5.2 Arusha

5.2.1 Transmission Facilities

Concerning the existing and planned transmission facilities in Arusha, the Study Team, together with engineers of TANESCO, investigated their present conditions, problems, operating conditions, maintenance conditions, etc. Characteristics of the transmission facilities in the individual areas of Arusha are described below.

(1) Existing transmission lines

(a) 132 kV transmission line

The present condition of the 132 kV Njiro-Kiyungi transmission line is in fairly good condition. However, it is not that there are no problems. As an example, the corrosion-preventive coal tar that had been applied to the legs of the steel towers has declined in protective effect due to aging. As another example, the guys of guyed towers employed for suspension towers have been cut off and stolen. It is, therefore, considered indispensable to implement periodical patrol, inspection, and repair of the transmission line. The outline of the existing 132 kV transmission line in Arusha is given below.

Table 5.2.1 Specifications of 132 kV transmission lines in Arusha

Name	Length (km)	No. of CCT	Tower Type	No. of insulators (pieces/phase)	Conductor size (mm^2)	Ground wire size (mm^2)
Njiro-Kiyungi	70	1	Horizontal Self support	11	ACSR 240	ACS 55

(b) 66 kV transmission line

(i) Unga LTD (Arusha)-Kiyungi (Moshi)

- This transmission line is of triangle-arranged. Wooden poles used as the supports have rotten in the inside due to aging. About 50% of the wooden poles included in the scope of maintenance by Arusha Regional Office need replacement.
- In the areas where the lower parts of wooden poles are submerged during the rainy season, the wooden poles have badly rotted. Besides, they have leaned due to softening of the ground and are supported with temporary guys or struts.
- Most of the guys and ground wires of the guyed wooden poles have been cut off and stolen. Therefore, it is considered necessary to implement periodical patrol, inspection, and repair of the guyed wooden poles.
- At present, 66 kV power is transmitted from Kiyungi to Unga LTD. The maximum transmission capacity is about 4 MW.

The outline of the existing 66 kV transmission line in Arusha is given below.

Table 5.2.2 Specifications of 66 kV transmission lines in Arusha

Name	Length (km)	No. of CCT	Support Type	No. of insulators (pieces/phase)	Conductor size (mm^2)	Ground wire size (mm^2)
Unga LTD-Kiyungi	78	1	Triangular Wooden Poles	6	ACSR 50	1/4'DIA

(c) 33 kV transmission lines

- Many sections of the 33 kV transmission lines outgoing from the Njiro S/S need replacement. At a glance, the conductor size seems uniform. Actually, however, conductors of different type or size are used in part, causing a substantial power loss.
- There are many supports which have leaned for some reason or other (e.g., loosening of the ground in the rainy season or incomplete fixing of poles). They should be reinforced by a suitable method based on results of a thoroughgoing investigation of the cause.
- Most of the 33 kV transmission lines serve also as 33 kV distribution lines. In Usa River, Monduli, and other districts where there are comparatively large towns and the demand for electric power is expected to increase in the future, the transmission line and the distribution line should be separated from each other (even though the voltage is the same) to prevent unwanted voltage problems.
- Wooden poles are used as the supports for the 33 kV transmission lines. Three pieces of insulators are provided for each phase.

The outline of the existing 33 kV transmission lines in Arusha is given below.

Table 5.2.3 33 kV transmission lines in Arusha

Name	Length (km)	No. of CCT	Conductor (mm^2)	Remarks
Njiro-Mt.Meru	7.3	1	ACSR 100	
Njiro-Themi	2.1	1	ACSR 100	
Themi-Tengeru	9.8	1	ACSR 100	
Tengeru-KIA Tap	22.7	1	ACSR 100	
Njiro-Unga LTD	5.8	1	ACSR 100	
Unga LTD-Kiltex	1.5	1	ACSR 100	

(2) Planned transmission lines

(a) 132 kV transmission line

(i) Njiro-Kiyungi (new line; initially single circuit, then expanded to double circuits; conductor ACSR 240 mm^2; line length 70 km)

A new 132 kV Njiro-Kiyungi transmission line is to be constructed to improve the reliability of power supply. For the existing transmission line, a steel tower exclusive for single circuit is used. For the new transmission line, like the one in Dar es Salaam, a square steel tower designed to accommodate double circuits is used so that the transmission line can be duplicated as required.

(b) 66 kV transmission line

It has been decided that expansion of the transmission facilities in Arusha should be implemented by 132 kV and 33 kV. Therefore, construction of a new 66 kV transmission line is left out of consideration. It has also been decided to dismantle the existing 66 kV Unga LTD-Kiyungi transmission line after expansion of the 132 kV Njiro-Kiyungi transmission line. For details, see 6.3.3.

(c) 33 kV transmission lines

For the 33 kV transmission line expansion plan in Arusha, see 7.2.3 (1) (b).

5.2.2 Substation Facilities

(1) Present conditions and problems of substation facilities in Arusha

With the exception of the new substations, like the Mt. Meru S/S that was put into operation in the 1990s, the existing substations in Arusha are generally obsolescent. In particular, the 33 kV facilities have deteriorated noticeably. It is to be desired that the circuits feeding the distribution lines directly should be rehabilitated as early as possible.

On the whole, the present conditions of the substation facilities in Arusha are as follows.

- Almost all of the transformers are more or less leaking oil. Some transformers are leaking a large amount of oil from several parts of the transformer gaskets.
- Concerning the circuit breakers, which are the most important outdoor switches, defective contacts of the interrupting parts of oil circuit breakers and deterioration of the operating circuits are especially noticeable. Thus, there are many circuit breakers which are not functioning as such.
- With respect to the steel structures and buses too, the buses of some substations have not been maintained properly. These buses need to be repaired at the same time that the main devices are renewed.
- The transmission line protective panels, device protective panels, and control panels are judged to have deteriorated markedly from their appearances. Some meters give incorrect indications. Thus, most of the panels need to be renewed as soon as possible.
- Concerning the 11 kV indoor cubicles, many substations have experienced a fire (or fires) caused by some electrical trouble with them. Besides, like the case of the outdoor circuit breakers, many of the 11 kV indoor cubicles need replacement because the contacts of the interrupting part have worn markedly. Since the spare parts are no longer available, they are repaired by using the parts of stand-by circuits. These parts are running short too, making proper operation and maintenance difficult.
- The control power supplies were installed at the same time as the outdoor circuit breakers or 11 kV enclosed switchboards, hence there are several control power supplies whose batteries are not functioning. This is as though the output of the charger were directly used. There is concern that the devices might be adversely affected by the ripple component of the charger output.
- Many of the substation transformers that have been operated since the substations were put into operation need repair too.

For each of the substations that are judged to need renewal, the degree of deterioration of each individual device shall be evaluated below. The method of evaluation is the same as applied to the substations in Dar es Salaam.

(2) Results of evaluation of Njiro S/S

The Njiro S/S is the main substation in Arusha. It is the only substation in Arusha that leads in 220 kV and 132 kV transmission lines. The entire area of Arusha is fed by this substation with a 33 kV circuit. Namely, the stability of power supply in Arusha depends on the Njiro S/S.

(a) Transformers

As its main transformers, the Njiro S/S has two 220 kV/132 kV, 60 MVA transformers and two 132 kV/33 kV, 20 MVA transformers. The former two transformers have no problems at all, since they are new and the load in Arusha and Moshi has not been very large. The latter two transformers have not any immediate problems either, since the amount of oil they leak is negligibly small. They can continue to be used for a considerable period of time as long as they are kept from overload operation by installing an additional transformer as required in the future.

(b) Gas circuit breaker (for 132 kV)

Alstom, made by Atlantique, 145 kV, 2,000 A, 25 kA, made in 1981

Table 5.2.4 Result of judgment of deterioration of gas circuit breaker in Njiro S/S

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
1	Years in use	More than 30 years	25 to 30 years	20 to 25 years	---	---	---	3
2	No.of times of fault current interruption (contact condition)	---	---	More than 40	30 to 40	11 to 30	---	0
3	No. of times of load switching (contact condition)	---	---	---	More than 1,000	500 to 1,000	---	0
4	Switching operation	Switching operation impossible	---	Switching operation failure occurred in the past.	---	---	No defective switching operation	0
5	Conduction condition	Incomplete conduction due to defective contact	---	---	---	---	No defective switching operation	0
6	Internal inspection of interrupting unit	---	---	Not done in 24 yrs or more	Not done in 18 yrs or more	Not done in 12 yrs or more	---	2
7	Inspection of operating mechanism	---	---	Not done in 18 yrs or more	Not done in 12 yrs or more	Not done in 6 yrs or more	---	3
8	Gas leak	There is gas leak.	---	---	---	Gas leaked in past.	No gas leak	0
9	Control circuit	---	---	Abnormal	---	---	Normal	3
10	Availability of spare parts	---	---	---	Unavailable	Available	Normal	2
11	TOTAL							12

(c) Oil circuit breaker

36 kV, 1,250 A, 12.5 kA, made by Alstom in 1981

Table 5.2.5 Result of judgment of deterioration of oil circuit breaker in Njiro S/S

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
1	Years in use	More than 30 years	25 to 30 years	20 to 25 years	---	---	---	3
2	No.of times of fault current interruption (contact condition)	---	---	More than 20	13 to 20	10 to 12	---	3(Estimate from fault records)

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
3	No. of times of load switching (contact condition)	---	---	---	More than 500	400 to 500	---	0
4	Switching operation	Switching operation impossible	---	Switching operation failure occurred in the past.	---	---	No defective switching operation	0
5	Conduction condition	Incomplete conduction due to defective contact	---	---	---	---	No defective switching operation	0
6	Internal inspection of interrupting unit	---	---	Not done in 24 yrs or more	Not done in 18 yrs or more	Not done in 12 yrs or more	---	2
7	Inspection of operating mechanical	---	---	Not done in 18 yrs or more	Not done in 12 yrs or more	Not done in 6 yrs or more	---	3
8	Oil leak	---	---	---	There is oil leak.	---	No oil leak	2
9	Control circuit	---	---	Abnormal	---	---	Normal	0
10	Availability of spare parts	---	---	---	Unavailable	Available	Normal	2
11	TOTAL							15

(d) Instrument transformer

Since the 132 kV/33 kV transformer is not provided with a current transformer at the primary side, the transformer cannot be protected.

(e) Summary

Gas circuit breaker: A large amount of operating oil is leaking in the operating box of the circuit breaker for the 132 kV/33 kV transformer. Besides, the circuit breaker is not inspected periodically. There is concern that the circuit breaker should fail to function. Therefore, it is considered necessary to replace it as early as possible.

Oil circuit breaker: The 33 kV oil circuit breaker is very unreliable since there are worn contacts, oil leak, etc. Besides, the repair parts are no longer available. Therefore, it needs to be replaced as early as possible.

Current transformer: The current transformer that had been installed at the primary side of the 132 kV/33 kV transformer when the transformer was put into operation has been removed for some reason or other. Since this current transformer is indispensable for protection of the transformer, it needs to be reinstalled. At the same time, it is necessary to install a suitable transformer protective panel.

(3) Unga LTD S/S

All the substation devices of the Unga LTD S/S have become obsolescent. The reason for this is that the transformers, circuit breakers, etc. have been used since the substation was put into operation and that some of the transformers are used ones obtained from other substations. It is judged that these devices have deteriorated so much that they cannot be repaired. Therefore, they cannot maintain the present level of reliability of power supply.

In view of the above facts, it shall be planned to renew the entire equipment of the substation.

(4) Kilitex S/S

Like the Unga LTD S/S, the Kilitex S/S has many devices which have deteriorated markedly. In addition to the deterioration of substation equipment, the substation devices and building have been badly damaged by vandalism. The marked damage of transformer insulators was apparently caused by stones thrown by someone. The circuit breaker operating mechanisms have broken down so completely that it is meaningless to analyze them.

In view of the above facts, it shall be planned to renew the entire equipment of the substation.

(5) Summary

The substation devices of the substations in Arusha that need to be rehabilitated are as follows.

Table 5.2.6 Rehabilitation plan for substations in Arusha

Name of S/S	Tr	Bus	132/33kV CB	11kV CB	Protection /control panels	Control power supply
Njiro			x			
Unga LTD	x	x	x	x	x	x
Kiltex	x	x	x	x	x	x

5.2.3 Distribution Facilities

On the whole, the power facilities in Arusha are obsolescent and have a number of problems. The Njiro S/S, the primary substation, is connected to both the 132 kV northern grid and the 220 kV national grid and has sufficient supply capacity. However, because of insufficient capacity of its 132 kV/33 kV transformers, the Njiro S/S cannot supply adequate power to the distribution facilities.

In order to compensate for the insufficient capacity mentioned above, TANESCO receives power from the Nyumba ya Mungu P/S by a markedly obsolescent 66 kV transmission line and feeds the city of Arusha over a 11 kV distribution line. However, the 66 kV transmission line is not enough to compensate for the insufficient transmission capacity because of many fallen supports and deteriorated insulators, small conductor size, etc. Therefore, it cannot be expected that the 66 kV transmission line will contribute much to the improvement in reliability of power supply in the future.

Aside from the insufficient transformation capacity mentioned above, voltage drops of the 11 kV long-distance distribution lines have become a problem in the distribution network. For the Monduli line (32 km) and the Usa River line (26 km) that are long-distance distribution lines subject to especially large voltage drops, a project to boost them to 33 kV is under way. After completion of the project, the two long-distance distribution lines are planned to be connected to the Njiro S/S.

However, as already mentioned, the 132 kV/33 kV transformers of the Njiro S/S are already under an overload and have no extra supply capacity to feed new 33 kV lines. Because of this, even if the project to boost the long-distance distribution lines to 33 kV is completed as planned, they can only be operated with 11 kV for some time, hence the project will not produce the desired effect in the near future. It is, therefore, necessary first to reinforce the 33 kV supply capacity of the Njiro S/S and secure sufficient capacity to

feed the distribution facilities and then to carry out a project to improve the distribution network in earnest.

The 33 kV side of the Njiro S/S has already been overloaded and if this situation cannot be remedied, there is concern that it should become necessary to limit the power supply by load shedding, etc. so as to prevent burnouts of the transformation devices and that the problem of voltage drops in the Monduli and Usa River areas should remain unsettled.

The high-voltage distribution lines in Arusha, like those in Dar es Salaam, are of 3-phase, 3-wire type. 11 kV is used in the urban area, whereas 33 kV is used in the suburban areas. The 11 kV feeders led out from the individual substations in Arusha are as long as about 16 km, whereas those in Dar es Salaam are about 3 to 7 km in length. As in Dar es Salaam, the load current of distribution feeders has not been unified. The overhead distribution lines are obsolescent, and there are still many sections using Cu 25 mm^2 and Cu 16 mm^2. Therefore, they involve a number of problems, including the problem of voltage drops, which ascribable to the insufficient capacity and deterioration of the wires.

In Arusha, there are very few lines which are provided with section switches. Therefore, whenever it becomes necessary to change the service area or effect load shedding, they manually disconnect and reconnect the jumper wires of the line.

The distribution network is to be expanded, repaired, and reinforced as the substations are reinforced. As a special situation unique to this area, there is a land problem. Since securing a site for construction of a new distribution line is difficult, it is necessary to provide double-circuit line pole configurations from the beginning of a new line construction project. In addition, considering the difficulty involved in securing a suitable installation site for a new distribution transformer, it is necessary to discuss installation of a small-sized transformer on a pole and feed the low-voltage network from this transformer.

In Arusha, the Study Team measured loads of the Njiro S/S, Mt. Meru S/S, and Unga LTD S/S. The measurement results are shown in Fig.s 5.2.1 to 5.2.3. The present conditions and problems of the distribution facilities in Arusha are as described in paragraph 5.1.3.

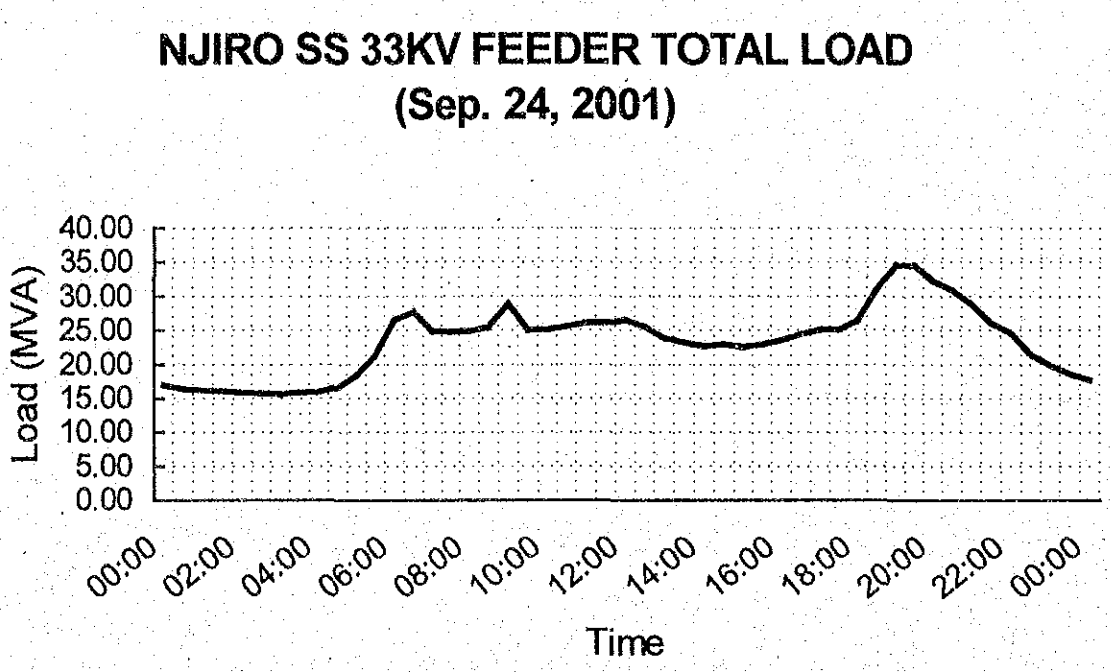

Fig.5.2.1 Measured Load Record of Njiro S/S 33kV Feeder

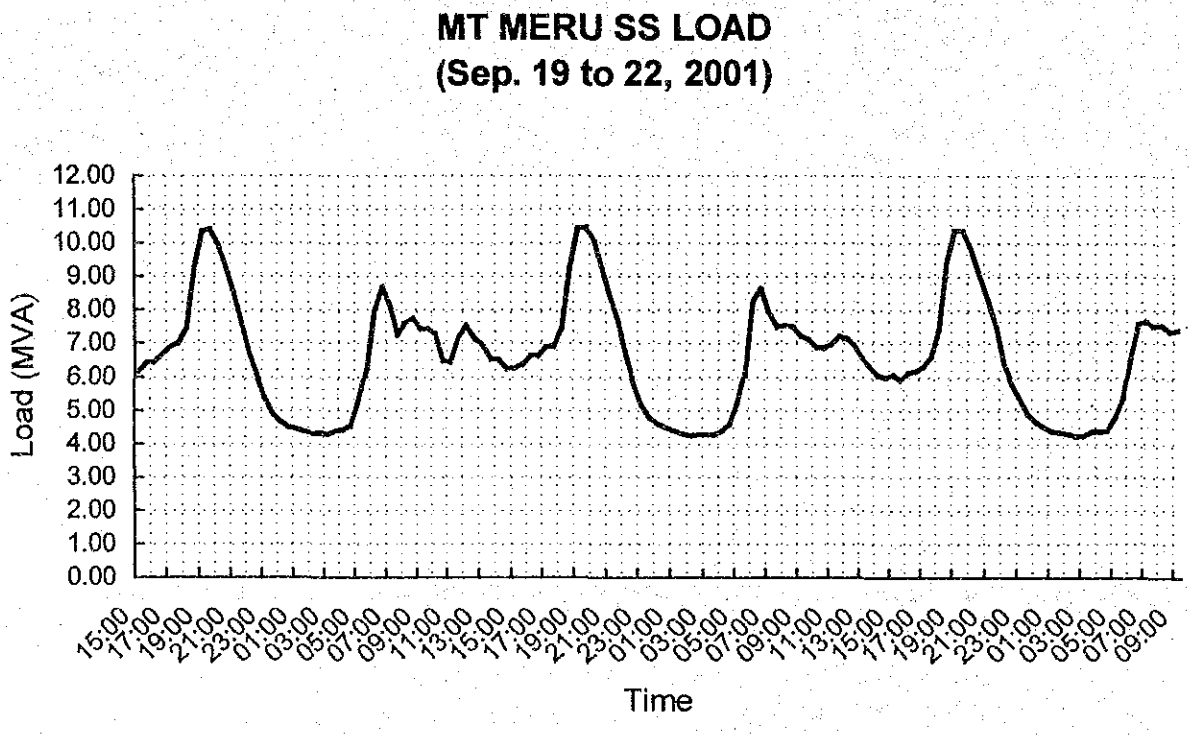

Fig.5.2.2 Measured Load Record of Mt. Meru S/S

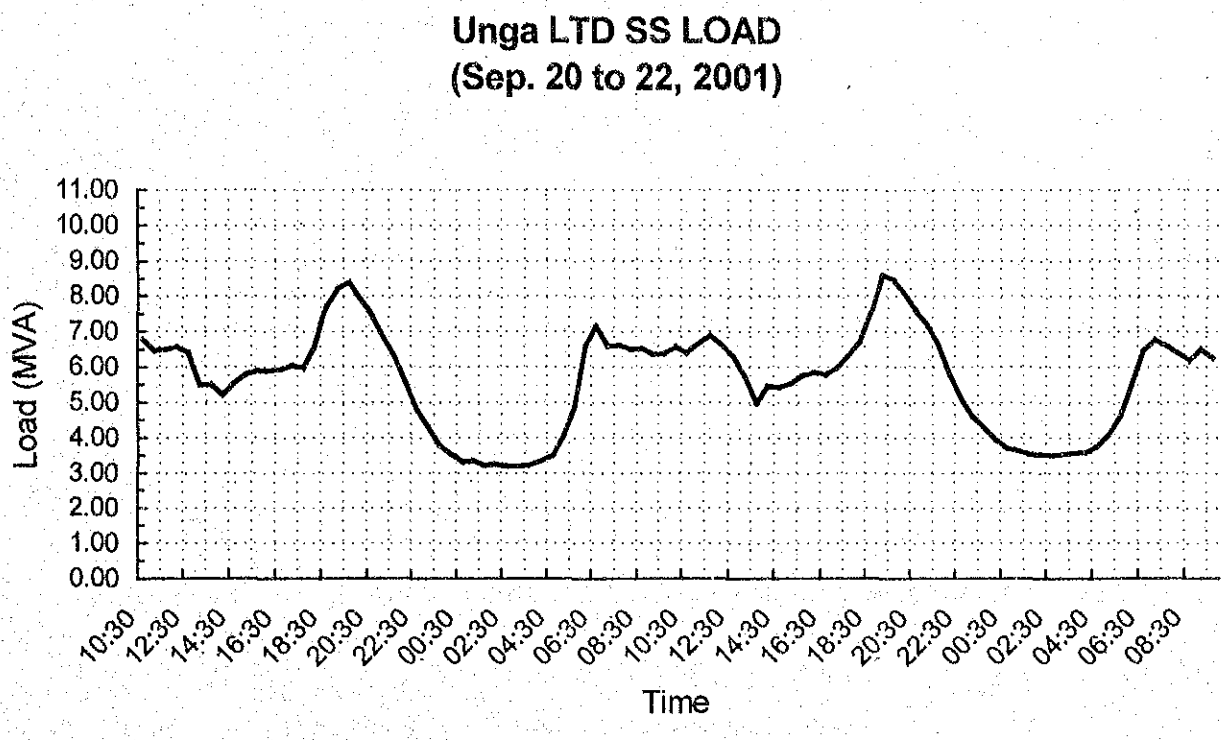

Fig.5.2.3 Measured Load Record of Unga LTD S/S

5.3 Moshi

5.3.1 Transmission Facilities

Concerning the existing and planned transmission facilities in Moshi, the Study Team, together with engineers of TANESCO, investigated their present conditions, problems, operating conditions, maintenance conditions, etc. Characteristics of the transmission facilities in the individual areas of Moshi are described below.

(1) Existing transmission lines

(a) 132 kV transmission lines

(i) Njiro-Kiyungi

The present condition of this transmission line is as described in 5.2.1(1)(a).

(ii) Kiyungi-Same

The 132 kV Kiyungi-Same transmission line was generally in fairly good condition. However, as is the case of the 132 kV Njiro-Kiyungi transmission line, the corrosion-preventive coal tar that had been applied to the legs of the steel towers has declined in its protective effect due to aging, and the guys of the guyed towers have been cut off and stolen. Therefore, it is considered necessary to implement periodical patrol, inspection, and repair of the guyed steel towers.

The outline of the existing 132 kV transmission lines in Moshi is given below.

Table 5.3.1 Specifications of 132 kV transmission lines in Moshi

Name	Length (km)	No. of CCT	Tower Type	No. of insulators (pieces/phase)	Conductor size (mm^2)	Ground wire size (mm^2)
Hale-Same	173	1	Horizontal Guyed	10	ACSR 150	Steel 50
Same-Kiyungi	102	1	Horizontal Guyed	10	ACSR 150	Steel 50

(b) 66 kV transmission lines

(i) Unga LTD (Arusha)-Kiyungi (Moshi)

- The specifications and problems of this transmission line are as described in 5.2.1(1)(b)(i).
- Because of internal corrosion of the wooden poles due to aging, 50% of the wooden poles of the transmission line included in the scope of maintenance by the Moshi Office need replacement.

(ii) Nyumba ya Mungu-Kiyungi

- This transmission line is the outgoing line that transmits a maximum of 8 MW from the Nyumba ya Mungu P/S. Therefore, it is considered necessary to implement periodical maintenance of the transmission line.
- Because of internal corrosion of wooden poles due to aging, 25% of the wooden poles need replacement.

The outline of the existing 66 kV transmission line in Moshi is given below.

Table 5.3.2 Specifications of 66 kV transmission lines in Moshi

Name	Length (km)	No. of CCT	Support Type	No. of insulators (pieces/phase)	Conductor size (mm^2)	Ground wire size (mm^2)
NYM-Kiyungi	53	1	Triangular Wooden Poles	6	ACSR 50	1/4'DIA

(c) 33 kV transmission lines

- The Rombo feeder (K50) outgoing from the Boma Mbuzi S/S is as long as 122 km. Since it feeds not only Rombo but also Himo and Marangu along the way, there are problems of voltage drops and unreliable power supply for users at the end of the feeder.
- The conductors of the transmission lines connecting Kiyungi with distribution substation, Same with Gonja, and Nyumba ya Mungu with Mwanga are all ACSR 100 mm2. Nevertheless, the feeders branching out from the distribution substation (e.g., the Rombo feeder and the Machame feeder) are made up of conductors of different material and size. Besides, they have problems with conductor connection work. As a result, the power loss is substantially large.
- Wooden poles are used as the supports, and three pieces of insulators are used per phase.

The outline of the existing 33 kV transmission lines in Moshi is given below.

Table 5.3.3 33 kV transmission lines in Moshi

Name	Length (km)	No. of CCT	Conductor (mm^2)	Remarks
Kiyungi-Trade school	10	1	ACSR 100	
Kiyungi-Boma Mbuzi	7	1	ACSR 100	
Trade school-Machame	22.2	1	ACSR 100	
Kiyungi-Boma Ngombe	25.1	1	ACSR 100	
Boma Ngombe-Lawate	15.3	1	ACSR 100	
Boma Ngombe-KIA Tap	22.2	1	ACSR 100	
KIA Tap-KIA	3	1	ACSR 100	
NYM-Mwanga	27.3	1	ACSR 100	
Same-Gonja	50	1	ACSR 100	
Boma Mbuzi-Marangu	27.9	1	ACSR 100	
Kiyungi-TPC	5	1	ACSR 100	

(2) Planned transmission lines

(a) 132 kV transmission line

- The 132 kV Kiyungi-KCMC (Kilimanjaro Christian Medical Center) transmission line that TANESCO proposed to construct in order to feed the northern part of Kilimanjaro was changed to a 33 kV line based on the result of a demand forecast. For details of the demand forecast, see 6.3.3.

(b) 66 kV transmission lines

- The present condition and problems of the existing 66 kV Unga LTD-Kiyungi transmission line are as described in 5.2.1(2)(b).
- Concerning the 66 kV Kiyungi-Marangu transmission line that TANESCO proposed to construct in order to solve the voltage problems with the existing 33 kV Rombo feeder (K50), the Study Team made an on-site survey of the route planned by TANESCO. The flatland is partly submerged in the rainy season, hence the ground condition is considered unsuitable for steel tower foundation. The route in the mountain area could not be surveyed because there were no access roads. The surveyor said that it would be necessary to construct a road about 9 to 15 km in length for the project.
- The electric power demand forecast shows that the demand in Marangu will not increase much in the foreseeable future. Besides, constructing the planned transmission line requires a considerable amount of temporary work. Taking these two points into consideration, it was decided to substitute a 33 kV transmission line for the planned 66 kV transmission line.

(c) 33 kV transmission line

For the transmission line expansion plan in Moshi, see 7.2.3(1)(b).

5.3.2 Substation Facilities

(1) Present conditions and problems of substation facilities in Moshi

On the whole, it seems safe to say that the existing substations in Moshi (Kilimanjaro) have become obsolescent. This is due in part to the fact that many of the important substations, including the Kiyungi S/S, still use the equipment that was

installed when the power station was put into operation. In particular, the 66 kV and 33 kV facilities have deteriorated markedly. It is to be desired that these facilities should be renewed as early as possible.

The present conditions and problems of the substation facilities are as follows.

- Almost all of the transformers are more or less leaking oil. There are even transformers which are leaking a large amount of oil from various parts of the transformer gaskets.
- Concerning the circuit breakers, which are the most important outdoor switches, defective contacts of the interrupting part of oil circuit breaker and deterioration of the operating circuit are especially noticeable. There are many circuit breakers which are not functioning as such.
- At some substations, the bus configuration is insufficient. These substations need to be rehabilitated at the same time that the main devices are renewed.
- The transmission protective panels, device protective panels, and control panels are judged to have deteriorated much from their appearances. There are meters which do not give correct indications. Most of the panels need immediate replacement.
- The 11 kV indoor cubicles have not experienced a fire due to electrical trouble as have those of the other substations. However, many of them have become obsolescent. Besides, like the case of the outdoor circuit breakers, the wear of the contacts of the interrupting part is especially noticeable. Although these cubicles need replacement, they are repaired by using the parts of stand-by cubicles because the spare parts are no longer available. Even the parts of the stand-by cubicles are running short, preventing proper operation and maintenance significantly.
- Most of the batteries of the control power supplies are not functioning.
- Many of the substation transformers need renewal because they have been used ever since the substation was put into operation.

For each of the substations, the degree of deterioration of the individual devices shall be evaluated. The method of evaluation is the same as applied in Dar es Salaam.

(2) Kiyungi S/S

The Kiyungi S/S is the main transformer in Moshi. It is the only substation in this area that leads in a 132 kV transmission line. The Moshi area is mostly fed by this substation through a 33 kV circuit. Namely, stable power supply in this area depends on the Kiyungi S/S.

(a) Transformers

As its main transformers, the Kiyungi S/S has one 132 kV/66 kV, 15 MVA transformer and one 132 kV/33 kV, 20 MVA transformer. Characteristically, two 66 kV/33 kV, 5 MVA transformers and one 66 kV/33 kV, 10 MVA transformer of different vector group are connected to the secondary side of the 132 kV/66 kV main transformer.

The 132 kV transformers are judged to be in comparatively good condition, whereas the 66 kV/33 kV transformers are leaking oil.

The results of deterioration evaluation of the transformers are described below.

(i) Transformer: Product of South Wales Switchgear, 66 kV/33 kV, rated capacity 5 MVA, 2 units, made in 1967

Table 5.3.4 Result of judgment of transformer deterioration in Kiyungi S/S -1

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
1	Years in use	More than 30 years	25 to 30 years	20 to 25 years	---	---	---	5
2	Overload operation	More than 55% and/or 1hr except accident		40%-50% OL for about 3 hrs	30%-40% OL for about 3 hrs	20%-30% overload for about 3 hrs	Less than 20% OL for about 3 hrs	1(Experience overload operation in the past)
3	Unusual sound	---	---	---	Yes	---	No	0
4	Vibration	---	---	---	Unusual vibration	---	No vibration	0
5	Leak of TR insulating oil				Large amount of oil leak from two or more points, including TR upper part	Considerable amount of oil leak, but not from TR upper part	No oil leak	1
6	Oil leak from on-load tap changer				Large amount of oil leak from two or more points, including TR upper part	Considerable amount of oil leak, but not from TR upper part		1
7	Properties of on-load tap changer insulating oil					Hot line oil filter is absent or in trouble, causing insulating oil deterioration Oil property test is required.		1
8	Conservator condition					Conservator has been damaged or does not function.	Normal	0
9	Bushing condition				Bushing has been badly damaged.	Bushing has been partly damaged.	Normal	0
10	Cooling device condition				Large amount of oil leak from two or more points, including TR upper part	Considerable amount of oil leak, but not from TR upper part	Normal	1
11	Pressure releasing device condition				Device has been damaged.		Normal	0
12	CT condition				CT has been damaged or does not function.		Normal	0
13	Instrument condition					Instrument has been damaged or does not function.	Normal	1
14	TOTAL							11

(ii) Transformer: Product of South Wales Switchgear, 66 kV/33 kV, rated capacity 10 MVA, made in 1967

Table 5.3.5 Result of judgment of transformer deterioration in Kiyungi S/S -2

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
1	Years in use	More than 30 years	25 to 30 years	20 to 25 years	---	---	---	5
2	Overload operation	More than 55% and/or 1hr except accident		40%-50% OL for about 3 hrs	30%-40% OL for about 3 hrs	20%-30% overload for about 3 hrs	Less than 20% OL for about 3 hrs	0
3	Unusual sound	---	---	---	Yes	---	No	0
4	Vibration	---	---	---	Unusual vibration	---	No vibration	0
5	Leak of TR insulating oil				Large amount of oil leak from two or more points, including TR upper part	Considerable amount of oil leak, but not from TR upper part	No oil leak	2

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
6	Oil leak from on-load tap changer				Large amount of oil leak from two or more points, including TR upper part	Considerable amount of oil leak, but not from TR upper part		1
7	Properties of on-load tap changer insulating oil					Hot line oil filter is absent or in trouble, causing insulating oil deterioration Oil property test is required.		1
8	Conservator condition					Conservator has been damaged or does not function.	Normal	0
9	Bushing condition				Bushing has been badly damaged.	Bushing has been partly damaged.	Normal	0
10	Cooling device condition				Large amount of oil leak from two or more points, including TR upper part	Considerable amount of oil leak, but not from TR upper part	Normal	1
11	Pressure releasing device condition				Device has been damaged.		Normal	0
12	CT condition				CT has been damaged or does not function.		Normal	0
13	Instrument condition					Instrument has been damaged or does not function.	Normal	1
14	TOTAL							11

(b) Oil circuit breaker: 36 kV, 1,250 A, 12.5 kA and 72.5 kV, 1,200 A, product of CGE or South Wales Switchgear, made in 1967

Table 5.3.6 Result of judgment of deterioration of oil circuit breaker in Kiyungi S/S

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
1	Years in use	More than 30 years	25 to 30 years	20 to 25 years	---	---	---	5
2	No.of times of fault current interruption (contact condition)	---	---	More than 20	13 to 20	10 to 12	---	2(Estimate from fault records)
3	No. of times of load switching (contact condition)	---	---	---	More than 500	400 to 500	---	0
4	Switching operation	Switching operation impossible	---	Switching operation failure occurred in the past.	---	---	No defective switching operation	0
5	Conduction condition	Incomplete conduction due to defective contact	---	---	---	---	No defective switching operation	0
6	Internal inspection of interrupting unit	---	---	Not done in 24 yrs or more	Not done in 18 yrs or more	Not done in 12 yrs or more	---	3
7	Inspection of operating mechanism	---	---	Not done in 18 yrs or more	Not done in 12 yrs or more	Not done in 6 yrs or more	---	3
8	Oil leak	---	---	---	There is oil leak.	---	No oil leak	2
9	Control circuit	---	---	Abnormal	---	---	Normal	0

No.	Item	Degree of superannuation/aging deterioration/performance decline (pts)						Result of Judgment
		5	4	3	2	1	0	
10	Availability of spare parts	---	---	---	Unavailable	Available	Normal	2
11	TOTAL							17

(c) Other devices:

Those devices which are combined with a control power supply and circuit breaker shall be given priority in replacement.

(d) Summary

Transformers: The transformers are judged to have almost reached their life: they have deteriorated markedly due to aging and are leaking oil. Considering this and the possible overload due to an increase in demand in the future, it is necessary to install additional transformers without delay.

Oil circuit breakers: Some of the oil circuit breakers are very unreliable because of worn contacts, oil leak, etc. Since repair parts are no longer available, those oil circuit breakers should be replaced as early as possible.

(3) Boma Mbuzi S/S

The transformers of the Boma Mbuzi S/S are in fairly good condition. However, the oil circuit breakers have experienced a number of accidents. The oil circuit breakers for distribution line are old ones which have been relocated from other substations. These circuit breakers are incapable of even load switching. They need to be replaced without delay.

Oil circuit breakers: Those for distribution line shall be renewed without delay. In addition, oil circuit breakers exclusive for use with transformer need to be installed.

Control power supplies: Since the batteries are not functioning, all control power supplies need to be replaced when the circuit breakers are renewed.

Protective devices: Need to be renewed when additional circuit breakers are installed to the transformers.

(4) Trade School S/S

The devices of the Trade School S/S have deteriorated markedly. Some of the transformers have experienced a burnout. The outdoor circuit breakers too have deteriorated so much that they are very unreliable. Furthermore, since this substation is supposed to become the base of expansion of the 33 kV system in Moshi in the future because of its location, it is necessary to carry out a drastic rehabilitation, including expansion of the substation site.

In this context, it is considered wise to plan rehabilitation of almost all of the substation facilities.

(5) Same S/S

The present condition of the Same S/S is judged to be free of problems due in part to the fact that the transformer load is very light. However, the 33 kV oil circuit breakers have defective contacts and need to be renewed as early as possible.

Besides, the transformer primary side is not provided with a circuit breaker which is absolutely necessary. Since this will have adverse effect not only on the Same S/S but also on the entire power supply system of Moshi, it is necessary to install a circuit breaker to the transformer primary side. At the same time, the line disconnecting

switches that are now incapable of operation need to be replaced.

(6) Summary

The facilities of the substations in Moshi that need renewal are as follows.

Table 5.3.7 Rehabilitation plan for substations in Moshi

Name of S/S	Tr	Bus	132/66/33 kV CB	11kV CB	Protection /control panels	Control power supply
Kiyungi	x	x	x		x	x
Boma Mbuzi			x	x	x	x
Trade School	x	x	x	x	x	x
Same			x		x	

5.3.3 Distribution Facilities

On the whole, many of the distribution facilities in Moshi, like those in Arusha, have become obsolescent and have various problems in distribution operation. The Moshi area includes not only the city of Moshi but also Kilimanjaro International Airport and adjacent towns and villages, towns and villages at the foot of Mt. Kilimanjaro and in the mountains, the Same district, etc. Since the distribution area is wide and scattered, there are many long-distance distribution lines which pose the problems of voltage drops and power losses. In particular, the 33 kV distribution line that runs to Rongai via Marangu at one of the entrances to Mt. Kilimanjaro is more than 130 km in length. Since there is a sawmill at the terminal of this line, there is concern about voltage drops. Therefore, it is necessary to work out an effective plan to improve the situation.

Because of insufficient supply capacity of the existing substations, many of the distribution lines are laid out in an unnatural way, impeding smooth power supply. In view of this, it is necessary to expand and reinforce the trunk distribution lines after expansion of the Kiyungi S/S that is the primary substation in the Moshi area. In particular, the 33 kV feeders - K20 and K50 - are highest in importance and emergency. Reinforcing these feeders is indispensable in planning expansion of the distribution facilities in the city of Moshi and the Rombo/Marangu districts.

In the Moshi and Same areas, many of the distribution facilities show traces of device burnouts caused by many years of overload operation and load imbalance. Most of those accidents could have been prevented if the circuit breakers of the substation were functioning properly. Because of shortage of funds, many substations are not provided with those circuit breakers which are absolutely necessary. Thus, the protective functions are extremely poor, putting some substations in a dangerous situation. In addition, there are substations, like the Trade School S/S, which have been subjected to an overload for many years and have experienced many accidents with their equipment. Therefore, it is considered necessary to take suitable measures without delay.

As emergency measures, it is important to replace or install the irreducible minimum of circuit breakers and plan protection of the 33 kV feeders in the Moshi and Same areas. These measures will have a far-reaching effect, protecting about 43,000 consumers, or 91% of the consumers in the Kilimanjaro Region.

The high-voltage distribution lines in Moshi, like those in other areas, are of 3-phase, 3-wire type. The high voltage is 11 kV in the urban area and 33 kV in the suburban areas. The 11 kV feeders outgoing from the substations in Moshi are as long as about 16 km, whereas the 11 kV feeders in Dar es Salaam are about 3 to 7 km. The distribution feeder load currents are not unified as in other areas. Many of the overhead distribution lines are obsolescent like those in Arusha and have many sections in which Cu 25 mm^2, Cu 16 mm^2, etc. are used. Because of this, there are many problems, including the voltage problems, which are ascribable to insufficient conductor capacity and deterioration.

In Moshi, there are very few lines which are provided with section switches. Therefore, whenever it becomes necessary to change the service area or effect load shedding, they manually disconnect and reconnect the jumper wires of the line.

In the Moshi area, the Study Team measured loads of the Boma Mbuzi S/S and Trade School S/S. The measurement results are shown in Fig.s 5.3.1 and 5.3.2. The present conditions and problems of the distribution facilities in Moshi are as described in paragraph 5.1.3.

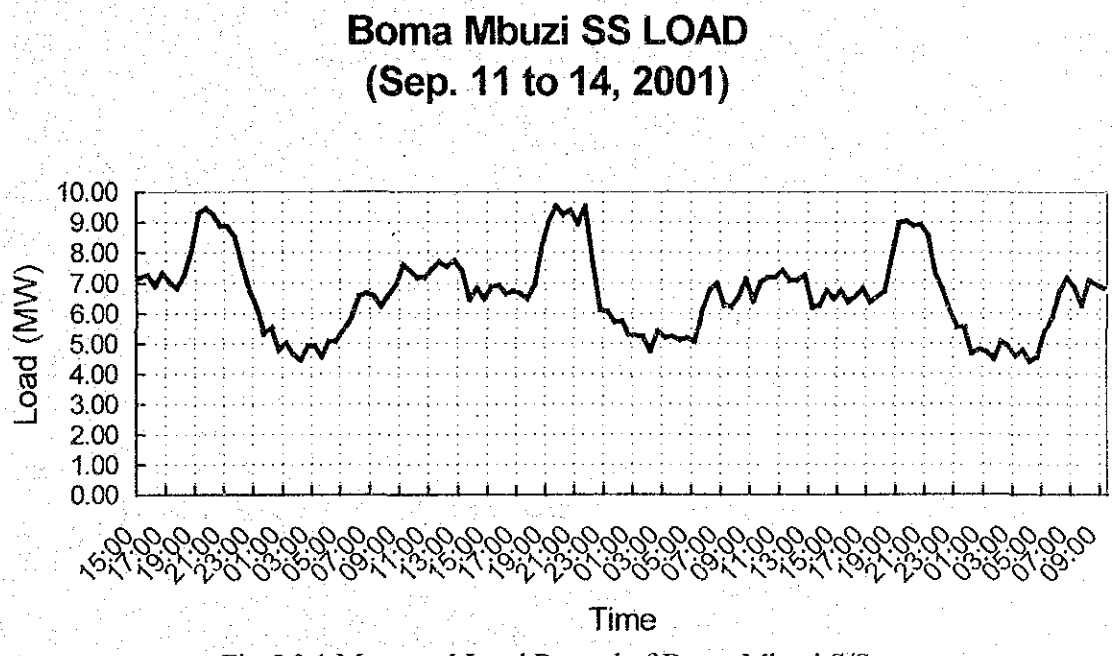

Fig.5.3.1 Measured Load Record of Boma Mbuzi S/S

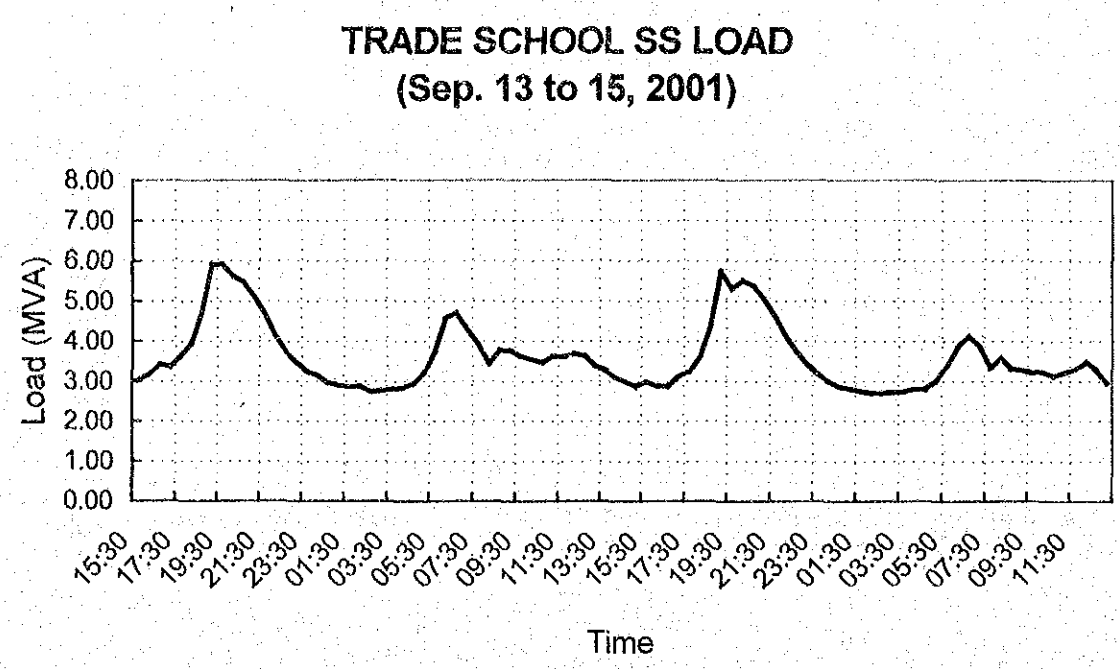

Fig.5.3.2 Measured Load Record of Trade School S/S