CHAPTER 7

CONCEPTUAL DESIGN
OF
TARGET FACILITIES

CHAPTER 7 CONCEPTUAL DESIGN OF TARGET FACILITIES

In this study, the design of the target facilities was done in two stages according to the progress of the research. The first stage is the conceptual design for studying the master plan, and the second stage is the detailed design for the FS step. The difference in the conceptual and detailed designs is that the conceptual design is usually made by preliminarily applying common specifications to individual projects depending on the voltage classes and capacity of facilities, while the detailed design is made precisely and specifically for individual target projects. This means that the conceptual design includes a study relating to the construction costs of a 66kV transmission line that is not scheduled in the final master plan.

This chapter describes the contents of the conceptual design of the transmission line, substation, and distribution equipment made in this study. The Study Team has calculated the construction costs based on the results of the conceptual design described here, and made several master plans for economic evaluation and expansion plan optimization (see Chapter 6).

In the detailed designs made after determining the master plan, the basic design policy is also based on the results of the conceptual design. However, some of the items determined after the conceptual design such as the transmission line length and line type are reviewed at the time of producing the detailed design. Where there are differences between the conceptual and detailed designs, the detailed design has precedence.

7.1 Transmission Line Facilities Conceptual Design

7.1.1 132kV Transmission Line

This section gives the results of study in regard to the 132kV transmission line expansion plan, its conceptual design, and construction costs.

(1) 132kV Transmission Line Expansion Plan

The 132kV transmission line expansion plan for Dar es Salaam, Arusha, and Moshi from 2002 to 2010 is given below.

Table 7.1.1 132kV transmission line expansion plan (Dar es Salaam)

Year	Name of TL	Specifications of conductor	Line length (km)	
			New	Additional
2003	Ubungo-NOB	$240mm^2$ 1cct	8.5	
2004	FZ III-Yombo	$240mm^2$ 1cct	8.5	
	Yombo-Mbagala	$240mm^2$ 1cct	10	
	Kurasini-Mbagala	$240mm^2$ 1cct	16	
	Ilala-Kurasini	$240mm^2$ 1cct	10	
2005	Ubungo-Ilala	$240mm^2$ 1cct		7.5

Table 7.1.2 132kV transmission line expansion plan (Arusha, Moshi)

Year	Name of TL	Specifications of conductor	Line length (km)	
			New	Additional
2003	Njiro-Kiyungi	$240mm^2$ 1cct	70	

(2) 132kV Transmission Line Conceptual Design

(a) Applicable standards

Standards of IEC or its equivalent should be applied to the design of these transmission lines.

(b) Heights of transmission lines

According to the results of TANESCO, the heights of transmission lines should be as given in the table below.

Table 7.1.3 132kV transmission line heights

Item	Minimum height (m)
General points	6.7
Road	8.0
Railway	9.0
Waterway, sea-lane	10.0

(c) Wind pressure loads

According to the results of TANESCO at Dar es Salaam and Kilimanjaro, the wind pressure loads to be applied to the support should be as given in the table below.

Table 7.1.4 Wind pressure loads to 132kV transmission line

Item	Wind Pressure (kg/m^2) *	
	Dar es Salaam	Arusha、Moshi
Steel tower	266	200
Conductor	92	71

Designed wind pressure (steel tower) Dar es Salaam = 38 m/sec
Arusha, Moshi = 33 m/sec
Designed wind pressure (conductor) Dar es Salaam = 40 m/sec
Arusha, Moshi = 35 m/sec

(d) Natural conditions

The natural conditions for the transmission line design should be as given in the table below.

Table 7.1.5 Natural conditions considered for 132kV transmission line design

Item		Dar es Salaam	Arusha, Moshi
Altitude		1,000 m or less	800 to 1,500m
Outside temp.	Maximum	40°C	40°C
	Minimum	10°C	10°C
	Average	20°C	32°C

(e) Number of 132kV transmission lines

Considering the increase of electric power demand in the future, double circuits transmission line should be designed. Actually, only single circuit should be installed at the beginning of the construction, and then the second circuit should be added when necessary.

(f) Support

Self-support type double circuits steel towers should be used for the support for 132kV transmission lines, because they allow easy increase in capacity when the demand for electric power increases in the future, requiring only narrow ground width and requiring no stay wires. The number of successive suspension towers should be 10 or less. See Fig. 7.1.1 for the outline of the support.

(g) Foundation

Various types of foundations may be used for transmission line towers, depending on the ground conditions of the site. Concrete reinforced foundations should be used for sites with good ground conditions, and steel-pipe pile foundations for those with bad conditions, such as marshy areas.

(h) Selecting conductors

According to the results of electric current calculation based on assumed electric power demand and from the point of view of electric conductor standardization, ACSR 240mm^2 should be used for 132kV transmission lines. For the Dar es Salaam area, where salt damage has been reported over a wide area, ACSR of anti-corrosion type should be used.

(i) Ground wires

AAC (hard-drawn aluminum stranded wire) of 55 mm^2 should be used for the 132kV transmission line ground wires. For the Dar es Salaam area, where salt damage has been reported over a wide area, use of ACS (aluminum-coated twisted steel wire) of anti-corrosion type is recommended.

(j) Insulators

The 132kV transmission line insulators should be designed according to the standards of IEC or its equivalent. For the Dar es Salaam area, where salt damage has been reported over a wide area, use of zinc sleeved suspension insulators is recommended. For reference, in the Dar es Salaam power supply expansion plan executed before, eleven pieces of 250mm suspension insulators were used, with the withstand voltage per insulator in dirty or damaged state to be 7.7 kV. In the current study, similar values should be used.

(3) 132kV transmission line construction cost

The results of trial calculation of the 132kV transmission line construction cost are given below. For the calculation, the detailed design estimate project cost (May 1997) was used as reference. The exchange rate used is US$1 = 900 Tsh = ¥130. The prices escalation since 1997 was ignored.

(a) 132kV transmission line construction cost per km

The cost for constructing new 132kV transmission line (stringing single circuit with double circuits design) and adding second circuit is given below.

Table 7.1.6 132kV transmission line construction cost per km (Unit: US$1,000/km)

Item	Foreign currency	Domestic currency	Total
Construction cost for new 132kV transmission line per km	221	67	288
Construction cost for additional 132kV circuit per km	54	11	65

(b) 132kV transmission line construction cost

The 132kV transmission line construction cost for Dar es Salaam, Arusha, and Moshi from 2002 to 2010 is given below.

Table 7.1.7 132kV transmission line construction cost (Dar es Salaam)

Year	Name of TL	Specifications of conductor	Line length (km)		Construction cost (US$1,000)		
			New	Additional	Foreign currency	Domestic currency	Total
2003	Ubungo-NOB	240mm² 1cct	8.5		1,883	567	2,450
2004	FZ III-Yombo	240mm² 1cct	8.5		1,883	567	2,450
	Yombo-Mbagala	240mm² 1cct	10		2,216	667	2,883
	Kurasini-Mbagala	240mm² 1cct	16		3,545	1,067	4,612
	Ilala-Kurasini	240mm² 1cct	10		2,216	667	2,883
2006	Ubungo-Ilala	240mm² 1cct		7.5	403	85	488
Total					12,146	3,620	15,766

Table 7.1.8 132kV transmission line construction cost (Arusha, Moshi)

Year	Name of TL	Specifications of conductor	Line length (km)		Construction cost (US$1,000)		
			New	Additional	Foreign currency	Domestic currency	Total
2006	Njiro-Kiyungi	240mm² 1cct	70		15,511	4,667	20,178

7.1.2 66kV Transmission Line

This section gives the results of study regarding the 66kV transmission line expansion plan, its conceptual design, and construction cost.

(1) 66kV transmission line expansion plan

Though the current master plan contains no 66kV transmission line expansion plan, its conceptual design is made in order to compare economic conditions with the 33kV transmission line, using the Kiyungi-Marangu line (40.1 km) requested by TANESCO as a model.

(2) 66kV transmission line conceptual design

(a) Applicable standards

See 7.1.1 (1) (a).

(b) Heights of transmission lines

The heights of 66kV transmission lines are not clear in detail. The values for the 132kV transmission lines should be used.

(c) Wind pressure loads

See 7.1.1 (1) (c).

(d) Natural conditions

See 7.1.1 (1) (d).

(e) Number of 66kV circuits

Considering the electric power demand assumed in the 66kV transmission line study, single circuit should be planned.

(f) Support

Self-support type single circuit triangle-arranged steel towers should be used for support of 66kV transmission lines, as they require narrow ground width and no stay wires. The number of successive suspension towers should be 10 or less.

(g) Foundation

See 7.1.1 (1) (g).

(h) Selecting conductors

According to the results of electric current calculation based on the assumed electric power demand, and because it is considered to be more economical when the load span of supports are made longer, with the supports decreased, the load span is determined as 300m. Therefore, ACSR 150mm^2 should be used, with consideration for the maximum available tension, though it has an excessive transmission capacity.

(i) Ground wires

AAC (hard-aluminum stranded wire) of 55 mm^2 should be used for the 66kV transmission line ground wires.

(j) Insulators

The 66kV transmission line insulators should be designed according to the standards of IEC or its equivalent. For the existing 66kV transmission line in the Kilimanjaro area, six pieces of 250mm suspension insulators are used per phase.

(3) 66kV transmission line construction cost

The results of a trial calculation of the 66kV transmission line construction cost are given below. For the calculation, the detailed design estimate project cost (May 1997) was used as reference. The exchange rate used is US$1 = 900 Tsh = ¥130. The prices escalation since 1997 was ignored.

(a) 66kV transmission line construction cost per km

The cost for constructing a new 66kV transmission line (single circuit) is given below.

Table 7.1.9 66kV transmission line construction cost per km (Unit: US$1,000/km)

Item	Foreign currency	Domestic currency	Total
Construction cost for new 66kV transmission line per km	121	36	157

(b) 66kV transmission line construction cost

The 66kV transmission line construction cost for Kiyungi-Marangu is given below.

Table 7.1.10 132kV transmission line construction cost (Arusha, Moshi)

Name of TL	Specifications of conductor	Line length (km)		Construction cost (US$1,000)		
		New	Additional	Foreign currency	Domestic currency	Total
Kiyungi-Marangu	150mm^2 1cct	40.1		4,852	1,444	6,296

7.1.3 33kV Transmission Line

This section gives the results of study in regard to the 33kV transmission line expansion plan, its conceptual design, and construction cost.

(1) 33kV Transmission Line Expansion Plan

The 33kV transmission line expansion plan for Dar es Salaam, Arusha, and Moshi from 2002 to 2010 is given below.

Table 7.1.11 33kV transmission line expansion plan (Dar es Salaam)

Year	Name of TL	Specifications of conductor	Line length (km)	
			New	Additional
2002	Tegeta-Bahari Beach*	100mm^{2}x2 1cct	13	
	Tegeta-Bagamoyo*	100mm^{2}x2 2cct	60	
	City Center-Sokoine	100mm^2 1cct		3
	Ilala-Kurasini	150mm^2 1cct		7.1
	Ubungo-Tandale Tap	100mm^{2}x2 2cct		1
	Magomeni-Magomeni Tap	100mm^2 1cct	1	
	FZ III-Tandika	100mm^{2}x2 1cct	5	
2003	Ilala-Muhimbili	100mm^2 1cct	6	
	Ilala-TOL	100mm^{2}x2 1cct	5	
	Ubungo-University	100mm^2 1cct	7	
	NOB-Oysterbay	150mm^{2}x2 1cct	1.6	
	NOB-Msasani	150mm^{2}x2 1cct	5	
2004	Ubungo-Mbrahati	100mm^2 1cct	4	
	Yombo-Kitunda	100mm^2 1cct	3.9	
2005	Mbezi-Kawe	100mm^2 1cct	9	
	Mikocheni-Kinondoni	100mm^2 1cct	8	
	Kurasini-Chang'ombe	120mm^2 1cct		3
2006	Tegeta-Kunduchi	100mm^2 1cct	3.2	
	Ilala-Kigogo	100mm^2 1cct	12	
	Ilala-City Center #2	100mm^2 1cct		2.8
2007	Tegeta-Mbezi	100mm^2 1cct		8.4
	Ilala-Kariakoo	100mm^2 1cct		1.3

*:On going

Table 7.1.12 33kV transmission line expansion plan (Arusha, Moshi)

Year	Name of TL	Specifications of conductor	Line length (km)	
			New	Additional
2002	Njiro-Mt.Meru	100mm² 1cct		7.3
	Kiyungi-Boma Mbuzi	100mm² 1cct		7
	Kiyungi-Trade School	100mm² 1cct		10
	Kiyungi-Marangu	100mm² 1cct	43	
2003	Njiro-Unga LTD	100mm² 1cct		5.8
	Njiro-Usa River	100mm² 1cct	21.3	
	Tengeru-Usa River	100mm² 1cct	12.5	
	Njiro-Monduli	100mm² 1cct	38.6	
2004	Njiro-Sakina	100mm² 1cct	13.2	
	Mt.Meru-Sakina	100mm² 1cct	8.1	
	Trade School-KCMC	100mm² 1cct	3.7	
2005	Njiro-Njiro B	100mm² 1cct	3	
2006	KCMC-Gomberi	100mm² 1 cct	4.9	

(2) 33kV transmission line conceptual design

(a) Applicable standards

See 7.1.1 (1) (a).

(b) Heights of transmission lines

According to TANESCO, the heights of transmission lines should be as given in the table below.

Table 7.1.13 33kV transmission line heights

Item	Minimum height (m)
General points	5.0
Road	6.7
Railway	9.0
Waterway, sea-lane	10.0

(c) Wind pressure loads

According to the results of TANESCO at Dar es Salaam and Kilimanjaro, the wind pressure loads to be applied to the support should be as given in the table below.

Table 7.1.14 Wind pressure loads to 33kV transmission line

Item	Wind Pressure (kg/m^2)	
	Dar es Salaam	Arusha、Moshi
Wooden pole, steel pipe pole	73	75
Conductor	50	50

(d) Natural conditions

See 7.1.1 (1) (d).

(e) Number of 33kV circuits

According to the electric current calculation results based on the assumed electric power demand, constructing or adding single or double circuits is determined suitable.

(f) Support

For the 33kV transmission lines, wooden poles or steel pipe poles should be used. In addition, stay wires should be used when necessary.

(g) Selecting conductors

According to the results of electric current calculation based on the assumed electric power demand, ACSR 100mm^2, 120mm^2, or 150mm^2 should be used for 33kV transmission lines. For the Dar es Salaam area, where salt damage has been reported over a wide area, use of ACSR of anti-corrosion type is recommended.

(h) Ground wires

AAC (hard-aluminum stranded wire) of 30 mm^2 should be used for the 33kV transmission line ground wires. For the Dar es Salaam area, where salt damage has been reported over a wide area, use of ACS (aluminum-coated twisted steel wire) of 30mm^2 of anti-corrosion type is recommended.

(i) Insulators

The 33kV transmission line insulators should be designed according to the standards of IEC or its equivalent. For the Dar es Salaam area, where salt damage has been reported over a wide area, use of zinc sleeved suspension insulators is recommended. For reference, in the Dar es Salaam power supply expansion plan executed previously, 250mm suspension, LP, or pin insulators were used. Three pieces of insulators are used per phase, with the withstand voltage per insulator in dirty or damaged state to be 7.7 kV. In the current study, similar values should be used.

(3) 33kV transmission line construction cost

The results of electric current calculation of the 33kV transmission line construction cost are given below. For the calculation, the detail design estimate project cost (May 1997) was used as a reference. The exchange rate used is US$1 = 900 Tsh = ¥130. The prices escalation since 1997 was ignored.

(a) 33kV transmission line construction cost per km

The cost for constructing new 33kV transmission line or adding single circuit is given below.

Table 7.1.15 33kV transmission line construction cost per km (Unit: US$1,000/km)

Transmission line specifications	Foreign currency	Domestic currency	Total
ACSR 150mm^2 single conductor 1cct	56	6	62
ACSR 120mm^2 single conductor 1cct	55	6	61
ACSR 100mm^2 single conductor 1cct	54	6	60
ACSR 150mm^2 2 cct ACSR 150mm^2 double conductor 1cct	79	9	88
ACSR 100mm^2 double conductor 1cct	74	9	93
ACSR 100mm^2 double conductor 2cct	152	16	168

(b) 33kV transmission line construction cost

The 33kV transmission line construction cost for Dar es Salaam, Arusha, and Moshi from 2002 to 2010 is given below.

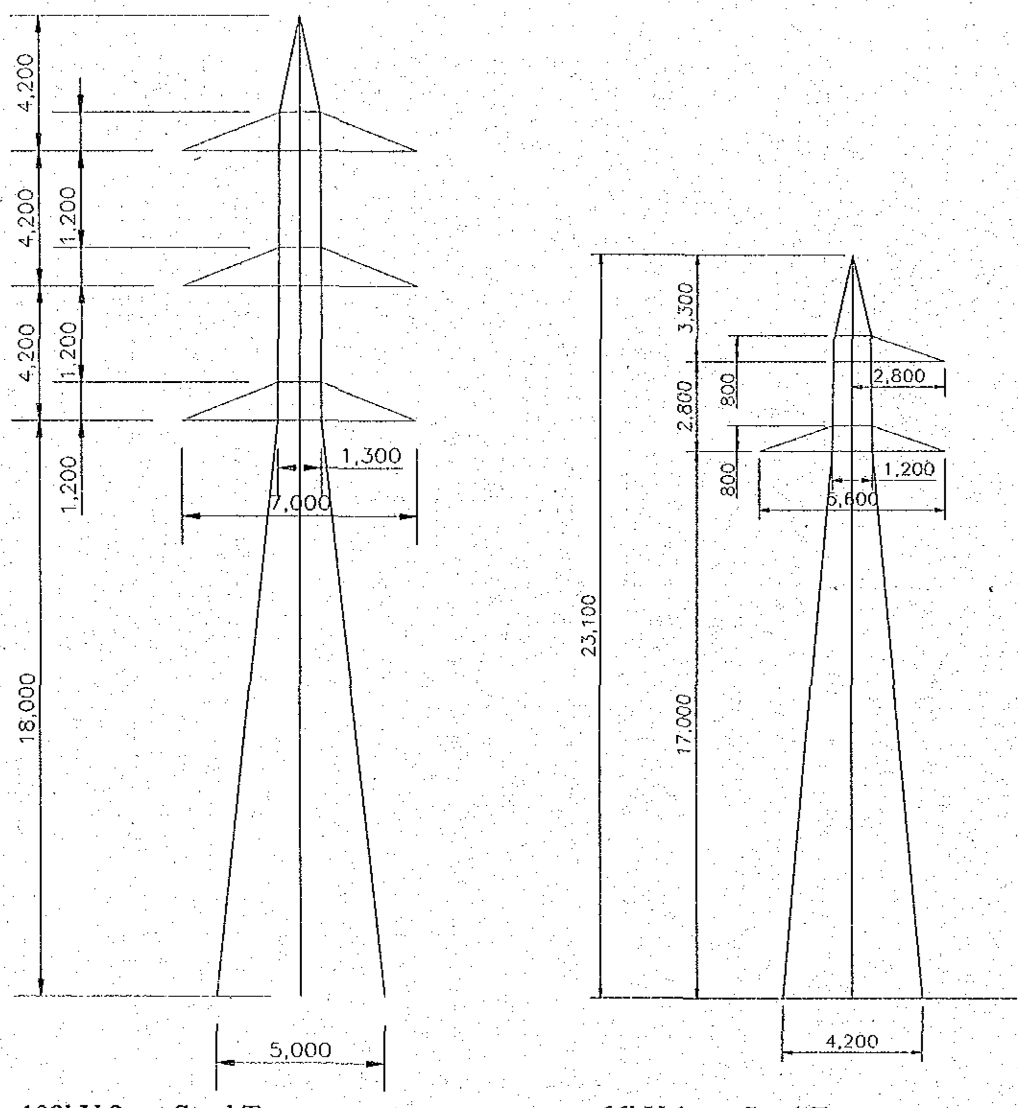
Table 7.1.16 33kV transmission line construction cost (Dar es Salaam)

Year	Name of TL	Specifications of conductor	Line length (km)		Construction cost (US$1,000)		
			New	Additional	Foreign currency	Domestic currency	Total
2002	Tegeta-Bahari Beach*	100mm²x2 1cct	13		969	113	1,082
	Tegeta-Bagamoyo*	100mm²x2 2cct	60		9,136	977	10,113
	City Center-Sokoine	100mm² 1cct		3	163	19	182
	Ilala-Kurasini	150mm² 1cct		7.1	395	47	442
	Ubungo-Tandale Tap	100mm²x2 2cct		1	152	16	168
	Magomeni-Magomeni Tap	100mm² 1cct	1		54	7	61
	FZ III-Tandika	100mm²x2 1cct	5		372	44	416
2003	Ilala-Muhimbili	100mm² 1cct	6		326	38	364
	Ilala-TOL	100mm²x2 1cct	5		372	44	416
	Ubungo-University	100mm² 1cct	7		380	44	424
	NOB-Oysterbay	150mm²x2 1cct	1.6		126	15	141
	NOB-Msasani	150mm²x2 1cct	5		394	46	440
2004	Ubungo-Mburahati	100mm² 1cct	4		217	25	242
	Yombo-Kitunda	100mm² 1cct	3.9		212	24	236
2005	Mbezi-Kawe	100mm² 1cct	9		489	57	546
	Mikocheni-Kinondoni	100mm² 1cct	8		435	50	485
	Kurasini-Chang'ombe	120mm² 1cct		3	166	19	185
2006	Tegeta-Kunduchi	100mm² 1cct	3.2		174	20	194
	Ilala-Kigogo	100mm² 1cct	12		652	75	727
	Ilala-City Center #2	100mm² 1cct		2.8	152	18	170
2007	Tegeta-Mbezi	100mm² 1cct		8.4	456	53	509
	Ilala-Kariakoo	100mm² 1cct		1.3	71	8	79
Total					11,036	1,261	12,297

*: On Going

Table 7.1.17 33kV transmission line construction cost (Arusha, Moshi)

Year	Name of TL	Specifications of conductor	Line length (km)		Construction cost (US$1,000)		
			New	Additional	Foreign currency	Domestic currency	Total
2002	Njiro-Mt.Meru	100mm² 1cct		7.3	397	46	443
	Kiyungi-Boma Mbuzi	100mm² 1cct		7	381	44	425
	Kiyungi-Trade School	100mm² 1cct		10	543	63	606
	Kiyungi-Marangu	100mm² 1cct	43		2,336	271	2,607
	Njiro-Unga LTD	100mm² 1cct		5.8	315	37	352
	Njiro-Usa River	100mm² 1cct	21.3		1,157	134	1,291
	Tengeru-Usa River	100mm² 1cct	12.5		679	79	758
2003	Njiro-Monduli	100mm² 1cct	38.6		2,097	243	2,340
	Njiro-Sakina	100mm² 1cct	13.2		717	83	800
	Mt.Meru-Sakina	100mm² 1cct	8.1		440	51	491
	Trade School-KCMC	100mm² 1cct	3.7		201	23	224
	Njiro-Njiro B	100mm² 1cct	3		163	19	182
2004	KCMC-Gomberi	100mm² 1 cct	4.9		266	31	297
Total					9,692	1,124	10,816



132kV 2 cct Steel Tower

66kV 1 cct Steel Tower

Fig. 7.1.1 Typical Design of 132kV and 66kV Steel Towers

7.2 Substation Facilities Conceptual Design

7.2.1 Basic Concept of Design

The purpose of this project is to renew the necessary facilities and to make use of existing substations availably by utilizing the transmission facilities, substations, and distribution facilities that make up the existing electric power system, to expand facilities coping with increased power demand in individual regions and areas, and to keep supplying stable power to users by adding transmission facilities, substations, and distribution facilities as required for new users.

The characteristics of this project are that power is basically supplied from remotely positioned large-scale hydroelectric power plants and that the number of transmission lines for supplying power to the load centers is quite limited.

Actually, there is only one primary substation at Ubungo S/S in the Dar es Salaam area, at Njiro S/S in the Arusha area, and at Kiyungi S/S in the Moshi area. The supply capacity and facilities reliability of each of these substations is the key to the stable power supply to these areas. This hierarchical configuration will be maintained in the future.

Except for the existing secondary substation in the Dar es Salaam area, power from the substations is supplied directly to the 33kV distribution substations. Therefore, the most reasonable and economical way for maintaining and operating the facilities is to determine the basic design conditions so that the adequate for each substation hierarchy level is acquired, and to plan, evaluate, and determine the facilities configuration, facilities specifications, and device specifications.

(1) Setting reliability levels

The substation reliability levels to be set are classified to lowest absolute levels and relative levels within the power network. The absolute levels are related mainly to basic performance of devices, and the relative levels are related mainly to the bus configuration, main circuit configuration, grounding method, protective relay devices, and system configuration.

The reliability levels are classified by the following factors:

- Positioning in hierarchy in the power system
- Voltage level
- Number of primary incoming / outgoing
- Total number of transformers
- Installed capacity
- Grounding system (such as transformer neutral point directly grounded, non-grounded system)
- Extend of influence by fault
- Protective relay system applied

The reliability levels finally classified by the factors above are given in the table below.

Table 7.2.1 Reliability assignment table

No.	Reliability items		Reliability level I	Reliability level II	Reliability level III
i	Positioning in hierarchy		Primary substation	Primary or secondary substation	Distribution substation
ii	Extent of influence by fault		*Influence to load center* whole area or wider range	*Influence to load center* whole area or wider range	Influence mainly to feeder lines
iii	Primary voltage level		220kV *or* 132kV	132kV	33kV (*partly 66*kV)
iv	Number of primary and secondary *incoming/outgoing* transmission lines		More than 4 lines	2 to 4 lines	2 or less lines
v	Total number of transformers		More than 6	3 to 6	3 or less
vi	Installed capacity		More than 100MVA	60MVA to 100MVA	60MVA or less
vii	Grounding system		Direct grounding	Direct grounding	Non-grounded in principle
viii	*Protective relay* system		*Short-circuit protection,* ground fault protection	*Short-circuit protection,* ground fault protection	*Short-circuit protection* in principle
ix	Applicable S/S name	DSM	Ubungo, Ilala, Tegeta Kinyerezi	NOB, FZIII, Yombo, Mbagala, Kurasini	Distribution substation
		Arusha	Njiro	———	Distribution substation
		Moshi	Kiyungi	———	Distribution substation

(2) Substation Bus Configuration

(a) Primary or secondary substation

For the primary or secondary substation bus configuration, single bus, inspection bus, double bus, 1.5CB, or quadruple bus type may be adopted.

However, in the target substations of this project, the number of incoming / outgoing lines for each voltage for the 220kV or 132kV line is eight for the 132kV lines for Ubungo S/S. For the transformers of these lines, the number of feeders is fourteen assuming a maximum of four banks that includes the current two banks and two more to be added, and Ilala expansion line and New Oysterbay new line in future. The bus configuration of this circuit is already comprised of double bus of one tie.

Theoretically, the more the bus is divided, the higher the reliability of the facilities, because the range influenced in case of an accident is limited. But, if the number of necessary circuit breakers increases, protection of the bus becomes complex. Therefore, an appropriate type should be selected considering economical, maintenance, and operational factors.

Moreover, many of the substations requiring a high reliability level in this project are existing ones, which have not been designed as highly reliable bus types such as double bus. Changing the single bus type to double bus type requires large-scale reconstruction of the outdoor bus, switchgears, and protective relay devices. This involves large costs and the system will need to be stopped for a long time.

Considering the matters above, the bus configuration is planned as described below.

For Ubungo and Njiro, the additional 220kV bus should be connected to the existing 220kV bus via a disconnecting switch, to avoid the long time system outage due to bus faults.

Even when the number of feeder lines connected to the 132kV line of each substation exceeds 6, a disconnecting switch should be inserted between the existing and new buses to avoid system outage due to bus failures.

(b) Bus configuration of distribusion substation

In distribution substations, a single bus type should be adopted, because large-scale repairs are not required for bus accidents and back-up by 11kV distribution facilities extended in the future can be expected.

(c) Insulation coordination

Insulation cooperation is a function of a substation, which maintains its insulation performance against lightning surges or switching surges.

The important items for insulation cooperation are:

1. Ensuring the device withstand voltage level is in cooperation with the surge arrester protection level.
2. Setting an appropriate protection level, that is, regulating the lightning arrester protection level and the maximum residual voltage for operating the lightning arrester.
3. Setting appropriate values for the ground and phase segregations of device chargers including outdoor buses.

The design values for items above are given below. These values are based on IEC.

(i) Device withstand voltage levels

The maximum continuous operation voltage and lightning impulse withstand voltage for each of nominal voltages adopted are given in the table below.

Table 7.2.2 Withstand voltage levels of devices

No.	Nominal voltage (kV)	Maximum operation voltage (kV)	Lightning impulse withstand voltage (LIWV, kV)
1	33	34.5	200
2	66	69	350
3	132	138	650
4	220	230	900

(ii) Rated values of lightning arrester

The rated voltage, minimum discharge voltage, and maximum residual voltage for each of the nominal voltages of the lightning arrester for protecting the devices are given in the table below.

Table 7.2.3 Rated values of lightning arrester

No.	Nominal voltage (kV)	Rated voltage (kV)	Minimum discharge voltage (kV)	Maximum residual voltage (kV)
1	33	42	59	140
2	66	84	119	269
3	132	126	178	403
4	220	210	230	605

(iii) Electrical clearance design

The minimum and standard electrical clearance between the outdoor bus conductor and ground and those between conductors (phase to phase) should be set as the insulation clearance.

In the same way for the device charged part, the minimum and standard values between the changed part and ground and between charged part phases should be set. In the table, the minimum value refers to the minimum distance between the conductor and ground when the charged part is fixed and the standard value refers to the distance between conductor centers applied when the tension bus is influenced by wind, etc.

When expanding the existing facilities, their values should be adopted for consistency in the substation if they satisfy the current conditions and not less than the indicated values.

Table 7.2.4 Insulation segregations of design

No.	Nominal voltage (kV)	LIWV (kV)	Insulation segregation for ground (cm)		Phase insulation segregation (cm)	
			Minimum value	Standard value	Minimum value	Standard value
1	33	200	35	50	50	90
2	66	350	65	90	90	150
3	132	650	130	170	170	250
4	220	900	180	230	230	360

(d) Salt contamination design

For this project, the Dar es Salaam area has a problem with salt contaminatin. In this area, the 33kV substation in Msasani S/S suffers from severe salt contamination. Actually, salty wind blows into the 11kV cubicle, causing damage to the internal insulation.

No outdoor facilities have occurred in the substation most influenced by salt contamination. Therefore, the devices used for the 33kV lines of substations with the same or less salty conditions can be assumed to have no problems with salt.

As a result, 132kV substations near the seashore would have problems. These are 132kV circuits in New Oysterbay and Kurashini S/S's.

(i) 132kV equipment contamination design

The most important factor in the salt contamination design is the past flashover faults caused by salt contamination and the data indicating the grade of contamination density at the faults. However, there is no such data in existence. The only data that is assumed to be useful is the example of the Tegeta S/S positioned relatively close (3 km) to the seashore and the design of 132kV transmission.

For the Tegeta S/S bus, nine insulators are used on the TANESCO side and sixteen on the IPP side. On the other hand, eleven insulators are used for the 132kV transmission line. They are all standard suspension insulators and the difference between insulators should be only small. In this case, the difference may have increased because different designers designed them.

In the Tegeta S/S, no flashover faults have occurred due to salt contamination in five years. Insulators outdoor are washed by rain, and the volume of salt put on the insulators by seasonal wind increases and decreases repeatedly every year. That is, it reaches the maximum level in dry seasons and goes lower in rainy seasons. Five-year data showing no accidents would be a kind of index.

For the eleven insulators of the transmission line that leads to the cable landing point for Zanzibar, few member of flashovers have occurred under the same design. Therefore, eleven or more insulators would be sufficient if the position is not too close to the seashore.

Next, when a ground fault occurs on a single transmission line of the 132kV system where direct grounding is adopted, the increase of the voltage to ground is less than that for a non-grounding type. Therefore, for 11+1=12 insulators, the density of equivalent salt adhered is 0.06 mg/cm^2, which is converted to 0.03 mg/cm^2 for insulators used in substations.

Thus, the 132kV circuit for the 132kV substation should be designed as follows:
For bus insulators, equivalent salt adhered (ESDD: 0.06 mg/cm^2)
For device insulators, equivalent salt adhered (ESDD: 0.03 mg/cm^2)

(ii) 11kV cubicle contamination design

Currently, most of the 11kV cubicles of the distribution substations in Dar es Salaam are of the indoor type, although some are of the outdoor type.

When installing cubicles of the outdoor type in an area that may suffer salt contamination, the characteristics of contamination on the indoor facilities and the conditions that cause dielectric breakdown should be given due consideration.

- Relationships between adhered salt inside and outside a cubicle

As a matter of course, the measurement results in the past show that the more the salt adheres outside a cubicle, the higher the degree of contamination inside the cubicle.

What should be noticed in these measurement results is that the salt adhered (ESDD) outside a closed type outdoor cubicle is 0.2 mg/cm^2 and the ESDD inside the cubicle is 0.002 mg/cm^2, which is negligible, while the ESDD outside a ventilation type outdoor cubicle is 0.1 mg/cm^2 and the ESDD inside the cubicle is 0.02 mg/cm^2, which is 20% of the outside value.

- Characteristics of indoor contamination

The salt adhering to outdoor facilities will be saturated at a certain value because of the cleaning effect of rain over a long period of time, except for rapid contamination in a comparatively short time during the period of the monsoon. On the other hand, indoor contamination may be assumed to have no notable saturation tendency because no cleaning effect by rain may be expected. However, the results of exposure tests in the past show that (1) the top side of a suspension insulator shows a tendency to saturation in approximately two years and the bottom side shows the same tendency in approximately one year, and (2) a station post insulator shows a tendency to saturation in approximately two years, but it is not notable. Therefore, the contamination of indoor facilities or the inside of outdoor cubicles will reach saturation in two years or more, and in this period of time the accumulated contamination steadily increases.

- Conditions for causing flashover faults by contamination

Even when salt contamination inside a cubicle has increased to a certain level, flashover faults will not occur if no dew is condensed. In other words, flashover faults may be avoided by lowering the relative humidity inside a cubicle.

- Effect of cleaning

Table 7.2.5 shows the effect of dry wiping measured in the past. In this measurement, the equivalent adhered salt was measured before and after dry wiping the sample, which had been left approximately one month with no power applied.

Table 7.2.5 Measured results of dry-wiping effect

Insulator type	Equivalent salt adhered (ESDD) (mg/mm^2)		Remarks
	Before dry wiping	After dry wiping	
Standard porcelain support insulator for 22kV	0.0045	0.0020	Average value from three samples
Standard porcelain support insulator for 6kV	0.0067	0.0028	Average value from four samples
Epoxy resin support insulator for 6kV	0.0101	0.0063	Average value from four samples

Measures for avoiding flashover faults due to contamination

According to the measurement results and flashover fault conditions described above, possible measures for avoiding flashover faults may be as follows:

① Use of sealed cubicles
② Use of structure allowing closure of ventilating holes
③ Preventing condensation of dew by appropriate use of heaters of appropriate capacity
④ Decreasing adhered salt by periodic cleaning
⑤ Over-insulation design of internal devices
⑥ Shielding cubicles to reduce salty wind blown in

- Evaluation of measures for avoiding flashover faults due to contamination

Table 7.2.6 Measures for avoiding flashover faults due to contamination and their evaluation

Table 7.2.6 Measured for avoiding flashover faults due to contamination and their evaluation

	Measures	Advantages	Disadvantages	Comprehensive evaluation
①	Use of sealed cubicles	Steadily decreases contamination, promising internal contamination equivalent to that on indoor cubicles.	Countermeasures for raised internal temperature require special designs for internal devices and housings.	B
②	Use of structure allowing closure of ventilating holes	Effective as emergency escape from rapid contamination. Comparatively economical method.	Unavailable when both heavy load and rapid contamination occur simultaneously in high-temperature period. Difficult to manage.	B
③	Use of heaters	Comparatively economical method promising effectiveness.	Difficult to use appropriately during a period when both the relative humidity and temperature are high.	B
④	Periodic cleaning	Steadily reduces contamination.	Requires sufficient safety measures. Requires complete or partial shutdown.	A
⑤	Over-insulating internal devices	Design for appropriately assumed contamination will promise sufficient effectiveness.	Requires high cost for insulation-related parts.	AA
⑥	Installing shielding structures	Already has certain results. A double-shielding wall containing a part of the roof may promise higher effectiveness.	May not be effective for some areas depending on the route of salty wind blown in.	A

- Recommended measures for avoiding flashover faults

According to the evaluation results given above, over-insulation design of internal devices, shielding structures surrounding cubicles, and periodic cleaning can be considered as effective countermeasures. Note that cleaning requires sufficient safety measures such as a complete shutdown.

(e) Standards of devices and rated values of main devices

The standards applied when selecting devices should be based on IEC or its equivalent. The rated values of devices used in this project are given below.

(i) Transformers

The standards should be based on IEC or its equivalent. The targets are the major transformers in substations for 33kV or more. The cooling type should be self-cooling with oil and a tap changer for loading should be equipped.

Table 7.2.7 Transformer specifications

No.	Primary voltage (kV)	Secondary voltage (kV)	Capacity (MVA)	OLTC adjusting width (+%, -%)	Connecting type	Remarks
1	220	132	60	+10、-10	Y-Y-D	Applied to Njiro
2	132	33	45	+5、-15	Y-Y-D	
3	33	11	30	+10、-10	Y-D	Applied to City Center
4	33	11	15	+10、-10	Y-D	
5	33	11	10	+10、-10	Y-D	For Arusha, Moshi
6	33	11	5	+10、-10	Y-D	For Arusha, Moshi

(ii) Circuit breakers

The standards should be based on IEC or its equivalent. The targets are the circuit breakers in substations for 11kV or more. Considering the future compatibility, the rated values should be consistent as far as possible.

Table 7.2.8 Circuit breaker specifications

No.	Nominal voltage (kV)	Rated voltage (kV)	Rated current (A)	Rated breaking current (kA)	Standard rated operating voltage (V)	Rated breaking time (cycles)	Remarks
1	220	240	2000	31.5	DC100	3	Rated values of equivalent or more
2	132	145	1200	25	DC100	5	
3	66	72	800	20	DC100	5	
4	33	36	600	12.5	DC100	5	
5	33	36	1200	12.5	DC100	5	
6	33	36	2000	25	DC100	5	
7	11	12	1200	25	DC100	5	
8	11	12	2000	25	DC100	5	

(iii) Disconnecting switches

The standards should be based on IEC or its equivalent. The targets are the circuit breakers in substations for 33kV or more. Considering the future compatibility, the rated values should be consistent as far as possible.

Disconnecting switches used in combination with circuit breakers should be in cooperation with them.

Table 7.2.9 Disconnecting switch specifications

No.	Nominal voltage (kV)	Rated voltage (kV)	Rated current (A)	Rated short-time current (kA)	Standard rated operating voltage (V)	Rated breaking time (cycles)	Remarks
1	220	240	2000	31.5	DC100	3	Rated values of equivalent or more
2	132	145	1200	25	DC100	5	
3	66	72	800	20	DC100	5	
4	33	36	600	12.5	DC100	5	
5	33	36	1200	12.5	DC100	5	
6	33	36	2000	25	DC100	5	

(iv) Other devices

Also for the other devices, the standards should be based on IEC or its equivalent. Considering the future compatibility, the rated values should be consistent as far as possible.

(f) System voltage

This project does not include selecting the system voltage for transmitting to the load center from a far remote power station. It is within the limited range of an existing system.

The system voltage applied to a substation is related to the new or expanded facilities of a substation in an existing system. The standard voltage in cooperation with the existing facilities is most economical and most advantageous for operation. Therefore, the existing voltage should basically be adopted. That is, the substation primary voltage should be based on 220kV or 132kV, and the secondary voltage should be based on 33kV.

Other voltages, for example 66kV, may only be used when existing facilities in a limited area such as Moshi are available.

(g) Basic conditions for system operation

The devices designed, installed, and operated in this project are to be used in the same place as or close to the place where the existing devices are being used. That means, the system operator may use these devices under allowable conditions for the existing facilities. The actual conditions are given below.

The long-term voltage fluctuation assumed value is 50% of tap changer adjusting width under load of the transformer.

220kV system: ±5% or less
132kV system: +2.5%, -7.5% or less
33kV system: 5%, -5%

(h) Transportation limit

Because a transformer of approximately 70 tons can be transported by land for Moshi and Arusha, devices not heavier than 70 tons may be transported without any problems for the Moshi and Arusha area. Because the heaviest device in this project is no heavier than 70 tons, no problems may arise for transportation.

Possible problems in transportation for the Dar es Salaam area may arise when transporting transformers to the Kinyerezi point, which is planned to be adjacent to the power plant and to Yombo.

For Kinyerezi, transportation problems may arise for turbines used for the power plant. If a transformer is heavy and it causes a transportation problem, transportation methods need to be considered, such as breaking down the transformer before transportation.

For Yombo, there is a railway approximately at a point 1 km away from the scheduled construction place. There may be no transportation problems if unloading is possible at this point.

7.2.2 Scope of Substation Rehabilitation, Expansion, and New Construction

In conclusion of the current study, this section gives the scopes of the existing substation rehabilitation and expansion and the new substation construction and their completion years.

To make the construction plan efficient and economical, the facilities to be rehabilitated and those related are treated sequentially and construction of new facilities contain a part of the next construction range, to reduce the operation cessation time. The completion years are given assuming that the construction progresses as planned.

(1) Scope of rehabilitation

(a) Dar es Salaam rehabilitation scope

Table 7.2.10 Contents of Rehabilitation in Dar es Salaam

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	Mbezi	2004	33/11kV 15MVA TR	1	Construction Start in 2003 Construction Span 18 months
			CB with CT for Line	2	
			DS for Line	2	
			33kV CB with CT	1	
			33kV DS	3	
			Lightning Arrester	1	
			Protection Panel for Line	2	
			Protection Panel for TR	1	
			11kV Cubicle	5	
			Auxiliary Panel	1	
			Monitor Panel	2	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
2	City Center	2004	33/11kV 30MVA TR	1	Construction Start in 2003 Construction Span 18 months
			33kV CB with CT	2	
			33kV DS	2	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	7	
			Auxiliary Panel	1	
			Monitor Panel	2	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
3	FZ II	2004	33kV CB with CT	1	Construction Start in 2003 Construction Span 18 months
			33kV DS	1	
			11kV Cubicle	2	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
4	FZ I	2004	11kV Cubicle	3	Construction Start in 2003
			Auxiliary Panel	1	Construction Span 18 months
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
5	Ubungo	2002	132/33kV 50MVA TR	2	
			33/11kV 15MVA TR	3	
			132kV Switchgear	1	
			33kV Switchgear	1	
			11kV Switchgear	1	
			Protection Panel for Line,TR	1	
			Station Service, DC Supply Equipment	1	
			Control House	1	
6	Kurasini	2002	33kV CB with CT	4	
			DC Supply Equipment	1	
7	Oysterbay	2004	33/11kV 15MVA TR	1	Construction Start in 2003
			33kV CB with CT for Line	1	Construction Span 18 months
			33kV DS for Line	1	
			PT	1	
			33kV CB with CT	2	
			33kV DS	3	
			Lightning Arrester	1	
			Structure	1	
			Bus	1	
			Protection Panel for Line	1	
			Protection Panel for TR	1	
			11kV Cubicle	8	
			Auxiliary Panel	1	
			Monitor Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

(b) Rehabilitation scopes for Arusha and Moshi

Table 7.2.11 Contents of Rehabilitation in Arusha, Moshi

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	Njiro	2004	132kV CB	2	Construction Start in 2003
			132kV CT	2	Construction Span 18 months
			33kV CB	7	
			33kV DS	16	
			Monitor Panel	1	
			DC Supply Equipment	1	
2	Kiyungi	2004	66kV CB	4	Construction Start in 2003
			66kV PT	1	Construction Span 18 months
			33kV CB	6	
			Monitor Panel	1	
			DC Supply Equipment	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
3	Trade School	2004	33/11kV 10MVA TR	1	Construction Start in 2003 Construction Span 18 months
			33kV CB with CT for Line	2	
			33kV DS for Line	2	
			33kV PT	2	
			CB with CT	1	
			DS	3	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus	1	
			Protection Panel for TR	1	
			Protection Panel for Line	2	
			11kV Cubicle	5	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
4	Boma Mbuzi	2004	33kV CB with CT for Line	1	Construction Start in 2003 Construction Span 18 months
			33kV DS for Line	1	
			33kV PT	1	
			33kV CB with CT	1	
			33kV DS	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
5	Kiltex	2004	33/11kV 10MVA TR	1	Construction Start in 2003 Construction Span 18 months
			33kV CB with CT	1	
			33kV DS	1	
			33kV PT	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
6	Unga LTD	2004	33/11kV 10MVA TR	3	Construction Start in 2003
			33kV CB with CT for Line	2	Construction Span 18 months
			33kV DS for Line	2	
			33kV PT	3	
			33kV DS	5	
			Station Service TR	1	
			Lightning Arrester	3	
			Structure	1	
			Bus	1	
			Protection Panel for TR	3	
			Protection Panel for 33kV Line	2	
			11kV Cubicle	7	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
7	NYM	2005	66kV T/L CB.DS	1	
8	Same	2005	132kV CB	1	
			132kV DS	2	
			132kV CT	1	
			33kV CT	3	
			Protection Panel for TR	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	

(2) Expansion and new construction

(a) Expansion and new construction for Dar es Salaam

For the Dar es Salaam expansion plan, expansion should be carried out as long as the site and other conditions permit, because the existing substation is adjacent to the load and most of the existing distribution lines or routes are available. The outline of the expansion and new construction are given below.

Table 7.2.12 Contents of Expansion in Dar es Salaam

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	Sokoine	2004	33/11kV 15MVA TR	1	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			33kV PT	1	Bus is omitted due to limited
			Station Service TR	1	space
			Lightning Arrester	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	5	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
2	Kurasini	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
3	Mbagala	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
4	Mikocheni	2004	33/11kV 15MVA TR	1	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Bus	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
5	Tandale	2004	33/11kV 15MVA TR	1	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	5	
			Monitor Panel	1	
			Auxiliary Panel	1	
			Bus Expansion Material	1	
			Construction Material	1	
			Installation	1	
6	FZ III	2004	33/11kV 15MVA TR	1	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			Bus Expansion Material	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
7	Ilala	2006	33/11kV 15MVA TR	1	Construction Start in 2005
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			Bus Expansion Material	1	
			Construction Material	1	
			Installation	1	
8	Msasani	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV CB with CT for Line	2	Construction Span 18 months
			33kV DS for Line	2	
			33kV CB with CT	1	
			33kV DS	3	
			Lightning Arrester	1	
			Structure	1	
			Bus Expansion Material	1	
			Protection Panel for 33kV Line	2	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
9	Bahari Beach	2007	33/11kV 15MVA TR	1	Construction Start in 2006
			33kV DS for Line	2	Construction Span 18 months
			33kV CB with CT	3	
			33kV DS	3	Bahari Beach S/S will be
			Lightning Arrester	1	commissioned in 2002.
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	2	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
10	Mbagala	2005	132/33kV 45MVA TR	1	Construction Start in 2003
			132kV CB with CT for Line	2	Construction Span 24 months
			132kV DS for Line	2	
			132kV CB for TR	1	
			132kV DS	3	
			132kV CVT	3	
			132kV CT	3	
			132kV Lightning Arrester	1	
			33kV CB with CT	2	
			33kV DS	3	
			33kV Lightning Arrester	1	
			Structure	1	
			Bus Expansion Material	1	
			Protection Panel for Line	2	
			Protection Panel for TR	1	
			Protection Panel for 132kV CCT	1	
			Protection Panel for 33kV CCT	1	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
11	Kurasini	2005	132/33kV 45MVA TR	2	Construction Start in 2003
			132kV CB with CT for Line	2	Construction Span 24 months
			132kV DS for Line	2	
			132kV CB for TR	2	
			132kV DS	4	
			132kV CVT	3	
			132kV CT	4	
			132kV Lightning Arrester	2	
			33kV CB with CT	2	
			33kV DS	2	
			33kV Lightning Arrester	2	
			33kV CVT	1	
			Structure	1	
			Bus Expansion Material	1	
			Protection Panel for Line	2	
			Protection Panel for TR	2	
			Protection Panel for 132kV CCT	1	
			Protection Panel for 33kV CCT	1	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
12	Ilala	2005	132kV CB with CT for Line	1	Coordination expansion
			132kV DS for Line	2	with Kurasini S/S upgrade
			132kV CB for TR	1	
			132kV DS for TR	1	
			132kV CVT	1	
			132kV CT	1	
			Protection Panel for Line	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
13	FZ III	2005	132kV CB with CT for Line	1	Coordination expansion
			132kV DS for Line	2	Kurasini S/S upgrade
			132kV CB for TR	1	
			132kV DS for TR	1	
			132kV CVT	1	
			132kV CT	1	
			Protection Panel for Line	1	
			Construction Material	1	
			Installation	1	
14	Chang'ombe	2008	33/11kV 15MVA TR	1	Construction Start in 2007
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
15	City Center	2006	33/11kV 30MVA TR	1	Construction Start in 2005
			Lightning Arrester	1	Construction Span 18 months
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
16	Ilala	2006	132/33kV 45MVA TR	1	Construction Start in 2005
			132kV CB for TR	1	Construction Span 24 months
			132kV DS for TR	1	
			132kV CT	1	
			132kV Lightning Arrester	1	
			33/11kV 15MVA TR	1	
			33kV CB with CT	2	
			33kV DS	2	
			33kV Lightning Arrester	2	
			Structure	1	
			Bus Expansion Material	1	
			Protection Panel for TR	2	
			Protection Panel for 132kV CCT	1	
			Protection Panel for 33kV CCT	1	
			Construction Material	1	
			Installation	1	
17	Mbezi	2009	33/11kV 15MVA TR	1	Construction Start in 2008
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
18	Kariakoo	2010	33/11kV 15MVA TR	1	Construction Start in 2009
			33kV CB with CT	3	Construction Span 18 months
			33kV DS for Line	2	
			33kV DS	3	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
19	Msasani	2009	33/11kV 15MVA TR	1	Construction Start in 2008
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
20	City Center	2004	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Sokoine S/S expansion
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
21	Tegeta	2007	33kV DS for Line	1	Coordination work with
			33kV CB with CT	1	Bahari Beach S/S expansion
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
22	Tegeta	2009	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Mbezi S/S expansion
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
23	Ilala	2010	33/11kV 15MVA TR	1	Construction Start in 2009
			33kV CB with CT	2	Construction Span 18 months
			33kV DS	3	Including Addition of
			Lightning Arrester	1	33kV leadout for Kariakoo Line
			Protection Panel for TR	1	
			Protection Panel for Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	
24	Kigamboni	2005	33kV CB with CT	2	Conversion to Switching Station
			33kV DS	2	
			33kV CVT	1	
			Protection Panel for Line	2	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Construction Material	1	
			Installation	1	

Table 7.2.13 Contents of New Construction in Dar es Salaam

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	Bahari Beach	2003	33/11kV 15MVA TR	1	Construction Start in 2002
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
2	Bagamoyo	2004	33/11kV 5MVA TR	1	Construction Start in 2003
			33kV CB with CT for Line	3	Construction Span 18 months
			33kV DS for Line	3	
			33kV CVT	3	
			33kV CB for TR	4	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	3	
			11kV Cubicle	4	
			Monitor Panel	2	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
3	Magomeni	2003	33/11kV 15MVA TR	1	Construction Start in 2002
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	on going under the co-operation
			Station Service TR	1	of other donor.
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
4	Tandika	2004	33/11kV 15MVA TR	1	Construction Start in 2003
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
5	Muhimbili	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
6	TOL	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
7	University	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
8	New Oysterbay	2004	132/33kV 45MVA TR	2	Construction Start in 2003
			132kV CB with CT for Line	1	Construction Span 24 months
			132kV DS for Line	1	
			132kV CB for TR	2	
			132kV DS	3	
			132kV CVT	2	
			132kV CT	4	
			132kV Lightning Arrester	2	
			33/11kV 15MVA TR	2	
			33kV CB with CT	6	
			33kV DS for Line	2	
			33kV DS	4	
			33kV Lightning Arrester	3	
			33kV CVT	4	
			Structure	1	
			Bus Material	1	
			Protection Panel for Line	3	
			Protection Panel for TR	4	
			Protection Panel for 132kV CCT	1	
			Protection Panel for 33kV CCT	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
9	Mburahati	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
10	Yombo	2005	132/33kV 45MVA TR	1	Construction Start in 2003
			132kV CB with CT for Line	2	Construction Span 24 months
			132kV DS for Line	2	
			132kV CB	1	
			132kV DS	3	
			132kV CVT	3	
			132kV CT	3	
			132kV Lightning Arrester	1	
			33/11kV 15MVA TR	1	
			33kV CB with CT	2	
			33kV DS for Line	2	
			33kV DS	1	
			33kV CVT	1	
			33kV Lightning Arrester	2	
			Structure	1	
			Bus Material	1	
			Protection Panel for Line	3	
			Protection Panel for TR	2	
			Protection Panel for 132kV CCT	1	
			Protection Panel for 33kV CCT	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
11	Kitunda	2005	33/11kV 15MVA TR	1	Construction Start in 2004
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
12	Kawe	2006	33/11kV 15MVA TR	1	Construction Start in 2005
			33kV DS for Line	1	Construction Span 18 months
			33kV CVT	1	
			33kV CB for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
13	Kinondoni	2006	33/11kV 15MVA TR	1	Construction Start in 2005
			33kV PT	1	Construction Span 18 months
			33kV CB for TR	1	
			33kV DS for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
14	Kunduchi	2007	33/11kV 15MVA TR	1	Construction Start in 2006
			33kV PT	1	Construction Span 18 months
			33kV CB for TR	1	
			33kV DS for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
15	Tegeta	2007	33kV CB with CT	1	Construction Start in 2006
			33kV DS for Line	2	Construction Span 8 months
			33kV CVT	1	Lead out for Bhari Beach Line
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
16	Kigogo	2007	33/11kV 15MVA TR	1	Construction Start in 2006
			33kV PT	1	Construction Span 18 months
			33kV CB for TR	1	
			33kV DS for TR	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
17	FZ III	2004	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Tandika S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
18	Ilala	2005	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with TOL S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
19	Ubungo	2005	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with University S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
20	Ubungo	2004	132kV DS for Line	1	Coordination work
			132kV CB with CT	1	with NOB S/S construction
			132kV DS	2	(Addition of 132kV leadout)
			132kV CVT	1	
			Structure	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
21	Mbezi	2006	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Kawe S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
22	Mikocheni	2006	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Kinondoni S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
23	Tegeta	2006	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Kunduchi S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
24	Ilala	2007	33kV DS for Line	1	Coordination work
			33kV CB with CT	1	with Kigogo S/S construction
			33kV DS	1	(Addition of 33kV leadout)
			33kV CVT	1	
			Protection Panel for Line	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
25	Tabata	2005	33kV DS for Line	4	
			33kV CB with CT	4	
			33kV DS	4	
			33kV CVT	4	
			Protection Panel for Line	4	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	

(b) Expansion and new construction for Arusha and Moshi

For the Arusha and Moshi expansion plans, expansion should be carried out as long as the site and other conditions permit because the existing substation is adjacent to the load and most of the existing distribution lines or routes are available. The outline of the expansion and new construction are given below.

Table 7.2.14 Contents of Expansion in Arusha, Moshi

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	Njiro	2004	132/33kV 45MVA TR	1	Construction Start in 2003
			132kV CB	1	Construction Span 18 months
			132kV DS	2	
			132kV CT	1	
			132kV CVT	1	
			132kV Lightning Arrester	1	
			33kV CB with CT	1	
			33kV DS for TR	1	
			33kV Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			33kV Bus Interconnector	1	
			Protection Panel for TR	1	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
2	Kiyungi	2004	132/33kV 45MVA TR	1	Construction Start in 2003
			132kV CB	1	Construction Span 18 months
			132kV DS	2	
			132kV CT	1	
			132kV Lightning Arrester	1	
			33kV CB with CT	4	
			33kV DS for Line	3	
			33kV DS	3	
			33kV Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			33kV Bus Interconnector	1	
			Protection Panel for TR	1	
			Monitor Panel	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
3	Mt. Meru	2004	33/11kV 10MVA TR	3	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	3	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
4	Boma Mbuzi	2004	33/11kV 10MVA TR	1	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
5	Machame	2004	33/11kV 5MVA TR	1	Construction Start in 2003
6	Njiro	2006	220/132kV 60MVA TR	1	Construction Start in 2005
			220kV CB	1	Construction Span 24 months
			220kV DS	2	
			220kV CT	1	220kV TR Expansion
			220kV Lightning Arrester	1	
			132kV CB	1	
			132kV DS	2	
			132kV CT	1	
			132kV Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	
		2006	132/33kV 45MVA TR	1	Construction Start in 2005
			132kV CB	1	Construction Span 24 months
			132kV DS	2	
			132kV CT	1	132kV TR Expansion
			132kV Lightning Arrester	1	in Parallel with 220kV TR
			33kV CB with CT	1	Expansion
			33kV DS for TR	2	
			33kV Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			33kV Bus Interconnector	1	
			Protection Panel for TR	1	
			Monitor Panel	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
7	Themi	2008	33/11kV 10MVA TR	1	Construction Start in 2007
			33kV DS for Line	2	Construction Span 18 months
			33kV CVT	3	
			33kV CB	3	
			33kV DS	4	
			Station Service TR	1	
			Lightning Arrester	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
8	Lawate	2009	33/11kV 5MVA TR	1	Construction Start in 2008

Table 7.2.15 Contents of New Construction in Arusha, Moshi

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	YMCA	2003	33/11kV 10MVA TR	1	Construction Start in 2002
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
2	Marangu Sw/S	2004	Voltage regulator	1	Construction Start in 2003
			33kV DS for Line	1	Construction Span 12 months
			33kV CB with CT	1	
			33kV DS	1	
			33kV Lightning Arrester	1	
			Station Service TR	1	
			Structure	1	
			Bus Material	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
1	YMCA	2003	33/11kV 10MVA TR	1	Construction Start in 2002
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
2	Marangu Sw/S	2004	Voltage regulator	1	Construction Start in 2003
			33kV DS for Line	1	Construction Span 12 months
			33kV CB with CT	1	
			33kV DS	1	
			33kV Lightning Arrester	1	
			Station Service TR	1	
			Structure	1	
			Bus Material	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
3	Monduli	2004	33/11kV 10MVA TR	1	Construction Start in 2003
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
4	Usa River Sw/S	2006	33kV DS for Line	2	Construction Start in 2003
			33kV CVT	1	Construction Span 18 months
			33kV DS	3	
			33kV CB	2	
			Station Service TR	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	

No.	Name of S/S	Year	Contents		Remark
			Equipment	Qty.	
5	Sakina	2005	33/11kV 10MVA TR	1	Construction Start in 2004
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			33kV CVT	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	3	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	4	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
6	KCMC	2005	33/11kV 10MVA TR	1	Construction Start in 2004
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	
7	Trade School	2005	33kV CB with CT for Line	1	Coordination work
			33kV DS for Line	2	with KCMC S/S construction
			Protection Panel for 33kV Line	1	Construction Start in 2004
			Construction Material	1	Construction Span 18 months
			Installation	1	
8	Njiro B	2005	33/11kV 10MVA TR	1	Construction Start in 2004
			33kV CB with CT	1	Construction Span 18 months
			33kV DS	1	
			Station Service TR	1	
			Lightning Arrester	1	
			Structure	1	
			Bus Material	1	
			Protection Panel for TR	1	
			Protection Panel for 33kV Line	1	
			11kV Cubicle	3	
			Monitor Panel	1	
			Auxiliary Panel	1	
			DC Supply Equipment	1	
			Control House	1	
			Construction Material	1	
			Installation	1	