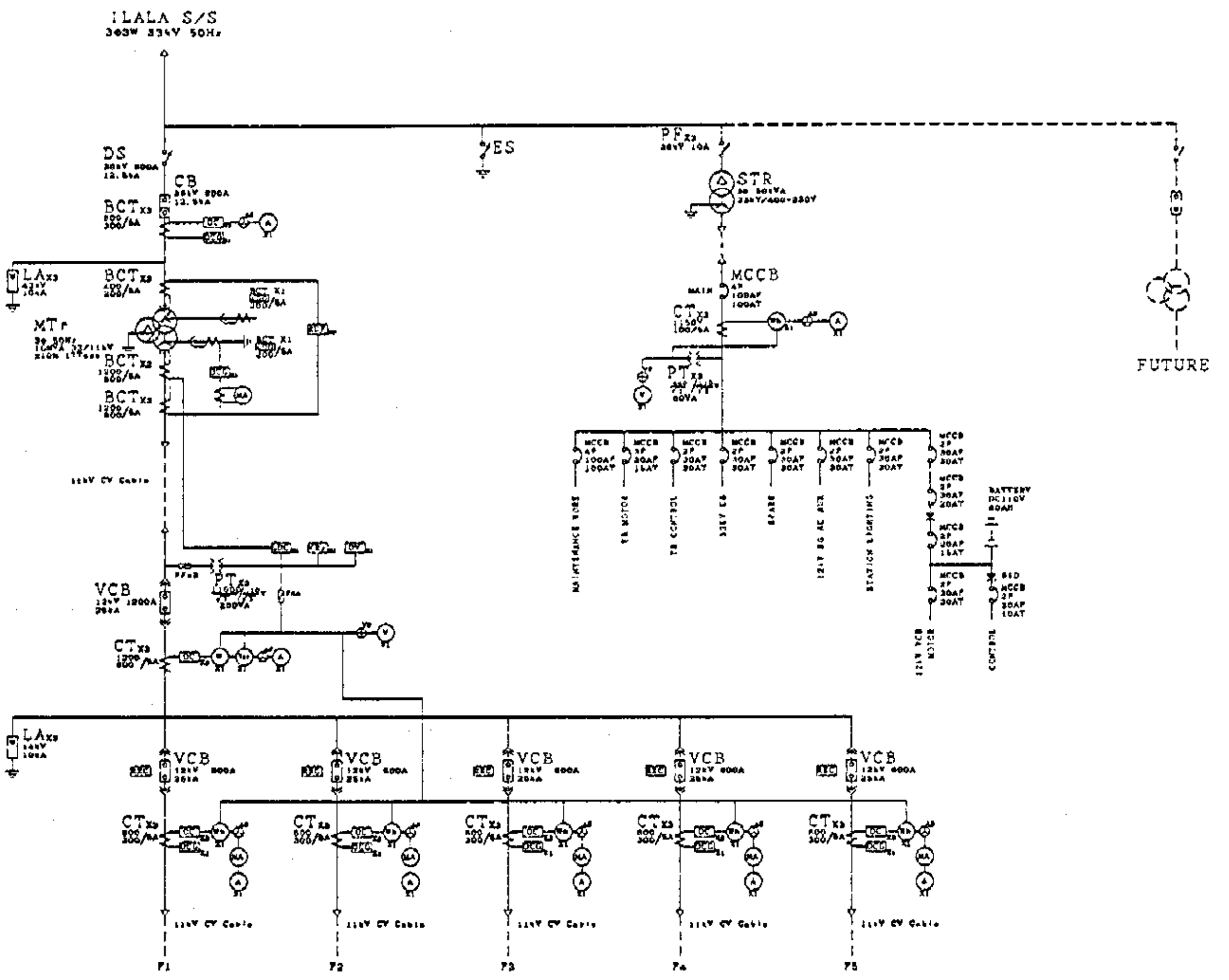


Fig. 2-3-13 Single Line diagram Kariakoo Substation

Drawing No.

SINGLE LINE DIAGRAM
KARIAKOO S/S

SHEET NO. OF

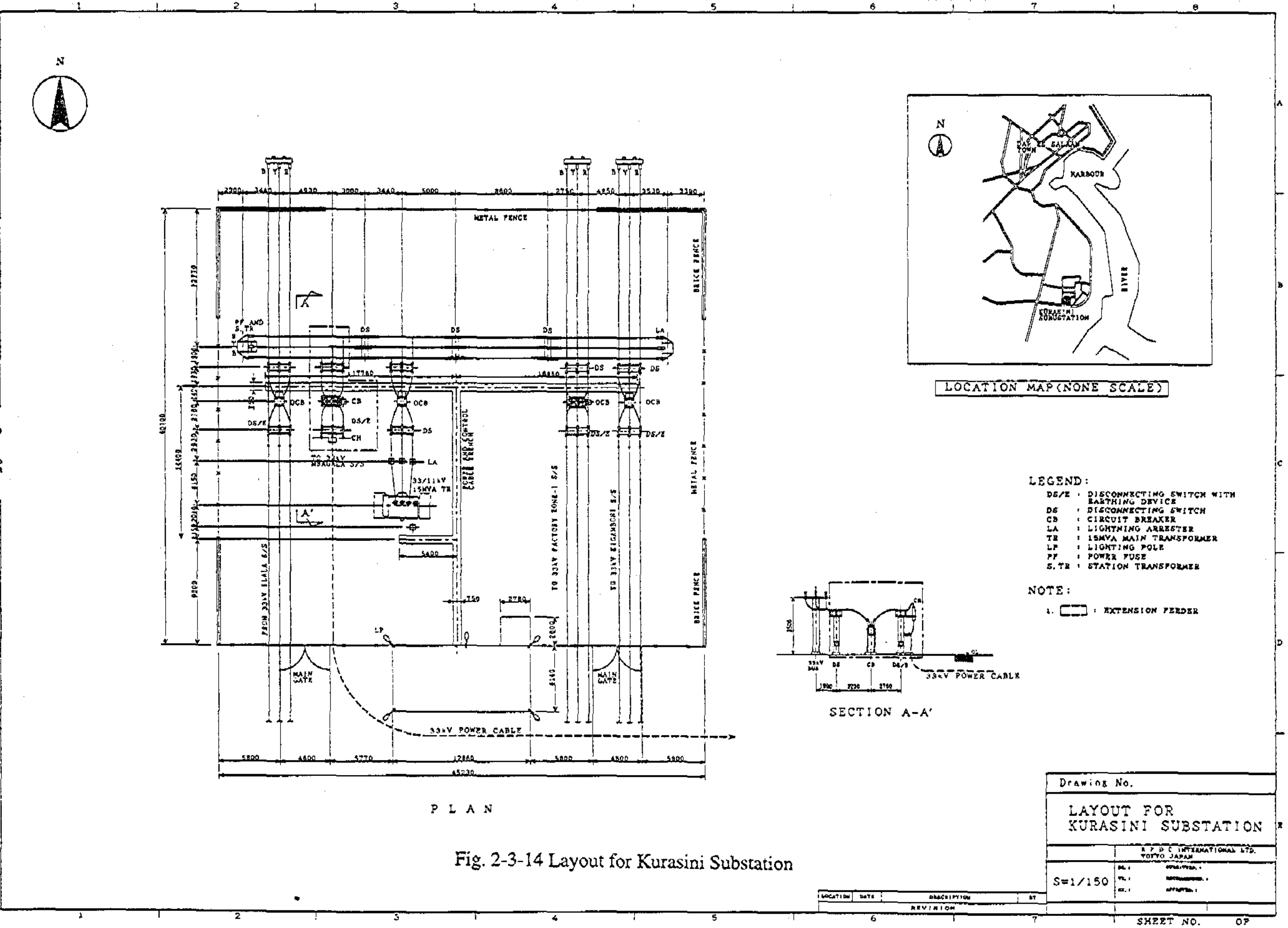


Fig. 2-3-14 Layout for Kurasini Substation

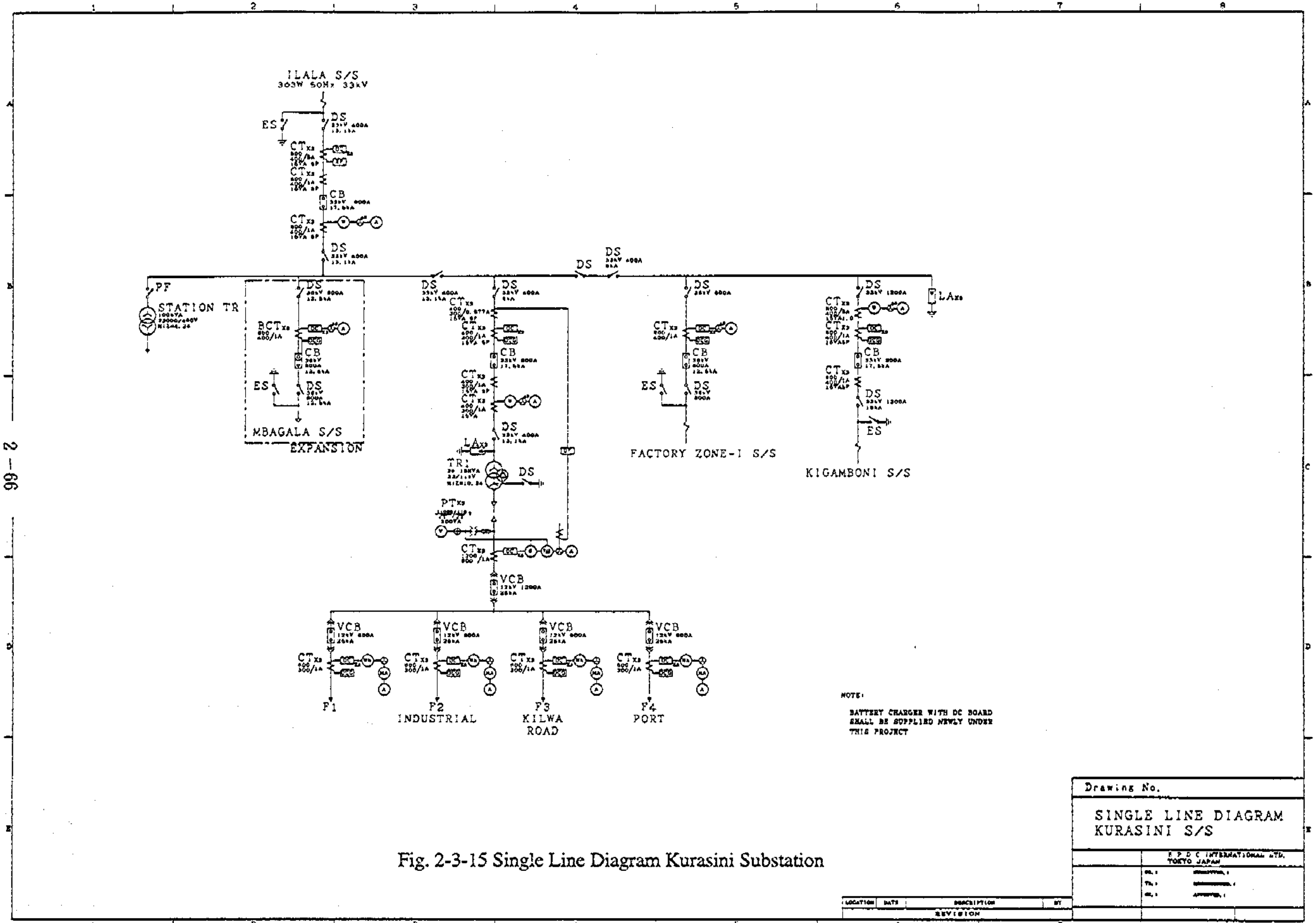


Fig. 2-3-15 Single Line Diagram Kurasini Substation

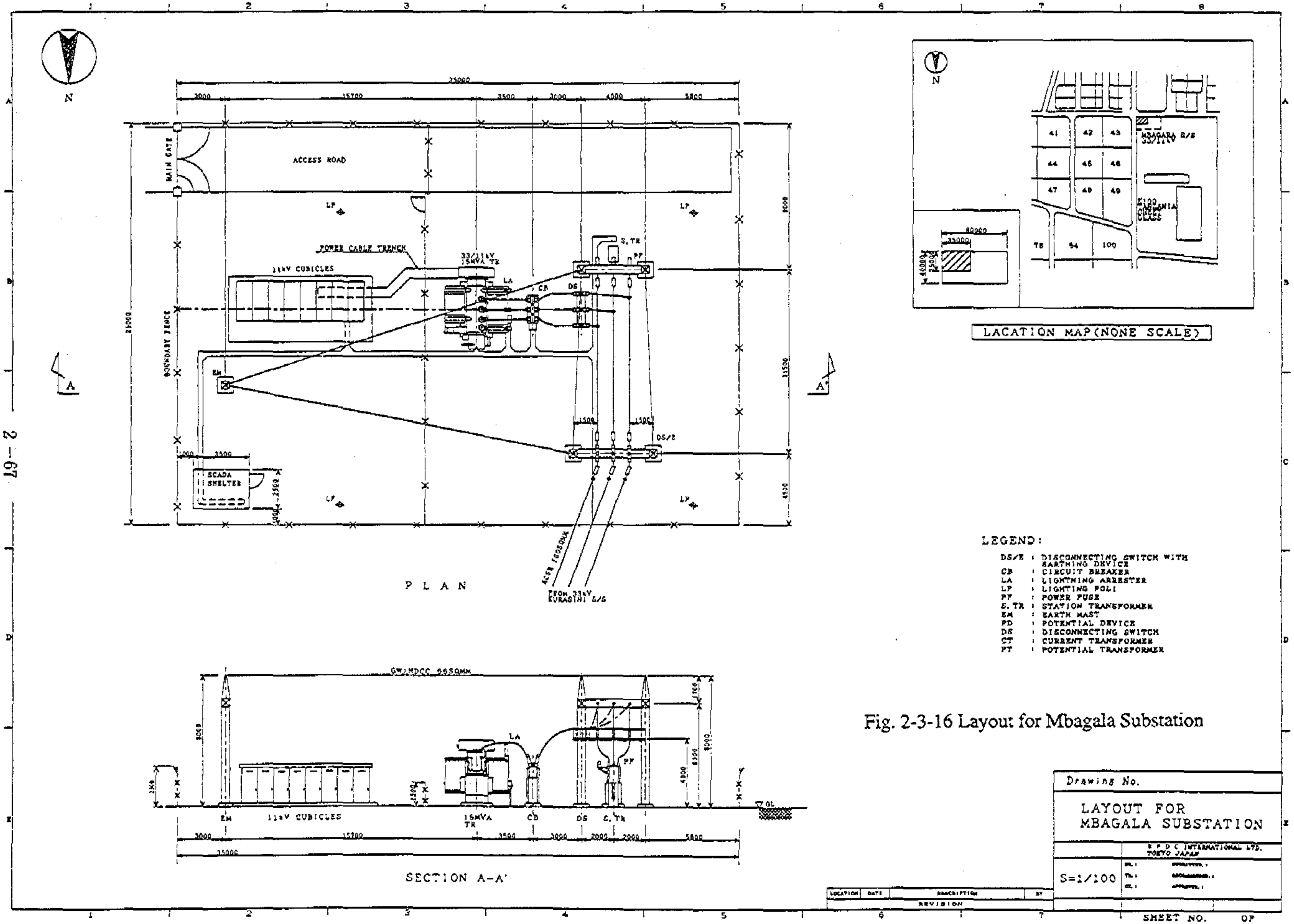


Fig. 2-3-16 Layout for Mbagala Substation

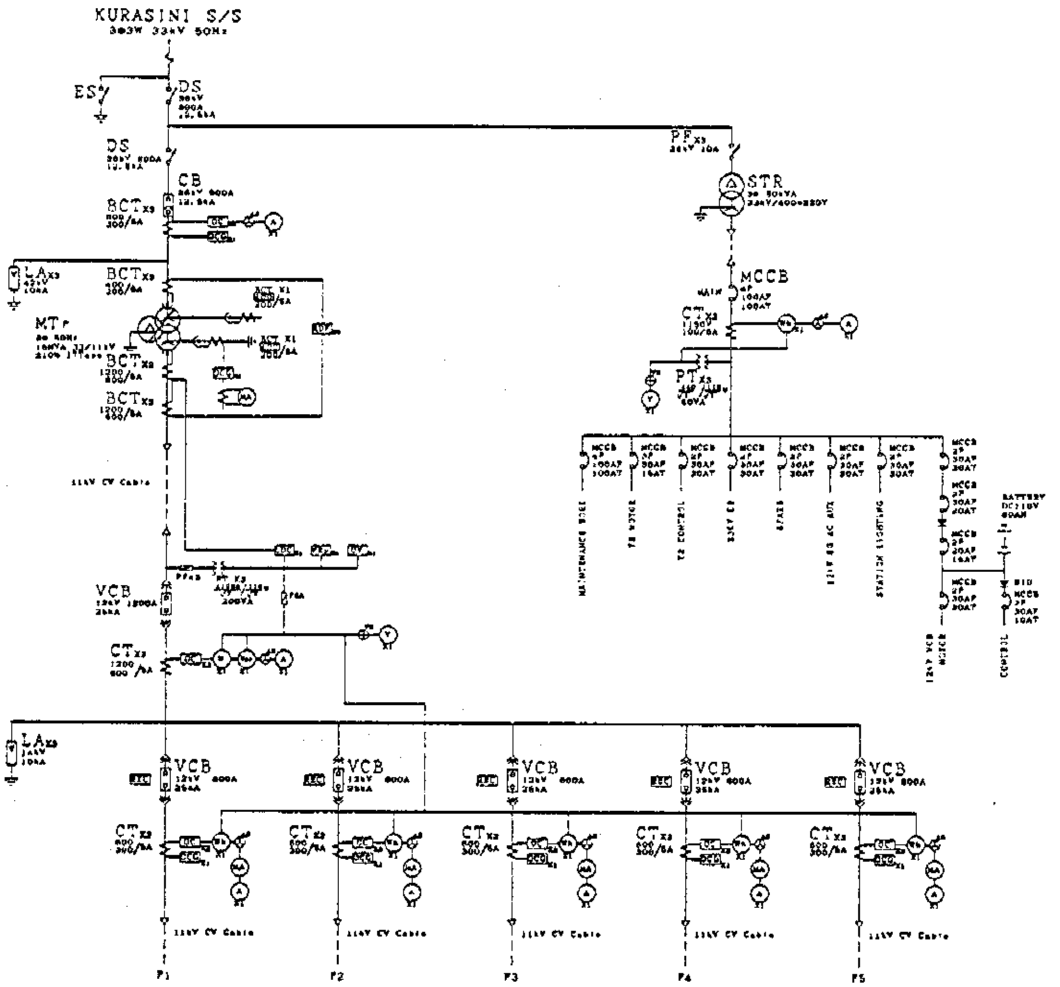


Fig. 2-3-17 Single line Diagram Mbagala Substation

Drawing No.

SINGLE LINE DIAGRAM
MBAGALA S/S

SHEET NO. OF

xi) Specifications of major equipment (transmission and distribution)

a) 132 kV transmission line

- Steel tower

Standard:	JEC-127 (1979)
Design conditions	
Wind pressure (tower)	266 kg/m^2
Wind pressure (overhead line)	92 kg/m^2

- Conductor

Standard: ASTM B232-78	ASTM B232-78	
Type	240 mm^2 ACSR/AW (Hawk)	
Nominal sectional area (MCM, mm^2)	477 (236.9)	
Sectional area, calculated (mm^2)		
- Aluminum	241.5	
- Steel	39.34	
- Total	280.8	
Stranding structure (No./mm)		
- Aluminum	241.5	26 / 3,439
- Steel	39.34	7 / 2,675
- Outside diameter (mm)	21.78	
Weight (kg/m)	0.9294	
Minimum tensile strength (kgf)	8,586 (84.2kN)	
Electrical resistance (Ω/km at 20°C)	0.1133	

— Overhead ground wire

Standard:	JEC / JCS
Type	55 mm^2 ACS
Nominal sectional area (mm^2)	
Sectional area, calculated (mm^2)	56.29
Stranding structure (No./mm)	7/3.2
Outside diameter (mm)	9.6
Weight (kgf)	0.3565

Minimum tensile strength (kgf)	6,620
Electrical resistance (Ω/km at 20°C)	1.34

— Insulator

Type of ball and socket coupling	IEC 16 mm A
Creepage distance, mm	292
Electro-mechanical failing load, kN	120
Dry lightning impulse withstand voltage, kV	110
Wet power-frequency withstand voltage, kV	40
Power-frequency puncture voltage, kV	110

b) 33 kV transmission line

- Conductor

Standard: BS 215 Part 2	BS 215 Part 2
Type	150 mm^2 ACSR (Wolf)
Nominal sectional area (MCM, mm^2)	477
Sectional area, calculated (mm^2)	
- Aluminum	158.1
- Steel	36.88
- Total	194.9
Stranding structure (No./mm)	
- Aluminum	26/3.439
- Copper	7/2.675
Outside diameter (mm)	21.78
Weight (kgf/m)	0.9294
Minimum tensile strength (kgf)	8,586(84.2kN)
Electrical resistance (Ω/km at 20°C)	0.1133

- Overhead ground wire

Standard:	JEC

Type	30 mm^2 ACS
Nominal sectional area	30 mm^2
Sectional area, calculated (mm^2)	27.09
Stranding structure (No./mm)	7/2.3
Outside diameter (mm)	6.9
Weight (kg/m)	0.1918
Minimum tensile strength (kgf)	3,530
Electrical resistance (Ω/km at 20°C)	2.94

- Suspension insulator

Standard:	IEC Pub 383-(1983)
Type of ball and socket coupling	IEC 16 mm A
Creepage distance,	292
Electro-mechanical failing load, kN	70
Dry lightning impulse withstand voltage, kV	110
Wet power-frequency withstand voltage, kV	40
Power-frequency puncture voltage,	110 kV

- Pin insulator

Standard:	BS 137 : Part 2
Voltage rating	33 kV
Wet power-frequency flashover voltage	95 kV
50% shock wave flashover voltage (positive)	215 kV

c) 11 kV distribution line

- Conductor

Standard:	BS 125 Part 2
Type	100 mm^2 ACSR (Dog)
Nominal sectional area	100 mm^2
Stranding structure	A16/4.72, St7/1.57
Sectional area, calculated (mm^2)	118.5
Outside diameter (mm)	14.15
Unit weight (km)	3,330
Tensile strength (kg)	3,330
Electrical resistance (Ω/km at 20°C)	0.2733

- 11 kV power cable

Standard:	IEC-502
Type	XLPE insulated
Nominal sectional area	185 sq. mm
Electrical resistance (Ω/km at 20°C)	0.0991
Insulation resistance (MΩ-km)	1,500

- Section switch (LBS)

Voltage rating (kV)	12
Rated current (A)	400
Rated frequency (Hz)	50
BIL (kV)	95
Power-frequency withstand voltage	31.5
Rated short-time current (1 sec) (kA)	12.5

- Arrester

Standard	JEC-203
Voltage rating (kV)	14
Power-frequency discharge initiating voltage (kV)	21

Lightning impulse discharge initiating voltage (kV)	50
Nominal discharge current (kA)	5
Clamping voltage (kV)	50

d) *Drawings*

Drawings of the transmission facilities are shown in Figs. 2-3-21 through 2-3-31.

STEEL TOWERS

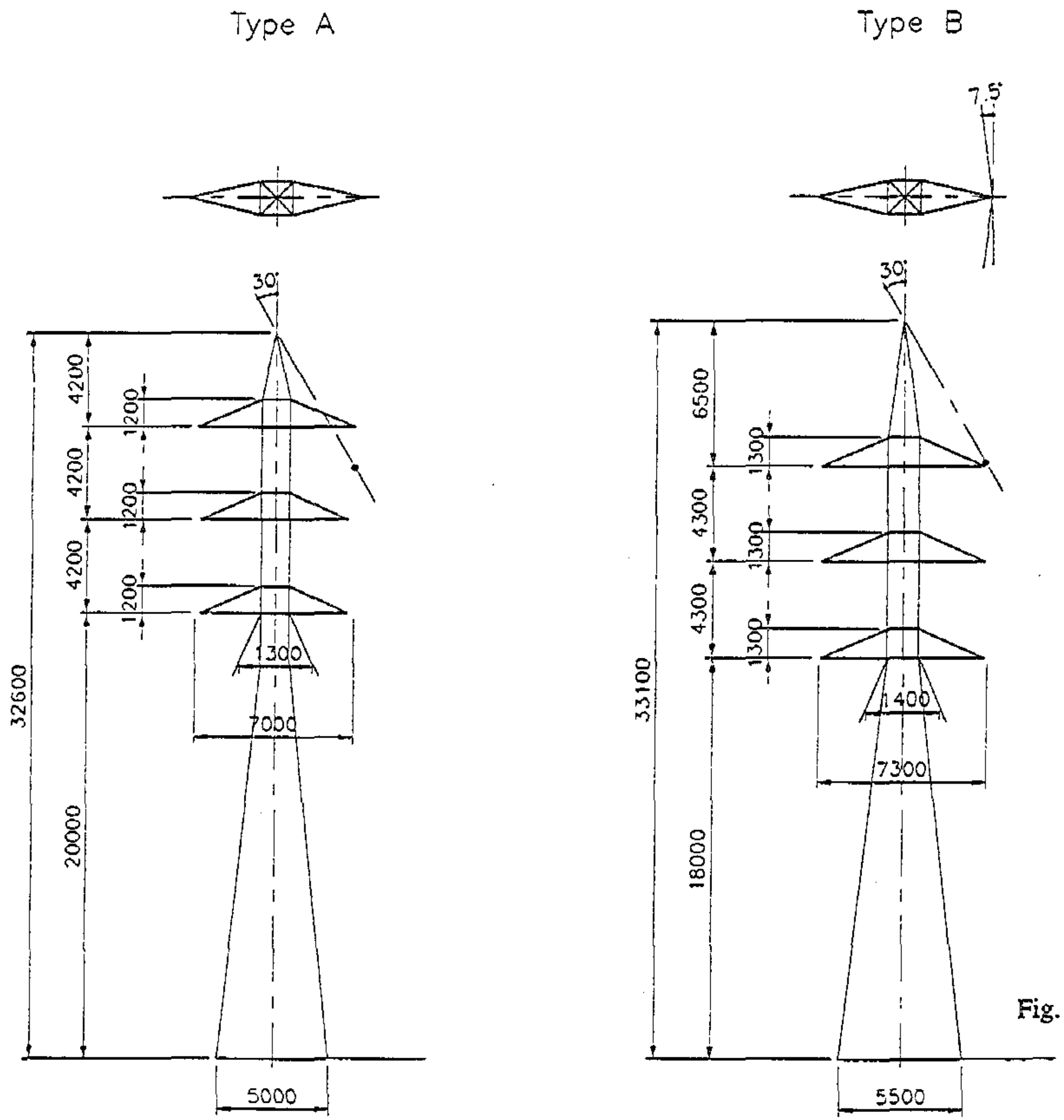


Fig. 2-3-21 Steel Towers (Types A and B)

STEEL TOWERS

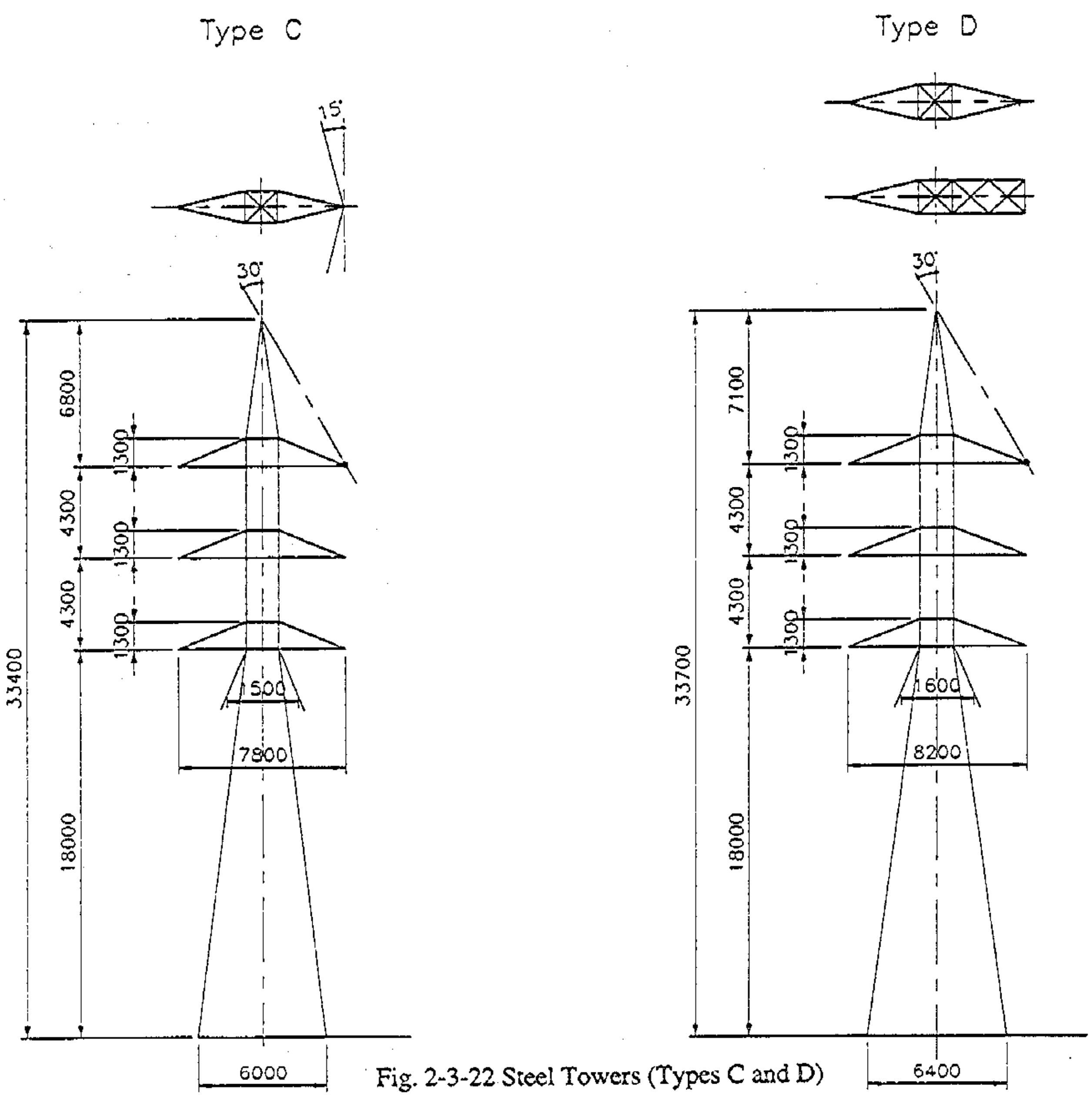


Fig. 2-3-22 Steel Towers (Types C and D)

Insulator Strings

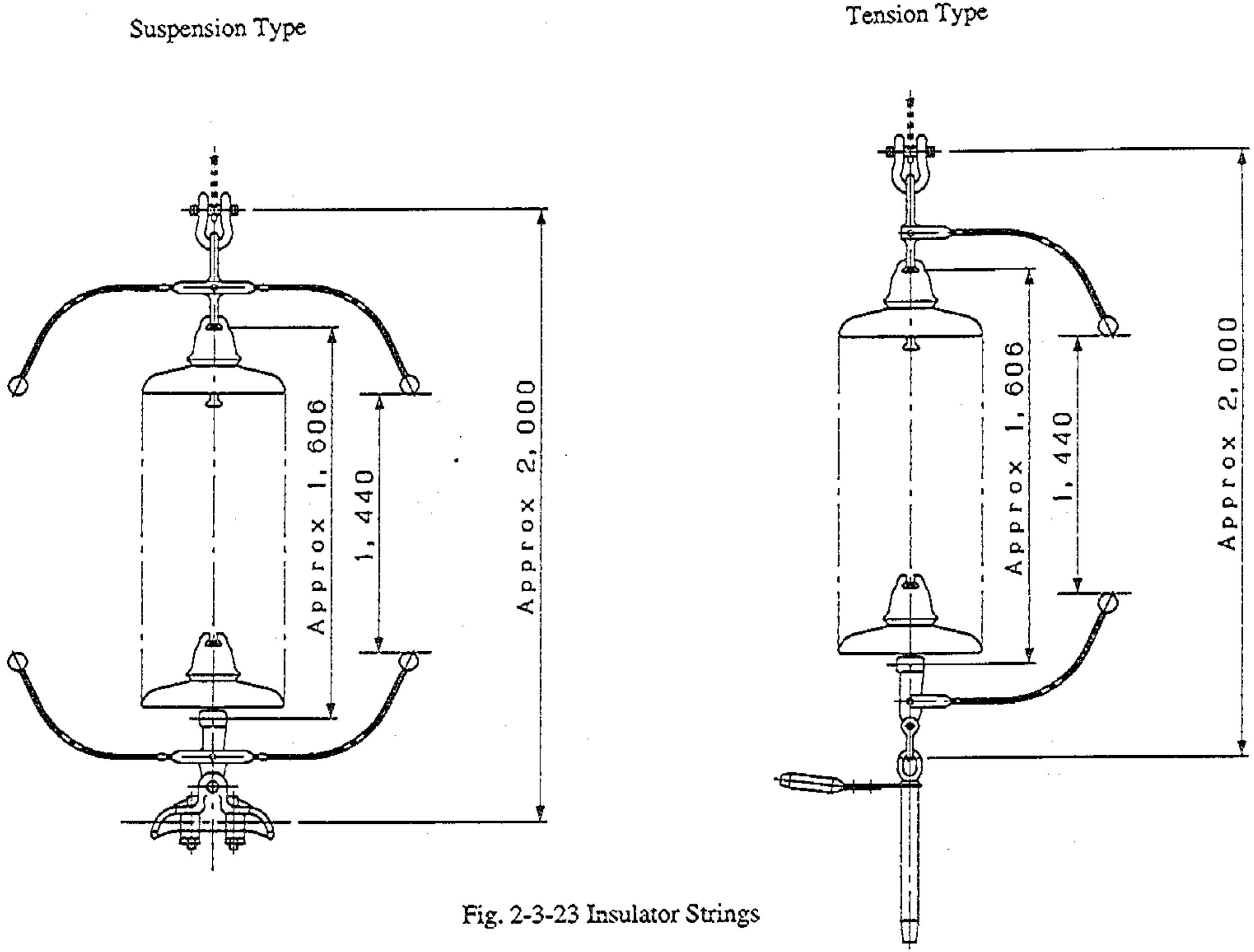
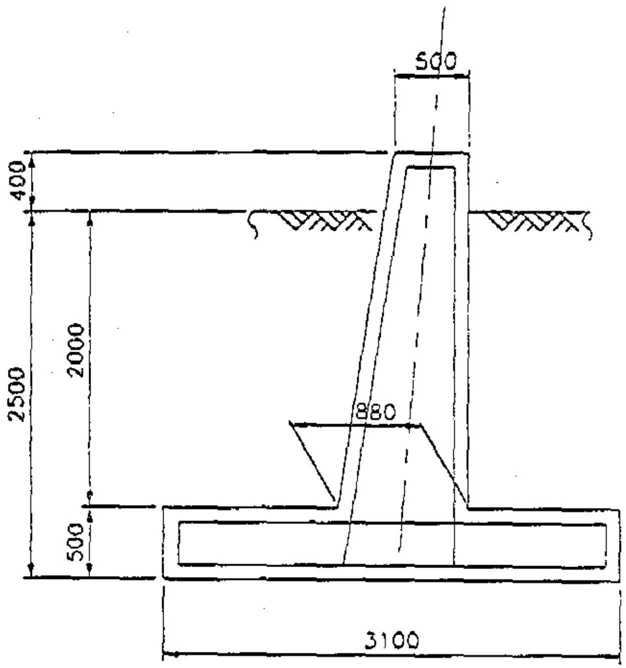


Fig. 2-3-23 Insulator Strings

PAD TYPE FOUNDATION

TYPE A15



TYPE B15

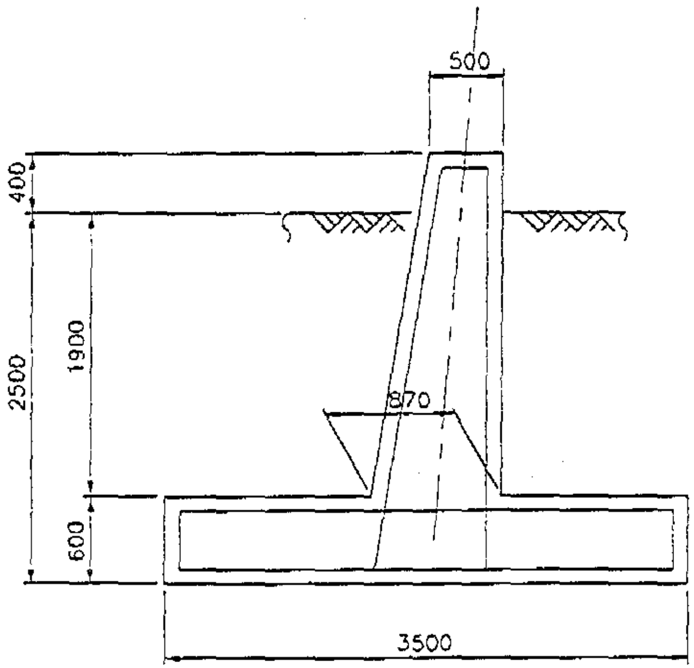


Fig. 2-3-24 Pad Type Foundation (Types A15 and B15)

PAD TYPE FOUNDATION

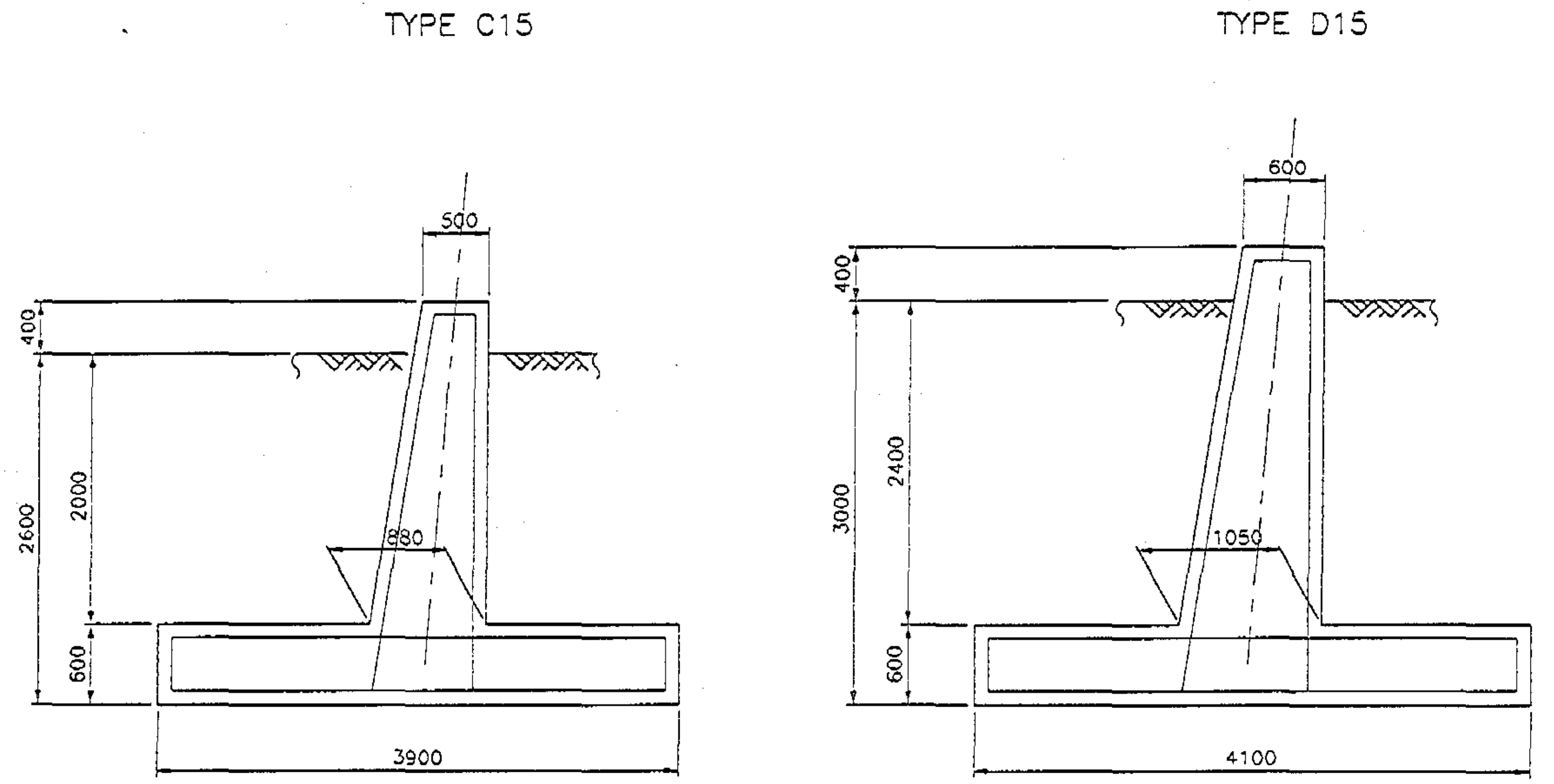


Fig. 2-3-25 Pad Type Foundation (Types C15 and D15)

'TEEL PIPE PILE FOUNDATION

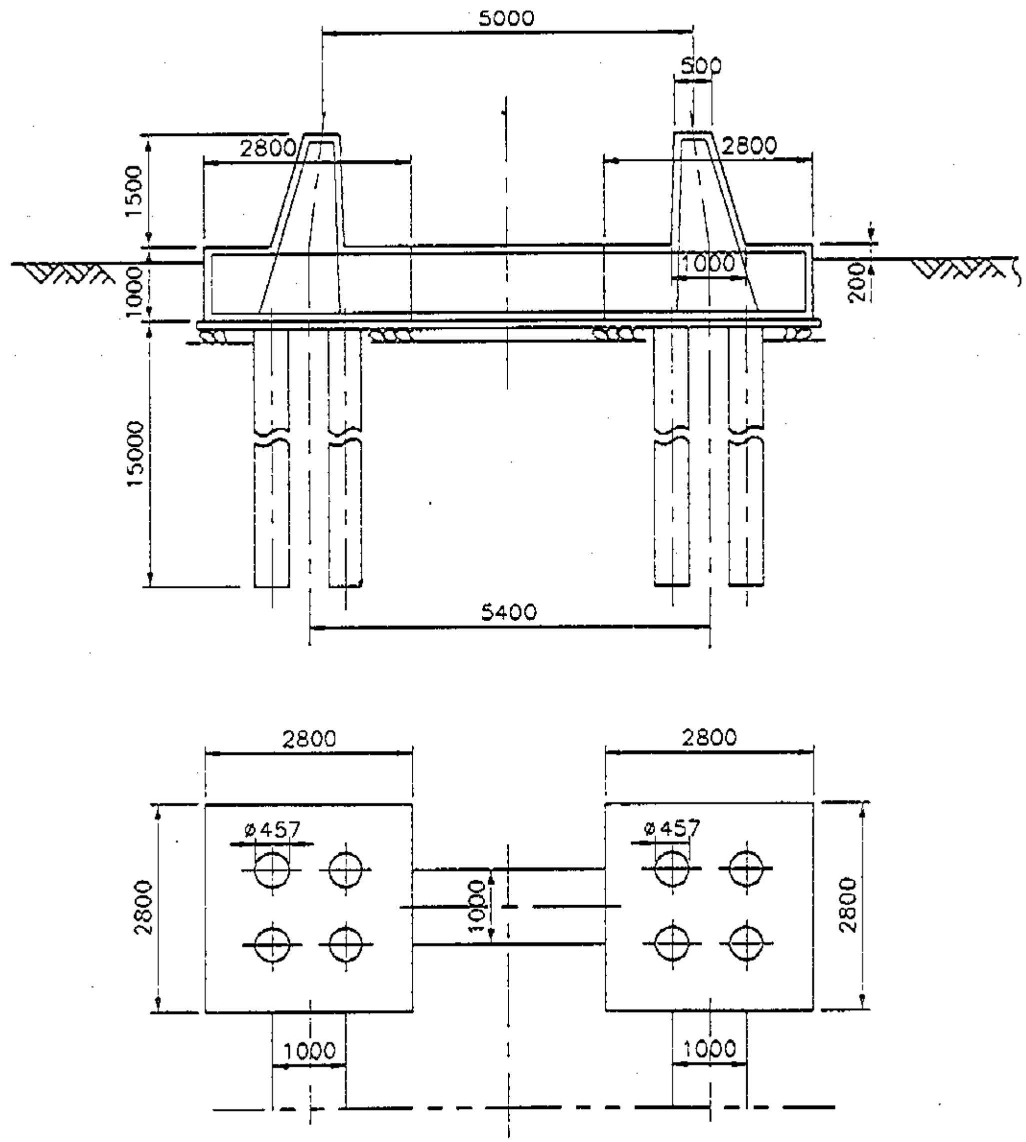


Fig. 2-3-26 Steel Pipe Pile Foundation

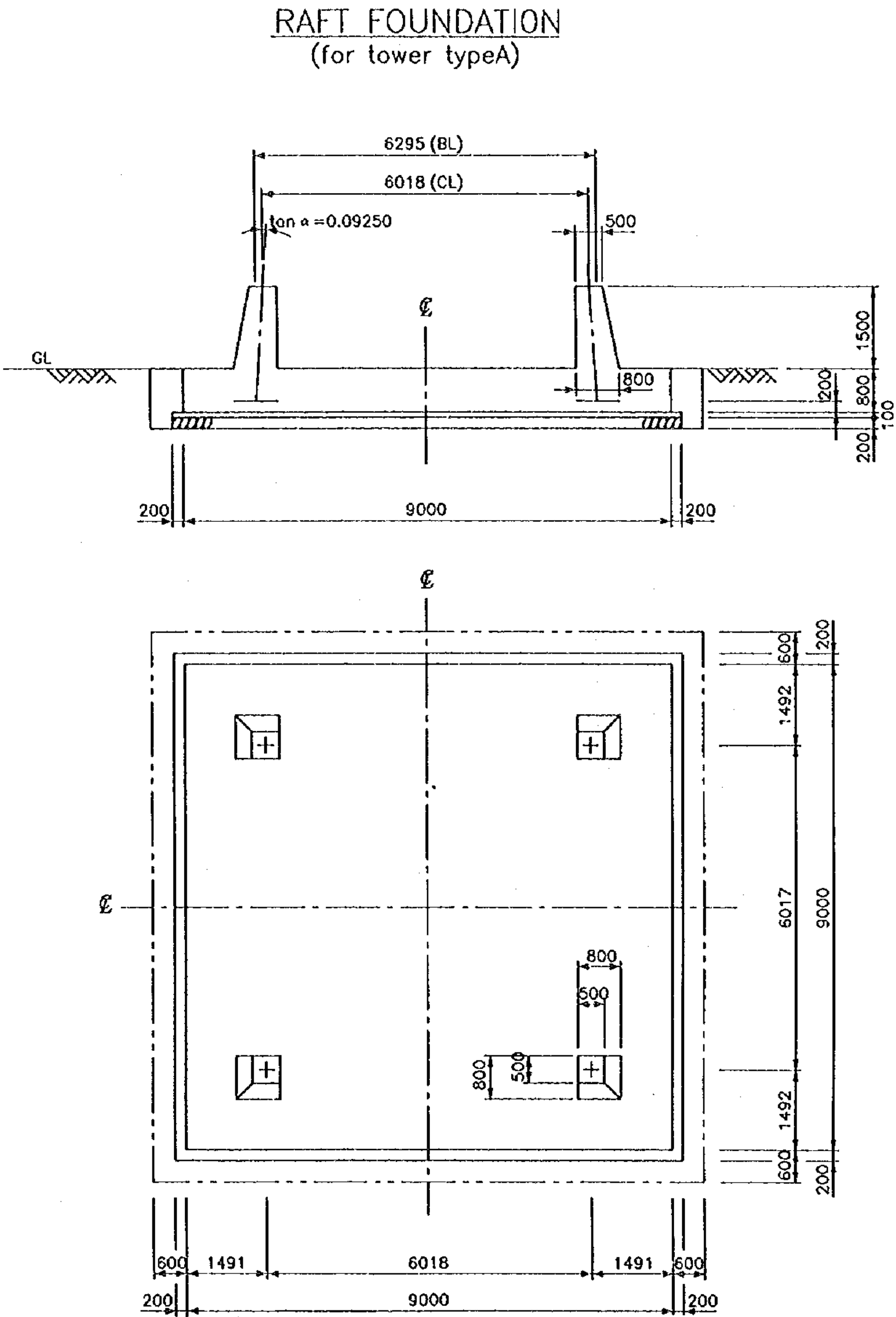


Fig. 2-3-27 Raft Foundation (for tower Type A)

Typical 33kV Pole Assembling (Straight Line)

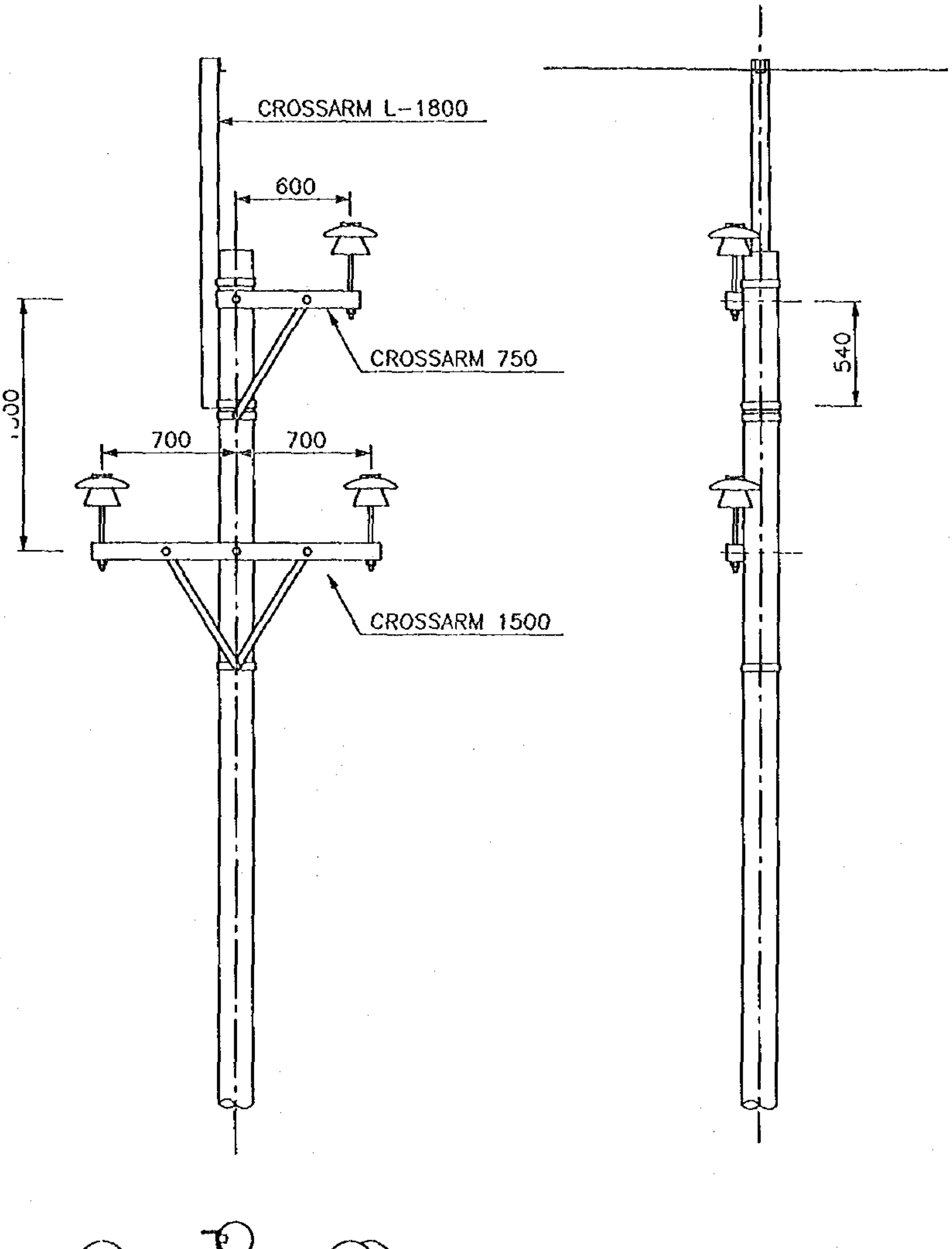


Fig. 2-3-28 Typical 33kV Pole Assembling (Straight Line)

Typical 33kV Pole Assembling (Heavy Angle)

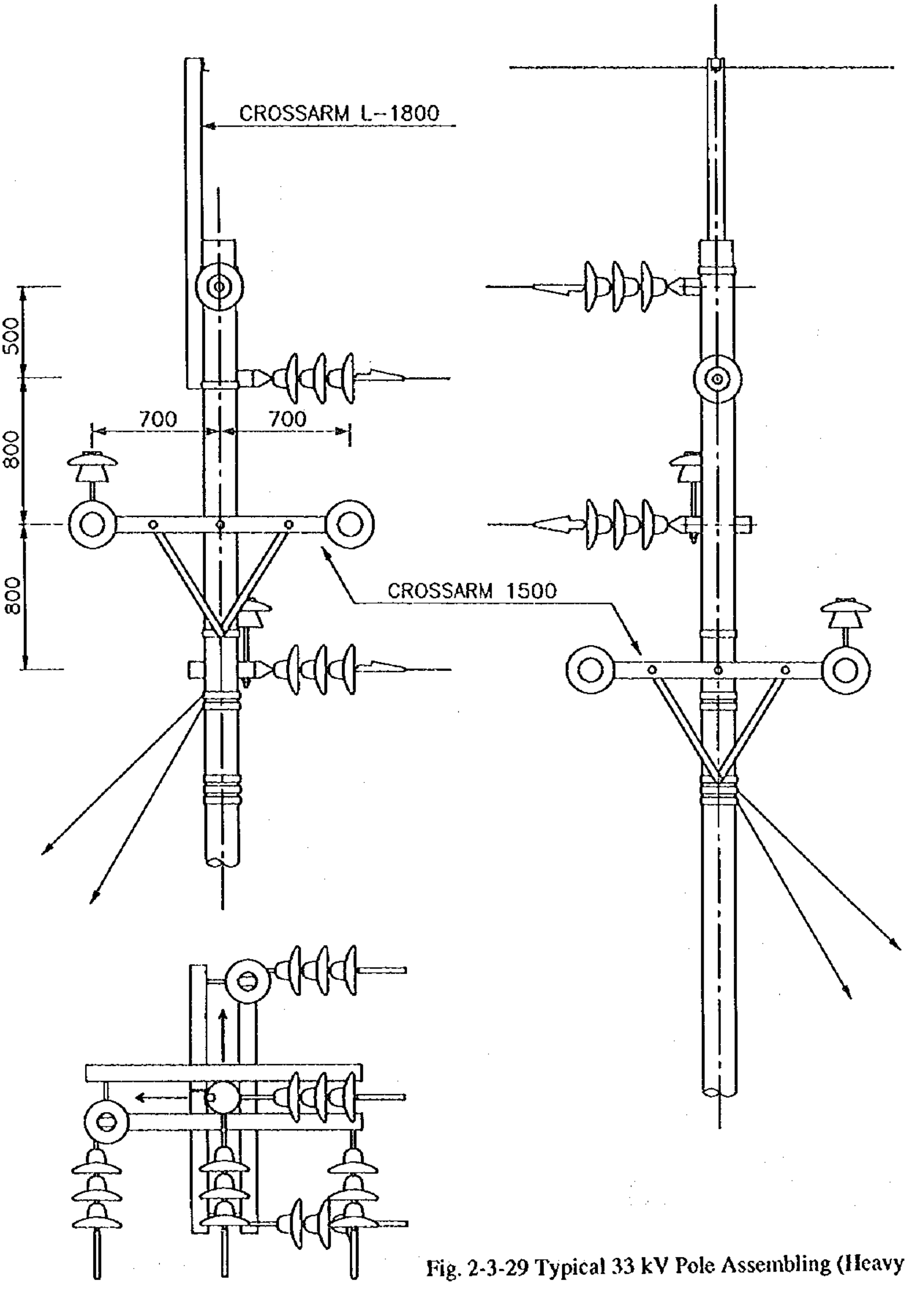


Fig. 2-3-29 Typical 33 kV Pole Assembling (Heavy Angle)

Typical 11kV Pole Assembling (Cable Termination)

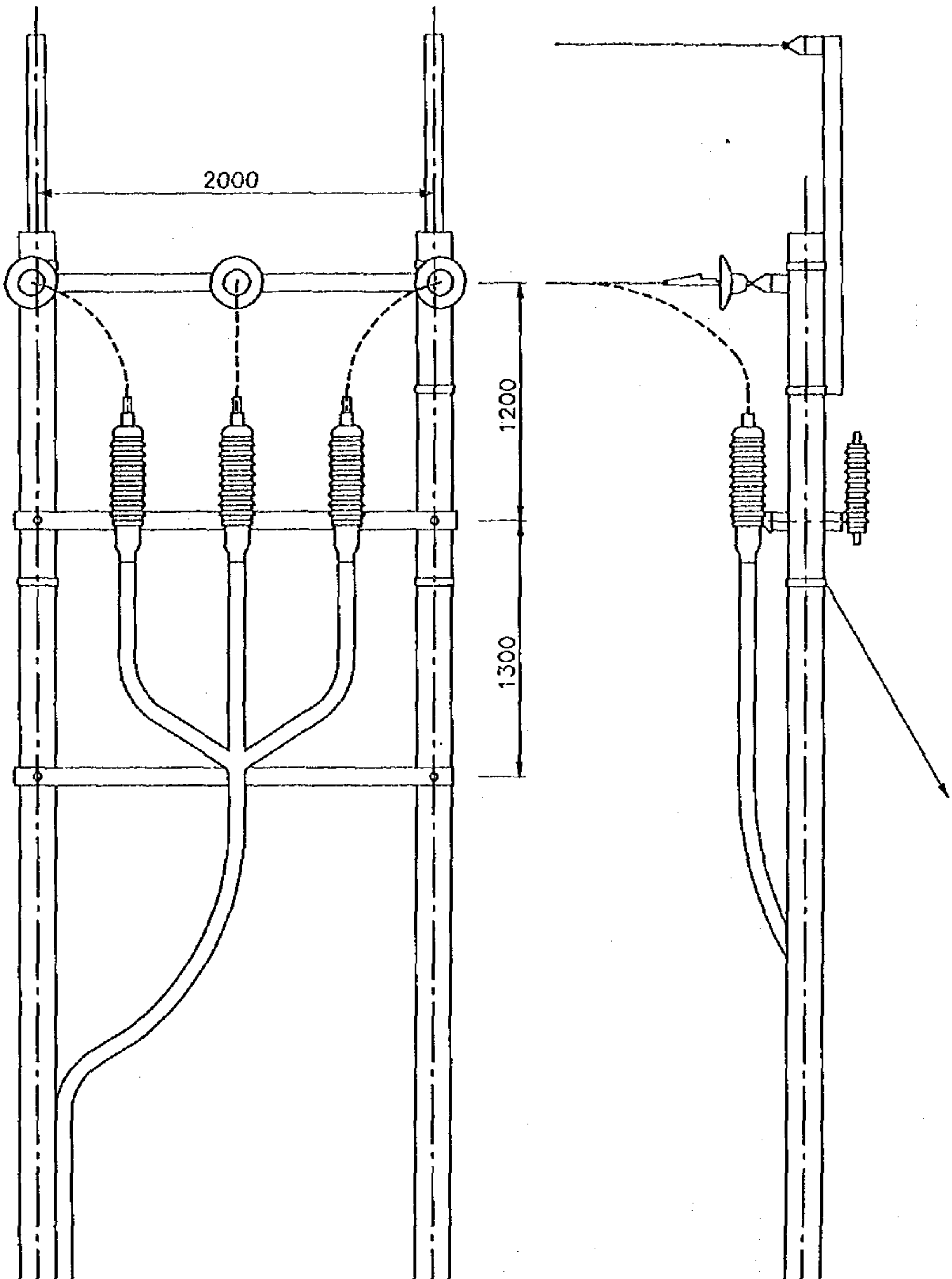


Fig. 2-3-30 Typical 11 kV Pole Assembling (Cable Termination)

Typical 11kV Pole Assembling (Straight Line)

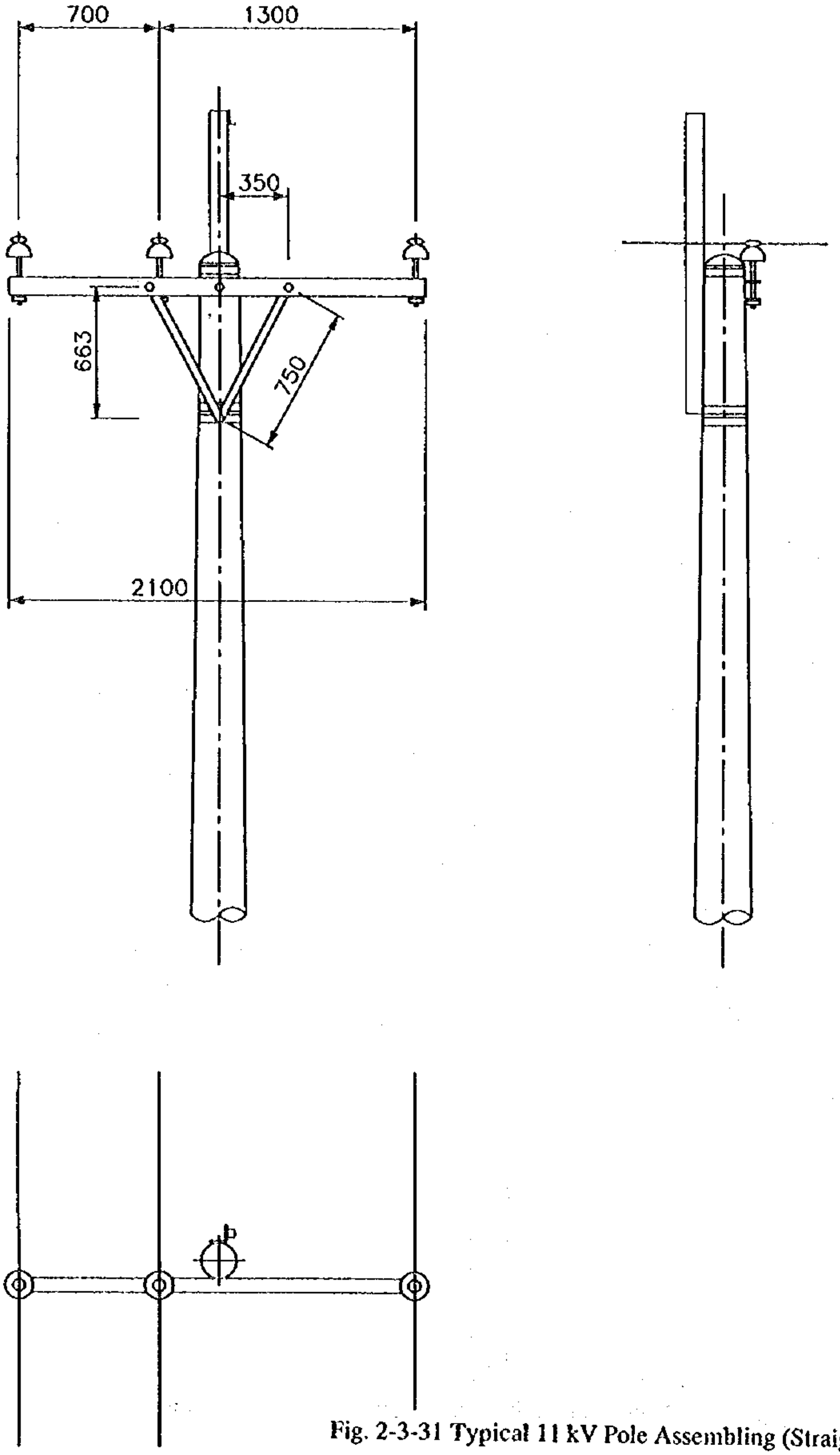


Fig. 2-3-31 Typical 11 kV Pole Assembling (Straight Line)

Chapter 3 Implementation Plan

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Chapter 3 Implementation Plan

3-1 Implementation Plan

3-1-1 Implementation Concept

This project for the Dar es Salaam area in Tanzania uses the Japanese government grant aid grant system. This project should thus be planned and implemented by an appropriate organization and procedure subject to satisfaction of the timetable as defined by the grant system.

TANESCO will implement this project. The managing director of TANESCO is responsible for this project. The construction work will be managed by the relevant regional office managers.

To complete this project within the specified term and budgets to the satisfactory level as defined by the Japanese government grant system, total assistance and cooperation by TANESCO is vital.

The Japanese consultant will carry out preliminary design and surveys, preparation of tender documents, management of the tender, supervision of procurement, supervision of the construction work, etc. after E/N by the governments of the both countries.

The contractor (the tender winner) shall construct the specified substation and transmission facilities based on the Contract, Specifications and Drawings under the supervision and assistance by TANESCO and the consultant.

This project requires manufacturers and suppliers of major equipment such as main transformers, circuit-breakers, protective devices and their controls and general testing to dispatch his engineers to all the installation sites.

This project shall be completed. This tight schedule requires that ground leveling and foundations will have been completed prior to the delivery of the equipment.

Also, the contractor, manufacturers and suppliers are required to shorten as possible the lead time to delivery and/or installation term of any of production drawings and equipment. The consultant shall carefully monitor the progress of the project, and supervise the progress of the project at important time sections.

3-1-2 Implementation Conditions

(1) Site conditions

This project will require a ground leveling and foundation work even at existing substations, so that these works should be subject to detailed scheduling of service interruption and safety precautions of wide scope. The project sites are mostly on a plain land, so that local civil contractors are eligible.

Since the planned route for the 132 kV line will run on a wet land where there may be some difficulties in foundation work, geological investigations are required before starting the field work.

(2) Procurement of equipment and materials

Ordinary portland cement, aggregate (sand and gravel), crushed stones and reinforcements (for concrete) are procurable from local suppliers.

Crane vehicles, concrete mixers, trucks, power shovels and other construction machinery are procurable from local lease agents. Gasoline is also procurable locally.

(3) Others

1) The access way (mostly national road) from the Dar es Salaam port to the project sites has been mostly paved. As it is running through towns,

transportation should be subject to special attention to the safety of the inhabitants.

2) All the project sites are located near the existing electric facilities. Due considerations should be given to ensure the safety of these existing facilities.

3) The project term includes hot summer seasons. Outdoor works should be subject to giving greater considerations to the safety and health of the workers.

3-1-3 Scope of Works

The Japan side will implement the construction and installation of substation equipment and transmission lines, while the Tanzania side will implement the construction of the distribution systems, 11kV only.

Table 3-1-1 shows the scope of the works to be implemented by the Japan and Tanzania sides.

The expenses to be borne by Tanzania side for this Project is shown on Appendices 5.

Table 3-1-1 Scope of Works for Both Countries

Item	Japan side	Tanzania side
Substation		
Leveling of ground		○
Foundation	○	
Manufacture of equipment	○	
Transportation (to the sites)	○	
Storage		○
Installation and adjustment, Transmission and distribution	○	
Test	○	○
Manufacture	○	
Transportation (to warehouse)	○	
Storage		○
Shipment and transportation to the sites	○	
Construction work	○ 132, 33kV	○ 11 kV
Test	○	○

Tanzania-made transformers are limited only to pole transformers. Considering that using the same types of equipment as those currently used in Tanzania will ease the operation and maintenance, the major equipment and materials should be made in Japan as far as practicable. The Japan side will be responsible for the project work for these equipment up to the installation and adjustment.

3-1-4 Consultant Supervision

(1) Responsibilities of the consultant

The Japanese consultant is responsible for designing and supervising the project as far as a project using the Japanese government grant aid system is concerned. Table 3-1-2 shows the scope of the consultant's responsibilities.

Table 3-1-2 Consultant's Responsibilities

		Responsibilities
1	Before starting the field work	Detailed design and surveys Preparing the tender documents Conducting the tender on behalf of TANESCO Evaluating the tenderers Supporting the contract Examining and approving the production drawings Witnessing factory testing
2	During the field work	Supervising the work Reporting the progress of the work OJT for local engineers Witnessing and approving the completion tests Final reporting

Project planning and procurement of equipment and materials are subject to detailed field surveys. Tender documents are prepared based on the detailed design of the project. The date of closing the tender is determined subject to negotiations with relevant governmental agencies. The consultant will conduct the tender and examine the offers from tenderers on behalf of the project implementer. The consultant will support the project implementer in entering into a contract with the tender winner.

Upon completion of the project, the consultant will inspect the completed facilities, equipment and materials, and give the technical personnel instructions for the operation and maintenance of these facilities and equipment, and prepare the final report.

(2) Supervision by the consultant

The consultant shall carry out continuous supervision by site-manager(s) throughout the construction period. The consultant shall carry out also occasional supervision at important time sections such as 1)when a substation, transmission line or civil work to be implemented by the Japan side has been completed, 2)when an equipment or material has been delivered, 3)when a preliminary meeting prior to the start of field work for a substation or transmission is held, 4)when a transmission or distribution line work is to be supervised, and 5)when a test after completion of a substation or transmission line is held. Construction of the distribution systems (11kV only) shall be implemented by TANESCO and completed.

Table 3-1-3 shows the organization and timing of supervision by the consultant.

Table 3-1-3 Organization and Timing of Supervision

Supervisor	Mission	Timing
Principal supervisor	Supervising the start of the field work	When starting the field work
Electrical engineer	Supervising the start of field work	When starting the field work
"	Supervising the civil work for substation and transmission	When the civil work is completed
"	Supervising the delivery of equipment and materials	When equipment or materials arrived
"	Supervising the start of the construction of a substation or transmission	When starting the construction of a substation
"	Supervising the construction of whole works	During the construction
"	Supervising the testing of substations and transmission lines	Upon completion of the substations and transmission lines

(3) Project implementation organization

Figure 3-1-1 shows the project implementation organization.

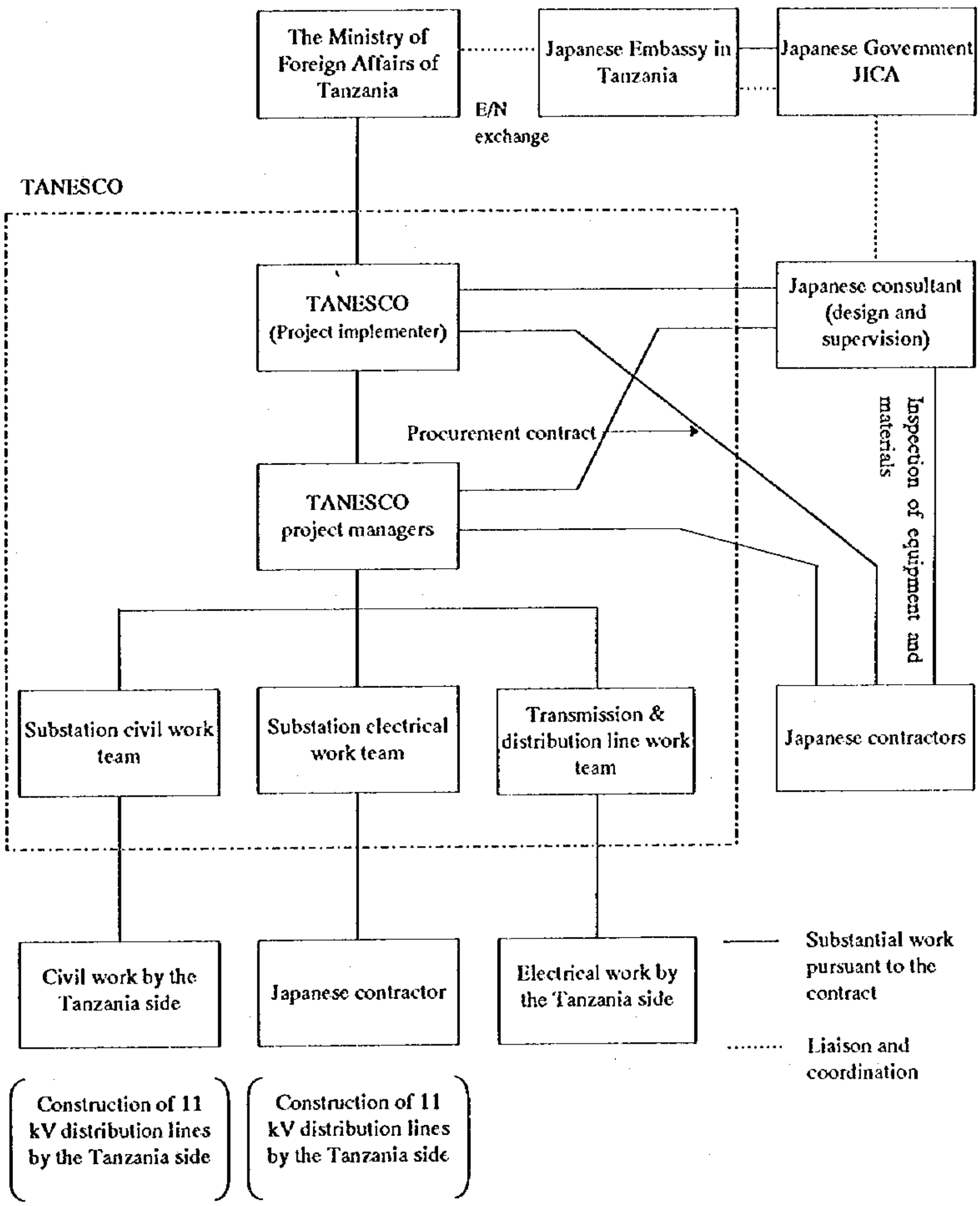


Fig.3-1-1 Project Implementation

3-1-5 Procurement Plan

This project should basically use Japan-made equipment and materials. Procurement of equipment and materials shall be made by Japanese agents under the supervision by the consultant.

Equipment and materials (e.g. wooden poles and bare electric wires) for distribution facilities shall be imported from third countries for reason of economy.

1) Substation equipment and materials shall be Japan-made.

2) Cement, aggregate and other materials for civil work and foundation shall be procured from local suppliers in Tanzania.

3) Distribution wires, wooden poles for low-voltage systems and bare aluminum wires shall be procured from neighbouring countries of Tanzania.

4) Construction machinery shall be procured locally.

Distribution wires and low-voltage system equipment and materials to be procured by Japanese agents shall be delivered at the warehouse in Mbagala specified by TANESCO.

Substation equipment and materials shall be delivered at the relevant substation. The Japanese suppliers shall be responsible for the goods until the completion of installation, adjustment and testing.

Table 3-1-4 shows where to procure the required equipment and materials.

Table 3-1-4 Procurement of Equipment, Materials and Construction Machinery

Name of equipment and materials	Tanzania	Japan	The third country
145 kVCircuit breaker			O
〃 Current transformer			O
〃 Potential transformer			O
〃 Disconnecting switch		O	
Main transformer		O	
Station service transformer	O		
33 kV Switchgear		O	
11 kV Panel		O	
Relay panel		O	
132 kVDistants relay		O	
Control panel		O	
UHF Telecommunication equipment			O
SCADA			O
132 kVTransmission tower		O	
132 kVConductor			O
33 kV Steel pipe pole		O	
33 kV Wooden pole			O
11 kV Wooden pole			O

3-1-6 Implementation Schedule

This project will follow the procedure shown below and Table 3-1-5.

(1) E/N exchange between governments

(2) Consultant contract

(3) Field survey (transmission route, etc.)

(4) Detailed design and discussions to determine the specifications

(5) Preparation of tender documents, invitation of tenders, and preliminary meeting at the site

(6) Evaluation of tenderers, and determination of the contractor

(7) Purchase order and inspection

(8) Transportation

(9) Installation

(10) Receipt, completion and delivery

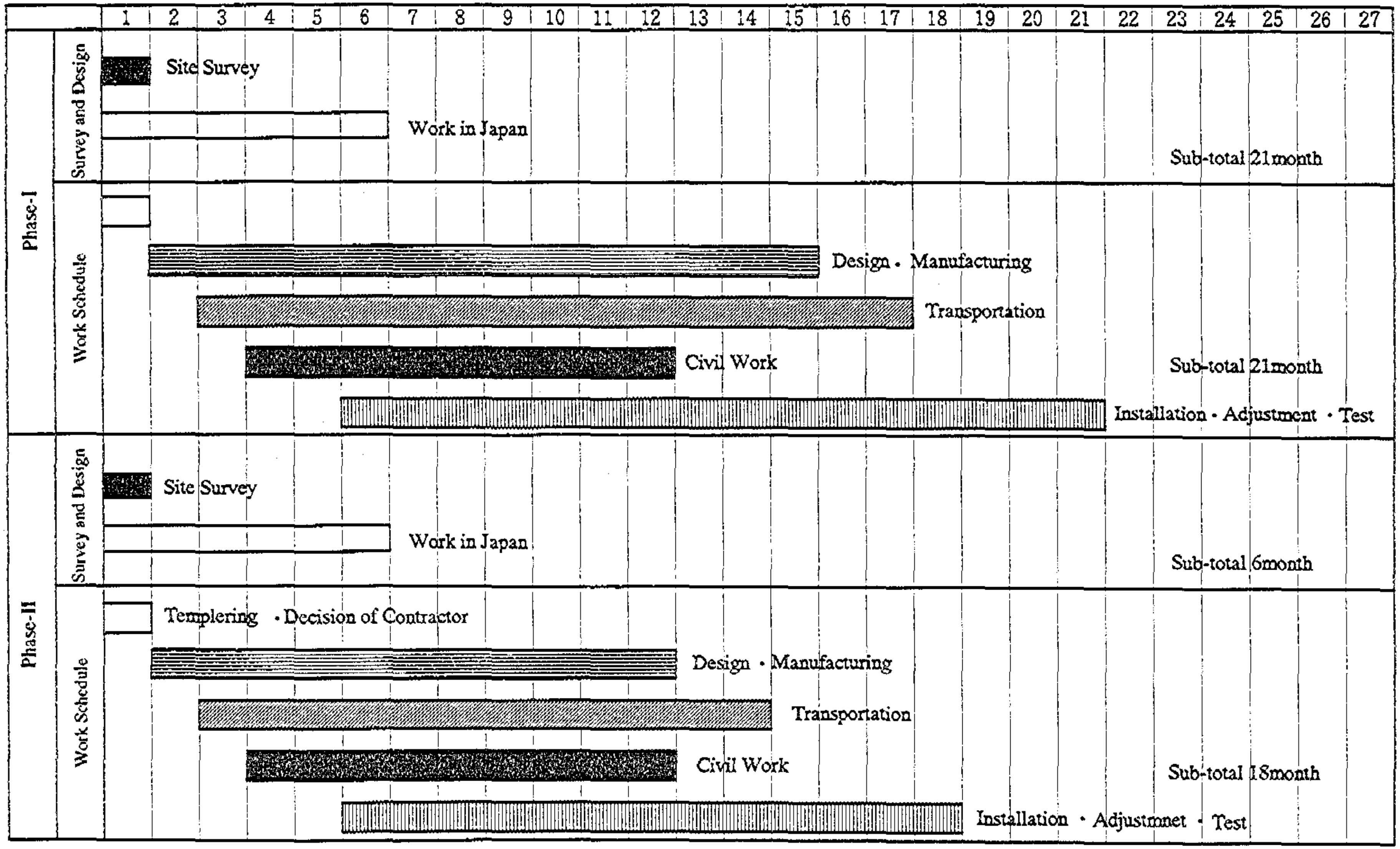
1) 1st stage of the project

The 1st stage will consume about 20 months for completing the project after final determination of the contractor. Item by item project terms are about 6 months for project implementation design and tender operation including preparing tender documents; about 12 months for producing equipment; about 11 months for transportation of equipment; about 10 months for constructing the transmission and distribution lines; about 14 months for retrofitting the existing substations; and about 20 months for constructing new substations and transmission/distribution lines.

2) 2nd stage of the project

The 2nd stage will consume about 17 months for completing the project after final determination of the contractor. Item by item project terms are about 6 months for project implementation design and tender operation including preparing tender documents; about 11 months for producing equipment; about 11 months for transportation of equipment; about 7 months for constructing the transmission lines; about 9 months for retrofitting the existing substations; and about 17 months for constructing new substations and transmission lines.

Table 3-1-5 Implementation Schedue (The Dar es Salaam Power Supply System Expansion Project)



3-1-7 Obligations of Recipient Country

The minutes of the basic design was signed in Dar es Salaam on November 6, 1996. The undertakings required to the Government of the recipient country in Annex II are shown below.

1. Obtainment of the project sites.
2. Land procurement negotiations and ground leveling prior to the start of the project.
3. Appendant outdoor work such as fitting fences, doors and lighting facilities inside and outside the sites.
4. arrangement for bank accounts, e.g. with a foreign exchange bank.
5. Unloading of the equipment and materials at a Tanzanian port, customs formalities and inland transportation in an efficient and speedy manner.
6. Exemption of all the Japanese citizens who produce or provide products and / or services pursuant to the contract from any taxes including customs and internal duties.
7. Giving every convenience to all the Japanese citizens who will enter into or are staying in Tanzania for the purpose of this project.
8. Maintenance and management of the equipment and materials in a proper and efficient manner.
9. Bearing all the transportation-related cost other than those covered by the grant aid.
10. Any safety measures and precautions for electric equipment during the construction.
11. Providing storage spaces / facilities for equipment and materials, and
12. Providing necessary budgets for the construction of the distribution systems in accordance with the specified schedule.

3-2 Operation and Maintenance Plan

(1) Maintenance and Management Plan

Maintaining, servicing or repairing a substation or transmission system uses a daily inspection scheme that does not need outages, or a periodical inspection scheme that needs planned outages. The latter should be performed as instructed by the manufacturers, but at least one time per year.

The non-outage daily inspection should be a visual check and/or sound and vibration check. It should be performed about weekly, plus after a heavy rain or strong wind.

If these inspections are properly done, the distribution systems may have an operation life of about 40 years.

Inspections and maintenance for the electric facilities will be performed by the regional offices each consisting of a manager, engineers (6 persons), and substation and line operation/maintenance crews (about 60 persons).

(2) Maintenance Cost

After the completionof the 1st and 2nd phases of this project, the maintenance and administration cost for the electric facilities will be as follows.

Labour :	Yen 34.4 million (T.sh 174 million)
Repair :	Yen 29.7 million (T.sh 150 million)
Overhead and others :	Yen 27.1 million (T.sh 137 million)
Depreciation :	Yen 75 million (T.sh 379 million)
Total :	Yen 166.2 million (T.sh 840 million)

This maintenance cost was estimated based on the project cost. Each cost component was calculated based on the statistics concerning the ratio of operating cost to construction cost for Japanese electric power companies.

It is concluded that the present manpower for the Dar es Salaam area (1,152 persons) and the operating cost (included in the 1996 total budget of Yen 9.81 billion) planned by TANESCO are enough even after the completion of the new distribution systems.