THE UNITED REPUBLIC OF TANZANIA

FEASIBILITY STUDY REPORT ON DAR-ES-SALAAM ELECTRIC POWER DISTRIBUTION NETWORK PROJECT

JANUARY 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

THE UNITED REPUBLIC OF TANZANIA

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PREFACE

It is with great pleasure that I present to the Government of the United Republic of Tanzania this report on Feasibility Study of Dar-es-Salaam Electric Power Distribution Network Project.

This report is based on the result of a field survey which was carried out from June to July, 1984 by the Japanese survey team commissioned by the Japan International Cooperation Agency (JICA), following the request of the Government of Tanzania.

The survey team, headed by Mr. Masashi KOIKE, had a series of discussions with the officials concerned of the Government of Tanzania and conducted a wide-ranging field survey and data analyses.

I sincerely hope that this report will be useful as a basic reference for implementation of the project and thereby contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the Japanese team.

January, 1985

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Keisuke Arita
President
Japan International Cooperation Agency

Dear Sir:

It is a great pleasure to herewith submit a Feasibility Study Report on the "Dar es Salaam Electric Power Distribution Network Project" which aims rehabilitation and improvement of power distribution system in Dar es Salaam city, capital of the United Republic of Tanzania.

In June 1984, at the request of the Japan International Cooperation Agency, a survey team was organized of seven experts from the EPDC International Ltd.

The survey team visited Tanzania for a period of 31 days from June 22, 1984 to July 22, 1984, and engaged in collection of data, discussion with agencies concerned, and field reconnaissances.

Upon returning to Japan, the Survey Team, based on the results of field investigations and the data collected, proceeded with studies and work regarding power demand, power transmission and distribution project design, approximate construction cost, and economic analysis, and have now prepared this Report.

Briefly described, the work contemplated for this Project is the following:

> Apart from the emergency materials which are now under consideration for supply upon Japanese grant aid system, the major facilities which consist the Project are 4 substation transformers of a total capacity 135 MVA, 33 kV transmission lines of 8 places 23 km, 11 kV distribution lines of a total length 116 km, low voltage distribution lines summed up to 480 km and drop wires for 24,000 consumers.
>
> And the construction costs are estimated foreign currency 2.63 billion Yen for materials and equipment to be imported and local currency 4.3 million TSh. for erection lavour cost.

It is strongly hoped that through submittal of this report this project will be realized at an early date and that public welfare, comprehensive development and economic progress of Dar es Salaam will be greatly facilitated.

It is wished to express the deepest gratitude to the government agencies concerned of the United Republic of Tanzania, the Tanzania Electric Supply Company and the Japanese Embassy in Tanzania for their cooperation and assistance in field investigation and data collection for preparation

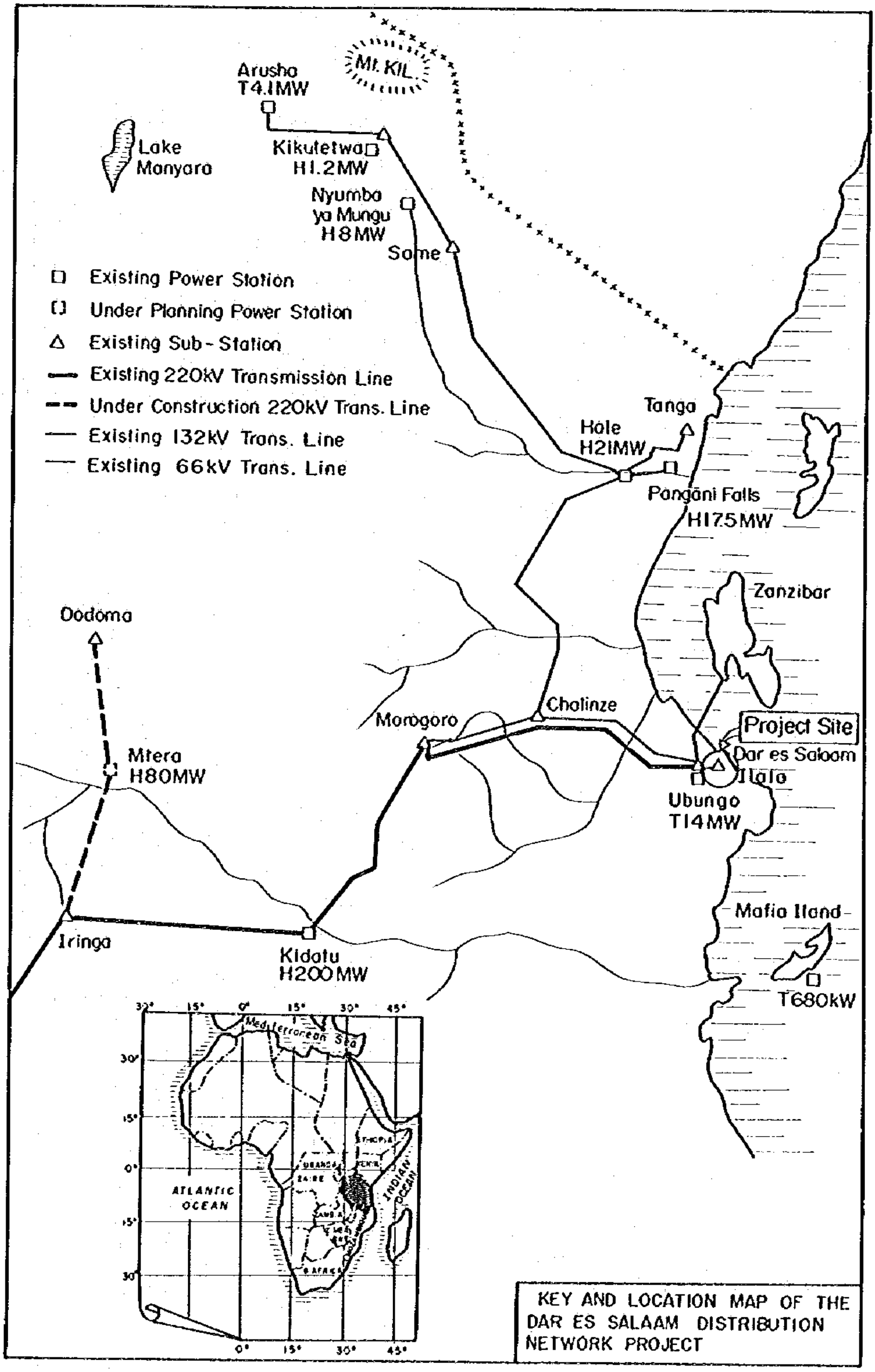
of this report, and those persons concerned at Ministry of Foreign Affairs, the Ministry of International Trade and Industry and the Japan International Cooperation Agency for their cooperation in carrying out the investigations.

January 1985

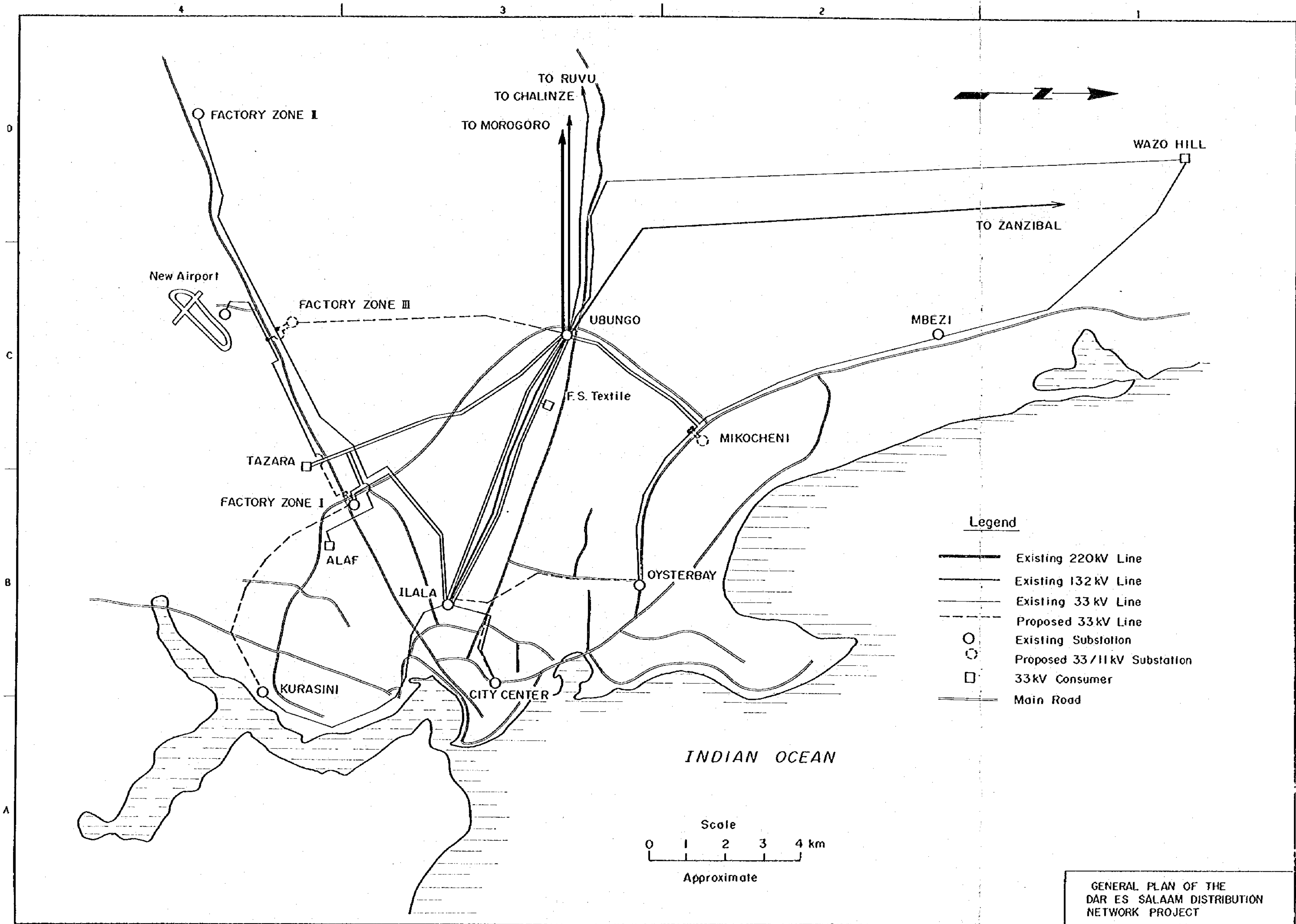
Yours respectfully,

M. Koike

Masashi Koike
Leader of Japanese Survey Team
for Dar es Salaam Electric Power
Distribution Network Project



Arusha
T4.1MW
Mt. KIL.
Lake
Manyara
Kikuletwa
H1.2MW
Nyumba
ya Mungu
H8MW
Same
Existing Power Station
Under Planning Power Station
Existing Sub-Station
Existing 220kV Transmission Line
Under Construction 220kV Trans. Line
Existing 132kV Trans. Line
Existing 66kV Trans. Line
Tanga
Hale
H21MW
Pangani Falls
H17.5MW
Zanzibar
Dodoma
Chalinze
Morogoro
Project Site
Dar es Salaam
Ilala
Ubungo
T14MW
Mtera
H80MW
Iringa
Kidatu
H200MW
Mafia Iland
T680kW
Mediterranean Sea
ATLANTIC
OCEAN
INDIAN
OCEAN
KEY AND LOCATION MAP OF THE
DAR ES SALAAM DISTRIBUTION
NETWORK PROJECT



GENERAL PLAN OF THE
DAR ES SALAAM DISTRIBUTION
NETWORK PROJECT

SHEET NO. OF

FEASIBILITY STUDY REPORT
ON
DAR ES SALAAM ELECTRIC POWER DISTRIBUTION
NETWORK PROJECT

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CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 1 CONCLUSIONS AND RECOMMENDATIONS

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CHAPTER 1 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

As the conclusion of this report, the summaries of each chapter of this report are presented below.

1.1.1 Geographical and economic status of Dar es Salaam City

Dar es Salaam City, the capital of Tanzania, is situated on the sea shore of Indian Ocean, at the middle of the eastern shore of Tanzania which is at latitude 6 degrees 50 minutes south, having a population of about 1 million. The City is the center of political and economic activities of Tanzania. Vested with a good natural harbor, most of export goods from Tanzania are shipped from here.

The Fourth 5 Year Plan is now under way in Tanzania, with the objectives of exporting processed indigenous products, self sufficiency of food, and increased production of cash crops. The Plan is not being implemented smoothly, and the stagnant production and the falling price of agricultural goods for export (coffee, sisal, etc.) has caused a particularly adverse balance of the international trade in recent years, accelerating material shortage and inflation.

The exchange rate for the Tanzania Shilling, as of July 1984, is shown below.

1 US$ = 17.5 T.shs. (1 T.shs. = 13.71 yen)

1.1.2 Present status of electric utility

Generation, transmission and distribution of electric power in the whole Tanzania is undertaken by the Tanzania Electricity Supply Company, Ltd. (TANESCO), which also assumes the responsibility of planning and development of electric power. The total installed generating power possessed by TANESCO is 380 MW today (including 250 MW of hydroelectric power). With these power stations, together with major transmission lines of extending 1,480 km in total length (220 kV and 132 kV), and distribution facilities in cities, TANESCO supplies 790 GWH of electric power to 130 thousand customers all over the country (as of 1981), and secured an income of 520 million Tsh from the sales of electricity.

TANESCO is one of the most stable business enterprises in Tanzania. In response to the national policy of Tanzania to reduce dependence on oil, TANESCO is today implementing a hydroelectric project (MTERA; 80 MW) and extension of trunk transmission lines to the inland area, supported by foreign finance, which is intended to introduce the power from hydro-electric plants to inland area, replacing the expensive diesel generations.

At present, all of the electric power is supplied by 4 hydroelectric plants, including Kidatu Power Plant having capacity of 200 MW, and the supply capability is more than sufficient to meet the demand of the whole country, except for the inland areas where the transmission system is not yet available.

The rate of electricity varies for different types of load, but generally is of the order of 1.05 T.Shs./kWh.

1.1.3 Status of power supply to Dar es Salaam City (upper power system)

The main power system of Tanzania, called the coastal grid, covers the central area, the northern coastal area and the western industrial area of this country. This power system consists of 220 kV and 132 kV transmission networks and the 4 hydroelectric power plants, including Kidatu as mentioned before.

Dar es Salaam City is the largest load center in this coastal grid. The power flow is from the Kidatu Power Station to Ubungo Substation at western outskirts of Dar es Salaam, transmitted by a single circuit 220 kV line, and the voltage is stepped down to 132 kV or 33 kV for distribution in the City.

The total demand of Dar es Salaam City is 76 MW in terms of peak power according to 1983 data, and the annual electricity consumption is 420 GWh, which means that more than half of power of the nation is consumed in this city.

The main transmission line from Kidatu Power Station is a single circuit line, and although there is interconnections by 132 kV lines to the 3 hydroelectric stations of medium capacities in the northern district, this upper power system is so vulnerable that definite power shortage (practically a total blackout of the city) is inevitable in a system fault. Thus in an elongated fault, the old diesels and gas turbines in Ubungo are started to supply about half of the load.

1.1.4 Status of transmission and distribution systems in Dar es Salaam city

(1) Distribution system

The power flows in the distribution system of the city is from Ubungo Primary Substation to the secondary substations inside the City, or substations of Ilala, City Centre, Oysterbay, Factory Zone I and Kurasini, to the suburban substations Mbezi and Factory Zone II, and to the large customers ALAF, WAZO Hill, etc., most of which being transmitted by 33 kV lines. To Ilala Substation, however, a single circuit 132 kV line with steel towers is connected, together with 33 kV lines.

The voltage is stepped down to 11 kV at the secondary substations described above, and supplied to each district of the City by 5 to 6 circuits of 11 kV feeders through 11 kV circuit breaker cubicles installed at buildings of secondary substations.

The distribution voltage is further stepped down to 400/230 V by distribution transformers connected to the feeders and their branches, and supplied to customers as low voltage power.

(2) The districts studied

As it has been decided to place emphasis on the central urban districts, this report deals with the distribution systems which are in the supply areas of the secondary substations listed below.

A3

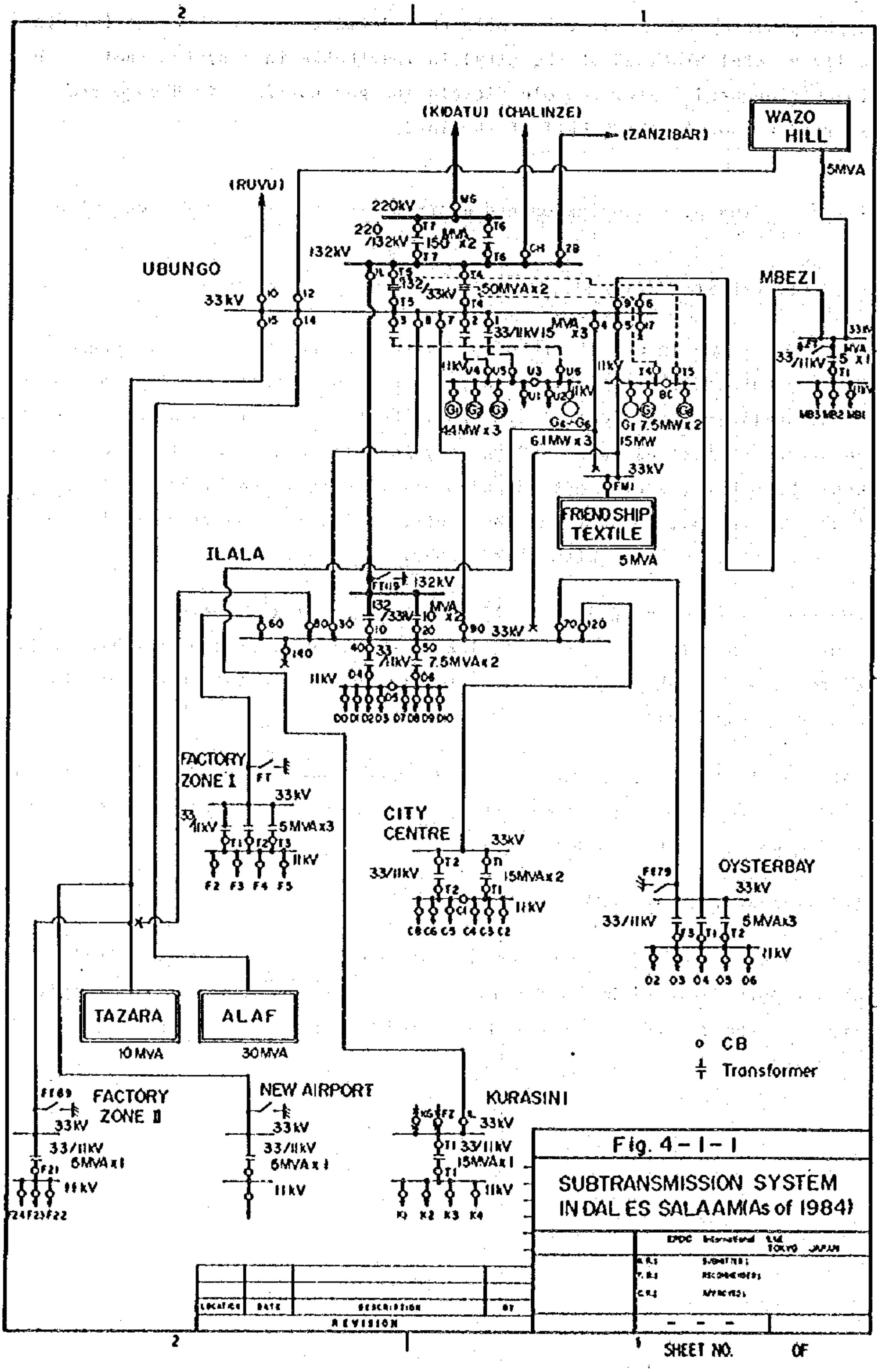


Fig. 4-1-1

SUBTRANSMISSION SYSTEM IN DAL ES SALAAM (As of 1984)

Table 4-1-1 33 kV/11 kV transformer capacities of distribution substations

Substations and Consumers	Transformer Capacity x Unit	Total Capacity
(Substations receiving from the Ubungo S.S.)		
Ubungo (Feeders)	15 MVA x 3	45 MVA
Oysterbay	5 x 3	15
Factory zone II	5 x 1	5
Mbezi	5 x 1	5
Kurasini	15 x 1	15
Sub-total	-	85
(Substations receiving from the Ilala S.S.)		
Ilala (Feeders)	7.5 x 2	15
City Centre	15 x 2	30
Factory zone I	5 x 3	15
New airport	5 x 1	5
Sub-total	-	65
(Big consumers receiving from the Ubungo S.S.)		
ALAF	15 x 2	30
WAZO hill	5 x 3	15
Friendship Textile	5 x 1	5
TAZARA	5 x 2	10
Sub-total	-	60
Total	-	210

Table 4 − 3 − 1 33KV Subtransmission Line

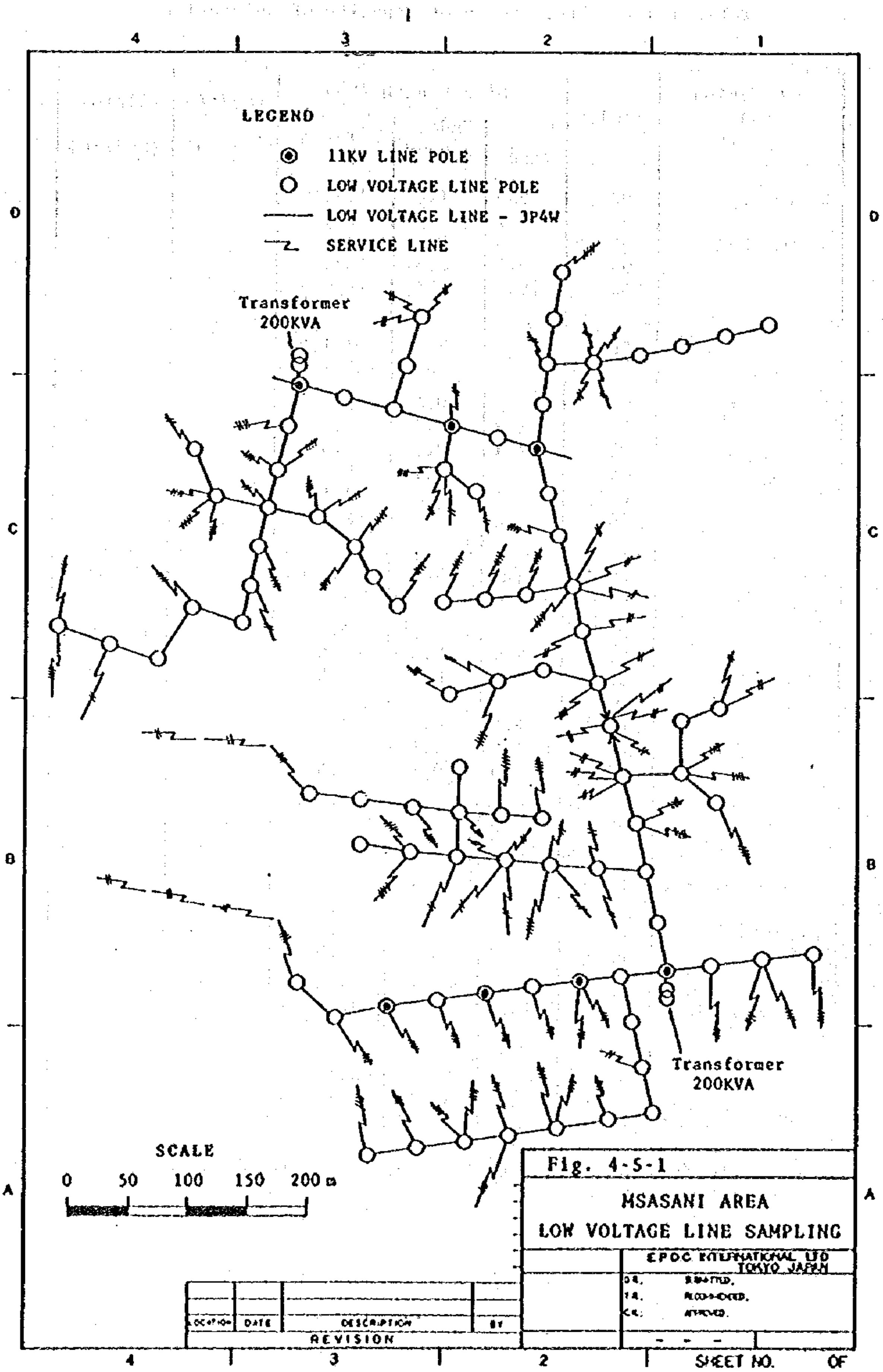
As of 1984

	Section	Length (km)	Circuit	Conductor		Support	Completion Year	Remark
				Kind	Size			
1	Ubungo～Ilala (Interconnection I)	7.5	1	ACSR	150	Wooden Pole	1970	
2	〃 ～ 〃 (〃 II)	7.5	1	〃	〃	〃	〃	
3	〃 ～ 〃 (Textile I)	7.3	1	〃	50	〃	1966	
4	〃 ～ 〃 ～Kurasini	14.3	1	〃	50/150/100	Wooden Pole/Steel	1966/1963	At Pugu road crossing between Ilala and Old P/S. Cu 90 sq.mm×2 are employed.
	(via Ilala. Old P/S)	(7.2+ 3.2+ 3.9)				Pole/Wooden Pole	/1982	
5	Ubungo～Oysterbay	8.3	1	ACSR	100	Wooden Pole	1976	
6	〃 ～Wazo Hill (No.1)	19.3	1	〃	〃	〃	1966	
	(via Mbezi)	(8.8+10.5)						
7	〃 ～Wazo Hill (No.2)	18.2	1	ACSR	100	Wooden Pole	1972	
8	〃 ～ALAF	9.0	1	〃	〃	〃	1975	
9	〃 ～TAZARA	7.8	1	〃	〃	〃	1973	
10	〃 ～Ruvu (Nordic Line)	60	1	〃	〃	〃	1965	
11	Ilala ～Oysterbay	5.0	1	〃	50	〃	1984	
12	〃 ～City Centre	2.8	1	〃	100	〃	1969	
13	〃 ～Factory Zone I	5.0	1	〃	〃	〃	1965	
14	〃 ～Factory Zone II	13.9	1	〃	50	〃	1967	
15	TAZARA～New Airport	4.8	1	〃	100	〃	1984	

Table 4-4-2 Line length of capacity of substations

Substation and Capacity	Feeder	Line Length (km)			(C)/(B)	(A)/(C)
		Over-head	Under-ground	Total	(km)	(kVA/km)
Oysterbay	02	9.5	1.8	11.3(C)		
	03	8.7	0.1	8.8		
15,000 kVA	04	7.5	0.1	7.6		
(A)	05	2.9	0.5	3.4		
	06	19.4	0.6	20		
Total	5(B)	48	3.1	51.1(C)	10.2	294
City Centre	C2	7	0.6	7.6		
	C3	1.8	0.6	2.4		
30,000 kVA	C4	1.3	0.6	1.9		
(A)	C5		0.9	0.9		
	C6		1.5	1.5		
	C8	1.3	1	2.3		
Total	6(B)	11.4	5.2	16.6(C)	2.8	1,807
Ilala	D0		0.3	0.3		
	D1	2	0.5	2.5		
15,000 kVA	D2	3.8	0.5	4.3		
(A)	D3					
	D8	6.5	0.5	7		
	D9	1.9	0.1	2		
	D10	7.5	0.1	7.6		
Total	6(B)	21.7	2	23.7(C)	4.0	633
Factory Zone I	F2	6.5	0.1	6.6		
	F3	3	2.8	5.8		
15,000 kVA	F4	9	0.3	9.3		
(A)	F5	4.8	0.1	4.9		
Total	4(B)	23.3	3.3	26.6(C)	6.7	564
Total 75,000 kVA (A)	21	104.4	13.6	118(C)	5.6	636

Note: (C)/(B) shows average line length per feeder (km).



LEGEND
11KV LINE POLE
LOW VOLTAGE LINE POLE
LOW VOLTAGE LINE - 3P4W
SERVICE LINE
Transformer
200KVA
Transformer
200KVA
SCALE
0 50 100 150 200 m
Fig. 4-5-1
MSASANI AREA
LOW VOLTAGE LINE SAMPLING
EPDC INTERNATIONAL LTD
TOKYO JAPAN
REVISION
DATE
DESCRIPTION
BY
SHEET NO.
OF

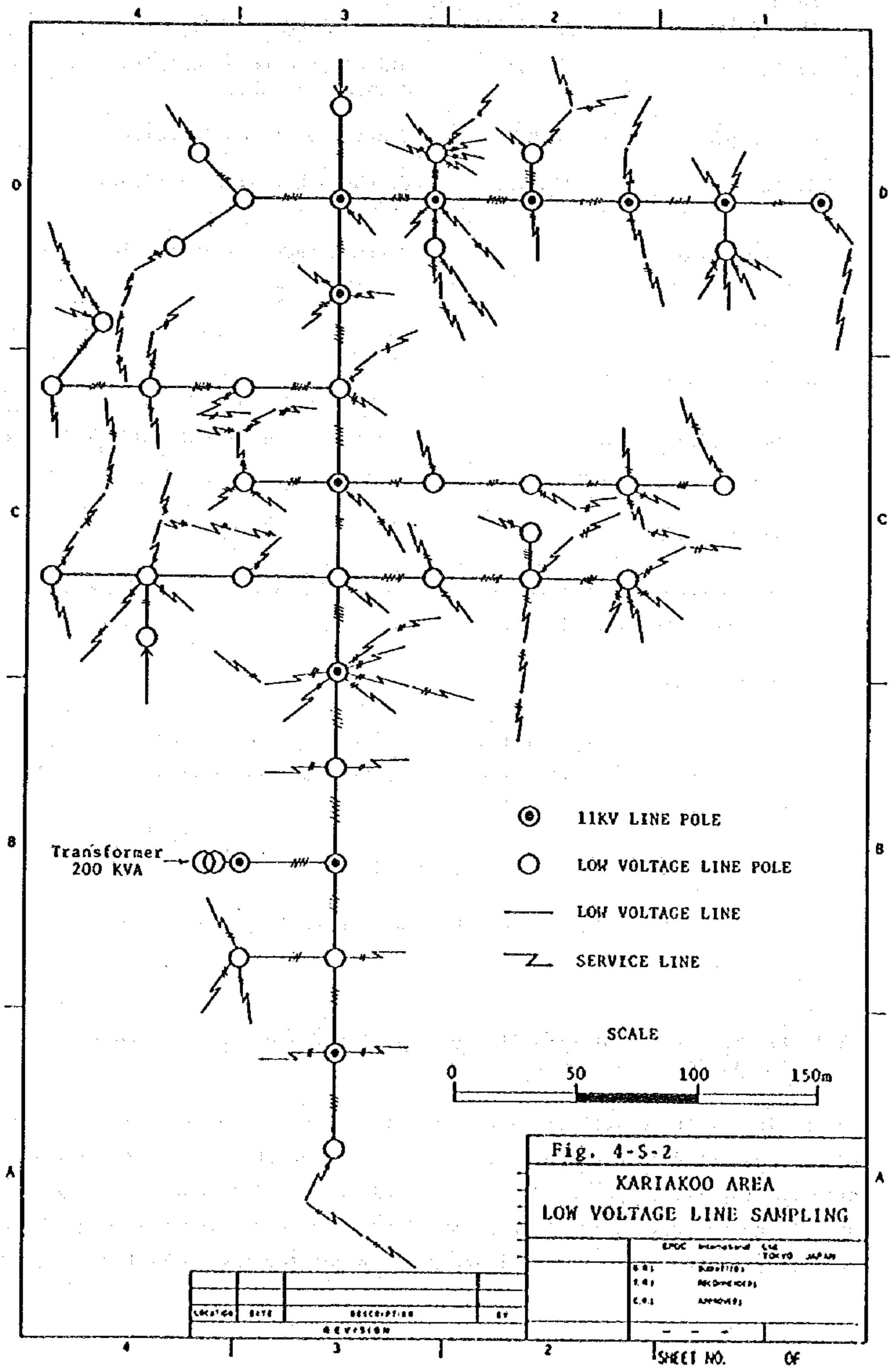


Fig. 4-S-2
KARIAKOO AREA
LOW VOLTAGE LINE SAMPLING

Name of Substation	S.S. Capacity	Supply Areas
Ilala	15 MVA	Old city centers including Upanga, Kariakoo
City Center	30 MVA	Central business district
Oysterbay	15 MVA	Northern Musasani residential area, etc.
Factory Zone I	15 MVA	Western industrial district

(3) Outline of facilities

- Substations

The outline of present facilities in the district substations in Dar es Salaam is presented in Table 4-1-1.

- Transmission lines

The outline of sub-transmission lines below Ubungo Substation is presented in Table 4-3-1.

- 11 kV feeders

The outline of the distribution feeders supplied from the 4 substations mentioned to the districts under study is presented in Table 4-4-2.

- Typical facilities in low voltage circuit

A typical low voltage distribution network is presented in Figures 4-5-1 and 4-5-2.

1.1.5 Present status of transmission/distribution system and problems involved

Declination of the distribution systems of Dar es Salaam is more than what has been expected before the survey. The power demand increases every year while the facilities get aged, making repair and replacement necessary on most of equipments. It must be presumed that the cause for this degradation has been the lack of normal and routine maintenance works for the past several years, probably due to extreme shortage of repair material inventories, and appallingly poor equipment of machines, tools and vehicles for maintenance. This status shows the degree of adversity which the economy of Tanzania has suffered in recent years.

(1) Problems in facilities

(i) Substation facilities

(a) Transformer capacity

The load demands are reaching the full station capacities in the 3 substations of Ilala, Oysterbay and Factory Zone I, with the only exception of City Centre S.S. which capacity has been doubled to 30 MVA last year. It is urgently required to expand the capacities of the said substations, with replacement of the transformers to those having larger capacity.

(b) Voltage regulation facilities

All the transformers in the secondary substations are equipped with on-load voltage regulators, capable of automatic voltage control. Unfortunately, non of the voltage regulators is in automatic operation. The regulators themselves require overhauls and re-adjustment of the control devices.

(c) Power factor improvement

The reactive power compensation facility is not employed, despite the low power factor of the loads.

(d) Equipment maintenance

Oil leakage has been observed on most of the transformers. Circuit breakers and cubicles, as well as the transformers, have reached the period when overhauls are mandatory. There is danger of deterioration of insulating oil, because the moisture absorbing agent for protection of the insulating oil has not been renewed.

(e) Operations

Ilala Substation is the only manned station, and the shift operators here are supposed to monitor the other 3 unmanned substations. In reality, the load dispatching operations on the 3 substations are not practiced, because the communication cables between substations are broken. The trip of the distribution feeders can be known to the operator only after the claim of blackout is presented by the customer.

(ii) Transmission facilities

(a) Transmission capacity

- Transmission Line between Ilala and City Centre S.S.

The capacity of City Centre S.S. has been doubled last year as mentioned, without measure on the transmission line. The load current of this line is approaching the current carrying capacity of the conductors.

- Transmission Line between Ubungo and Ilala

The power is transmitted from Ubungo to Ilala by a single circuit 132 kV line on steel towers and 2 circuits of 33 kV lines on wooden poles. As the transmission capacities of these lines are insufficient, substations such as Oysterbay and Kurasini, which have been originally designed to receive power from Ilala S.S., are supplied directly from Ubungo by provisional system connections.

It is recommended to increase the transmission capacity by measures described in separate paragraphs.

- Transmission Line between Ilala and Oysterbay

The existing small conductors (50 sq.mm) must be replaced.

(b) Other lines

The facilities related to 33 kV cables are kept in relatively good conditions in general, and there is no imminent need for replacement and repair, except for the part where there is a problem of transmission capacity.

(iii) 11 kV feeders

(a) Heavy load

Some feeders are carrying extremely heavy loads, and measures are required, including re-distribution of loads to other feeders.

(b) Idle feeders

In several places, feeders are idle because they have not been repaired after faults and the loads have been simply shifted to other feeders.

Repair and maintenance are commended.

(c) Cable and branching switch

A large number of specialized switch boxes of European manufacture are employed at branches of the cables, many of which having failed and requiring repairs. In cases that the related cables are excessively deteriorated, a comprehensive repair must be planned.

(iv) Distribution transformers

(a) Capacity and number

Generally speaking, a small number of large capacity transformers are employed. There is no imminent problem, however.

(b) Protective switches

In both primary and secondary circuits, many blown fuses are provisionally short circuited. This is a very dangerous status, presenting the most imminent problem in the system as a whole.

(c) Maintenance

Maintenance is poor, and all of the moisture absorbing agents have changed the color. Some equipment on the ground are covered by bushes. There are many circuits presenting large grounding current, which probably having grounding leaks in the secondary circuits.

(v) Low voltage distribution facilities

These facilities are extremely degraded, being the worst in the whole system.

(a) Conductors

The conductors have not been adequately replaced with the increase of load. The provisional measures after faults have not only been poor, but stayed there as permanent provisions. The workmanship of conductor connections is very low. Together with the use of conductors of mixed size, the broken conductor strands, mixed use of copper, aluminum and steel wires, and use of improvised short conductors, the situation is one that must not be overlooked. A comprehensive improvement program is recommended.

(b) Maintenance

The patrol of the lines is not exercised effectively, with trees contacting the line conductors as left as they are. Many guy wires are broken and left, with possibility of contacting the conductors. Generally there are problems with stringing, some conductors being too tightly strung or slack.

(2) Frequency of blackouts and status of voltage regulation

(i) The blackout cases in 1983 are listed in Table 4-6-3-1. According to the data, feeder trips occurred 169 times annually. The actual status of the blackouts is this frequency plus the number of outages of the distribution lines, which could be described as disastrous.

(ii) The status of voltage regulation is presented in Chapter 4.5. A sampling survey conducted in this study on several customers indicates that the maximum voltage is 285V, and the minimum 200V, for the rated voltage of 230V, presenting voltage fluctuation of 37% in magnitude. There are frequent reports from customers on burning out of household appliances, which may be attributable to this excessive fluctuation of voltage.

(iii) The high frequency of blackouts, and the intolerable status of the voltage fluctuation are the two strongest reasons on which this proposal for the improvement program is based.

1.1.6 Provisional countermeasures

As presented in the preceding paragraphs, there are many imminent problems in the ditribution systems. As the Japanese Government is under consideration to supply the urgent materials and equipment upon request of Tanzania, as a part of the grant aid program for this fiscal year, it has been assumed that the improvement on the low voltage distribution lines in certain important districts can be implemented by using the urgent materials and equipment described on the request list. The contents of the countermeasures are described in detail in Chapter 5.

In Chapter 5, the "The Most Urgent Countermeasures", which shall be conducted by TANESCO by itself on the part of the system subjected to imminent danger, without waiting for the arrival of the urgent materials and equipment, are recommended on items below. (A part of the recommended measures are already being implemented by TANESCO, as of October, 1984.)

1) Proper equipment of protective fuses on distribution

2) Removal of the objects presently in contact with the naked distribution lines

3) Improvement of conductor connections of poor workmanship

4) Proper setting of distribution transformer taps

1.1.7 Demand forecast and timing for expansion of substation capacity

(1) Demand forecast

The demands of electricity in the supply areas of the substations under consideration have been estimated as below, by forecasting time when the latent demands in the supply areas (mostly industrial loads) turns to real loads, and the growth of existing loads, based on realistic assumptions.

Table 4-6-3-1 Summary of service interruption caused by faults

Substation	Number of Feeders in Service (A)	Number of CB Trip of 11 kV Feeders (B)	(B)/(A)	Fuse Blowing Primary Side of Tr. (C)	Fuse Blowing on Secondary Side of Tr. (D)	Jumper Wire Breakage (E)	Number of Transformers (F)	$\frac{(C)+(D)+(E)}{(F)}$
Oysterbay	5	57	11.4	108	557	20	81	8.5
City Centre	4	45	11.3	25	223	7	64	4.0
Ilala	5	45	9.0	12	126	6	67	2.2
F.Z. I	4	22	5.5	24	53	0	73	1.1
Total	18	169	9.4	169	957	33	285	4.1

Note) 1. (B)/(A): Average number of service interruptions per consumer caused by 11 kV feeder CB trip

2. [(C)+(D)+(E)]/(F): Average number of service interruptions per consumer caused by transformer fuse blowing or jumper wire breakage

Substations

	1983	1985	1990	1993
				(MW)
Ilala	13.0	14.2	17.2	20.3
Factory Zone I	17.5	19.2	22.2	26.2
Oysterbay	12.2	13.3	17.2	20.3
Factory Zone I	12.6	12.6	22.2	26.7

(2) Expansion of transformer capacity in each substation

The transformer capacity in 3 substations, other than City Centre S.S., is 15 MVA, for which the load is already near the full capacity, and the capacity will be exceeded any time after next year, if we consider the load forecast. As it is postulated that the situations 5 or 6 years in future are to be taken into account in this study, we considered countermeasures based on a guideline that the necessary capacities are to be provided to meet the demand by 1990.

The unit capacity of the new transformers to be installed are decided by the following 3 criteria, and 15 MVA unit is selected: i) The unit capacity conform to the standard capacity employed for the existing transformers in substations for Dar es Salaam. ii) The choice between a 10 MVA unit and a 15 MVA unit is to be determined by economic advantage. iii) The criterion that the supply is not hampered by outage of one transformer in the system is to be observed.

(3) Substation transformer extension program

The program for expanding the transformer capacity has been formulated as illustrated in the table below, considering the status of existing transmission lines, locations of new demands, and the feasibility of adding new distribution feeders.

Substation	Existing Transformer	Expansion Measure	New Capacity	Time of Expansion
Ilala	7.5 MVA x 1	Replace one 7.5 MVA with a 15 MVA	22.5 MVA	1986
Oysterbay	5 MVA x 3	Construct new 15 MVA S.S. (Mikocheni)	30 MVA in total	1989
Factory Zone I	5 MVA x 3	Construct new 15 MVA S.S. (Factory Zone III)	30 MVA in total	1988

1.1.8 Details of improvement plan for Dar es Salaam distribution network

(1) Expansion of transmission capacity from Ubungo to Ilala (Replacing the two, 132/33 kV, 10 MVA transformers with two 45 MVA transformers)

All the power to Dar es Salaam City is being supplied from the 132 kV bus of Ubungo S.S., and the voltage step-down to 33 kV is being performed by the two 50 MVA transformers in Ubungo S.S. and the two 10 MVA transformers in Ilala S.S., that is, the total bank-down capacity is 120 MVA. As the composite maximum load for the whole city will be 136.6 MVA in 1990 (refer to 6.6.4), the shortage of the bank-down capacity is imminent.

In this plan, the necessary capacity expansion of substations will be implemented by replacing the existing two 132/33 kV transformers in Ilala S.S. with two 45 MVA transformers. This is a very appropriate plan for capacity expansion, because of the following reasons.

(i) The potential capacity of the 132 kV steel towered line leading to the city center can be effectively utilized. (The actual transmission is limited at only 20 MVA at present. Refer for details to Chapter 7, Power System Analysis.)

(ii) As the power supply to the 33 kV bus of Ilala S.S. is increased, the power to the neighboring 4 substations can be supplied from this bus, improving the reliability and the transmission loss.

(iii) The present heavy loading on the two 50 MVA transformers (having oil leaks) in Ubungo S.S. can be relieved, making the overhaul of the transformer possible.

(iv) The two 10 MVA transformers replaced at Ilala S.S. can be utilized in Ruvu Pumped Storage Hydroelectric Station, which has the problem of power supply at present. (Refer to 8.6 (2))

(v) The measure mentioned above can also solve the voltage regulation problem in Nordic Line.

(2) Details of capacity expansion program for substations

(i) One of the two 7.5 MVA transformers in Ilala S.S. is to be replaced by one 15 MVA transformer.

(ii) In planning the capacity expansion of Oysterbay S.S., it has been decided to construct Mikocheni S.S. (15 MVA) in the vicinity, by taking into account the limited land area in the existing substation, the difficulty of shutting down the transformer for replacement work, the economical advantage of the alternative plan, and the location of new demands in the supply area.

(iii) For the capacity expansion of Factory Zone I S.S., it is also planned to construct Factory Zone III S.S. at a suitable site to the west of the existing substation, for reasons similar to those in the preceding paragraph.

(3) Repair of substation facilities

In this plan, only the following repair items are to be implemented immediately, although a more substantial repair program would be desirable, as the facilities are generally old, and have been exploited without proper maintenance. A comprehensive repair program has been forsaken at this stage because the difficulties involved, in terms of finance and outages required for the work, would be enormous, and because the system can be operated as it is for the time being.

- Repair of on-load voltage regulators and their control devices
- Installation of new circuit breakers and switches, and partial repairs of existing circuit breakers and switches
- Partial repairs of lightning arresters
- Repair of DC power supply devices

(4) Capacity expansion of secondary transmission lines

The capacity expansion of the secondary transmission lines is required for a variety of reasons, that is, to relieve the overloading of existing facilities, to facilitate system operations, and for construction of new substations. An appropriate plan in meeting these needs have been worked out. The content of the expansion plan is illustrated in Table below.

Transmission line expansion program

Line Name (Section)	Length (km)	Measures	Year	Objective
Kurasini Line ② (System Modification)		Connect to Ilala bus	1986	System improvement
Mikocheni Line ③ (New Construction)	1.0	π-branch from existing line, ACSR 120 sq.mm	1967	For new substation
Ilala - Oysterbay ④	5.0	Replace ACSR 50 sq.mm with 120 sq.mm	1987	Overload relief
Ubungo - Fz III ⑤	7.0	New ACSR 120 sq.mm, single circuit, with double circuit tower	1987	For new substation
Fz III - Fz II ⑥	0.6	New branch from existing line, ACSR 120 sq.mm	1988	System improvement
Fz III - New Airport ⑦	0.7	New branch from existing line, ACSR 120 sq.mm	1988	System improvement
Fz III - Fz I ⑧	1.5	New branch from existing line, ACSR 120 sq.mm	1988	System improvement
Fz III - Kurasini ⑨	6.5	New branch from existing line, ACSR 120 sq.mm	1988	System improvement

Number in ○ shows a corresponding proposed line in Fig. 8-2-1.

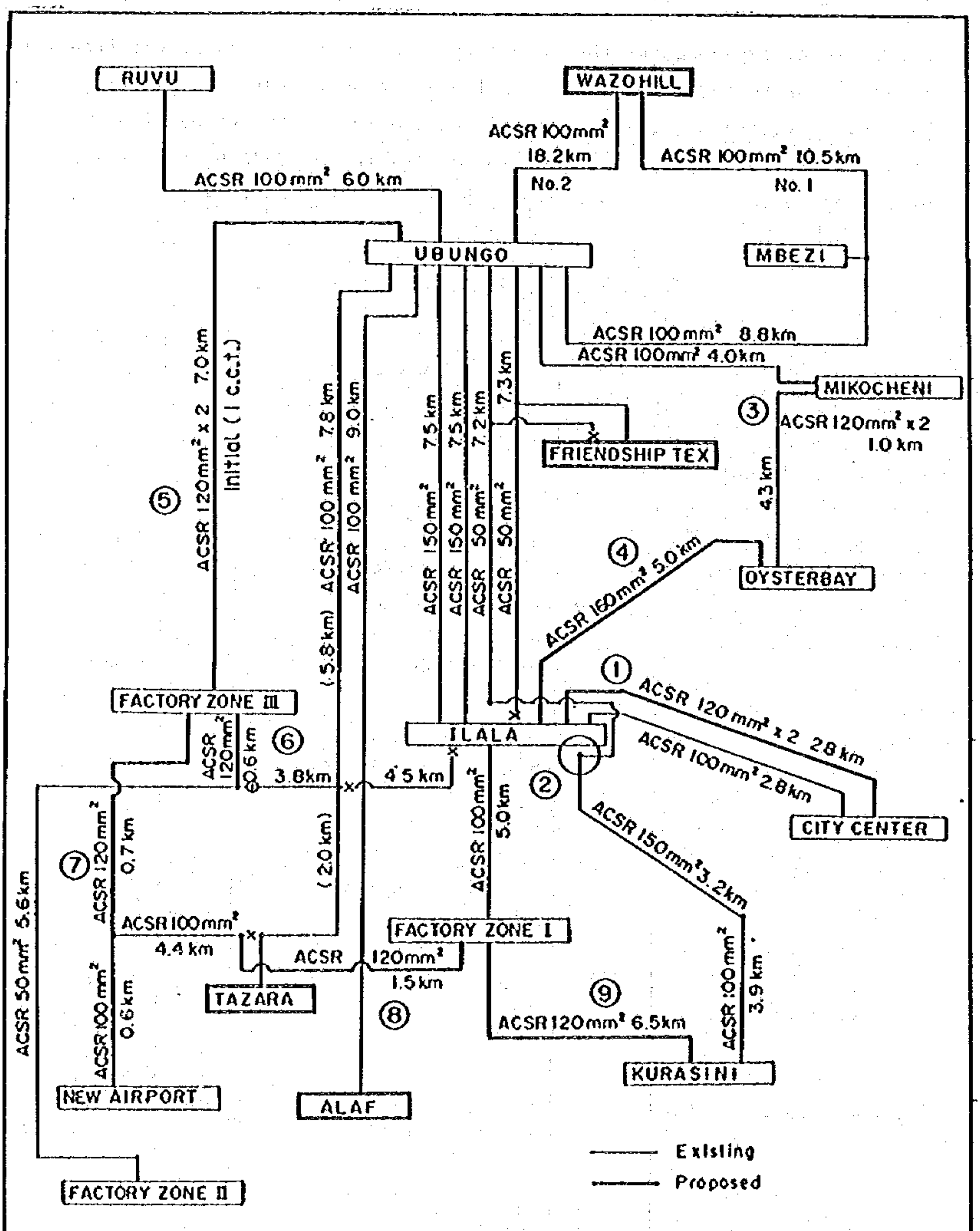


Fig. 8 - 2 - 1

33kV SUB-TRANSMISSION LINE SYSTEM

(5) Improvement program of 11 kV distribution lines

It has been planned to provide new distribution lines from Mikocheni S.S. and Factory Zone III S.S. to the load centers, 3 circuits and 5 circuits respectively. Several circuits of the new lines will be interconnected with the feeders from Oysterbay S.S. and Factory Zone I S.S., so that load distribution can be adjusted.

The details of the plan for new branches from the feeders to the new transformers, and replacement of the depleted conductors and small conductors are described in 8.3.

The total length of the new 11 kV distribution lines plus the sections to be improved extend to 116 km. The details are illustrated below.

	Trunks	Branches	Cables	Length in km
New lines	11.5	4.0	0.8	
Interconnections	5.5		2.7	
Extensions		10.0	2.4	
Improvement	58.5	21	---	
Total	75.5	35	5.9	116.4

(6) Improvement program of low voltage distribution lines

(i) Improvement of existing facilities

- Protection of transformer primary and secondary circuit: 153 banks
- Low voltage switches: 83 banks
- Conductor re-stringing and extension: Trunk line; 190 km
  Branch; 290 km
- Customers' branch; DV line; 480 km
- Supports: 600

(ii) Provisions for new loads

- New transformers: 35 (8,500 kVA)
- New low voltage lines: 99 km
- Supports (steel pipe and wooden poles): 2,400 in total

(7) Reconstruction of load dispatching communication system

VHF communication system will be installed, providing master station in Ilala S.S. and terminals in the other 3 substations and the two new substations. The minimum amount of information necessary for load dispatching and safety will be transmitted and displayed in the control room of the Ilala S.S., facilitating quicker response of the operators and maintenance personnel in case of power supply troubles.

(8) Procurement of vehicles

As the transmission and distribution system improvement program will be exercised in a wide area, with substantial amount of work, construction vehicles including one 6-ton crane vehicle and 6 elevated work vehicles will be procured. It is necessary to prepare spare parts that are suitable to the conditions of the project sites.

(9) Preparations of tools and measuring instruments

The necessary tools and instruments will be requested as the urgent materials and equipment. In addition to this, sufficient equipment must be provided for the working personnel which number is to be increased.

1.1.9 Special mention in design

(1) Standards

- The designs have been implemented taking into account the standards presently being practiced by TANESCO, and in conformity with the Japanese standard practice.

- The materials and equipment to be procured are based on the Japanese standards as much as possible.

(2) Standardization

Considering the conditions prevailing in Tanzania, it has been tried to avoid diversification of materials and equipment as far as possible. Standardizations of items have been pursued to facilitate interchangeability.

(3) Single phase supply to general customers

As a single phase supply is sufficient for residential customers, the service lines are designed to single phase, two wire system.

(4) The insulated conductors are used for the low voltage distribution lines in order to increase reliability. The conductor size is standardized to 120 sq.mm for the trunk line and 55 sq.mm for the brahcnes, to facilitate flexible use and simplification of the tools.

(5) The measures against salt pollution and for improvement of power factor have not been incorporated in the plan.

(6) It has been planned to eliminate the protection by the fault throw switch, as this system increases danger as the system capacity increases. The circuit breakers are also provided at the receiving ends.

(7) For the line support structures, steel pipe poles are employed in the commercial areas and wooden poles in the suburbs.

(8) In the new substations, circuit breakers of the 11 kV feeders are housed in outdoor cubicles, having no station building.

1.1.10 Construction plan

(1) Construction method

The construction works will be directly executed by TANESCO. In the expansion work of Ilala S.S., and construction works of new Mikocheni S.S. and Factory zone III S.S., only the civil engineering works will be directly owned, and the equipment will be supplied from the manufacturers including assembly, installation and adjustment, on semi-turnkey basis.

(2) Project organization

As the main part of this project is the modification, improvement and replacement works, including relatively little constructions of new facilities, frequent power cuts for works will be required.

In addition, most of the areas in which the project will be conducted are central districts of the city, with government offices, business offices and the surrounding congested residence, probably making power cut schedule a very difficult task.

Under the circumstances, it will be necessary to organize a specialized task force that produces design documents, work schedules and work procedure instructions, to operate the work teams efficiently, to complete the work with the minimum length of power cut time, and to assure the safety of the personnel. It has been planned to equip the vehicles procured for this project with VHF trancelvers, so that efficient implementation of project is accomplished by providing means of transmitting instruction and information, which are vital in construction works.

(3) The tentative project schedule is illustrated in Table 11-1.

1.1.11 Estimated project cost

(1) Premises for calculation of project cost

- Material cost

  The 1985 values are taken as the base. The escalation is assumed to be 2% per annum.

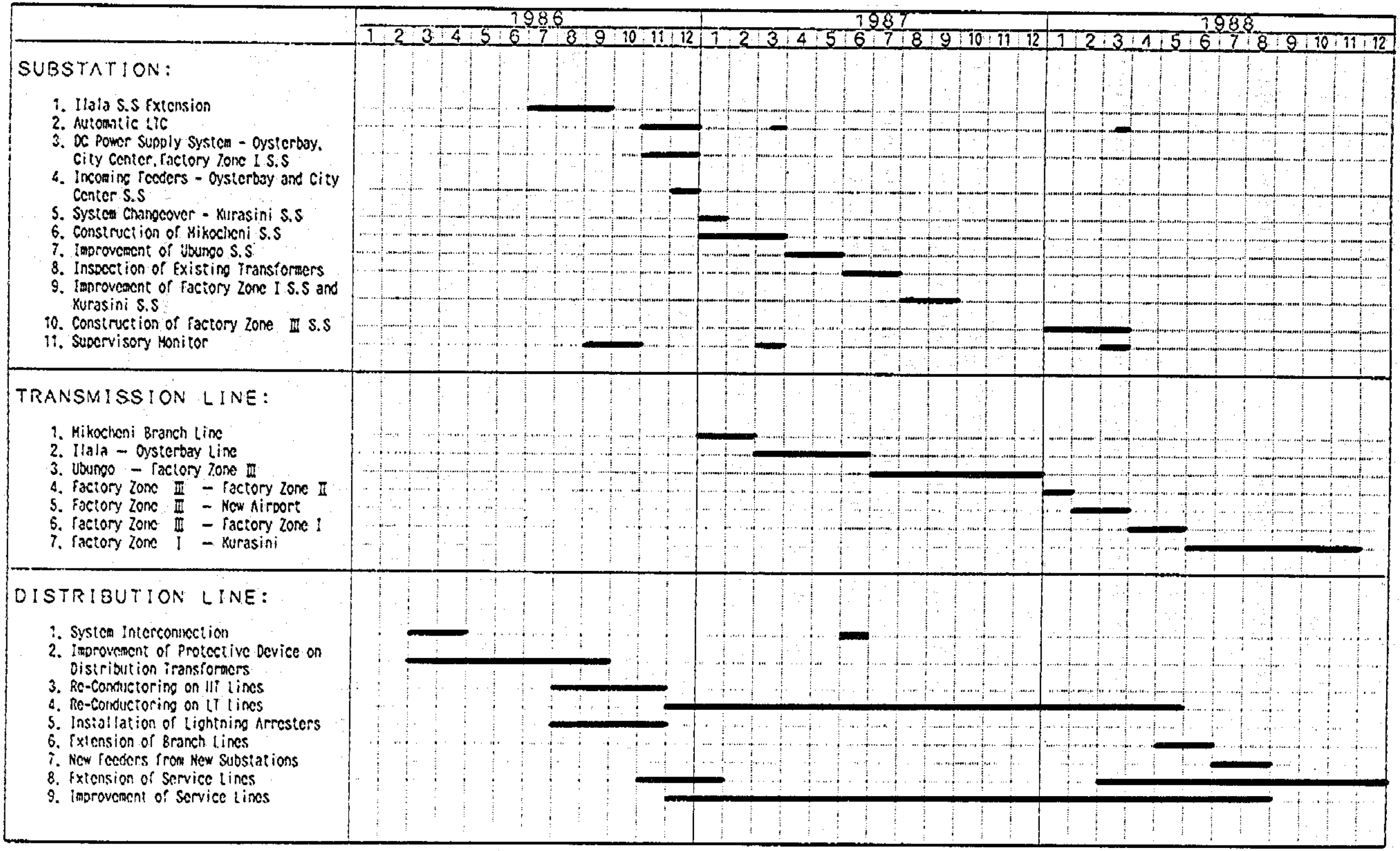
- Transport and insurance

  The CIF prices are estimated by adding the transportation cost and insurance fee of 9 to 21% to the FOB prices.

- Installation cost

  The installation cost on TANESCO is estimated by applying the ratio of the construction labor cost to the material cost, which is deduced from the past records of construction works conducted in Tanzania.

Table 11-1 Construction Schedule



- Contingency

  10% contingency is provided on both the domestic and foreign currency.

- Engineering fee

  The engineering fee is estimated at 8% of the total construction cost.

- Cost of training

  The cost for dispatching TANESCO personnel to an advanced country for training, and the cost of compiling manuals are counted.

  The training of work technique provided at the site will be on-job trainings, which cost is included in the engineering fee.

- Currency exchange rate

  The currency exchange rate is assumed at 1 T.shs. = 13.71 yen.

(2) Portions of foreign and domestic currency

(i) Portions of foreign currency

- Equipment and materials, excluding ballast, sand and cement
- Vehicles, tools, measuring instruments
- Transport and insurance fee
- Equipment and installation provided on semi-turnkey contracts
- Engineering fee, Training expenses

(ii) Portion of domestic currency

- Labor cost related to improvement and construction works executed by TANESCO, for transmission, distribution and substation facilities

- Cost of civil works for substation facilities

- Cost of domestic materials: ballast, sand, cement and small indigenous materials

(3) <u>Estimate of construction cost</u>

Presented in Table 12-1.

Table 12-1 Construction cost

	Materials	Construction		Total		
	FC 10^6 Yen	FC 10^3 Yen	DC 10^3 T.Shs	FC 10^6 Yen	DC 10^3 T.Shs	Total 10^6 Yen
I. Construction Cost						
1. Substation	556	55	11,225	611	11,225	765
2. 33 kV Sub-transmission Line	88		1,926	88	1,926	114
3. Distribution Line	1,342		30,160	1,342	30,160	1,756
4. Vehicles & Tools	120			120		120
Sub-total	(2,106)	(55)	(43,311)	(2,161)	(43,311)	(2,755)
II. Engineering Fee						
1. Engineering Fee				221		221
2. Technical Training Fee				30		30
Sub-total				(251)		(251)
III. Contingency				216	4,331	276
Total				2,628	47,642	3,282

Note) Conversion rate: T.Sh 1 = Yen 13.71

1.1.12 Economic evaluation

The details of the economic evaluation of the project are presented in Chapter 13, which outline is described here.

(1) Method of economic evaluation

The economy of the project is assessed by the equivalent discount rate, or the internal rate of return of the project, with which the present values of the cost and the benefit described below become equal.

(i) Cost

- Total investment
- Operation and maintenance expense after completion

(ii) Benefit

- The marginal amount of electricity that becomes available to the customers by increase of substation capacities

- The decrease, due to the improvement, in amount of electricity that is lost in blackouts

- The decrease of operation and maintenance expense due to the improvement

Other important benefits are expected by the improvement, such as the reduction of household appliance failure and burn-outs, effected by better voltage regulation, the reduction of inconvenience and hazards on people due to blackouts. However, as it is difficult to quantitatively estimate these benefits, they are not included in the estimate of economic effects.

(2) Premises

- Present value: The present value as of 1984
- Period of estimate: Until 2010
- Loss in distribution system: 10%
- Load factor: 65% until 1990, 66% afterwards

(3) Expense

(i) Total investment: 239.3 million T.Shs. (from 1986 to 1988)

(ii) Operation and maintenance expense:

Per annum; 1.7 million T.Shs. (in the beginning year) to 4.2 million T.Shs. (in 1988 and thereafter). (The reduction of the operation and maintenance expense by the improvement plan is taken into account.)

(4) Benefit

(i) Marginal increase of electricity by expansion of substation capacities:

4.1 GWh (in the beginning year) to 175.3 GWh (in 1999) and thereafter)

(ii) Reduction of electricity lost by failure:

2.5 GWh (from the beginning year)

(iii) Monetary unit of benefit:

Allocation of electricity prime cost to the distribution division, or, 15.7 cents/kWh

(iv) Annual benefit:

1.0 million T.Shs. (in 1986) to 27.9 million T.Shs. (1999 and thereafter)

(5) Internal rate of return

The internal rate of return (IRR) of the project, calculated by data described above, is 5.1%. This IRR may not be sufficient for a commercial project, as the internationally prevailing interest rate is usually above 11%, and that of export-import bank of each country is from 8.3 to 9.5%. However, this project will be judged feasible to implement even economically, taking into account the social benefits involved as described in Paragraph (1).

1.1.13 Financial assessment

For the financial assessment of the plan, the followings are assumed:

(1) Condition of loan

Foreign currency

Interest rate 6.5% per annum, Refund period 20 years

Domestic currency

Interest rate 9.0% per annum, Refund period 13 years

(2) Income

Unit price for marginal increase of electricity can be assumed as an allocation value of electricity rate to the distribution division, or, 20 cent/kWh.

Thus, the probable future annual balance sheet of the plan can be obtained, as shown in Table 14-4.

It shows that annual balance will become black in 1993 while aggregate balance cannot be in black until 2002.

It suggests that the financial condition should be much softer than the previous assumption for the materialization of the project.

Table 14-4 Cash-flow

No.	Year	Cash inflow				Cash flow				Balance	
		Borrowing	Net income	Depre-ciation cost	Total	Construc-tion	Repayment of principal: Foreign currency	Repayment of principal: Local currency	Total	Yearly	Accumu-lated total
	1986	91.6	-1.9	-	89.7	91.6			91.6	-1.9	-1.9
	87	74.1	-11.3	3.9	66.7	74.1			74.1	-7.4	-9.3
	88	73.6	-15.9	7.2	64.9	73.6			73.6	-8.7	-18.0
1	89		-18.9	10.6	-8.3		4.9	2.1	7.0	-15.3	-33.3
2	1990		-14.0	10.6	-3.4		5.3	2.3	7.6	-11.0	-44.3
3	91		-10.5	10.5	0		5.6	2.5	8.1	-8.1	-52.4
4	92		-6.3	10.5	4.2		6.0	2.7	8.7	-4.5	-56.9
5	93		-0.7	10.4	9.7		6.4	3.0	9.4	0.3	-56.6
6	94		1.4	10.4	11.8		6.8	3.2	10.0	1.8	-54.8
7	95		3.3	10.4	13.7		7.2	3.5	10.7	3.0	-51.8
8	96		6.3	10.4	16.7		7.7	3.9	11.6	5.1	-46.7
9	97		7.7	10.4	18.1		8.2	4.1	12.3	5.8	-40.9
10	98		10.2	10.4	20.6		8.7	4.5	13.2	7.4	-33.5
11	99		11.6	10.3	21.9		9.3	4.9	14.2	7.7	-25.8
12	2000		12.6	10.3	22.9		9.9	5.3	15.2	7.7	-18.1
13	01		13.5	10.3	23.8		10.5	5.6	16.1	7.7	-10.4
14	02		14.9	10.3	25.2		11.2		11.2	14.0	3.6
15	03		15.6	10.3	25.9		11.9		11.9	14.0	17.6
16	04		16.4	10.3	26.7		12.7		12.7	14.0	31.6
17	05		17.2	10.3	27.5		13.5		13.5	14.0	45.6
18	06		18.1	10.3	28.4		14.4		14.4	14.0	59.6
19	07		19.0	10.3	29.3		15.3		15.3	14.0	73.6
20	08		19.9	10.3	30.2		16.2		16.2	14.0	87.6
21	09		21.1	10.3	31.4					31.4	119.0
22	2010		21.1	10.3	31.4					31.4	150.4
	Total	239.3	150.4	239.3	629.0	239.3	191.7	47.6	478.6	150.4	

1.2 RECOMMENDATION

1.2.1 Urgency for implementation of the plan

As to be described in each chapter of this report, the distribution network of Dar es Salaam City, the capital of the United Republic of Tanzania, is in a serious situation in frequent supply outage and voltage fluctuation because of decrepitude of the facilities. If the conditions are left as they are, it might bring important social unrest.

For the City of Dar es Salaam to function as the capital of the United Republic, and to provide for stability and security of one million citizens, the stable supply of electricity is indispensable, and consequently, a prompt remedy to the present status of the transmission and distribution systems is imperative.

Economical efficiency of the plan is not very good because of the nature of the project which is improvement of the power distribution system. However, the implementation of the project can be feasible even in economical view, as far as soft condition of finance can be obtained. (Refer to chapters 13 and 14)

The plans recommended in this report consist of the emergent measures, and the improvement plans that are to follow the emergent measures. Both the emergent measures and the improvement plans must be implemented, by soundly providing the following steps.

1.2.2 Implementation of emergency measures

As the government of Japan, upon request of the government of the United Republic of Tanzania, gives a serious consideration for an emergency material aid, it is recommended that the Tanzanian government authorities, as well as TANESCO, take preparatory measures, in order that the implementation schedule as presented in Chapter 5 is met smoothly as soon as the aid is decided in the Japanese government.

As a part of the distribution facilities is in a dangerous state, the very emergent measures, remarked in the same chapter, must be implemented by the spontaneous effort of TANESCO, without waiting for the arrival of the urgent materials and equipment, as has been recommended in the inception report after field survey. (With respect to the very emergent measures, TANESCO has promptly started action, and a part of the measures has been already implemented.)

1.2.3 Implementation of improvement plan

The emergency measures mentioned in the preceding section are tentative actions for the improvement of the system in particular areas, not including the measures for substations and transmission lines of higher levels that support the power supply of the low voltage distribution system.

It is also necessary that the measures presented in chapter 8 of this report, including those for the high voltage systems, are implemented quickly.

For this purpose, we recommend that the government of the United Republic of Tanzania takes the following preparatory measures.

(1) Recognition by government authorities of importance and urgency of the plan

No delay is tolerable in implementation of the improvement plan. It is strongly recommended, accordingly, that the government of the United Republic of Tanzania formally recognizes the importance and urgency of the plan, gives priority to the plan among national projects, and arranges appropriate domestic currency (about 48 million T.Shs.) to TANESCO, which would be the executive agency of this plan.

(2) Arrangement for foreign finance

The impelementation of the project can be feasible even in economical view, as far as soft condition of finance can be obtained. (Refer to chapters 13 and 14)

Accordingly, it is required that the procedures for requesting a possible foreign economical assistance are started immediately, in order to prepare the foreign currency (about 2.6 billion Yen) needed for this plan. For the materialization, it may be a suggestible idea that the plan would be proceeded in two divided steps considering the necessary installation time schedule.

(3) Establishment of organization for the plan on the part of the executive agency

As TANESCO will be the executive agency to own the construction works of this plan, the particular organization for the construction work must be established, and the construction personnel must be prepared, by TANESCO. (In implementing the electrification program in Kilimanjaro Region which has been financed by Yen loan, the organization similar to one recommended in this plan has been formed, with very successful progress in the construction work.)

(4) Construction management

Assistance of talented foreign engineers, who can be consulted upon for management, formulation of working plans, procurement of materials and equipments, inspections, prosecution of construction work and education, is recommended for smooth implementation of the projects.

1.2.4 Recommendations on technical matters

(1) It is necessary that drawing, design standards and work standards are prepared for the good maintenance of facilities with unceasing efforts.

Education of supervisory personnel is a prerequisite. It is also important to have proper inventory of fixtures and utensiles to maintain drawings and ledgers of facilities.

(2) Alteration of supply system to general residents

It is recommended to establish a substandard that supply to general residents is to be made normally by single phase (2 wires) instead of present three phase system (4 wires).

For this purpose, it may be necessary to reform the tariff system, so as to charge those customers requesting three phase supply with a special rate.

(3) Improvement of power factor

It is recommended to request large customers demanding more than a certain amount of power to improve their own power factor, and make provisions in the tariff system to discount for the customers who improve their power factors, according to the degree of improvement.

(4) Establishing load dispatching function

Although the remedy for the critical state of the distribution system is a prerequisite, the improvement of supply reliability must be set as the next target. For this purpose, it is desirable to establish the load dispatching function, to implement a reliable and efficient operation of the power distribution systems for the City of Dar es Salaam.

CHAPTER 2

NATURAL AND ECONOMIC BACKGROUND

CHAPTER 2 NATURAL AND ECONOMIC BACKGROUND

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CHAPTER 2 NATURAL AND ECONOMIC BACKGROUND

2.1 GEOGRAPHICAL FEATRUES

2.1.1 Location

The Republic of Tanzania is located just south of Equator between latitudes 1°00'S and 11°44'S and longitudes 29°40'E and 40°27'E. It is bounded in the north by Kenya and Uganda, in the west by Rwanda, Burundi, Malawi, Zaire and Zambia, and in the south by Mozambique. The total area of the country is approximately 945,050 sq km.

2.1.2 Topography

The land is surrounded by the Great Lakes, i.e., in the north by Lake Victoria and in the west by Lake Tanganyika and Lake Nyasa. In the north, Mt. Kilimanjaro, covered by perpetual snows, rises up to 5,895 meters in height, and a belt of highlands runs south-west from the Usambara mountains behind Tanga to the highlands around the tip of Lake Nyasa. The great bulk of the country forms a plateau of about 1,000 meters in height, except for a narrow belt along the 900 km coast.

The rivers flow into the Indian Ocean or the Great Lakes. Many of them cease flowing during the dry season, and only the Rufiji, entering the Indian Ocean opposit Mafia Island, and the Kagera, flowing into Lake Victoria, are navigable throughout the year by anything larger than canoe.

Woodland, bushland and wooded grassland are the predominant types of vegetation. The land so covered is sparsely inhabited as much of it is tsetse infested.

2.1.3 Climate

The main climate feature is the long dry spell from May to October, followed by a period of low rainfall which is often concentrated into few days of heavy showers.

The main rainy season on the coast is from March to May, but there is a second rainy season from October to December, total rainfall increasing towards the north. Around Lake Victoria, rainfall is well distributed throughout the year but there is a peak during March to May.

The Dar-es-Salaam area faces the Indian Ocean at latitude 6°50'S and longitude 30°17'E. According to meteorological data expressed by the monthly averages for the period from 1978 to 1982 shown in Table 2-1, the weather conditions of this area can be summarized as follows:

Annual rainfall	1,130 mm
Maximum temperature	32.2° C
Minimum temperature	18.1° C

Table 2-1 Meteorological information on Dar-es-Salaam (Monthly averages : 1978-1982)

Month	Rainfall (mm)	Maximum temperature (°C)	Minimum temperature (°C)	Relative humidity (%)
January	75.0	31.6	23.2	79
February	65.2	32.1	23.0	79
March	135.5	32.2	22.6	83
April	265.5	30.6	22.4	87
May	163.9	29.8	21.1	85
June	39.4	29.1	18.9	84
July	29.8	28.7	18.2	85
August	25.8	29.3	18.1	84
September	28.3	30.1	18.4	78
October	60.2	30.9	18.7	75
November	126.7	31.3	21.3	76
December	110.9	31.6	22.7	78

Source: Meteorological Department

2.2 ECONOMIC CONDITIONS

The city of Dar-es-Salaam is commercical, industrial and administrative centre of Tanzania. The bulk of national economy, except for agriculture and forestory which hold about a half of GDP, is concentrated in this area. Its economic situation will be carved in relief by the following overall description.

2.2.1 Population

The latest population census was conducted in August 1978. This was the fourth modern census carried out in the country. The first census was conducted in 1967. According to these census, the total population of the country increased from 11,959 thousand in 1967 to 17,036 thousand in 1978 at an average rate of 3.2% per annum.

Population, number of households and number of persons per household in Dar-es-Salaam and in the whole country in 1978 were as follows:

	Whole country	Dar-es-Salaam
- Total population	17,036,499	843,090
- Number of households	3,441,056	207,534
- Persons per household	4.95	4.06

Projection of the growth in population for the period from 1978 to 1990 is shown in Table 2-2. According to this table, population of Dar-es-Salaam is forecasted to grow from 843 thousand in 1978 to 1,109 thousand in 1982 and 1,984 thousand in 1990 at an average rate of 7.1% for the period from 1978 to 1982 and 7.5% for the period from 1982 to 1990.

Table 2-2 Population projection

(1,000)

Year	Whole country (A)	Dar-es-Salaam (B)	Ratio of DES (B)/(A)
1978	17,036	843	4.9%
1979	17,507	886	
1980	18,080	1,043	
1981	18,648	1,076	
1982	19,233	1,109	5.8%
1983	19,837	1,154	
1984	20,460	1,209	
1985	21,162	1,394	6.6%
1986	21,860	1,440	
1987	22,582	1,488	
1988	23,327	1,537	
1989	24,097	1,743	
1990	24,972	1,984	7.9%
Annual average growth rate:			
1978-1982	3.1%	7.1%	
1982-1990	3.3%	7.5%	

Source: Statistical Abstract 1979 - Bureau of Statistics

2.2.2 Major economic sectors

(1) Agriculture

Agriculture is the predominant economic sector of the country. Its contribution to GDP was 51% in 1982. Export of agricultural products holds about 75 to 80% of the total export amount. Main products are coffee, cotton, sisal, cashewnut, tobacco, tea, pyrethrum, etc.

The self-sufficiency of food by increasing agricultural production constitutes the most important target of the Government, but this target is far from being achieved. It is said that this situation is partly due to extremely low prices of agricultural products and partly due to delay of payment to farmers by the Government.

(2) Manufacturing industries

Contribution of the manufacturing industries to GDP grew from 5% in 1964 to 9.3% in 1982. This is due to development of various industries in the 1970's, including oil refinery, cement, fertilizer, etc.

However, in the recent years and especially since 1981, performance of the industrial sector has been declining. A number of industries, especially those which depend heavily on imported inputs registered large declines in output. The marked decline in industrial output is almost entirely due to shortage of imported raw materials and spare parts caused by the foreign exchange crisis. It is said that at present the rate of operation is around 30 to 40% in the industries which depend mainly on local raw materials such as lumber processing, cement, oils and fats processing, etc., and only 10 to 15% in the other industries.

In the Dar-es-Salaam area also, lack of raw materials and imported inputs, non-availability of spare parts and machines and, to some extent, frequent interruption of power and water are affecting the production both in the small scale and large scale factories including WAZO Hill, Friendship Textile, ALAF, etc.

(3) Commerce

Contribution of the commercial sector to GDP was 7.5% in 1982. Since nationalization of commercial companies of European origin in 1967, the rationalization of circulation system of commodities has been promoted through utilization of co-operative associations, but the effect is insufficient and there are still black markets.

2.2.3 Economic development plans

(1) Situation up to 1980

According to data provided by the Ministry of Planning and Economic Affairs, GDP at 1966 prices grew from T.Shs 8,800 million in 1973 to T.Shs 9,553 million in 1975 and T.Shs 12,014 million in 1980 as shown in Table 2-3. The third 5-Year Plan was executed during the period from 1976 to 1980.

During the third 5-Year Plan, GDP in real terms grew at an average rate of 4.7% against target of 6% per annum, although economic situation has grown worse due to drought, large outflow of foreign exchange for oil, and financial difficulties caused by Uganda war.

(2) Fourth 5-Year Plan (1981-1985)

The fourth 5-Year Plan for the period from 1981 to 1985 is on-going. This plan aimes at growing GDP in real terms at an average rate of 6%, as shown in Table 2-4, and emphasis of the plan are placed on the following:

(i) In the industrial sector, development of iron and steel industry, chemical industry and local materials processing industries.

(ii) In the agricultural sector, atteinment of self-sufficiency of food.

(iii) In the energy sector, development of coal-fired, gas-fired and hydroelectric power stations.

In order to achieve the above target, it was planned to invest an amount of T.Shs 40.2 billion of which 80% should be financed from abroad. But, it is considered that this target will be far from being achieved due to shortage of funds both in foreign exchange and local currency. In fact, GDP at 1966 prices has been decreasing from T.Shs 12,014 million in 1980 to T.Shs 11,812 million in 1981 and T.Shs 11,435 million in 1982, as shown in Table 2-3.

2.2.4 Prices

Like other non-oil developing countries, Tanzania has continued to be hanted by inflation, and especially since 1980 the shortage of goods and price hike has intensified further due to delay in economic development. Table 2-5 shows that during 10 years from 1970 to 1980 the prices as measured by the National Consumer Prices Index (CPI) rose at an average rate of 14%, while from 1980 to 1982 the country has experienced a high inflation rate of more than 22% per annum. (For the period from 1970 to 1982 the annual average inflation rate is 15.3%).

2.2.5 Balance of payments

Since 1978 the Tanzanian economy has been passing through a difficult phase, and especially since 1980 the strains on the country's balance of payments has intensified further. The deteriolation is due to sluggish export performance - partly due to lower export volume and partly due to collapse of the world commodity prices.

Because of shortage of foreign exchange, coupled with higher import costs, the country's inadequate level of imports held back economic activities including export production. This, in return, undermined the balance of payments position.

The balance of payments for the years 1980 and 1981 is shown in Table 2-6.

Table 2-3 Recorded growth in GDP (1973 - 1982)

(Million T.Shs)

Sector	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1. Agriculture, forestry, fisheries	4,539	5,440	7,007	9,389	13,370	15,719	16,792	18,332	20,476	21,722
2. Mining and quarrying	131	128	101	107	134	120	176	207	175	162
3. Manufacturing, handcrafts	1,260	1,482	1,774	2,349	2,777	2,968	3,808	4,034	3,935	3,924
4. Electricity, water supply	109	116	146	185	224	240	281	432	417	515
5. Construction	609	682	735	712	866	921	1,129	1,376	1,776	1,720
6. Whole sale, retail sale, hotels and restaurants	1,505	1,913	2,172	2,351	3,012	2,959	3,118	3,386	3,296	3,183
7. Transport, storage and communication	1,017	1,282	1,453	1,618	1,808	1,775	1,884	2,075	2,182	2,093
8. Finance, insurance and business services	1,170	1,409	1,650	1,878	2,204	2,787	3,278	3,703	4,260	5,032
9. Public administration and other services	1,335	1,786	2,204	2,444	2,684	2,748	2,934	3,481	4,206	4,793
10. Less: Imputed bank services charges	135	220	254	388	510	680	821	850	901	964
GDP at factor cost	11,490	14,010	16,988	20,648	26,569	29,557	32,579	36,176	39,822	42,190
GDP at 1966 prices	8,800	9,020	9,553	10,169	11,061	11,253	11,657	12,014	11,812	11,435
GDP deflator (1966=100)	130.5	155.3	177.8	203.0	240.2	262.6	279.5	301.1	337.1	369.0

Source: Statistical Abstract 1982 - Bureau of Statistics, Ministry of Planning and Economic Affairs

Table 2-4 Target of growth in GDP (1981 - 1985)

(Million T.Shs)

Sector	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	Annual growth rate
1. Agriculture, forestry, fisheries	20,261	21,396	22,594	23,859	25,195	26,606	5.6%
2. Mining and quarrying	250	287	328	376	431	495	14.6%
3. Manufacturing, handcrafts	3,321	3,613	3,931	4,277	4,654	5,063	8.8%
4. Electricity, water supply	320	352	388	427	470	517	10.0%
5. Construction	1,656	1,817	1,993	2,186	2,398	2,631	9.7%
6. Whole sale, retail sale, hotels and restaurants	3,333	3,486	3,647	3,814	3,990	4,172	4.6%
7. Transport, storage and communication	2,087	2,244	2,412	2,593	2,787	2,996	7.5%
8. Finance, insurance and business services	3,228	3,376	3,532	3,694	3,864	4,041	4.6%
9. Public administration and other services	4,348	4,540	4,757	4,976	5,205	5,444	4.6%
GDP at factor cost	38,804	41,132	43,600	46,216	48,989	51,964	6.0%

Source: Fourth 5-Year Plan - Ministry of Planning and Economic Affairs

Table 2-5 Consumer prices index and currency exchange rate

Year	CPI (1970=100)	GDP deflator (1966=100)	Currency exchange rate to US$ (June)
1970	100.0	-	-
1971	104.7	-	-
1972	112.7	-	-
1973	124.5	130.5	-
1974	148.4	155.3	-
1975	187.7	177.8	-
1976	200.6	203.0	-
1977	223.8	240.2	8.338
1978	249.3	262.6	7.846
1979	283.6	279.5	8.278
1980	369.4	301.1	8.229
1981	464.1	337.1	8.350
1982	551.8	369.0	9.498
1983	-		12.346
1984	-		17.500

Source: CPI - Economic and Operations Report (June 1982), Bank of Tanzania

GDP deflator and currency exchange rate - Statistical Abstract 1982 - Bureau of Statistics

Table 2-6 Balance of payments

(Million US$)

Item	1980	1981
Export (FOB)	4,776.3	4,805.5
Import (CIF)	10,260.6	9,567.8
Trade balance	-5,484.3	-4,762.3
Net services	156.1	579.4
Net transfer	1,055.0	1,887.5
Current account balance	-4,273.2	-2,295.4
Net Government medium and long-term loans	799.5	1,399.9
Government compensation and interest	-26.0	-30.0
Parastatal medium and long-term loans	279.0	418.5
Private medium and long-term loans	5.0	5.7
Supplier's credit	496.0	681.2
Other capital movements	1,115.0	-956.8
Net errors and ommissions	703.5	-13.1
Exceptional financing	1,007.2	752.2
Overall balance	+106.0	-37.8

Source: Economic and Operations Report (June 1982), Bank of Tanzania

CHAPTER 3

PRESENT CONDITIONS OF ELECTRIC POWER INDUSTRY

CHAPTER 3 PRESENT CONDITIONS OF ELECTRIC POWER INDUSTRY

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CHAPTER 3 PRESENT CONDITIONS OF ELECTRIC POWER INDUSTRY

3.1 ORGANIZATION

All public generation, transmission and distribution of electricity in mainland Tanzania are undertaken by Tanzania Electric Supply Company Limited (TANESCO) in accordance with Article 131 of Electricity Ordinance.

It is said that in addition to power stations of TANESCO there are captive power plants of a total capacity of about 20 MW.

TANESCO is under the general control of the Ministry of Water and Energy. The supreme organ of TANESCO is the Board of Directors which is under a statutory duty to promote the generation of electricity with a view to the economic development of the country and to secure the stable supply of electricity to the people. The Board is composed of ten (10) members including Chairman. The Minister of Water and Energy is concurrent Chairman of the Board of Directors.

The general management of TANESCO is conducted by the Managing Director who is concurrent member of Board of Directors.

The daily business operation are carried out under the direct control of the following managing staffs:

CCM Party Secretary
Company Secretary
Director of Manpower Development and Administration
Director of Finance
Director of Planning
Director of Construction
Director of Operations
Chief Internal auditor

The number of persons employed as at the end of 1983 was about 6,500.

Organization charts of TANESCO Headquarter and Local Office are shown in Fig. 3-1(1) and Fig. 3-1(2), respectively.

3.2 POWER FACILITIES

3.2.1 Generating facilities

The TANESCO power system is divided into two power systems, i.e. the grid system composed mainly of hydro power stations and the isolated systems consisting mainly of small scale diesel power stations. As of the end of July 1984, the total capacity of these power stations is 380.5 MW of which 82% is of the grid system and 18% of the isolated systems.

The nominal generating capacity on the grid system is 247.7 MW hydro-electric and 65.7 MW thermal. The available thermal capability is said to be only 18.1 MW including two power stations of Ubungo and Arusha. These thermal power stations are operated only for stand-by use.

The most important is 200 MW Kidatu hydro power station on the Great Ruaha River, located about 280 km west of Dar-es-Salaam. In addition, there are three hydro power stations on the Nymba ya Mangu River. These are Nymba ya Mangu (8 MW), Hale (21 MW) and Pangani Falls (17.5 MW) from upstream to downstream. Nymba ya Mangu power station has a large reservoir which increases energy generation at Hale and Pangani Falls by regulation of discharge.

In the isolated systems power stations are scattered at 25 regional towns. Their total capacity is 67.1 MW of which 65.5 MW is of diesel power stations and 1.6 MW of mini hydro power stations.

The annual energy generation was 856.7 GWh in 1983 of which 740 GWh (86%) was generated in the grid system.

The general characteristics of these power stations are shown in Table 3-1.

3.2.2 Transmission facilities

With the commissioning of Kidatu hydro power station, the grid system has been completely equipped. 220 kV extremely high voltage transmission line between Kidatu and Dar-es-Salaam constitutes a trunk line from which 132 kV lines are extended to the east and the north of the mainland and also to Zanzibar Island, in order to incorporate all these areas into the grid system.

Table 3-1 General characteristics of power stations

Power system	No. of units	Installed capacity (MW)	Available capacity (MW)	Annual energy generation (GWh)
Grid System				
Hydro				
Kidatu	4	200.0	200.0	535.7
Hale	2	21.0	17.0	69.2
Pangani Falls	5	17.5	17.5	84.8
Nymba ya Mungu	2	8.0	7.0	46.2
Kikuletwa	3	1.2	1.2	3.1
Total hydro		247.7	242.7	739.0
Thermal				
Ubungo Gas turbine	1	15.0	0	0
Diesel	8	46.6	14.0	0.37
Arusha Diesel	7	4.1	4.1	0.56
Total thermal		65.7	18.1	0.93
Grid system total		313.4	260.8	740.0
Isolated Systems				
Central and north-west	77	51.9	41.1	73.96
South-west	20	7.3	6.2	35.07
South-east	18	7.9	4.2	7.67
Isolated systems total		67.1	51.5	116.7
Whole country		380.5	312.3	856.70

Source: Generating capacity - Planning Department

Energy generation - Operations Department (7th June, 1984)

The existing main transmission lines are as follows:

Voltage	No. of cct.	Line route	Length (km)
220 kV	1	Kidatu - Morogoro - Ubungo	300
"	1	Kidatu - Iringa - Mufindi	290
"	1	Iringa - Mtera - Dodoma (under construction)	237
"	1	Mufindi - Mbeya (under construction)	220
132 kV	1	Ubungo - Chalinze - Morogoro	179
"	1	Chalinze - hale - Same - Kiyungi - Arusha	563
"	1	Hale - Tanga	60
"	1	Ubungo - Zanzibar	79
"	1	Ubungo - Ilala	6.7

The transmission line map is shown in Fig. 3-2.

3.3 POWER DEMAND AND SUPPLY

3.3.1 Energy generation and peak load

The country's energy generation has grown from 515.1 GWh in 1973 to 799.6 GWh in 1980 and 856.7 GWh in 1983, which represents the following annual average growth rates:

Period	Annual growth rate
1973-1980	6.4%
1980-1983	2.3%

As described before, 86% (740 GWh) of the total generation of the country in 1983 was generated in the grid system. Of the energy generation in the grid system, about 57% (419.8 GWh) was sent-out from Ubungo substation to the city of Dar-es-Salaam.

Statistics over 11 years from 1973 to 1983 show that the ratio of sent-out energy of Ubungo substation to the total energy generation of the country was constantly around 50%.

Peak load in the grid system grew from 65.7 MW in 1973 to 117.6 MW in 1980 and 127.8 MW in 1983, while that of Dar-es-Salaam grew from 47.7 MW in 1973 to 70.5 MW in 1980 and 75.8 MW in 1983.

During the above period, load factor in the grid system as a whole was 66 to 68%. In Dar-es-Salaam, load factor decreased gradually from 65.8% (ever highest) to 63.2% in 1982 and 1983.

Both in Dar-es-Salaam and in the grid system as a whole, peak load occurs in October, November or December, reflecting the peak in temperature and humidity. Monthly variation of load is relatively small. In the daily load curve there are two peaks, the first peak occuring from 11:00 to 12:00 and the second peak from 20:00 to 21:00.

Energy generation, peak load and load factor for the period from 1973 to 1983 are shown in Table 3-2. A typical daily load curves for the grid system and Dar-es-Salaam is given in Fig. 3-3.

3.3.2 Average rate per unit sold

From 1973 up to present, the electricity tariff was amended four times in accordance with price rise of general commodities. The average rate per unit sold of electricity corresponding to each tariff amendment is as shown below:

Tariff amendment	Average rate (Cents/kWh)
In 1973	26.13 (Annual Report)
Amendment in 1976	40.34 (Annual Report)
Amendment in December 1979	65.05 (Annual Report)
Amendment in January 1983	88.0 (Estimated by JICA team)
Amendment in January 1984	105.0 (Estimated by JICA team)

The above records show that the electricity tariff has risen at an average annual rate of 13.9% for the period from 1973 to 1980 and 13.5% for the period from 1973 to 1983.

Energy sold, revenues from sales of energy and average rate per unit sold for the country as a whole and Dar-es-Salaam are shown in Table 3-3. In this context, attention must be paid to the fact that this energy sold is not necessarily the actual energy consumption of the consumers because a part of energy sold is estimated by meter readers. The only way to obtain

Table 3-2 Energy generation, peak load and load factor

Year	Country's energy generation (GWh)	Whole country			Dar-es-Salaam			
		Energy generation (GWh)	Peak load (MW)	Load factor (%)	Sent-out energy (GWh)	Peak load (MW)	Load factor (%)	Ratio to the whole country (%)
1973	515.1	-	65.7	-	262.1	47.7	62.7	51
1974	536.0	-	67.1	-	268.0	54.9	55.7	50
1975	557.6	-	80.2	-	271.9	51.0	60.9	49
1976	590.9	-	84.9	-	284.6	54.4	59.7	48
1977	619.1	-	91.4	-	320.4	59.1	61.9	52
1978	680.3	593.2	98.6	68.7	361.6	65.4	63.1	53
1979	752.0	649.1	110.9	66.8	397.8	69.0	65.8	53
1980	799.6	686.9	117.6	66.7	404.6	70.5	65.5	51
1981	843.4	735.0	122.8	68.3	408.4	72.0	64.8	48
1982	829.5	720.2	124.0	66.3	406.4	73.4	63.2	49
1983	856.7	740.0	127.8	66.1	419.8	75.8	63.2	49
Annual growth rate:								
1973-80	6.4%	-	8.7%		6.4%	5.7%		
1980-83	2.3%	2.5%	2.8%		1.2%	2.4%		

Source: TANESCO Operations Department

Table 3-3 Energy sold, sales revenues and average rate per unit sold

Year	Whole country			Dar-es-Salaam		
	Energy sold (GWh)	Sales revenues (Million Shs)	Average rate (Cents/kWh)	Energy sold (GWh)	Sales revenues (Million Shs)	Average rate (Cents/kWh)
1973	431.0	112.8	26.13	244.4	58.9	24.10
1974	459.0	141.0	30.72	258.7	94.1	36.37
1975	486.0	154.8	31.82	276.7	118.7	42.90
1976	490.0	197.7	40.34	280.4	123.9	44.19
1977	515.6	248.9	48.23	303.0	131.7	43.47
1978	588.3	274.3	48.14	343.3	149.9	43.66
1979	655.3	301.9	46.09	371.1	160.5	43.25
1980	737.9	480.0	65.05	437.0	269.8	61.74
1981	790.4	509.0	64.47	429.0	258.7	60.30
1982	737.2	523.0	70.94	408.1	272.8	66.85

Source: Values of energy sold and revenues from sales of energy for the whole country were taken from Annual Report 1982, while those for Dar-es-Salaam were provided by Planning Department of TANESCO.

Since a part of energy sold is estimated by meter readers, its values does not correspond to energy sent-out of Ubungo substation.

actual energy consumption in Dar-es-Salaam will be to estimate it by deducting distribution loss from sent-out energy of Ubungo substation.

Electricity consumers are classified into 6 categories of domestic (Tariff 1), commercial (Tariff 2), small industrial (Tariff 3), large industrial (Tariff 4), large commercial (Tariff 5) and public lighting (Tariff 6). Energy sold, energy sales revenues and average rate per unit sold for the whole country and Dar-es-Salaam are reported as follows:

Consumers	Whole country			Dar-es-Salaam		
	Energy sold	Sales revenue	Average rate	Energy sold	Sales revenue	Average rate
	(GWh)	(10^6Shs)	(Cents)	(GWh)	(10^6Shs)	(Cents)
Domestic	178.5	83.8	47	113.6	51.11	45
Commercial	77.8	131.3	169	42.6	65.35	153
Small industrial	32.2	29.9	93	11.1	9.93	89
Large industrial	353.6	217.7	62	203.0	117.56	58
Large commercial	61.8	45.6	74	35.4	26.68	75
Public lighting	4.4	4.0	90	2.4	2.18	90
Sales to Zanzibar	28.7	10.8	38	-	-	-
Total	737.2	523.0	70.9	408.1	272.81	66.8

3.4 POWER DEMAND ANALYSIS FOR DAR-ES-SALAAM

3.4.1 Electricity consumption level by categorical consumer

Number of consumers, energy sold and average energy consumption per consumer for the years after tariff amendment in December 1979 are shown in Table 3-4. According to this table, energy consumption by consumers category and energy consumption level by categorical consumer in Dar-es-Salaam in 1982 were as follows:

Table 3-4 Energy sold by category of consumers and energy consumption per consumer

Category	Whole country			Dar-es-Salaam			
	1980	1981	1982	1980	1981	1982	Proportion (1982)
Number of consumers							
Domestic	92,568	98,577	-	51,324	53,775	56,684	81%
Commercial	24,372	25,807	-	10,032	10,307	10,743	15%
Indusrial	3,226	3,540	-	1,729	1,761	1,793	3%
Public lighting	889	1,085	-	509	556	483	1%
Total	121,113	129,009	-	73,585	66,399	69,703	100%
Energy sold (GWh)							
Domestic	156.8	168.4	178.5	99.8	109.1	113.6	28%
Commercial	155.7	151.9	139.7	96.3	85.4	78.0	19%
Industrial	419.1	425.5	385.8	237.8	231.9	214.1	52%
Public lighting	6.2	6.0	4.5	3.1	2.6	2.4	1%
Sales to Zanzibar	-	38.7	28.7	-	-	-	-
Total	737.8	790.3	737.2	437.0	429.0	408.1	100%
Energy consumption per consumer (kWh/year)							
Domestic	1,694	1,708	-	1,942	2,029	2,004	
Commercial	6,388	5,886	-	9,608	8,286	7,260	
Industrial	128,322	120,198	-	137,536	131,687	119,409	
Public lighting	6,974	5,530	-	6,090	4,676	4,969	
Total	6,092	6,129	-	6,359	6,461	5,855	

Category	Number of consumers	(%)	Energy sold (GWh)	(%)	Consumption per consumer (kWh) (Yearly)	(kWh) (Monthly)
Domestic	56,684	81	113.6	28	2,004	167
Commercial	10,743	15	78.0	19	7,260	605
Industrial	1,793	3	214.1	52	119,409	9,950
Public lighting	483	1	2.4	1	4,969	414
Total	69,703	100	408.1	100	5,855	488

3.4.2 Access to electricity

As described in paragraph 2.2.1 in Chapter 2, the total population of Dar-es-Salaam was estimated to grow from 843 thousand in 1978 to 1,109 thousand in 1982. Since the number of persons per household is about 4.06, the number of households in 1982 is estimated at about 273,150. Therefore, the number of consumers 69,220 excluding public lighting means that even in Dar-es-Salaam, capital of the country, the rate of access to electricity is only around 25%.

$$69,220/273,150 = 0.25$$

3.4.3 Load allocation by substation

The system peak load in Dar-es-Salaam was 73.4 MW in 1982 and 75.8 MW in 1983. The individual peak load by substation in 1983 is shown in Tables 3-5(1) and 3-5(2).

The total load of Ilala substation shown in Table 3-5(1) is the sum of individual monthly peak load of each 11 kV feeder, and does not mean the peak load of this substation as a whole. It is considered that peak load of Ilala substation is restrained to about 13 MW because of its transformer capacity of 15 MVA.

From the above estimation and Table 3-5(2), the individual peak load by substation in Dar-es-Salaam in 1983 will be as follows:

Table 3-5(1) Maximum power demand by substation in Dar-es-Salaam (1983)
(11 kV feeders)

(Amps)

Substation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ilala												
Town 1	220	240	224	250	375	185	320	375	318	360	375	220
Town 2	146	140	140	160	180	110	100	195	185	145	220	190
Azania	70	80	68	87	60	60	55	-	60	65	65	70
Industrial	220	215	230	240	220	175	-	-	75	75	80	100
Breweries	115	120	105	120	115	105	100	98	140	100	110	110
Magomeni	120	120	110	125	135	115	245	325	250	115	235	
Ubungo												
Mabibo	110	125	125	110	110	110	110	110	110	120	120	110
University	125	140	140	140	140	220	225	225	225	225	225	150

Source: Operations Department

Note: Figures in the table are individual maximum power demand of each feeder.
The sum load of these feeders does not represent the peak load of substation.

Table 3-5(2) Maximum power demand by substation in Dar-es-Salaam (1983)
(33 kV feeders)

(MW)

Substation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kurasini	3.8	3.7	3.5	3.8	3.0	7.2	6.8	8.0	8.1	8.0	8.0	8.0
Factory Zone I	12.0	11.8	12.0	12.6	11.6	11.8	9.7	11.2	11.9	11.1	10.6	10.1
Factory Zone II	3.0	3.2	3.6	3.0	3.0	3.0	3.5	3 0	3.0	3.0	3.5	3.0
City Center	14.0	14.8	15.0	15.4	14.0	13.8	11.0	7.8	8.2	12.0	17.5	16.2
Oysterbay	12.0	8.9	8.9	8.9	10.4	10.4	8.9	10.0	10.8	11.2	11.4	12.2
WAZO Hill	8.0	8.8	8.9	7.7	6.4	6.0	3.8	4.9	6.4	6.0	6.0	7.8
Friendship Textile	2.8	2.8	2.8	2.9	3.0	3.0	2.8	3.0	2.7	2.6	3.0	2.5
TAZARA	0.7	0.8	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.9
NORDIC	4.4	4.8	4.9	5.8	5.2	5.2	2.8	4.0	4.2	5.6	5.8	5.8
ALAF	8.0	5.0	5.2	7.8	7.8	9.0	7.0	8.0	6.0	7.0	7.5	7.0

Source: Operations Department

Note: Figures in the table are individual maximum power demand of each substation.

Substation	Peak load (MW)
Ilala	13.0
City Center	17.5
Oysterbay	12.2
Factory Zone I	12.6
Ubungo	2.8
Mbezi	2.1
Kurasini	8.1
Factory Zone II	3.6
ALAF	9.0
NORDIC	5.8
TAZARA	0.9
WAZO Hill	8.9
Friendship Textile	3.0
Aggregated maximum demand	99.5
System peak load	75.8
Diversity factor	1.312

3.4.4 Potential power demand of the waiting consumers

(1) Consumers of the "Capital works orders"

At present, the number of waiting consumers and their applicated contract power of the "Capital works orders" are reported as follows:

	Domestic	Commercial	Industrial	Total
Number of waiting consumers	469	23	25	517
Applicated contract power (kVA)	2,300	7,175	31,015	40,490

According to Operations Department of TANESCO, the maximum power demand of these consumers is estimated at about 70% of their applicated contract power, and power factor is 0.9. Therefore, the maximum power demands of these waiting consumers are estimated as follows:

Category	Maximum power demand (MW)
Domestic	1.5
Commercial	4.5
Industrial	19.5
Total	25.5

(2) Consumers of the "Service lines works orders"

Consumers of the "Service lines works orders" are domestic and commercial consumers only. According to the above Department, about 10,000 consumers are awaiting connection.

Table 3-4 shows that in 1982 the proportion of number of consumers was 84% for domestic and 16% for commercial, and the energy consumption per consumer was 2,004 kWh/year for domestic and 7,260 kWh/year for commercial. The load factor is considered to be around 40% for domestic and 60% for commercial consumers.

Therefore, when adopting the energy consumption level of the existing consumers, the power demand of these waiting consumers will be as follows:

Domestic	(10,000 x 0.84 x 2,004)/(8,760 x 0.4)	= 4.8 MW
Commerical	(10,000 x 0.16 x 7,260)/(8,760 x 0.6)	= 2.2 MW
	Total	7.0 MW

However, in general the consumption level of the waiting consumers is fairly lower, namely about 60% of that of the existing consumers. This leads to estimate the power demand of these waiting consumers to be about 4 MW.

From the above, in accordance with progress of the distribution network rehabilitation programme, a total potential power demand of 29.5 MW will have to be included in the demand and supply planning.

Fig. 3-1 (1) ORGANIZATION CHART

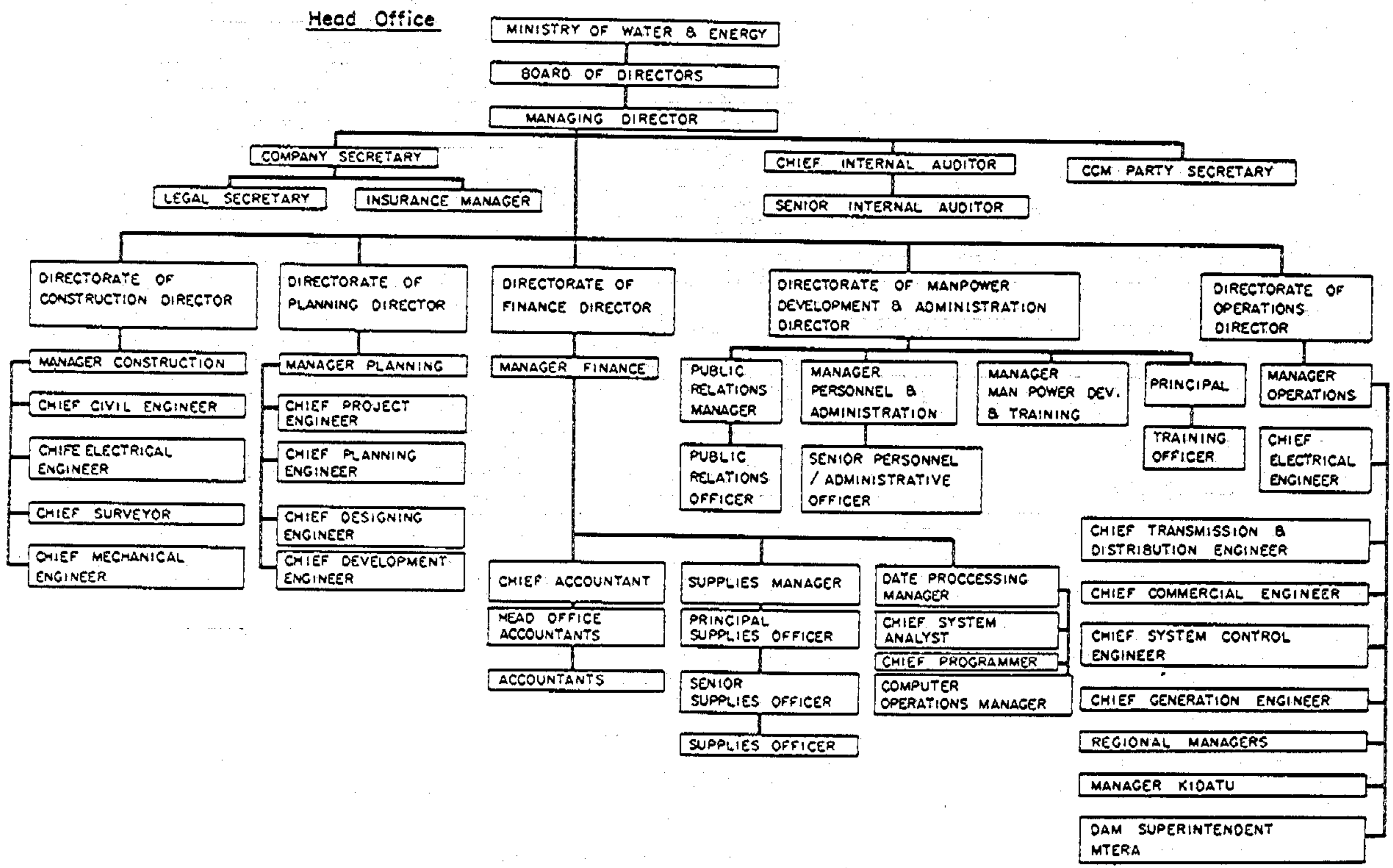
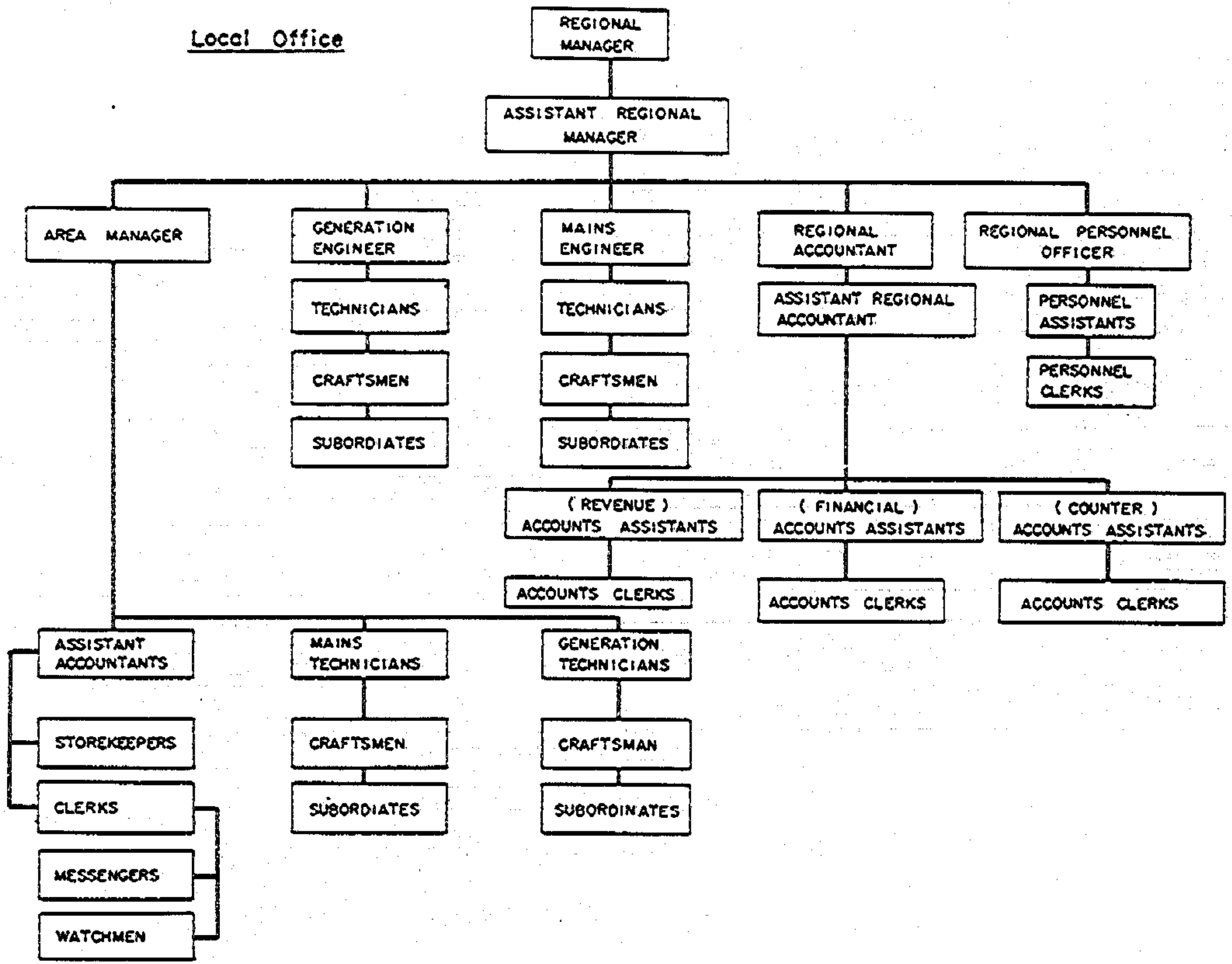


Fig. 3-1(2) ORGANIZATION CHART



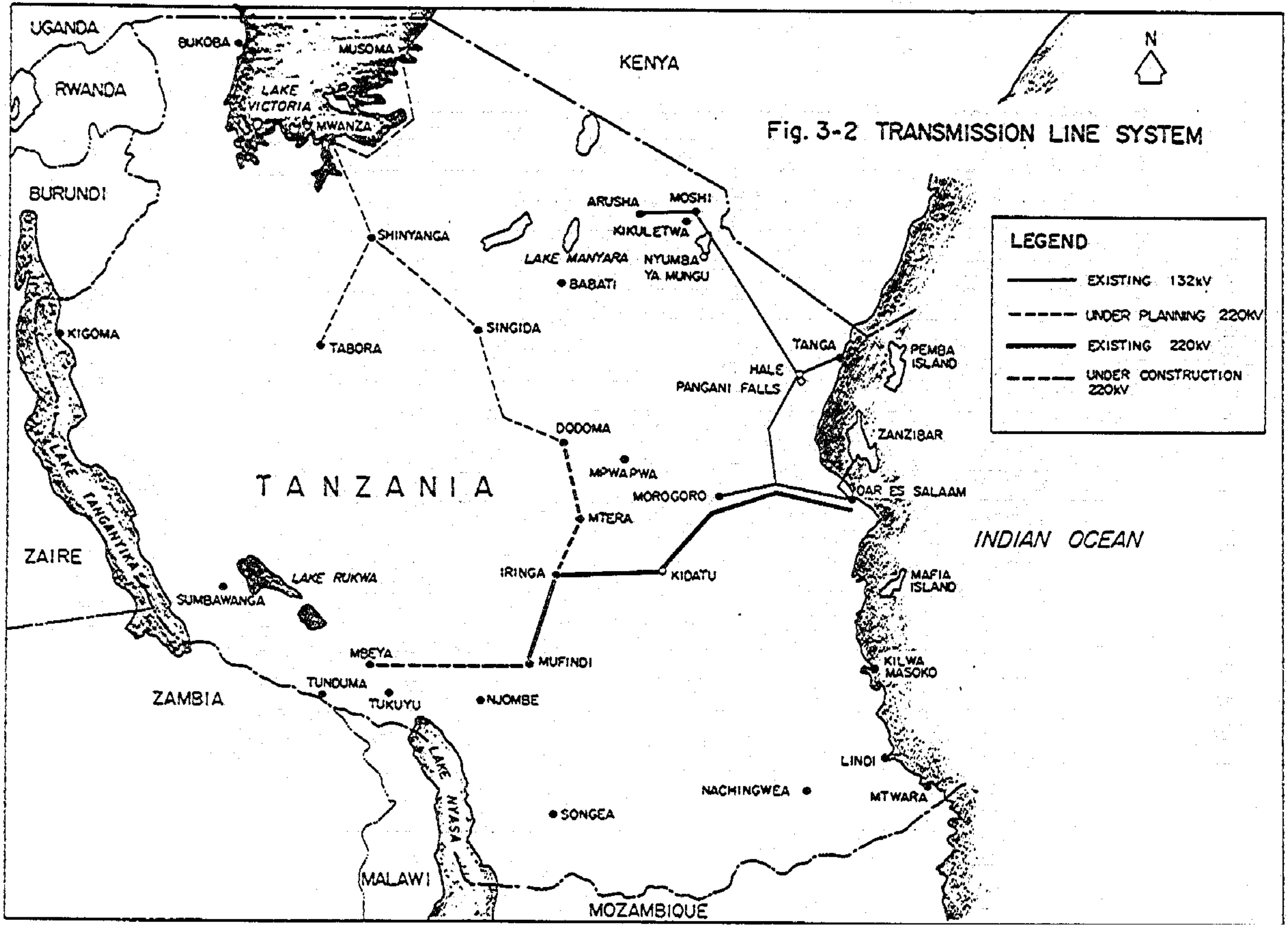
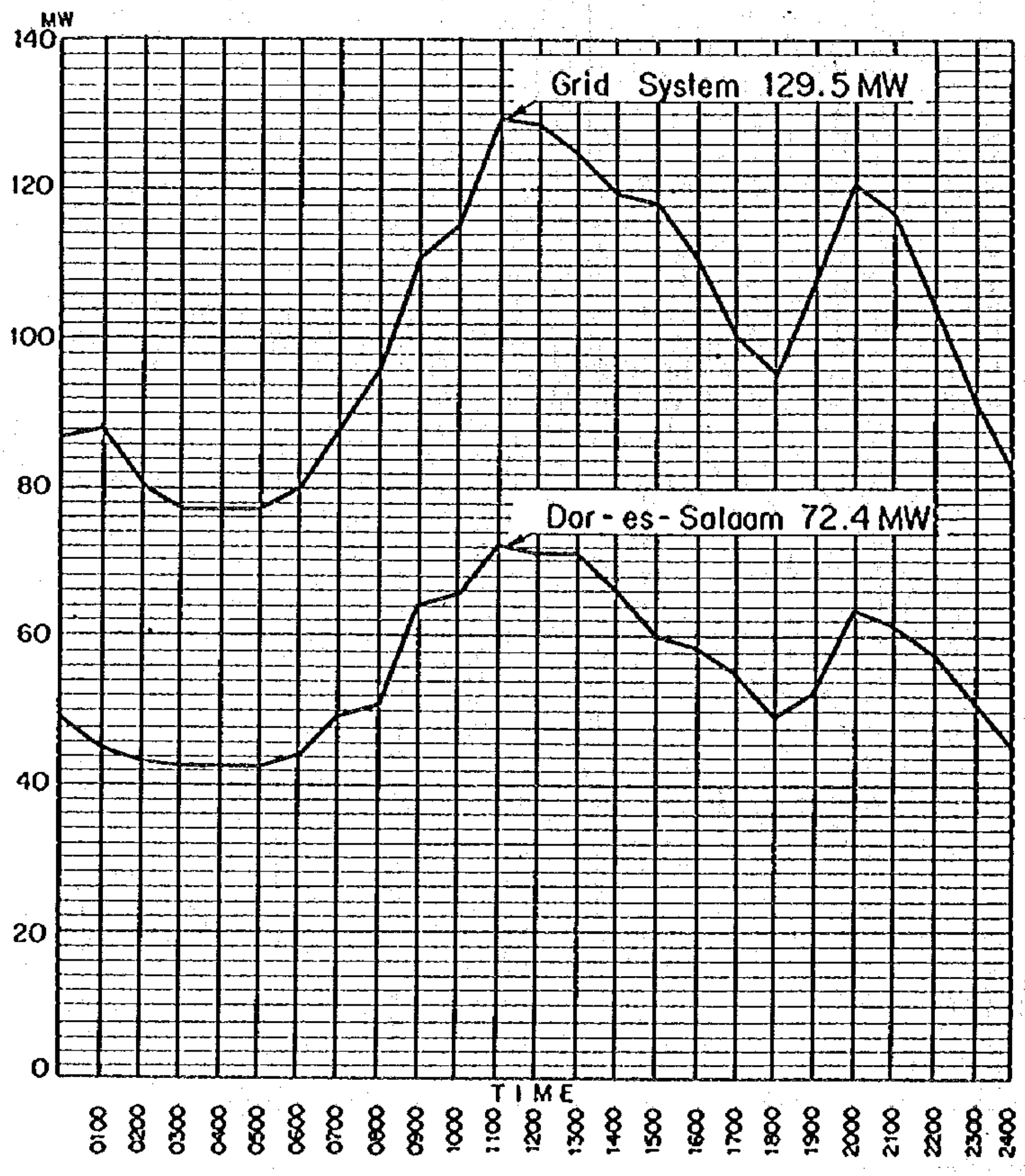


Fig. 3-2 TRANSMISSION LINE SYSTEM

Fig. 3-3 TYPICAL DAILY LOAD CURVES

27 March, 1984 (Tuesday)



CHAPTER 4

PRESENT SITUATION OF DAR ES SALAAM DISTRIBUTION FACILITIES

CHAPTER 4 PRESENT SITUATION OF DAR ES SALAAM DISTRIBUTION FACILITIES

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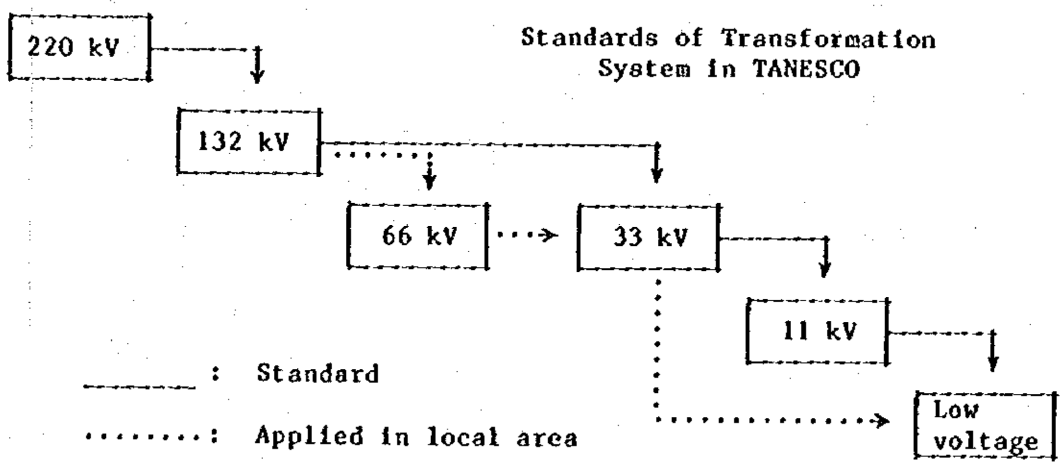
CHAPTER 4 PRESENT SITUATION OF DAR ES SALAAM DISTRIBUTION FACILITIES

4.1 CONFIGURATION OF DAR ES SALAAM DISTRIBUTION NETWORK

The power system consists of the Coastal Grid System which includes the Kidatu Hydroelectric P.S. (100 MW in 1970, 100 MW in 1980, total of 200 MW) as a main station and six other power stations and other isolated systems which do not belong to the Coastal Grid System. The power supply to the city of Dar es Salaam is generated in the Kidatu P.S. and transmitted to the Ubungo primary substation (300 MVA), which is located about 300 km apart, through a 220 kV transmission line via the Morogoro S.S. (90 MVA). One 132 kV line is also provided to connect the Morogoro S.S., the Chalinze S.S. (10 MVA) and the Ubungo S.S. each other.

The Ubungo S.S. and the Ilala Secondary S.S. (20 MVA) are connected by one 132 kV line and two 33 kV lines. The both substations transmit the power to the distribution substations (Oysterbay, City Center, Factory Zone I, New Airport, Factory Zone II, Kurasini, Mbezi) and big consumers (WAZO Hill, Friendship Textile, ALAF, TAZARA) in the city through a 33 kV line. The power is distributed from the individual distribution substations via 11 kV feeders and then stepped down by distribution transformers to 400V/230V before being supplied to general consumers. The voltage transformation steps are outlined below.



The power supply from the Kidatu Hydroelectric P.S. sufficiently covers the demand of the Dar es Salaam area, and the Ubungo P.S. (diesel engine generator, capability of about 14.0 MW), the operation of which was started ten and several years ago, is usually in a stand-by service after the completion of the Kidatu P.S. It is scheduled to be operated only in such cases when the power supply from the Kidatu P.S. is interrupted for a long time. The system frequency is comparatively stabilized by an AFC operation equipped in the Kidatu P.S. The existing distribution network in the Dar es Salaam area is shown in Fig. 4-1-1, and the distribution substation capacities are given in Table 4-1-1.

Table 4-1-1 33 kV/11 kV transformer capacities of distribution substations

Substations and Consumers	Transformer Capacity x Unit	Total Capacity
(Substations receiving from the Ubungo S.S.)		
Ubungo (Feeders)	15 MVA x 3	45 MVA
Oysterbay	5 x 3	15
Factory zone II	5 x 1	5
Mbezi	5 x 1	5
Kurasini	15 x 1	15
Sub-total	-	85
(Substations receiving from the Ilala S.S.)		
Ilala (Feeders)	7.5 x 2	15
City Centre	15 x 2	30
Factory zone I	5 x 3	15
New airport	5 x 1	5
Sub-total	-	65
(Big consumers receiving from the Ubungo S.S.)		
ALAF	15 x 2	30
WAZO hill	5 x 3	15
Friendship Textile	5 x 1	5
TAZARA	5 x 2	10
Sub-total	-	60
Total	-	210

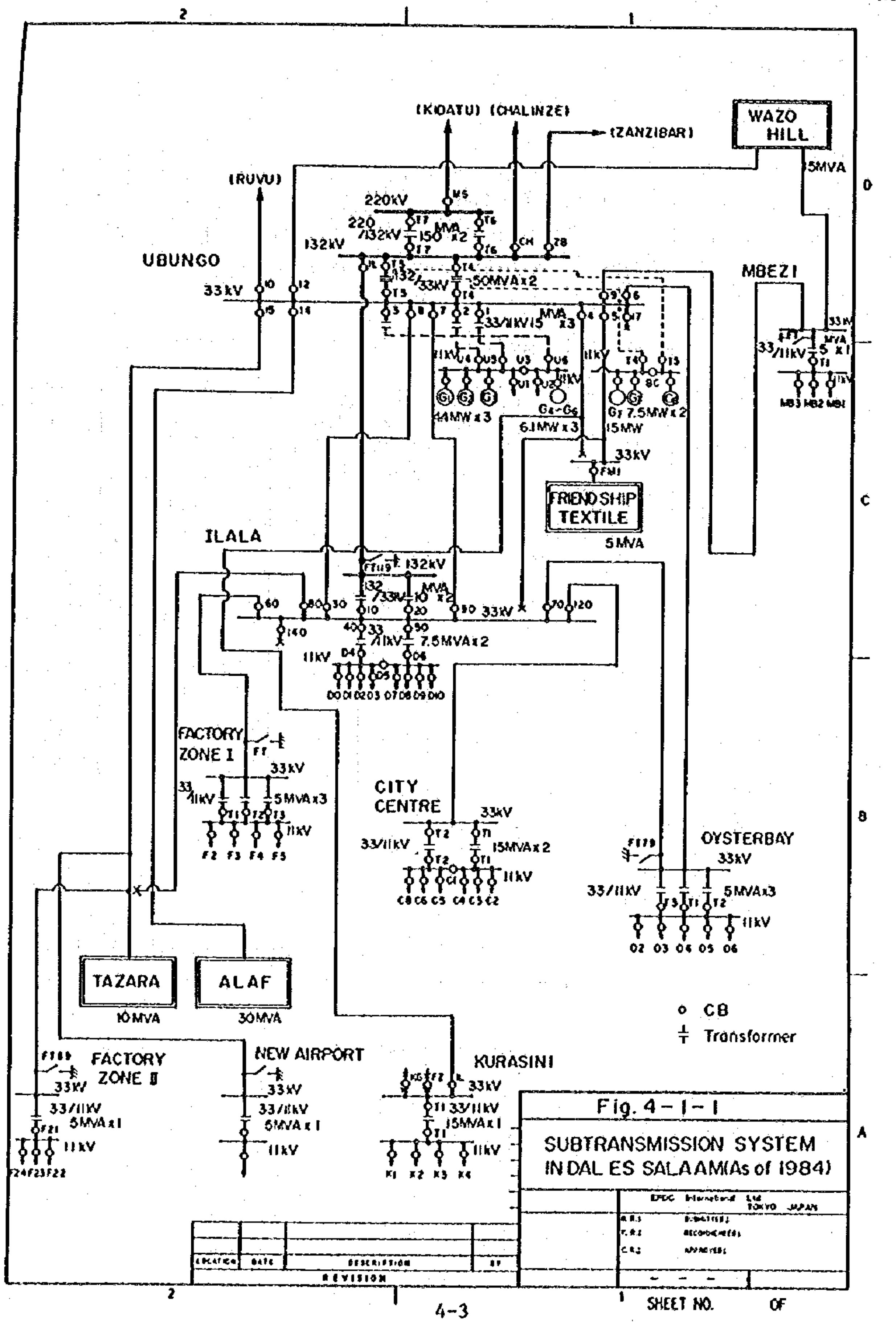


Fig. 4-1-1
SUBTRANSMISSION SYSTEM IN DAL ES SALAAM(As of 1984)

4.2 SUBSTATIONS

(1) Scale of substation

(i) Type of installation

Of the substations in Dar es Salaam area, equipment of 33 kV or above are installed outdoors, and the cubicles contain 11 kV breakers are of "semi-outdoor" type installed indoors. An outline of the substation equipment is given in Table 4-2-1.

Table 4-2-1 Outline of distribution substations

Substation (Capacity of Transf.)	Type	33 kV receiving line	11 kV Feeders		Site area	Service area
			Operating	Out of service		
Ilala (7.5MVAx2)	Semi-outdoor	3*	5	3	7,670 m^2 (85.3mx89.9m)	City Center
Oysterbay (5MVAx3)	"	2	5	0	690 m^2 (22.5mx30.5m)	City Center Suburbs
City Centre (15MVAx2)	"	1	4	2	890 m^2 (31.4mx28.4m)	City Center
Factory Zone (5MVAx3)	"	1	4	0	1,680 m^2 (45.7mx36.7m)	Suburbs Factories

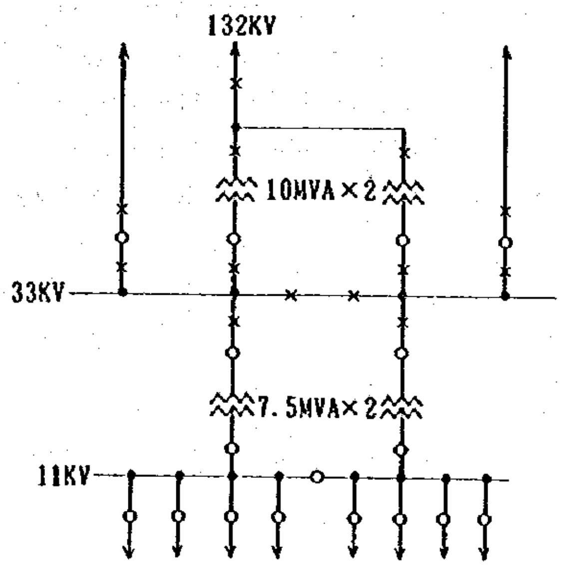
* One 132 kV line is included.

(ii) Bus and connection systems

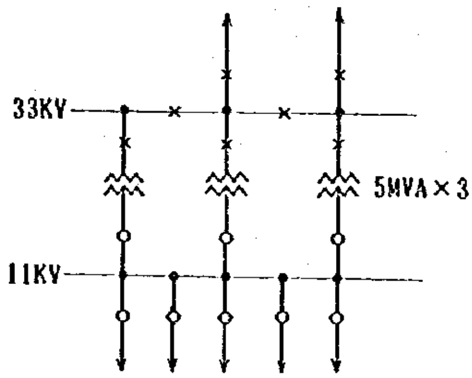
The outdoor bus structure of each substation is of an aerial tension bus. The connection of main circuits is shown in Fig. 4-2-1.

Fig. 4-2-1 Connecting system of distribution substation

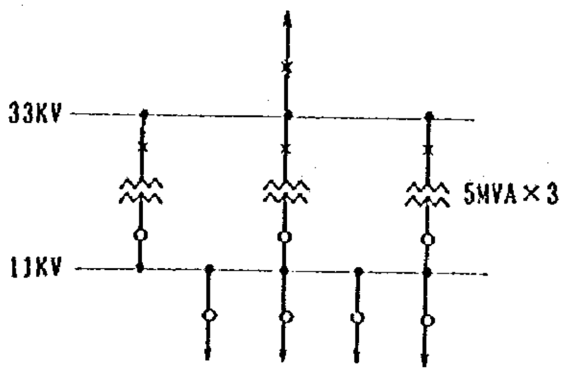
Ilala Substation	Section bus, both 33 kV and 11 kV



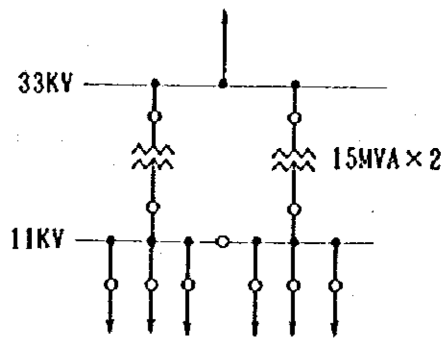
Oysterbay Substation	Section bus 33 kV	Single bus 11 kV



Factory Zone I Substation	Single Bus, both 33 kV and 11 kV



City Centre Substation	Single bus 33 kV	Section bus 11 kV



Note:

 : Transformer

 : Circuit breaker

 : Disconnecting switch

Regarding the 11 kV buses used, the Ilala and the City Center Substations use the section buses, while Oysterbay and Factory Zone I Substations use the single buses. Where the section bus is used, the interruption capacity in case of transformer and/or 11 kV bus troubles can be reduced to 50%. In addition, the recovery work in cases of trouble are facilitated, and the short-circuit capacity of the 11 kV circuit is reduced to 50%. The section bus is thus suited for comparatively large capacity substations and has the practical considerations. The Dar es Salaam distribution network including four substations stated above and the Ubungo primary substation is shown in Fig. 4-2-2.

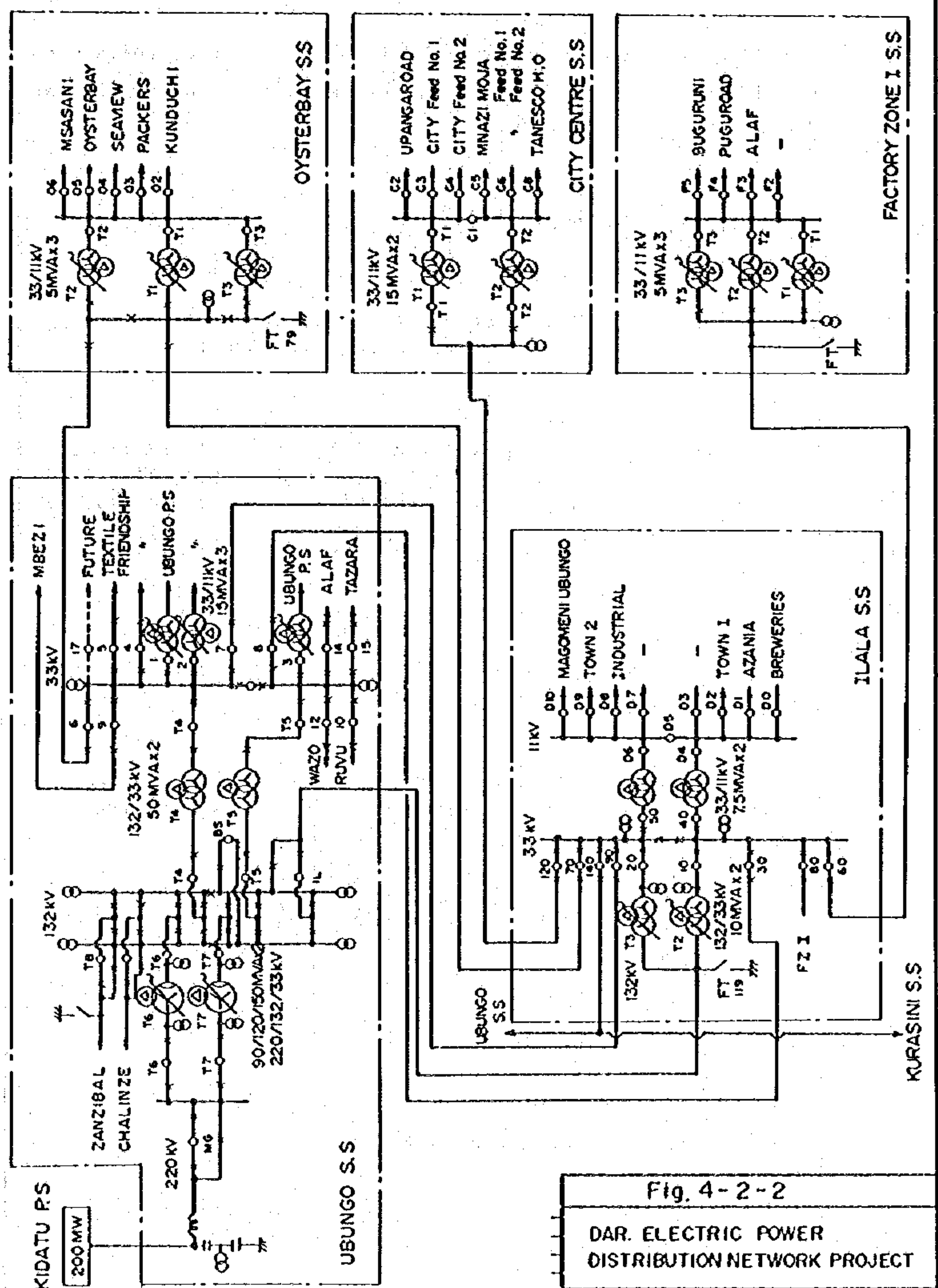


Fig. 4-2-2

DAR. ELECTRIC POWER DISTRIBUTION NETWORK PROJECT

LOCATION	DATE	DESCRIPTION	BY
REVISION			

EPDC International Ltd TOKYO JAPAN

SHEET NO. OF

(2) Capacity of substation

(i) Transformer

The standard capacities of 33 kV/11 kV transformer units used in the distribution substations and big consumers in the city are 15 MVA and 5 MVA as follows:

Capacity of transf.	Number of transf.	Substations and big consumers ( ): numbers of transf.
15 MVA	8	Ubungo (3), Kurasini (1) City Centre (2), ALAF (2)
7.5 MVA	2	Ilala (2)
5 MVA	15	Oysterbay (3), FZ I (3), FZ II (1) Mbezi (1), Wazo Hill (3), TAZARA (2) Friendship (1), New Airport (1)

(ii) Bus

The specifications of the 33 kV/11 kV buses used in the distribution substations are as follows:

Voltage	Bus specifications	Substation
33 kV	185 mm^2 HDCC 620A equivalent to 35 MVA	Ilala Oysterbay City Centre Kurasini
	70 mm^2 HDCC 330A equivalent to 19 MVA	FZ I, FZ II Mbezi
11 kV	600 mm^2 CuBB 1200A equivalent to 23 MVA	Ilala
	280 mm^2 CuBB 800A equivalent to 15 MVA	Substations other than the Ilala

Note: HDCC ... Hard-drawn copper conductor
CuBB ... Copper bus bar

(iii) Shunt reactors

Among the substations in the city, only the Ubungo S.S. is provided with the shunt reactors. The shunt reactors connected to the tertiary circuit of the transformers are manually controlled, and those for the Zanzibar line are directly connected to the line. The operating method of the shunt reactor is as follows:

Connected circuit	Capacity	Method of Operation
Ubungo S.S. Tertiary circuit of 220 kV/132 kV/ 33 kV transf.	10 MVA x 3 units	While the 220 kV line from the Kidatu is operated, 0 to 3 units are on-off controlled according to the work day and holiday time zone.
Ubungo S.S. 132 kV Zanzibal line	20 MVA x 1 unit	The unit is turned on while the 132 kV line to Zanzibaru is operated.

(iv) Circuit breakers

The ratings of the circuit breakers used in the substations are as follows:

Nominal Voltage	Type, interception capacity	Substation
132 kV	OCB 3,500 MVA	Ubungo
33 kV	OCB 1,000 MVA	Ubungo Ilala (for Kurasini line) Oysterbay, City Centre Kurasini
	OCB 500 MVA	Ilala (excepting Kurasini line)
11 kV	OCB 500 MVA	Ubungo
	OCB 350 MVA	Ilala (33/11 kV transformer secondary side)
	OCB 250 MVA	Ilala (for each feeder) Oysterbay, City Centre FZ I, FZ II Kurasini

(3) Operation of the substation equipment

(i) Voltage setting

The Ubungo and the Ilala Substations are operated to keep up the system voltage as the following value.

132 kV: 132 kV ± 5%

33 kV: Peak load time --- 34 kV ± 5%
Off peak load time --- 33.5 kV ± 5%

11 kV: Substation bus --- 11.4 - 11.6 kV
Receiving terminal of the feeder --- 10.5 - 11.0 kV

(ii) On-load tap changer (LTC)

The status of operation of the LTC attached to each transformer is as follows:

Substation	Transformer	LTC Specification	Method of Operation
Ubungo	220 kV/132 kV	+10 - -10%	Automatic
Ubungo Ilala	132 kV/33 kV	+5/+3.75/+2.5/+1.25/0/-1.25/ -2.5/-3.75/-5/-6.25/-7.5/ -8.75/-10/-11.25/-12.5/ -13.75/-15% (17 Taps)	Manual
Ubungo Ilala Oysterbay City Centre FZ I	33 kV/11 kV	+10/+8.75/+7.5/+6.25/+5/ +3.75/+2.5/+1.25/0/-1.25/ -2.51/-3.75/-5/-6.25/-7.5/ -8.75/-10% (17 Taps)	Manual
Kurasini	Same as above	Same as above	Automatic

(iii) Power factor

The calculated power factor of the Ilala S.S. bus obtained from a meter installed on the distribution board is around 0.85. Substantially the same values are obtained for the other substations.

(4) Insulation design

The nominal voltage and number of suspension insulators used in the individual substations in the city are as follows. The diameter of suspension insulator is of 10 inches (250 mm).

Nominal Voltage (kV)	Number of Suspension Insulators (pcs.)
220	13
132	9
33	3
11	2

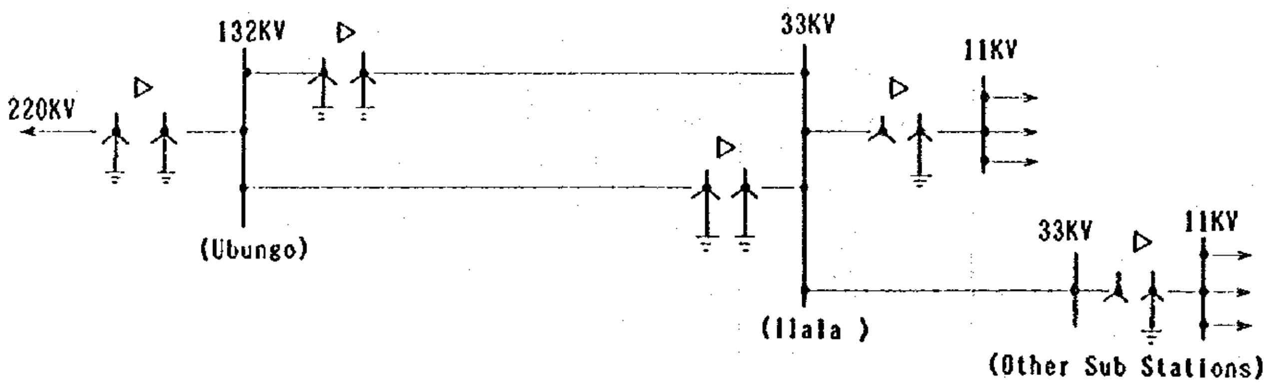
From the standpoint of the salt-resisting design, the above values correspond to lightly contaminated areas subject to equivalent salt adhesion (0.03 - 0.045 mg/cm^2). These numbers of insulators are the same as those of the transmission lines. The individual substations in the city used the same number of insulators regardless of the distance from the coast.

The distance from each substation to the coast is as follows:

Substation	Distance to the Coast (km)
Ubungo	9.0
Ilala	1.8
Oysterbay	2.0
City Centre	0.8
Factory Zone I	4.4

(5) Neutral grounding system

Directly grounded system is applied in the transformer circuits of the Dar es Salaam network, and the neutrals of transformers of all the 220 kV, 132 kV, 33 kV and 11 kV circuits are grounded directly as shown in the Figure below. Therefore, in the case of a ground-fault, a sufficiently large zero phase current flows at the neutral point. The protective relays thus can be reliably and selectively opened at a high speed. With the 33 kV/11 kV transformer, however, only the 11 kV side is grounded.



(6) Protective relay system

The protective relay system applied in the Dar es Salaam distribution network is as follows. The protective relays are all of the electromagnetic type.

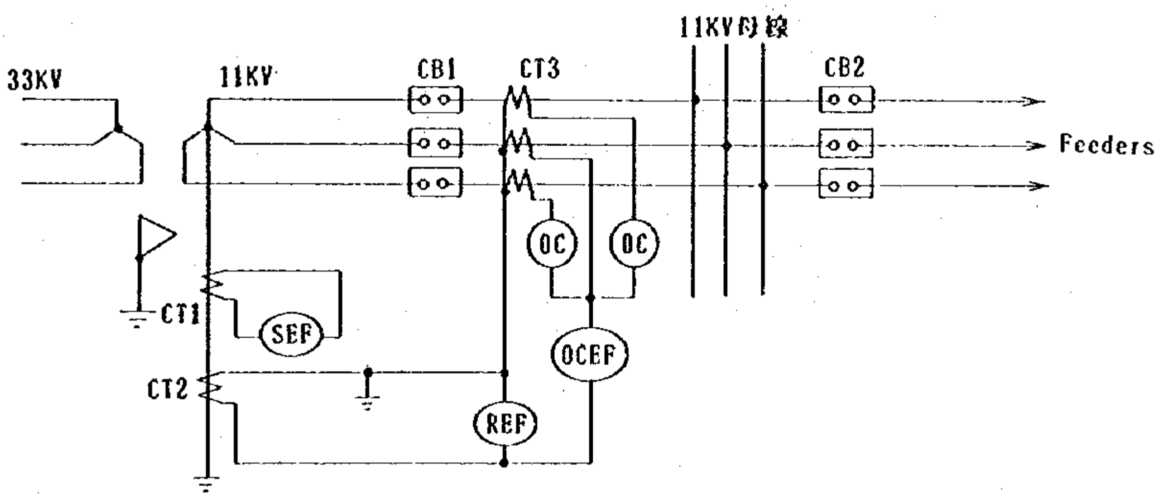
(i) Protection system of each transmission line

Protection / Fault / Line voltage	Main Protection		Back-up Protection	
	Short Circuit	Ground Fault	Short Circuit	Ground Fault
132 kV transmission line	DZ	DEF	OCR	OCEF
33 kV "	OC x 3ϕ	OCEF	——	——
11 kV "	OC x 2ϕ	OCEF	——	——

DZ : Distance relay for short-circuit
DEF : Power directional relay for ground-fault
OCR/OC: Overcurrent relay
OCEF : Overcurrent relay for ground-fault

The primary side (33 kV) buses of the distribution substations are covered within the protective range of transmission lines, and no protective relay exclusive for bus is provided.

(ii) 33 kV/11 kV, 5 MVA transformer protective system



- OC (Over Current) : 11 kV bus overcurrent
- OCEF (O.C. Earth Fault): 11 kV bus earth overcurrent
- SEF (Stand by E.F.) : 11 kV circuit earth overcurrent
- REF (Restricted E.F.) : Transformer low voltage winding ground fault detection

The purposes of installation of relay are as follows:

(a) OC is main protection to trip CB1.

(b) OCEF is main protection to trip CB1 and CB2.

(c) SEF is back-up protection for OCEF, which is to trip CB1 and CB2 in combination with timer relay.

(d) REF is operated by differential current between CT2 and CT3 and trip CB1 and CB2.

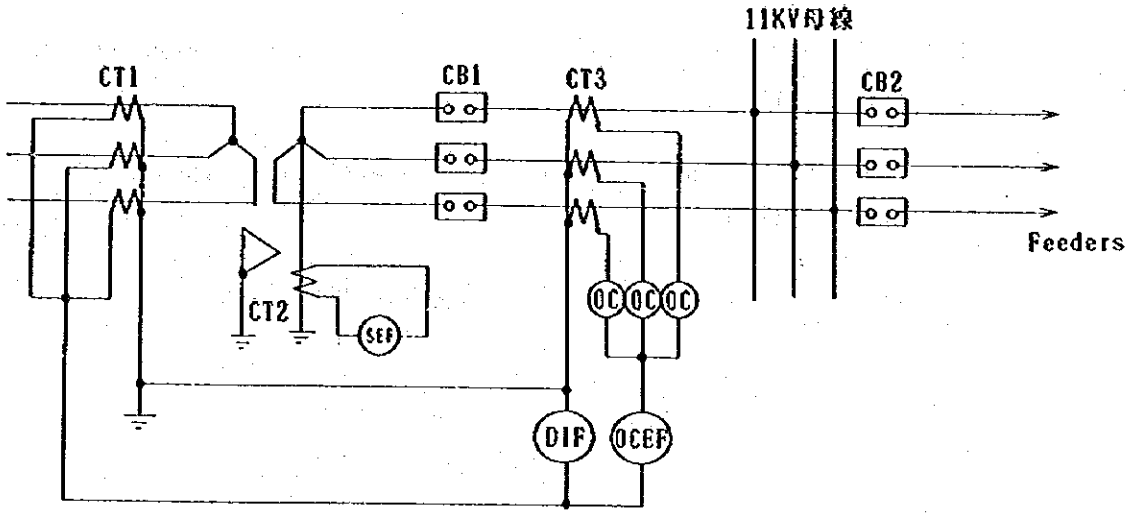
Other mechanical protective relays for transformer are as follows:

- Winding temperature rise, (primary) fan start, (secondary) alarm, (tertiary) trip,

- Oil temperature rise, (primary) fan start, (secondary) alarm, (tertiary) trip

- Buchholtz's relay, (gas) alarm, (surge) trip

(iii) 33 kV/11 kV, above 7.5 MVA transformer (132 kV/33 kV)



- OC (Over Current) : 11 kV bus overcurrent
- OCEF (O.C. Earth Fault) : 11 kV bus earth overcurrent
- SEF (Stand by E.F.) : 11 kV circuit earth overcurrent
- DIF (Differential E.F.): Transformer winding fault detection

The purposes of installation of the relays are as follows:

(a) OC is main protection to trip CB1.

(b) OCEF is main protection to trip CB1 and CB2.

(c) SEF is back-up protection for OCEF, which is to trip CB1 and CB2 in combination with timer relay. (In the City Centre S.S., only CB1 is tripped.)

(d) DIF is operated by differential current between CT1 and CT3 and trips CB1 and CB2.

Other mechanical protective relays of the transformer are as follows:

- Winding temperature rise, (primary) fan start, (secondary) alarm, (tertiary) trip

- Oil temperature rise, (primary) fan start, (secondary) alarm, (tertiary) trip

Settings of these relays for 15 MVA transformer of the City Centre are as follows:

- Winding temperature rise: (secondary) 85°C, (tertiary) 90°C

- Oil temperature rise : (secondary) 90°, (tertiary) 95°C

- Buchholtz's relay : (gas) alarm, (surge) trip

(iv) Reclosing system

A reclosure circuit is provided, which is capable of reclosure only once in the event of a ground-fault in the 11 kV feeder. The reclosure time is about 6 to 10 sec.

(v) Other

A minimum necessary protective relay system is provided, which is periodically inspected. The relay boards which are now out of use and those of old electromagnetic type were recognized.

4.3 33 KV SUB-TRANSMISSION LINES

Power supplied from Coastal Grid is relayed through the Ubungo Primary Substation to the Ilala Substation via one 132-kV line and two 33-kV lines. Power from the Ubungo and the Ilala Substations is also supplied to 12 distribution substations including large volume consumers in Dar-es-Salaam as well as in its suburbs via 33-kV sub-transmission lines.

More than 90% of supports for these 33-kV sub-transmission lines are wooden poles and the remaining supports are steel pipe poles. Conductor arrangement includes one-circuit horizontal array type, wish born type, and a vertical array two-circuits type combined with 11-kV line. Conductors used are of three different sizes, i.e., ACSR 50 mm^2, 100 mm^2 and 150 mm^2. Insulators used for tangent poles are pin insulators or line post insulators, and for angle poles and deadend poles, 250 mm^2 suspension insulators (of glass- or porcelain-made) are used.

As a whole, the 33-kV sub-transmission lines are operated with a considerable margin. As far as the external appearance of the said facilities was observed, it was not seemed essential that those facilities require urgent repair or maintenance service.

The outline of the 33-kV sub-transmission line facilites which constitute the Dar-es-Salaam distribution network is shown in Table 4-3-1, and the sub-transmission system diagram is shown in Fig. 4-3-1.

Table. 4 − 3 − 1 33KV Subtransmission Line

As of 1984

	Section	Length (km)	Circuit	Conductor Kind	Conductor Size	Support	Completion Year	Remark
1	Ubungo～Ilala (Interconnection I)	7.5	1	ACSR	150	Wooden Pole	1970	
2	〃 ～ 〃 (〃 II)	7.5	1	〃	〃	〃	〃	
3	〃 ～ 〃 (Textile I)	7.3	1	〃	50	〃	1965	
4	〃 ～ 〃 ～Kurasini	14.3	1	〃	50/150/100	Wooden Pole/Steel	1966/1963	At Pugu road crossing between Ilala and Old P/S. Cu 90 sq mm×2 are employed.
	(via Ilala. Old P/S)	(7.2＋ 1.2＋ 1.9)				Pole/Wooden Pole	/1982	
5	Ubungo～Oysterbay	8.3	1	ACSR	100	Wooden Pole	1976	
6	〃 ～Wazo Hill (No.1)	19.3	1	〃	〃	〃	1966	
	(via Mbezi)	(8.8＋10.5)						
7	〃 ～Wazo Hill (No.2)	18.2	1	ACSR	100	Wooden Pole	1972	
8	〃 ～ALAF	9.0	1	〃	〃	〃	1975	
9	〃 ～TAZARA	7.8	1	〃	〃	〃	1973	
10	〃 ～Ruvu (Nordic Line)	60	1	〃	〃	〃	1965	
11	Ilala ～Oysterbay	5.0	1	〃	50	〃	1964	
12	〃 ～City Centre	2.8	1	〃	100	〃	1969	
13	〃 ～Factory Zone I	5.0	1	〃	〃	〃	1965	
14	〃 ～Factory Zone II	13.9	1	〃	50	〃	1967	
15	TAZARA～New Airport	4.8	1	〃	100	〃	1984	

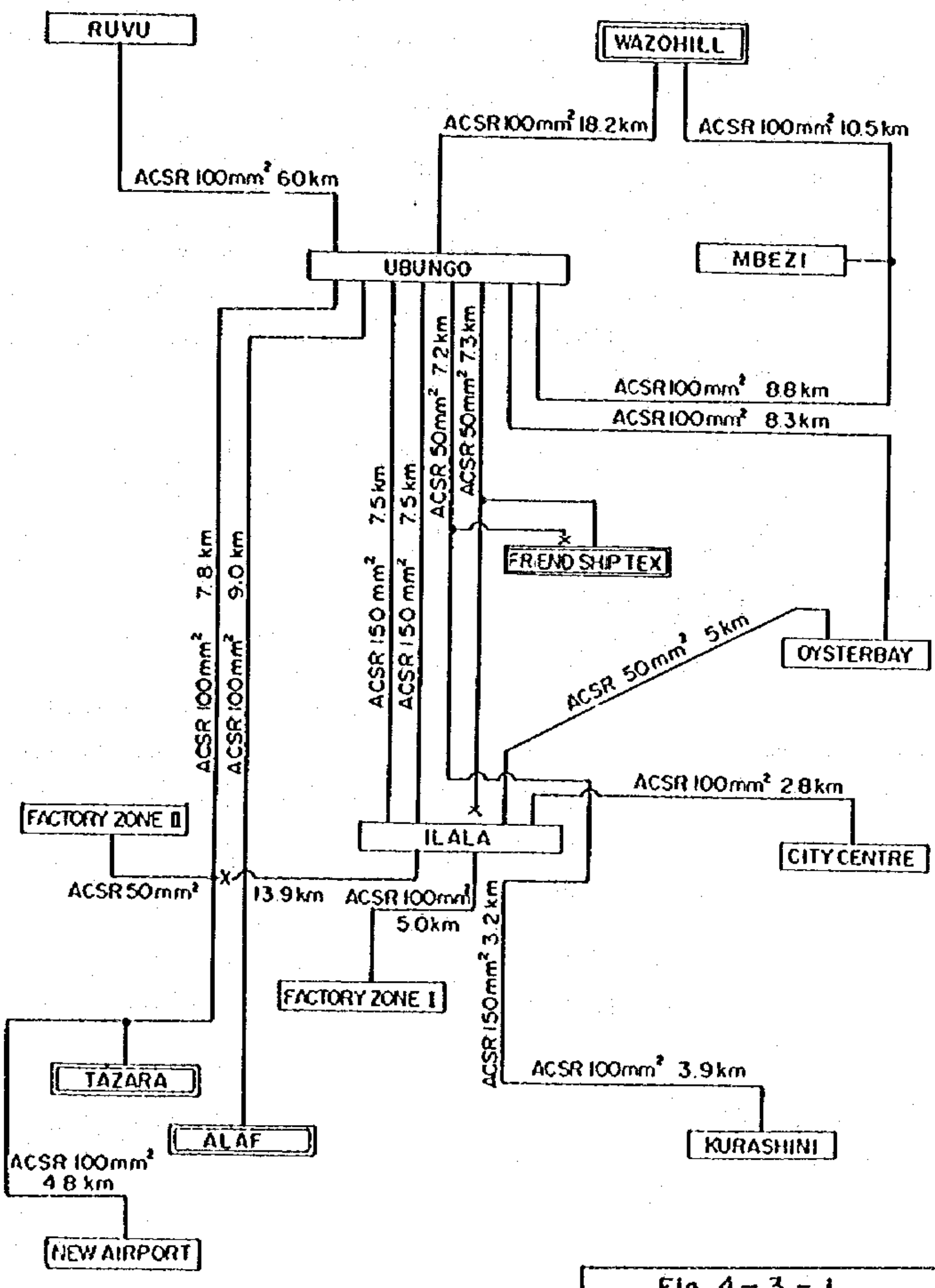


Fig. 4-3-1

33kV SUB-TRANSMISSION LINE SYSTEM (As of 1984)

4.4 11 KV DISTRIBUTION LINES

The present situation of the distribution facilities in Dar-es-Salaam is considerably deteriorated; most of the facilities are superannuated; electric wires are old and there are many strand breakages and imperfect connections.

4.4.1 Distribution system and voltage

The distribution system adopted in the substations in Oyster Bay, City Center, Ilala and Factory Zone I, where are the main target areas of this survey, is a 3-phase 3-wire 11,000 V system, and a direct grounding system for the neutral point is being carried out.

For the other 11 kV distribution lines in the city of Dar-es-Salaam, the same system is adopted.

4.4.2 Make-up of the distribution lines

Some of the feeders coming out of a substation are connected to the other feeders via normally open section switches; yet, for many of the feeders the tree branch system is adopted; but generally the loop point normally open tree branch distribution system is adopted. (See Figs. 4-4-1 - 4-4-3.)

4.4.3 Number of feeders from each substation

The relationship between substation capacity and the number of feeders is shown in Table 4-4-1 and single line connection diagrams in Figs. 4-4-4 - 4-4-7.

In Table 4-4-1, C5 and C6 feeders from the City Centre S.S. are being suspended and the CBs of D3 and D8 feeders in Ilala S.S. are opened because of repairing work.

Table 4-4-1 Capacity of substations and number of feeders

Substation	Capacity (A)	Number of Feeders (B)	(A)/(B)
Oysterbay	15,000 kVA	5 cct	3,000 kVA
City Centre	30,000 "	6 "	5,000 "
Ilala	15,000 "	7 "	2,140 "
Factory Zone I	15,000 "	4 "	3,750 "
Total	75,000 "	22 "	3,400 "

4.4.4 Length of distribution lines and the capacity of the substation equipment

The relation between the approximate length of distribution line, the average line length per feeder and the capacity of the substation equipment is shown in Table 4-4-2.

The average line length per feeder is short (3 - 7 km) except for Oysterbay S.S., and this reflects the characteristics of the city type feeder.

The distribution line overwhelmingly consists of overhead lines and its length is about 100 km for 4 substations. The underground line is used relatively in large volume in the areas such as outgoing line of the substations, the overcrowded area in the City Centre or Factory Zone I area, and it totals about 13 km.

Table 4-4-2 Line length of capacity of substations

Substation and Capacity	Feeder	Line Length (km)			(C)/(B)	(A)/(C)
		Over-head	Under-ground	Total	(km)	(kVA/km)
Oysterbay	02	9.5	1.8	11.3(C)		
	03	8.7	0.1	8.8		
15,000 kVA	04	7.5	0.1	7.6		
(A)	05	2.9	0.5	3.4		
	06	19.4	0.6	20		
Total	5(B)	48	3.1	51.1(C)	10.2	294
City Centre	C2	7	0.6	7.6		
	C3	1.8	0.6	2.4		
30,000 kVA	C4	1.3	0.6	1.9		
(A)	C5		0.9	0.9		
	C6		1.5	1.5		
	C8	1.3	1	2.3		
Total	6(B)	11.4	5.2	16.6(C)	2.8	1,807
Ilala	D0		0.3	0.3		
	D1	2	0.5	2.5		
15,000 kVA	D2	3.8	0.5	4.3		
(A)	D3					
	D8	6.5	0.5	7		
	D9	1.9	0.1	2		
	D10	7.5	0.1	7.6		
Total	6(B)	21.7	2	23.7(C)	4.0	633
Factory Zone I	F2	6.5	0.1	6.6		
	F3	3	2.8	5.8		
15,000 kVA	F4	9	0.3	9.3		
(A)	F5	4.8	0.1	4.9		
Total	4(B)	23.3	3.3	26.6(C)	6.7	564
Total 75,000 kVA (A)	21	104.4	13.6	118(C)	5.6	636

Note: (C)/(B) shows average line length per feeder (km).

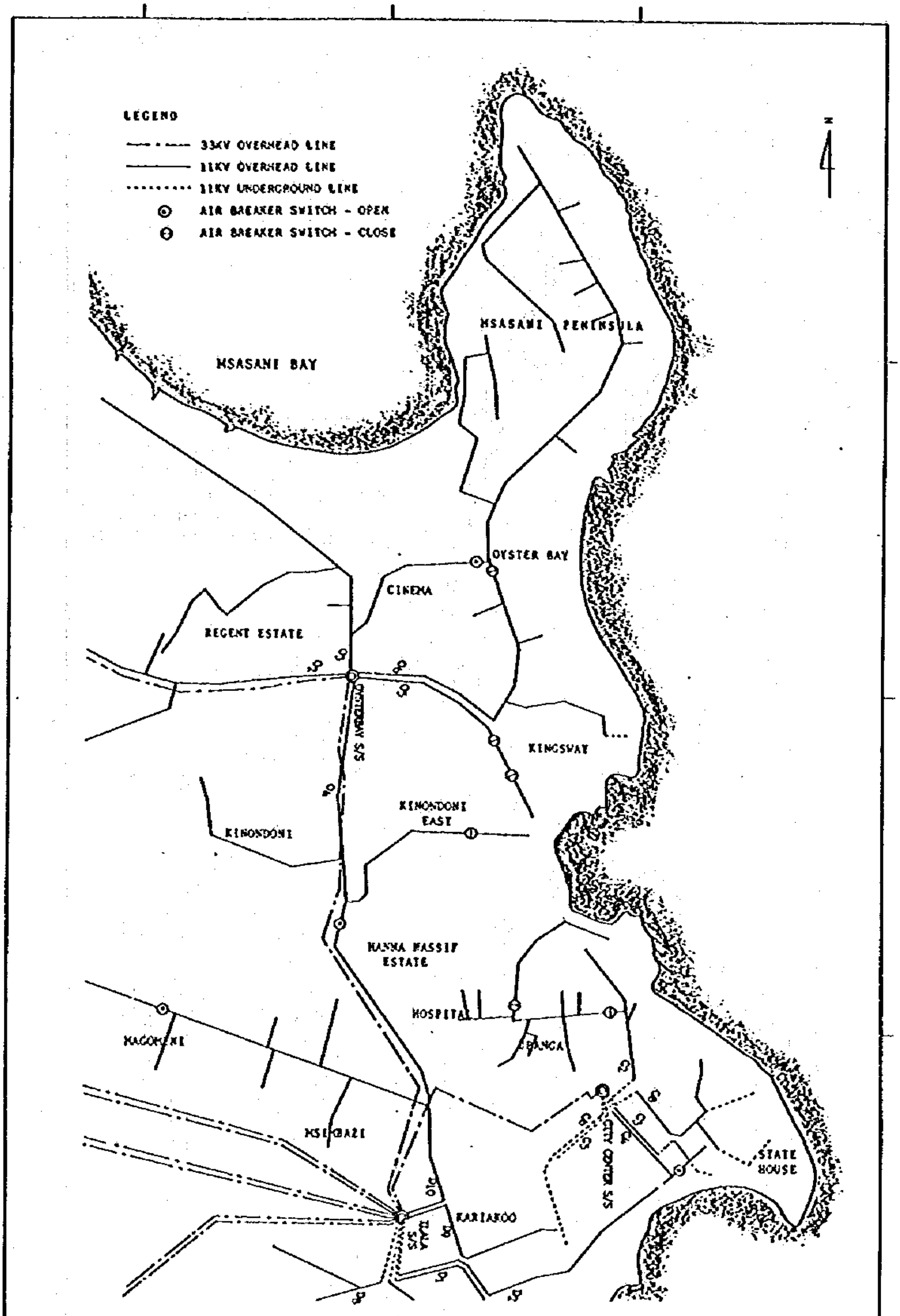


Fig. 4-4-1 EXISTING DISTRIBUTION LINES

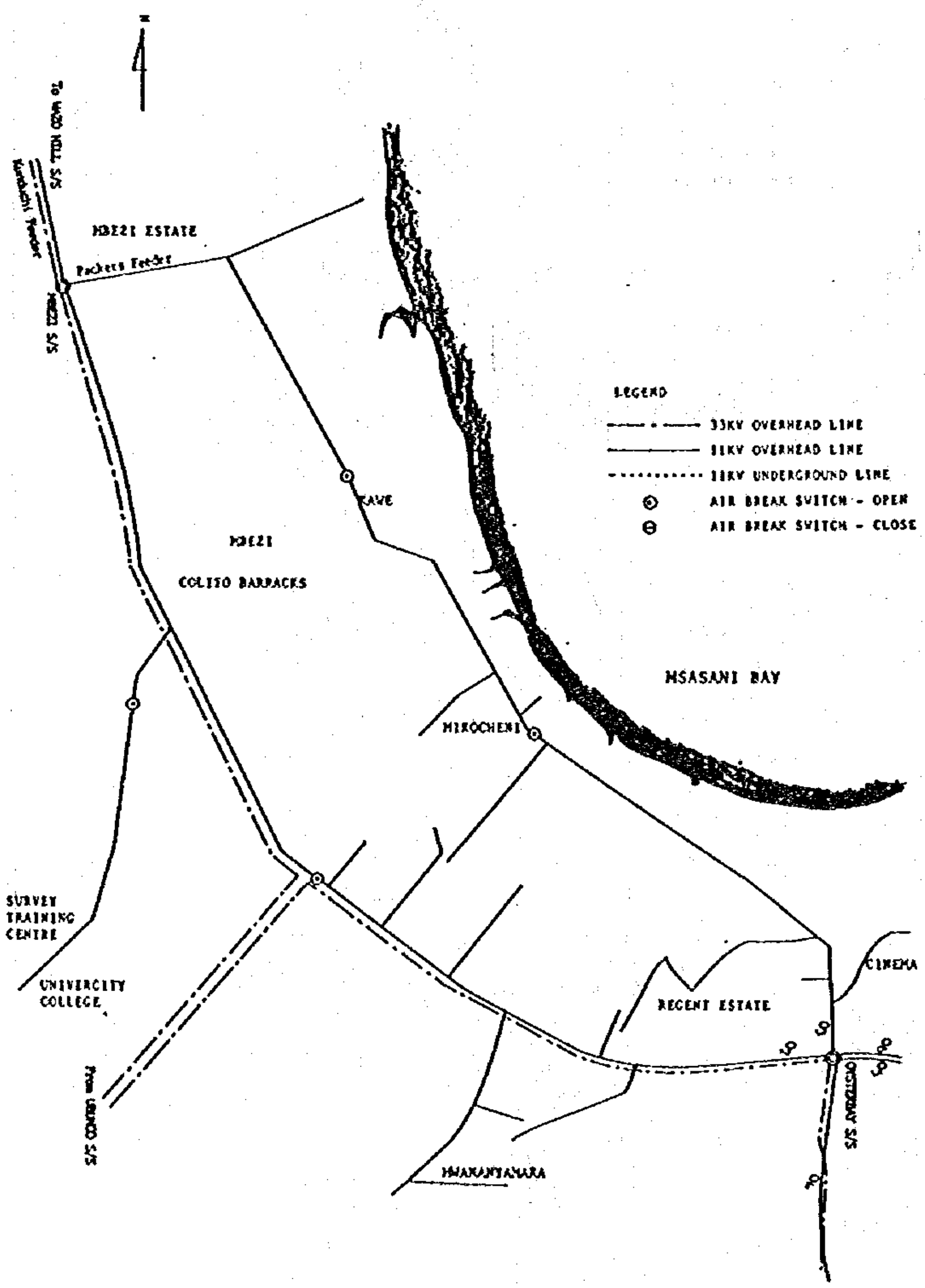


Fig. 4-4-2 EXISTING DISTRIBUTION LINES

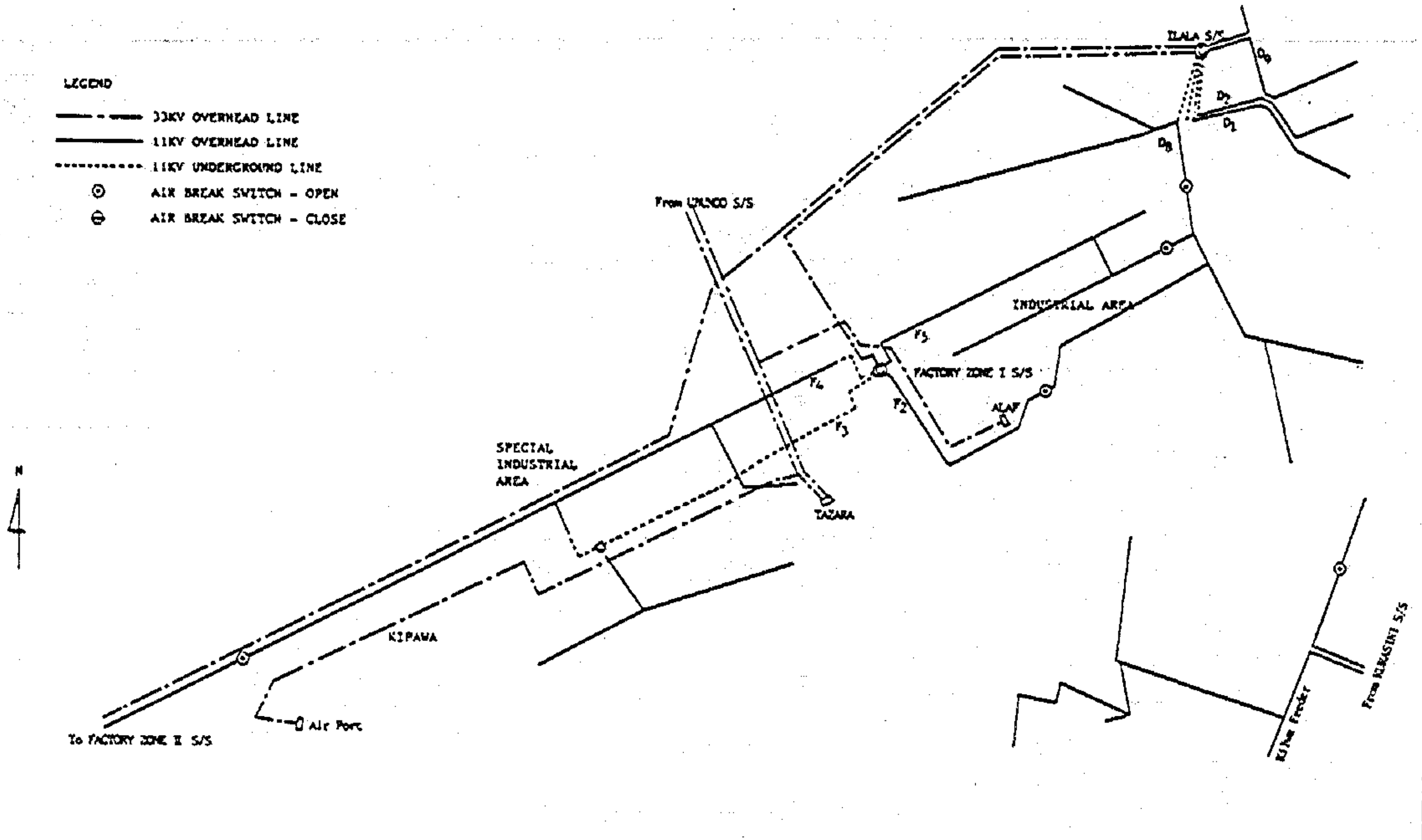


Fig. 4-4-3 EXISTING DISTRIBUTION LINES

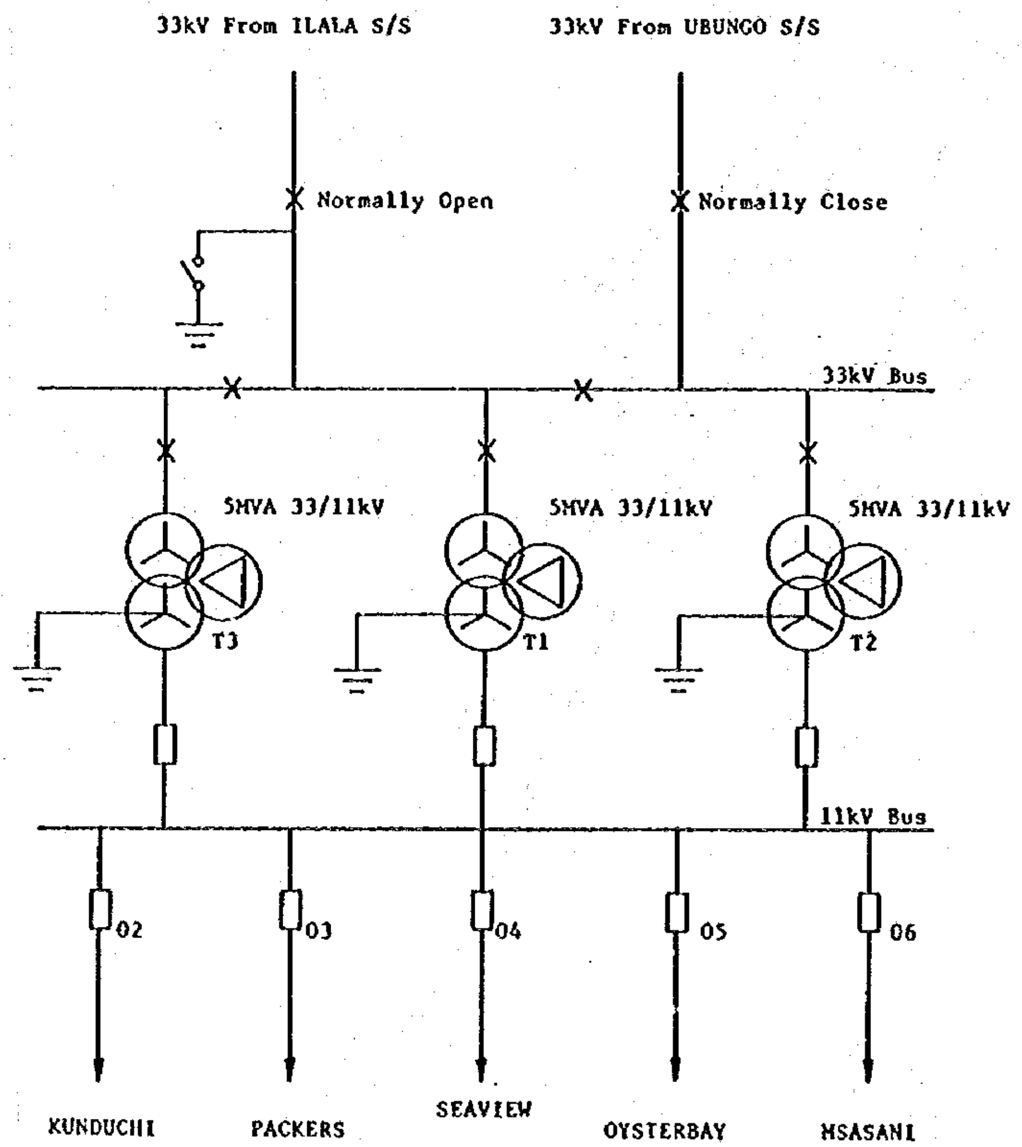


Fig. 4-4-4

SINGLE LINE DIAGRAM
OYSTERBAY S/S

EPDC INTERNATIONAL LTD
TOKYO JAPAN

LOCATION	DATE	DESCRIPTION	BY
REVISION			

SUBMITTED.
RECOMMENDED.
APPROVED.

SHEET NO. OF

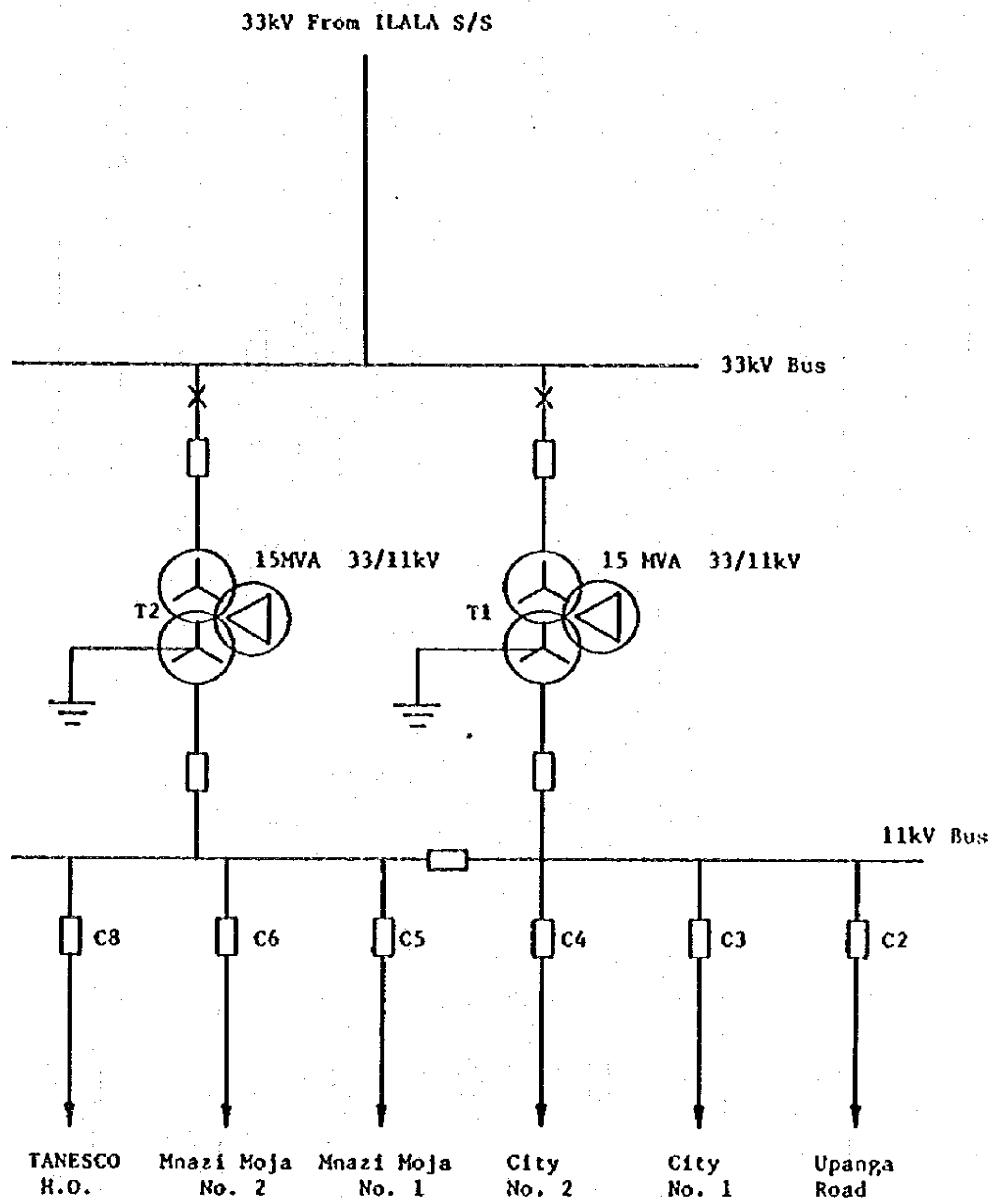


Fig. 4-4-5

SINGLE LINE DIAGRAM
CITY CENTER S/S

EPDC INTERNATIONAL LTD
TOKYO JAPAN

LOCATION	DATE	DESCRIPTION	BY
REVISION			

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

SHEET NO. OF

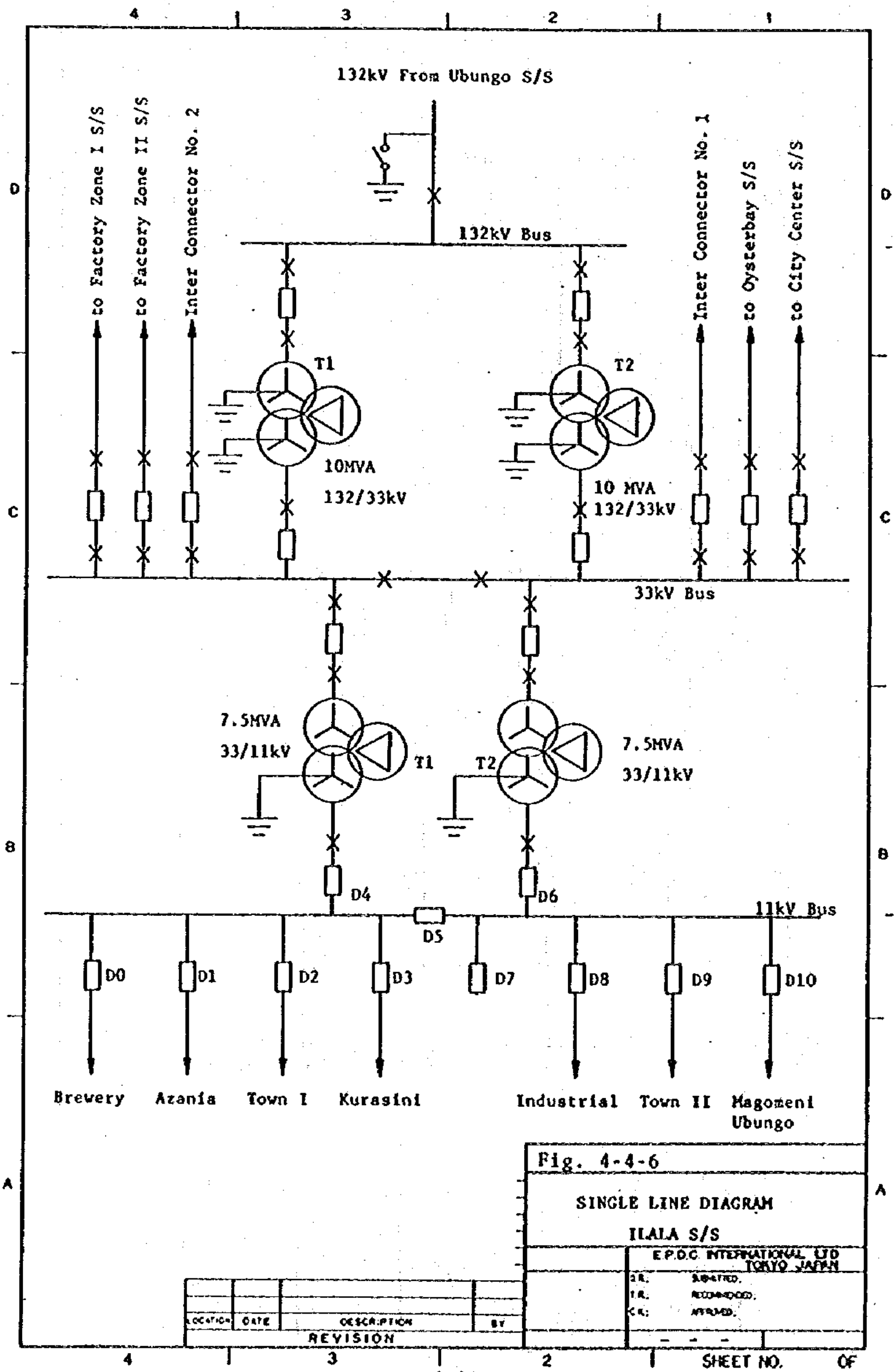


Fig. 4-4-6

SINGLE LINE DIAGRAM

ILALA S/S

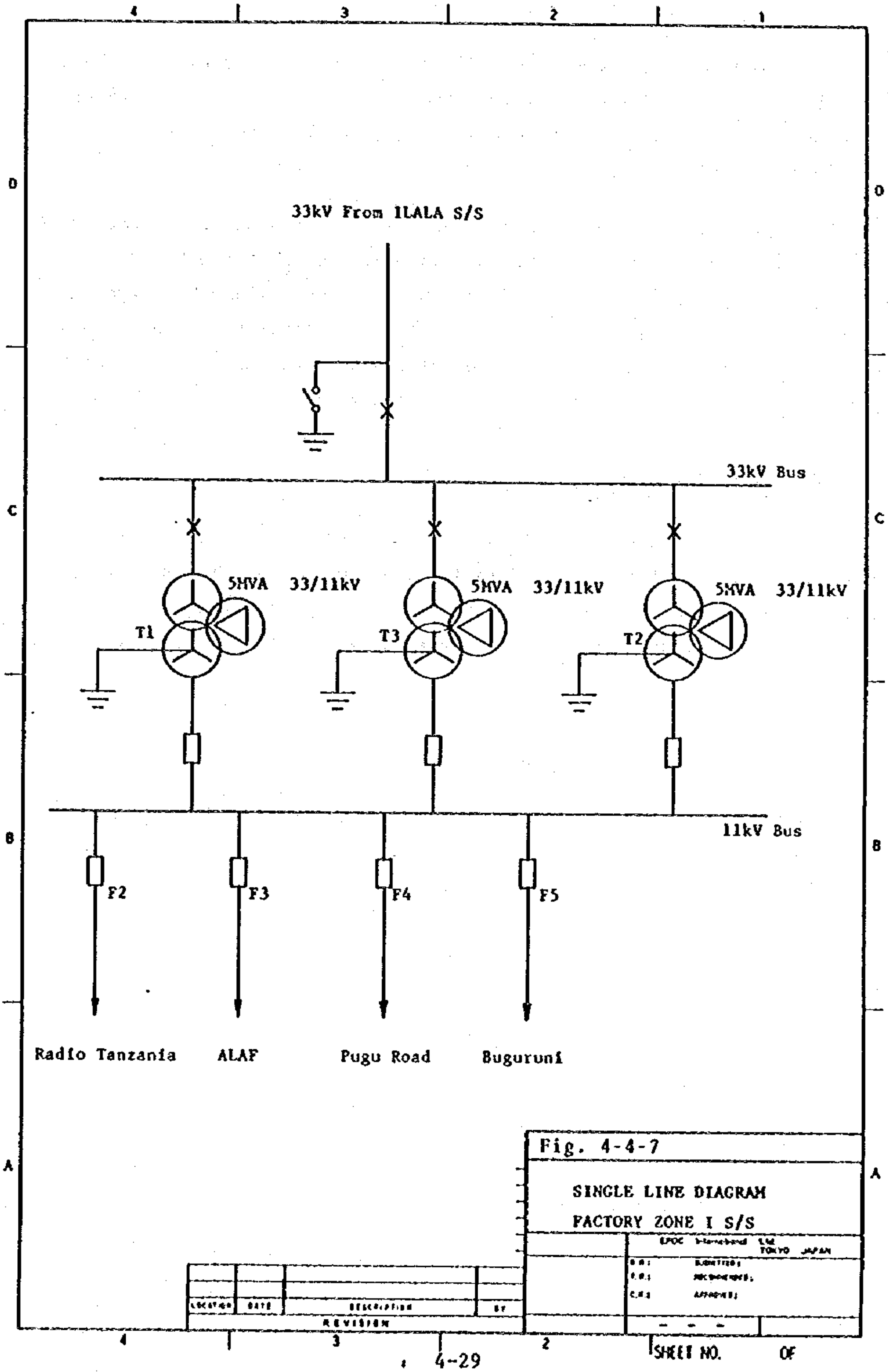


Fig. 4-4-7

SINGLE LINE DIAGRAM
FACTORY ZONE I S/S