4.4 Outline of System Design

4.4.1 Study of Propagation Path Profile Maps

For a large number of sites to be used for this Project, the site selection has already been made by the PTC. The survey reports for those sites have also been completed. Therefore, in the surveys conducted this time, main emphasis was placed on the study of already formulated profile maps and the summary surveys of sections where the surveys have not yet been made.

The attached profile maps, which have been newly formulated, are pertinent to the sites selected by the PTC and the sites selected by the surveys this time. Where the access road curtailment is possible, the locations of the already selected sites have been changed.

The profile maps have been formulated by means of geographical maps of a scale of 1:50,000. Where the maps used were without the contour line, the hop profiles have been produced pursuant to the profile maps prepared by the PTC. (Such hops correspond to the asterisked section in the attached profile maps.)

Most surveys have been carried out by PTC except for Lundazi-Chama and Indu-Mporokoso sections where surveys are primarily based on the map studies. However, in the surveys so far conducted by PTC and this time, the optical tests have not been done.
Therefore, prior to the formulation of Tender Specifications, the detailed surveys must be carried out to obtain more accurate data for determination of required antenna heights.

In this study, the antenna heights are calculated by the following conditions:

1) The height of trees in each radio section is set at 18 m. However, in the hops where eucalypti grow, as in the case of Luwingu Station, etc., the height of trees is set at 35 m.

2) The tower height at stations to be newly established is set at 20 m or more in consideration of nearby obstacles.

3) In case where K = 4/3 at the minimum clearance point, the 1st Fresnel zone is cleared. If, for this purpose, the tower height of greater than 90 m is required, the tower height increase is to be avoided within the limits of allowable noise performance.

4.4.2 Outline of Main Equipment

The typical parameters of main equipment required by the system design are described below.

1) Radio Equipment

The typical equipment parameters are as follows:

Table 4-1 Typical Parameters of Transmitter/Receiver

Item	2 GHz Band	6 GHz Upper Band	
	300 CH/960 CH	960 CH	1800 CH
Transmitting Output Power	19.0 dBm 25.0 " 32.0 "	26.0 dBm 29.0 " 33.7 "	26.0 dBm 29.0 " 33.7 "
Branching Circuit Loss	4.8 dB (2 RF CH)	4.0 dB (3 RF CH)	4.0 dB (3 RF CH)
Noise Figure of Receiver	3.5 dB	4.0 dB	4.0 dB
Frequency Deviation	200 kHz r.m.s.	200 kHz r.m.s.	140 kHz r.m.s.
Equipment Noise (at top CH)			
Transmitter-Receiver (1 hop)	20 pWOp	30 pWOp	40 pWOp
Modulator-Demodulator (1 section)	20 pWOp	25 pWOp	45 pWOp
Drop and Insertion Equipment			
Insertion Section	20 pWOp	20 pWOp	20 pWOp
Drop Section	100 pWOp	100 pWOp	100 pWOp

2) Antenna System

The typical antenna system parameters are as follows:

Table 4-2 Typical Parameters of Antenna System

Item	2 GHz Band		6 GHz Upper Band
	2.1 GHz	1.9 GHz	6.77 GHz
Parabolic Antenna Gain			
2.0 m	29.6 dB	28.7 dB	39.7 dB
3.3 m	33.9 dB	33.0 dB	44.1 dB
4.0 m	35.6 dB	34.7 dB	45.7 dB
Feeder Loss	4.5 dB/ 100 m	4.5 dB/ 100 m	5.0 dB/ 100 m

3) Remote Control and Supervisory System

Generally, the remote control and supervisory system holds three functions. They are remote control, remote supervisory, and order wire telephone functions.

The typical system diagram of the supervisory system for the radio route appears in Figures 4-10 and 4-11.

As is evident in the above illustration, remote supervising is carried out by the terminal stations at both ends. Remote control applies, in principle, to the unattended station only where the engine generator is installed.

4) Power Supply System

In order to ensure high reliability of a radio communication system, the selection of optimum power supply system assumes great importance. This selection requires the best consideration of system economy, on one hand, and easy system operation and maintenance, on the other.

The power supply systems which are used for the microwave radio system include the following representative systems:

(a) Full Floating System

For the power supply system to be used at the station where the commercial power is available, the full floating system is most economical. It allows easy maintenance also. However, to prepare for the commercial power failure, it requires the standby engine generator.

At the station where the commercial power is not available, this system performs full floating by alternate operation of two engine generators.

The full floating system holds these advantages:

i) The batteries remain fully charged at all times. The battery life is long.

ii) To the A.C. load, the A.C. output is supplied at all times.

Among the demerits of this system are that, when used where the commercial power is unavailable, the mechanically operating parts suffer the wear and tear due to the continuous engine operation, that the fuel consumption is large, and that the frequent overhauls are required.

Figure 4-12 presents a typical example of the full floating system.

(b) Charge-Discharge System

The charge-discharge system is featured in that from the batteries charged for a fixed length of time the discharge current is supplied and then the batteries are charged again. The discharge operation by two units of rectifier plus batteries is illustrated in Figure 4-13.

The merits of this system are:

i) Since the feeding of load is by the discharge from the batteries, the supplied power does not contain the noise ripple.

ii) The operating time of the engine is shorter than that of the full floatng system so that the fuel consumption can be saved and the engine life can be extended.

The demerit is that, due to the frequent charges and discharges of batteries, the battery life is reduced.

(c) Thermoelectric Generator (T.E.G.) System

The T.E.G. system is a primary galvanic element that continuously supplies the direct current electrical energy.

This system has these merits:

i) Because of no mechanically operating parts, the wear and tear are scarce so that the maintenance at long intervals suffices.

ii) The capacity can be easily increased by means of additional T.E.G. unit(s).

iii) The small size and light weight facilitate the installation work.

iv) The operational reliability is high.

The demerit is that the frequent replenishment of light oil or gas as fuel is required.

In case where the most part of radio relay stations are the D.C. load of 100W or less as in this Project, the solar cell system is more advantageous as a power supply system.

Figure 4-14 presents the typical T.E.G. system.

(d) Solar Cell System

When adopting the solar cell system, it is important to determine the solar cell capacity, based on the sunshine volume forecast data of the area where to use the system. Generally, it is safe to assume that the required solar cell capacity is 10 times the D.C. load or thereabouts.

The batteries must have the holding time of 10 days or so to compensate for no sunshine hours during night and rainy days.

The typical solar cell system appears in Figure 4-16.

The merits of this system are:

i) The fuel supply is not necessary. Hence no need for fuel tank construction. The access road construction cost can also be reduced because the fuel transport by tank lorries is not required.

ii) The solar cell life is semi-permanent so that the maintenance cost is extremely limited.

For the demerit, it can be pointed out that, when the D.C. load is 100 W or more, the initial cost is much higher than in any other system.

(e) Optimum System

The optimum power supply system for each radio station is proposed as follows:

i) A.C. Mains Station

For the station where the A.C. commercial mains can be utilized, the full floating system is optimum.

ii) Non-A.C. Mains Station

a) Station where D.C. load power is 100 W or more

The full floating system by dual engine generators is optimum.

b) Station where D.C. load power is up to 100 W

The solar cell system is optimum.

As previously stated, the most part of radio relay stations except the terminal stations hold the D.C. load whose load power is up to 100 W. For these stations, the solar cell system is the optimum choice.

Meanwhile, to prepare against the cases where the charging of batteries cannot be made as required due to bad weather, etc., a mobile power supply unit must be assinged to each Maintenance Center.

4.4.3 Radio Frequency Allocation Plan

In this report, study was made based on the assumption that the radio frequency bands of 6 GHz upper and 2 GHz be adopted. However, these frequency bands have already been allocated to the existing radio systems now in operation.

Therefore, due consideration must be taken in deciding the frequency allocation so as to reduce interference noise power between the existing radio system and projected system.

Especially, the existing stations of Lusaka, Sumina and Kanjara Hill require detailed examination.

For the respective radio frequency arrangement of the projected radio system, it is envisaged to apply CCIR Rec. 384-2 for 6 GHz upperband and CCIR Rec. 283-3 for 2 GHz band.

The existing microwave system of 2 GHz band (960 channel system) uses the center frequency (fo) of 2,101 MHz. On the other hand, the projected transmission capacity for 2 GHz band is 300 channel transmission system, except for Kasama-Mansa Links, so that, it is recommended to adopt the other radio frequency band (fo = 1,808 MHz) in order to reduce interference noise power.

The matters to be considered in terms of the radio frequency arrangement for the above 3 stations are described below.

1) Lusaka Terminal Station

After completion of this Project, the antennas of radio systems using 6 GHz upper band will face 3 directions with 4 routes in total, i.e.

(a) Pan Aftel Route (Existing)
(b) Lusaka-Livingstone Route (Existing)
(c) Lusaka-Mongu Route (Under construction as of 1981)
(d) Lusaka- Copperbelt Route (Projected)

In addition to the above four (4) routes, construction of TV link between Lusaka T.E.- New TV Studio - Existing TV studio is planned by PTC. This link requires six (6) radio frequencies (3 go and return bearers).
Should 6 GHz upper band be applied to this TV Link, it is forecasted serious interference problem to be experienced at Lusaka T.E. Therefore, it is recommended that the defferent radio frequency band such as 8 GHz band, be used for TV links.

In order to obtain sufficient front-to-back ratio between the Links Lusaka-Copperbelt and Lusaka-Mwembeshi Earth Station, it is recommended to use ultra-high performance antennas with very high directivity because included angle between these two (2) links is very narrow (Circa 80 degrees).

2) Sumina Repeater

The present arrangement of radio frequencies for Kasama-Sumina section of the Pan Aftel System is described as follows:

(a) The Pan Aftel system has 2 bothway protection RF channels between Sumina and Kasama section; one for Lusaka direction and the other for Nakonde.

(b) Notwithstanding 960 channel transmission system in actual operation, the existing radio frequency channel assignment uses CCIR Rec. 384-2 which is to be applied for 2,700 channel trasmission capacity or equivalent.

By the reason mentioned above, it is difficult to establish the Kasama-Mansa link in the 6 GHz upper frequency band. Interference noise will greatly affect to the newly established link.

Accordingly, should 6 GHz upper frequency band be assigned to the Kasama-Mansa link, the existing Kasama-Sumina link require some modification:

i) Change of radio system configuration
ii) Consolidation of the protection bearers
iii) Change of antenna polarization

Also it is likely necessary to study how to cope with the situation; improvement of existing antenna directivity, addition of IF bandpass filter etc.

However, such modifications to the existing facilities will not be recommended, because an additional cost is required. Furthermore, long time circuit interruption may happen during the implementation of the modification work.

As a result, a different frequency band such as 2 GHz band should be used for the Kasama-Mansa link.

3) Kanjara Hill Repeater

At present, the microwave radio systems extend to Lusaka and Malawi direction.

To avoid interference between existing microwave systems and projected microwave systems (Lundazi and Mfuwe Airport, 2 routes), it is advised to allocate the frequency band of CCIR Rec. 283-2 for 300 channel transmission capacity (fo = 1,808 MHz).

4.4.4 Noise Distribution Plan for Radio System

1) Telephone Signal Transmission

For the circuits to be established over real links, the composition of which, for planning reasons, differs substantially from the hypothetical reference circuit, CCIR recommends that the psophometrically weighted noise power at a point of zero relative level in a telephone channel of length L, where L is between 50 and 840 km, carried in one or more baseband sections of frequency division multiplex radio lines shall not exceed:

(a) 3 Lpw + 200 pW one-minute mean noise power for more than 20% of any month;

(b) 47,500 pW one-minute mean power for more than (280/2500) x 0.1% of any month when L is less than 280 km or more than (L/2500) x 0.1% of any month when L is greater than 280 km.

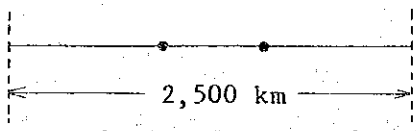
For the interruption of the 2,500 km hypothetical reference circuit, the Recommendation says:

(c) 106 pW unweighted (with an integrating time of 5 ms) for more than 0.01% of any month.

2) TV Transmission

Noise that takes place during TV relaying includes thermal noise (random noise), periodic noise and impulsive noise.

With regard to thermal noise, CCIR recommends the following standard to be given the hypothetical reference circuit illustrated below.



Hypothetical Reference Circuit

The ratio of the peak-to-peak signal, excluding synchronizing pulses, to the r.m.s. value of continuous random noise read on an instrument having an effective time constant (or integrating time) in terms of power of one second and using the recommended weighting network should not fall below the values as under.

(a) 57 dB for more than 20% of a month;
(b) 45 dB for more than 0.1% of a month.

3) Summary of System Performance Estimated

This section describes the system performance objectives in the case of telephone and TV signal transmission, as well as the system performance estimated.

There are many existing radio systems either extending from stations on the proposed microwave system route or operating near the proposed microwave system, using the same radio frequency band as in the proposed system.

Therefore, the transmission performance of the proposed system may likely be influenced adversely by the interference wave from the existing systems. However, the final system parameters of the proposed system have not yet been determined so that, in this study, the system performance is estimated, based on several temporary conditions.

Detailed system performance estimate will be made before the Project is implemented.

i) Telephony Transmission

Noise that takes place in the microwave radio system can be divided into three major categories according to the cause. They are thermal noise, interference noise and intermodulation noise. In this study, CCIR Rec. 395-2 is applied as system performance objectives, and the allowable noise power is equally assigned to the three noise categories. Shown below is an example of the noise assignment plan for the Lusaka - Kitwe baseband section.

Noise Budget Assignment Plan for Lusaka-Kitwe Baseband Section

	Thermal noise 403 pW
Lusaka-Kitwe baseband section (336.8km) 1210 pW	Intermodulation noise 403 pW
	Interference noise 403 pW

Essentially, the noise performance estimate should be made for each noise component according to the noise assignment plan shown above. In this study, interference noise component is assumed to be 40 pW/hop for 1,800 channel transmission capacity, 20 pW/hop for 960 and 120 channel transmission capacity.

The expected noise performance and system outage in each baseband section of the proposed microwave system satisfy almost completely the standard values established in the Table 4-3 so that the satisfactory system performance can be expected from the proposed microwave system.

ii) TV Signal Transmission

For TV signal transmission, the simultanesous transmission system for television and sound programs will be adopted. The system perofrmance objectives are established for each video section, based on CCIR Rec. 555 and Rec. 505-1, as in the case of sound transmission.

Table 4-4 and Table 4-5 present the noise performances in the case of TV sound transmission and TV signal transmission, respectively. The figures in these tables indicate that the noise performance in each video section satisfies the noise objectives.

Table 4-3 System Performance in Telephony Transmission

Sheet 1/3

Item	Lusaka Kitwe	Kitwe Chingola	Chingola Solwezi	Kasama Mansa	Kitwe Ndola
Number of Hops	7	2	4	8	2
Circuit Length (Km)	336.8	71.4	183.1	320.4	64.8
Overall Noise Performance					
- Expected (pW)	924	297	381	781.4	432
- Objective (pW)	1210	414	749	1161	394
Time Percentage Exceeding 47500 PW					
- Expected (%)	0.0071	0.0001	0.0068	0.0000	0.0038
- Objective (%)	0.0135	0.0012	0.0112	0.0128	0.0112

Table 4-3 System Performance in Telephony Transmission Sheet 2/3

Item	Kasama Mbala	Kasama Mporokoso	Mansa Kawambwa	Kawambwa Nchelenge	Mansa Mwense	Mansa Samfya
Number of Hops	5	5	3	2	4	3
Circuit Length (km)	166.9	182.9	159.3	64.0	128.2	107.9
Overall Noise Performance						
- Expected (pW)	318	316	360	138	407	323
- Objective (pW)	701	749	678	392	585	524
Time Percentage Exceeding 47500 pW						
- Expected (%)	0.0037	0.0042	0.0015	0.0000	0.0014	0.0001
- Objective (%)	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112

Table 4-3 System Performance in Telephony Transmission Sheet 3/3

Item	Chipata Lundazi	Lundazi Chama	Chipata Mfuwe Airport	Lusaka Chisamba	Kabwe Chibombo
Number of Hops	6	5	3	2	1
Circuit Length (km)	187.0	121.3	88.9	50.5	46.7
Overall Noise Performance					
- Expected (pW)	464	441	294	222	1642
- Objective (pW)	761	564	467	352	2000*
Time Percentage Exceeding 47500 pW					
- Expected (%)	0.0003	0.0026	0.0002	0.0001	-
- Objective (%)	0.0112	0.0112	0.0112	0.0112	-

* CCITT Rec. G 123 is applied.

Table 4-4 Overall System Performance in TV Signal Transmission

Item	Lusaka Kitwe	Lusaka Chingola	Lusaka Solwezi	Kasama Mansa
Number of Hops	7	9	13	8
Circuit Length (km)	336.8	408.2	591.3	320.4
Overall Signal to Noise Ratio				
- Expected (dB)	86.6	85.9	77.5	71.5
- Objective (dB)	61.8	61.8	61.8	61.8
Percent of Time (S/N falls below 45 dB)				
- Expected (%)	0.0002	0.0002	0.0013	0.0030
- Objective (%)	0.0135	0.0163	0.0237	0.0128

Table 4-5 Overall Noise Performance in TV Sound Program Transmission

Item	Lusaka Kitwe	Lusaka Chingola	Lusaka Solwezi	Kasama Mansa
Number of Hops	7	9	13	8
Circuit Length (km)	336.8	408.2	591.3	320.4
Overall Noise Performance				
- Expected (dB)	69.9	69.1	67.5	69.4
- Objective	60.8	60.8	60.8	60.8

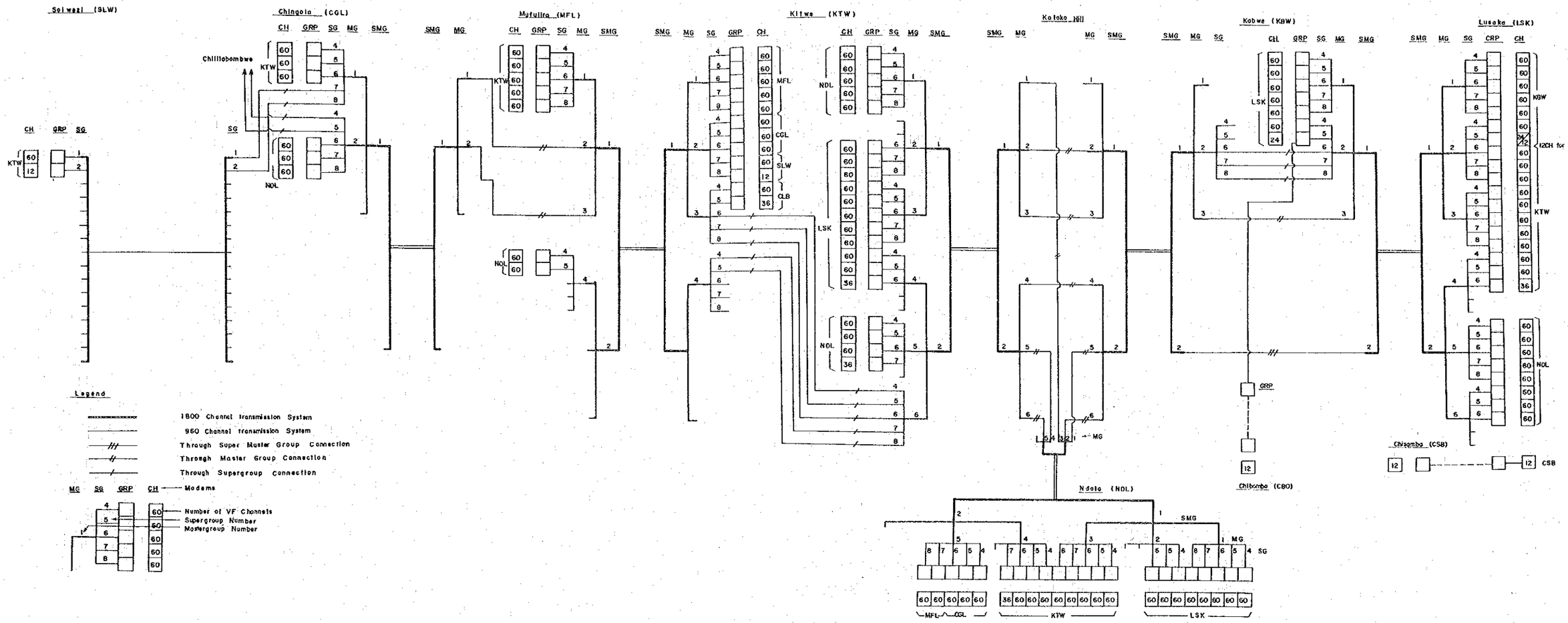


Figure 4-1 System Configuration of Lusaka-Copperbelt Route and Chingola-Solwezi Route

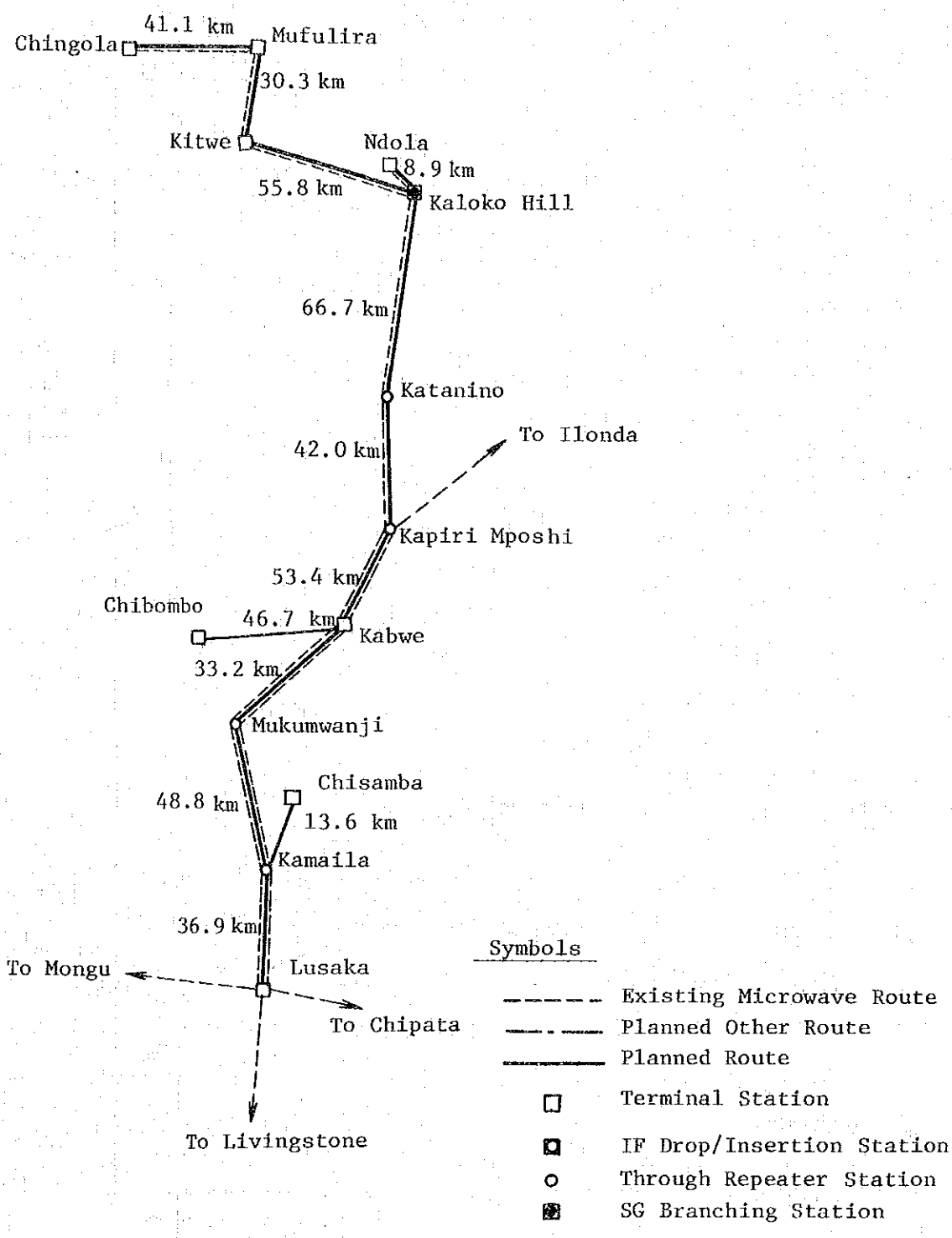


Figure 4-2 Route Map of Lusaka - Copperbelt

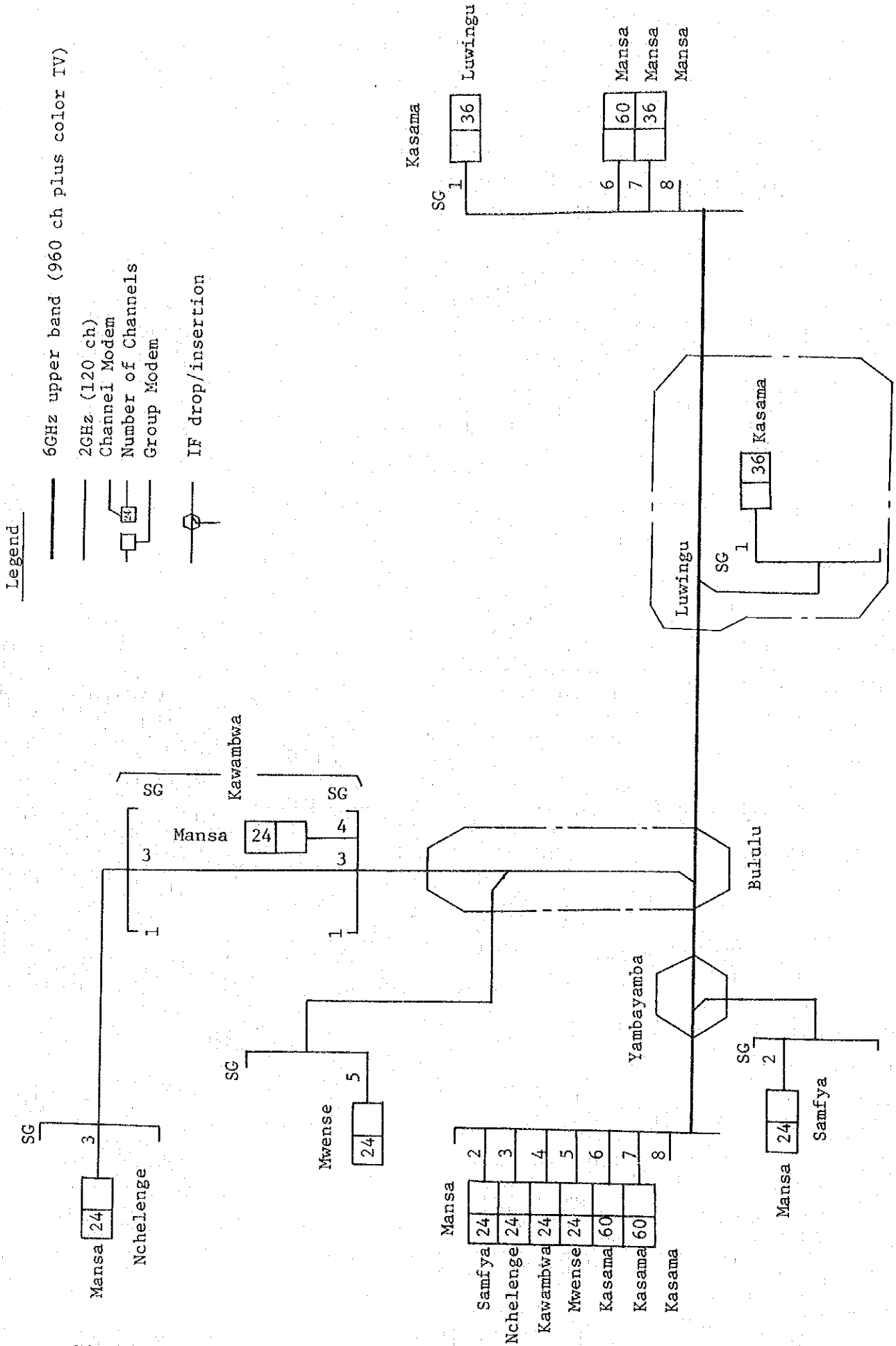


Figure 4-3 System Configuration of Kasama-Mansa Route

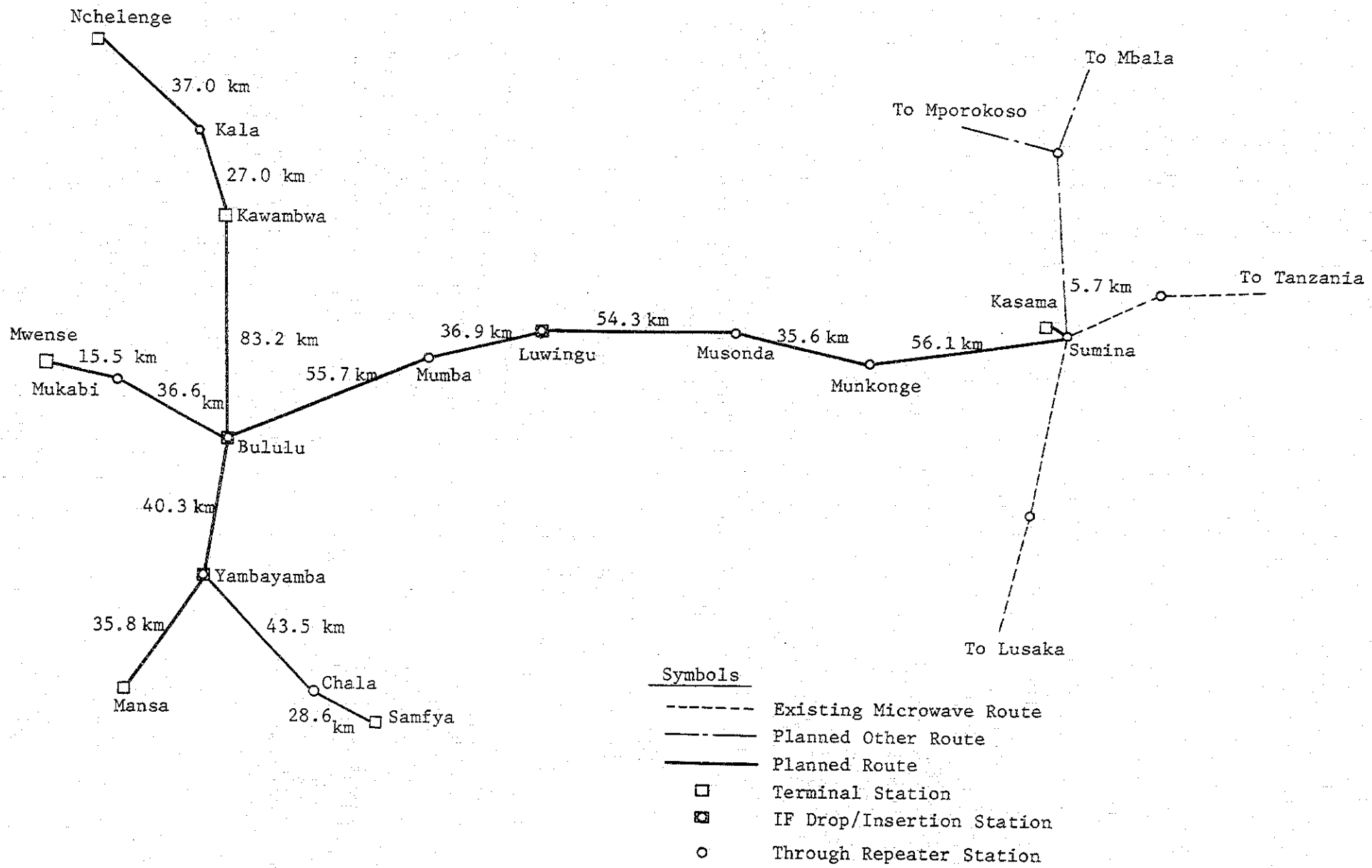
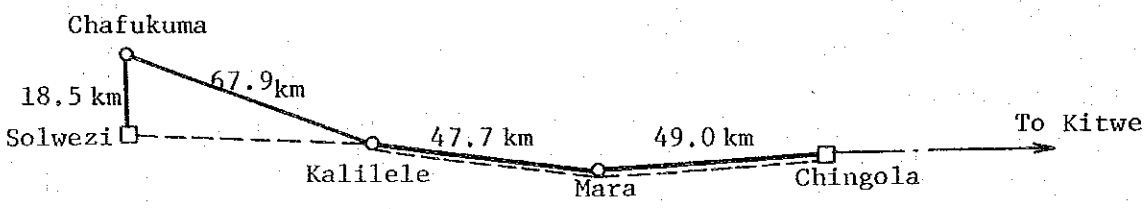


Figure 4-4 Route Map of Kasama - Mansa



Symbols

- Existing Microwave Route
- Planned Other Route
- Planned Route
- Terminal Station
- IF Drop/Insertion Station
- Through Repeater Station

Figure 4-5 Route Map of Chingola - Solwezi

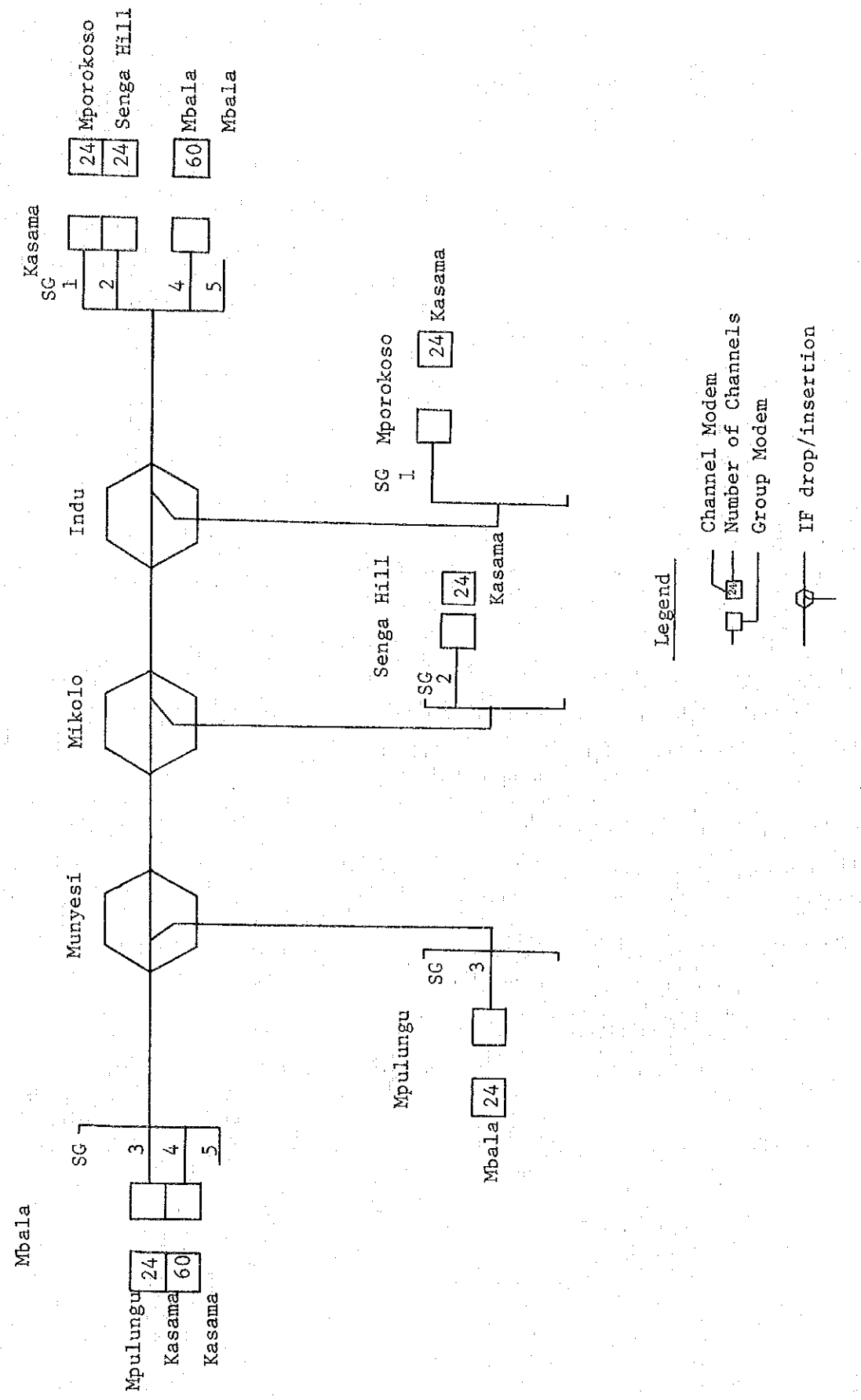


Figure 4-6 System Configuration of Kasama-Mbala and Mporokoso Routes

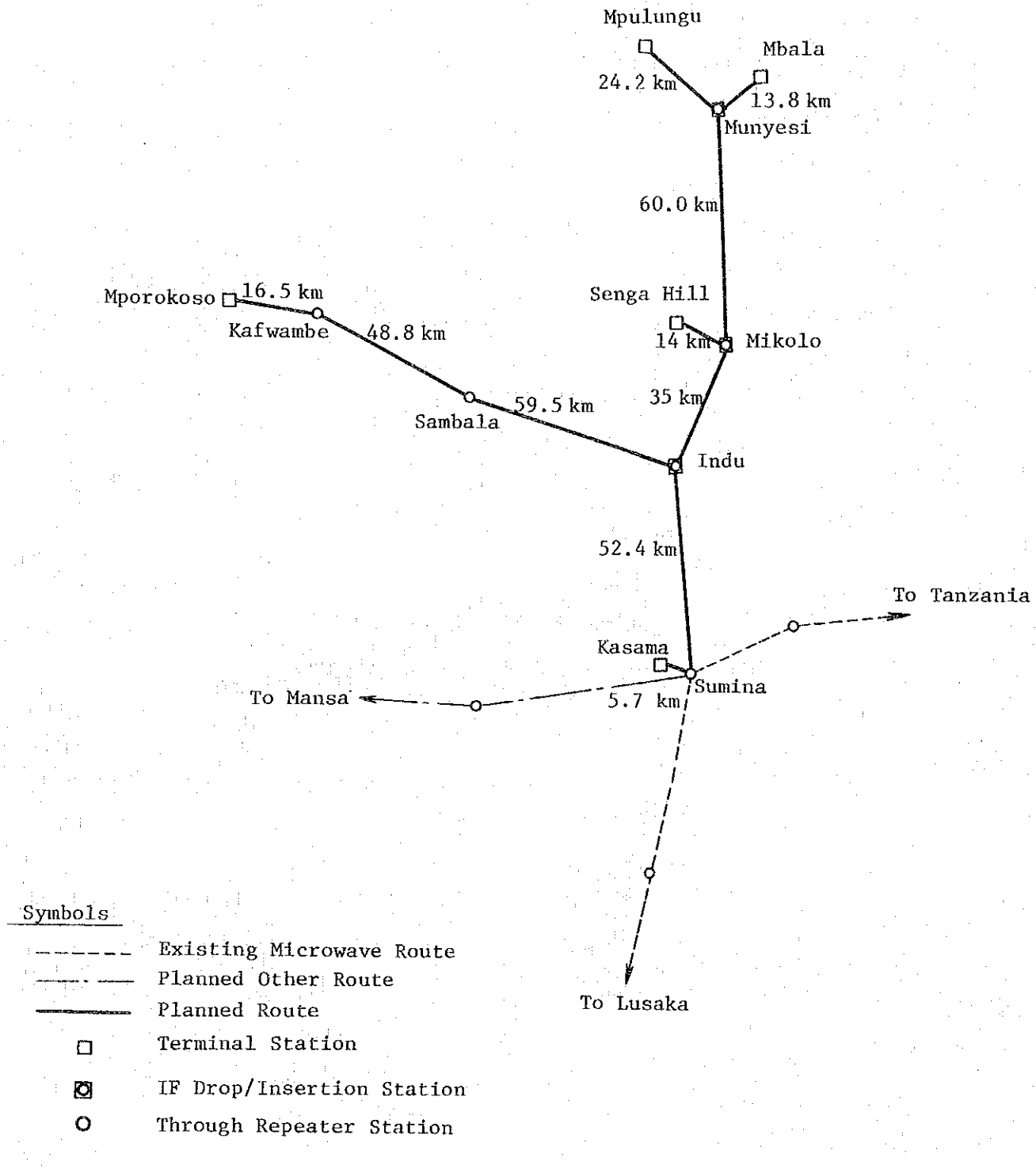


Figure 4-7 Route Map of Kasama - Mbala and Mporokoso

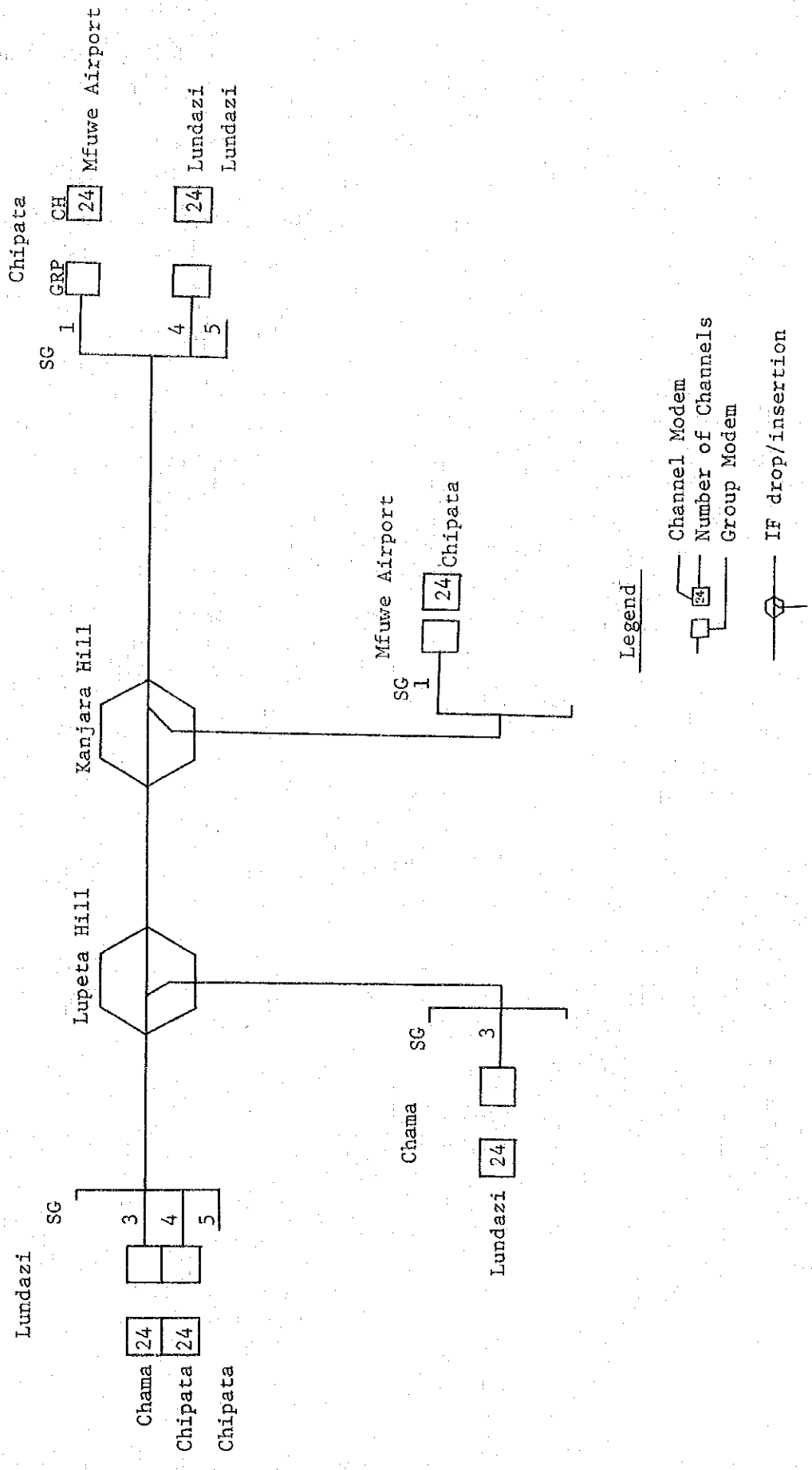


Figure 4-8 System Configuration of Chipata - Lundazi Route

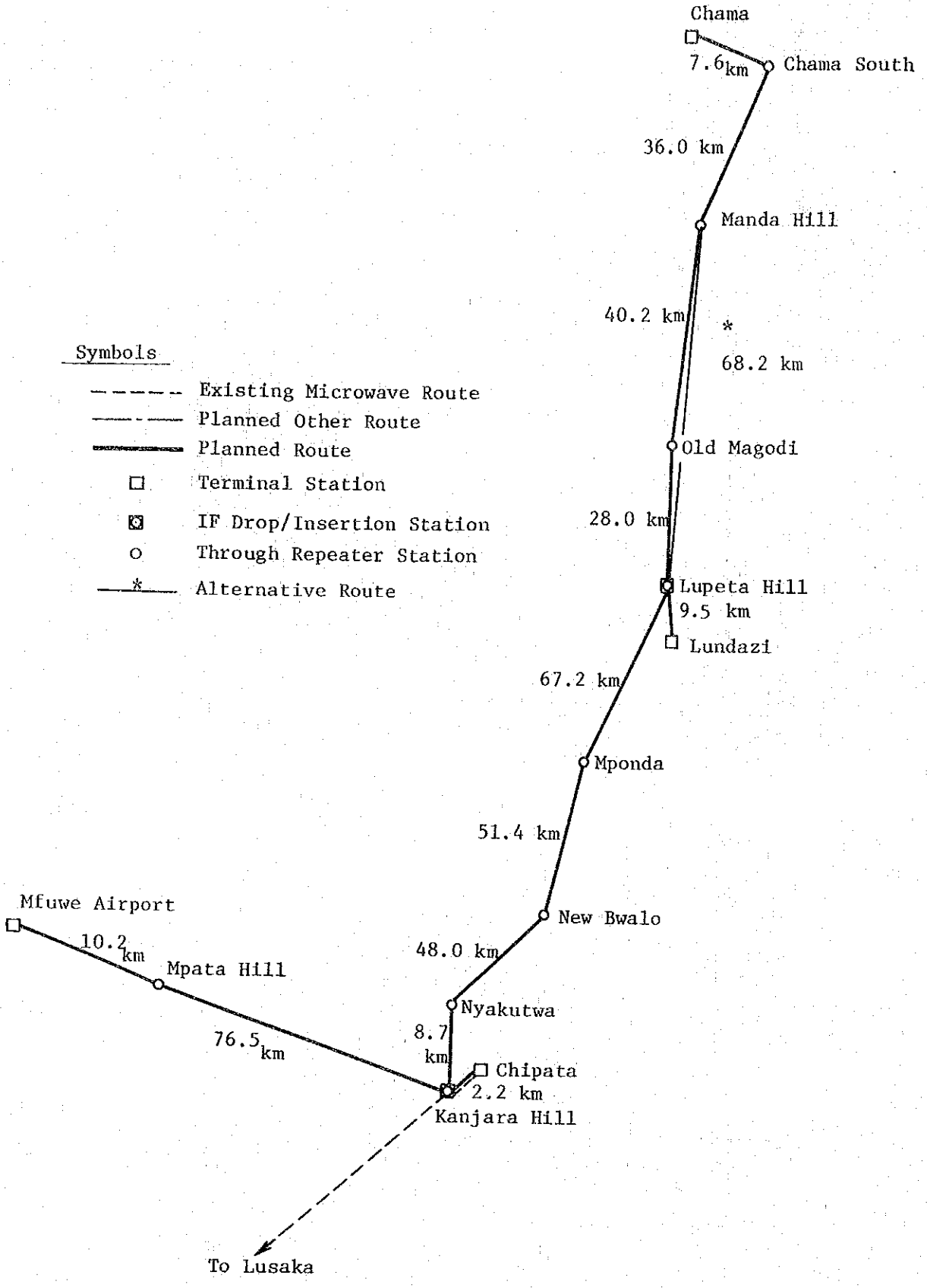


Figure 4-9 Route Map of Chipata - Lundazi

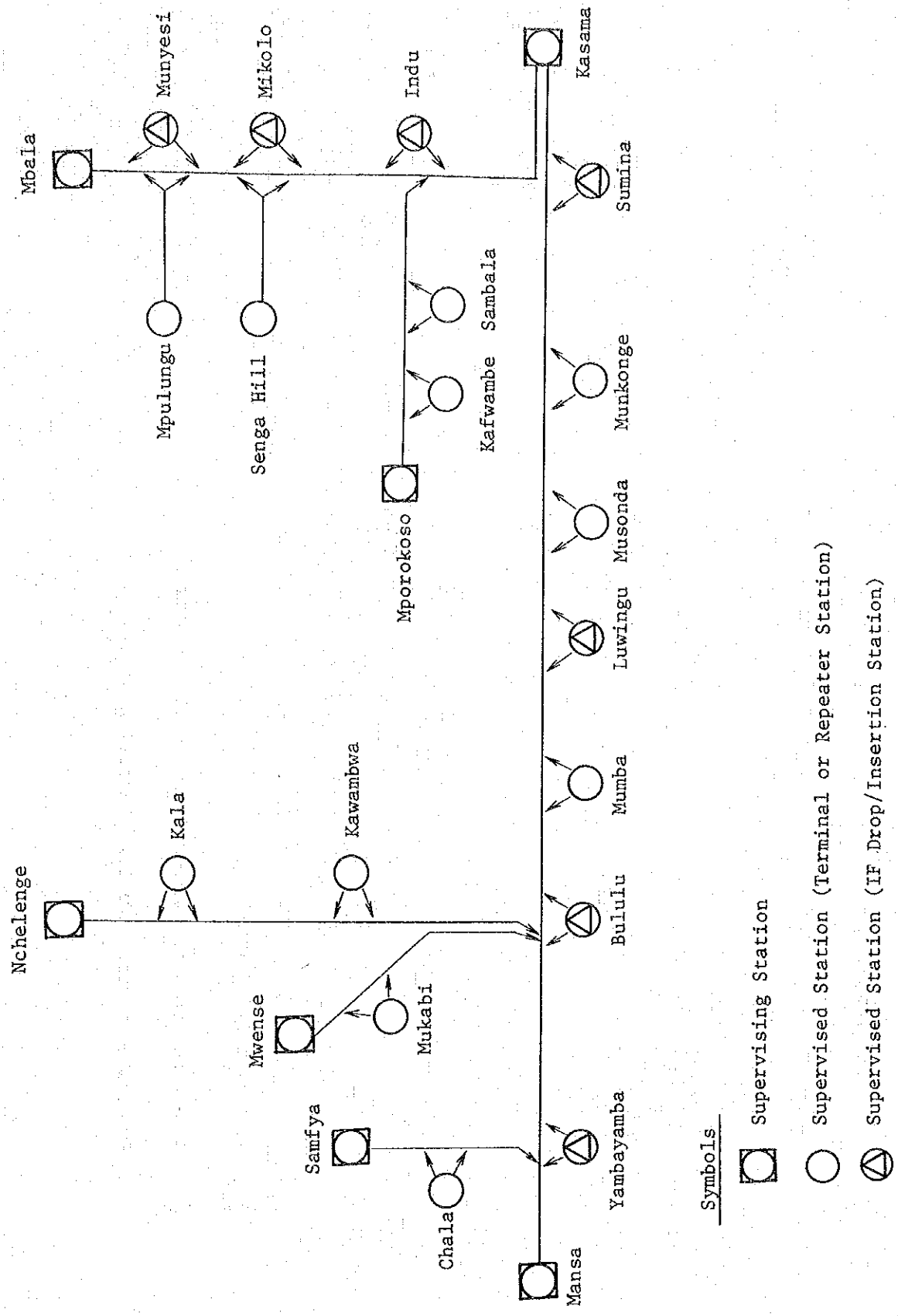


Figure 4-10 Remote Supervisory System for Kasama-Mansa, Mbala and Mporokoso Routes

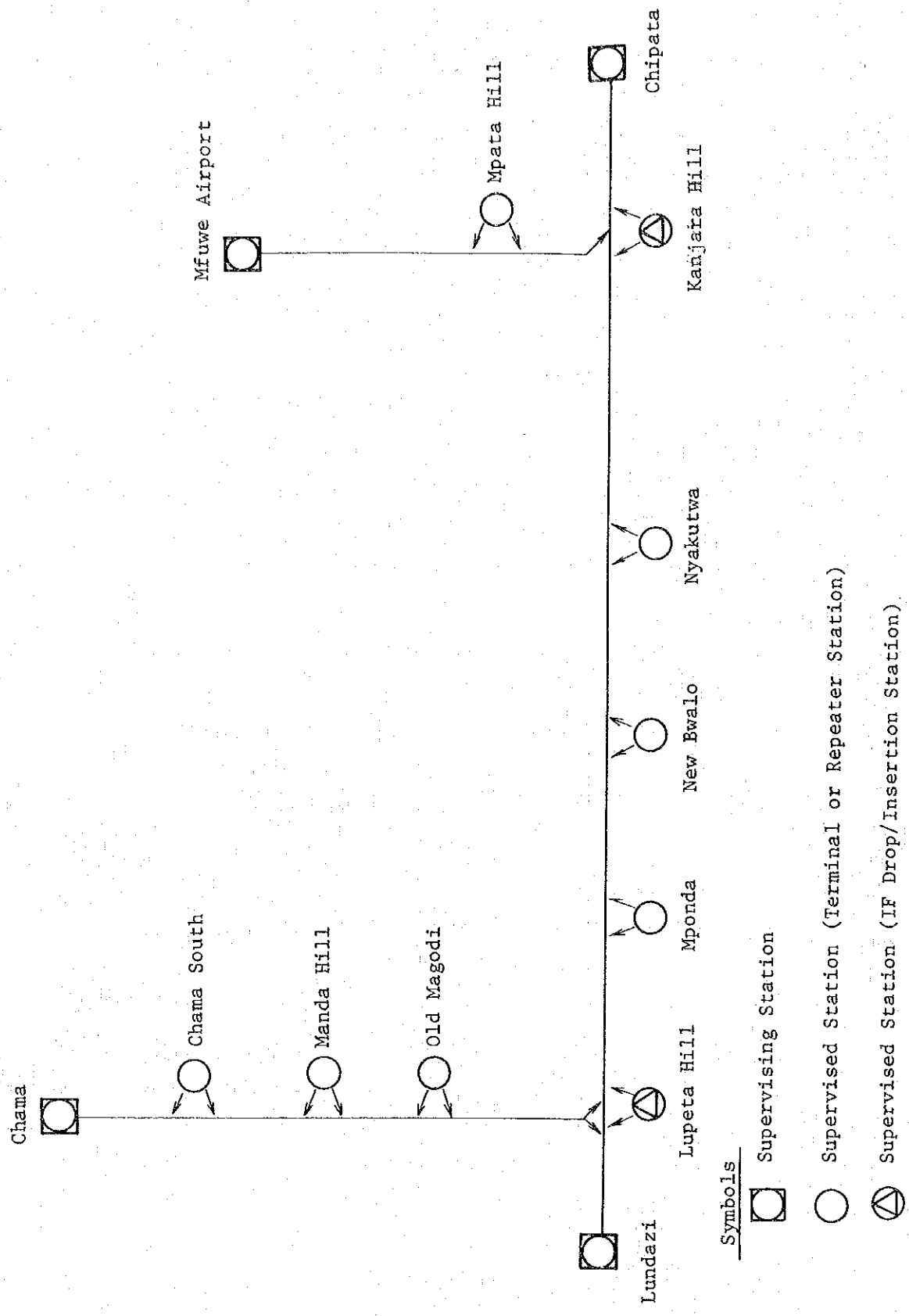


Figure 4-11 Remote Supervisory System for Chipata-Lundazi

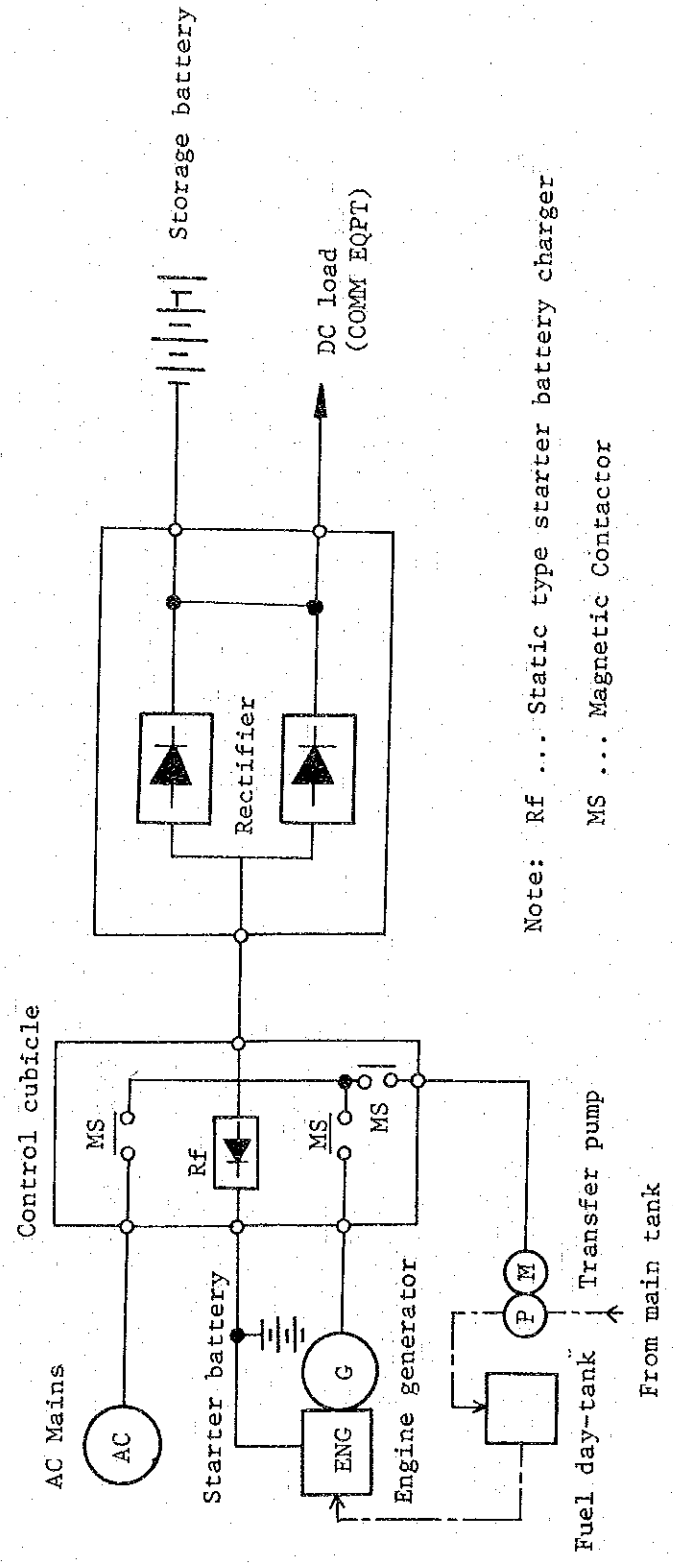


Figure 4-12 Power Supply System using Standby Engine Generator on Full-Floating Basis at AC Mains Station

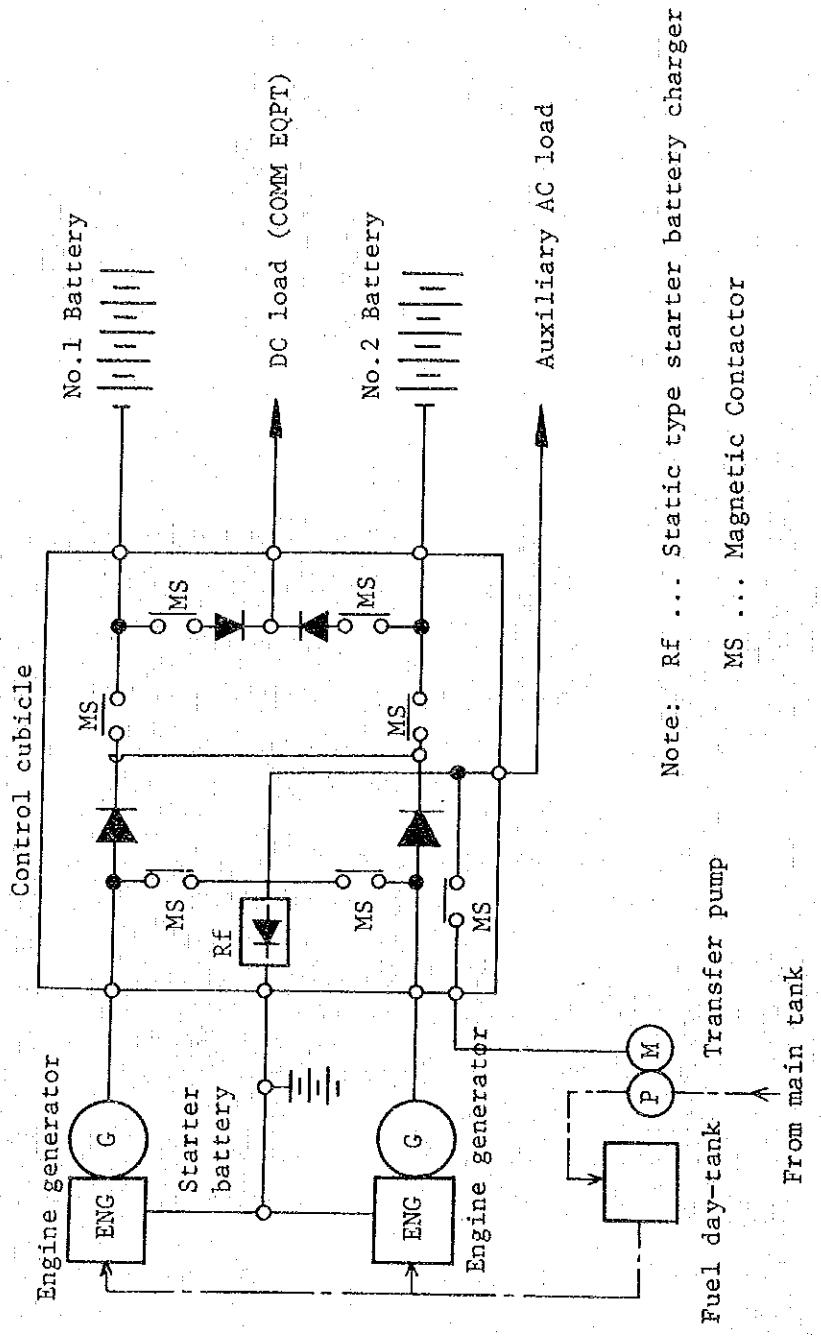


Figure 4-13 Power Supply System using Dual Prime Engine Generator on Charge-Discharge Basis

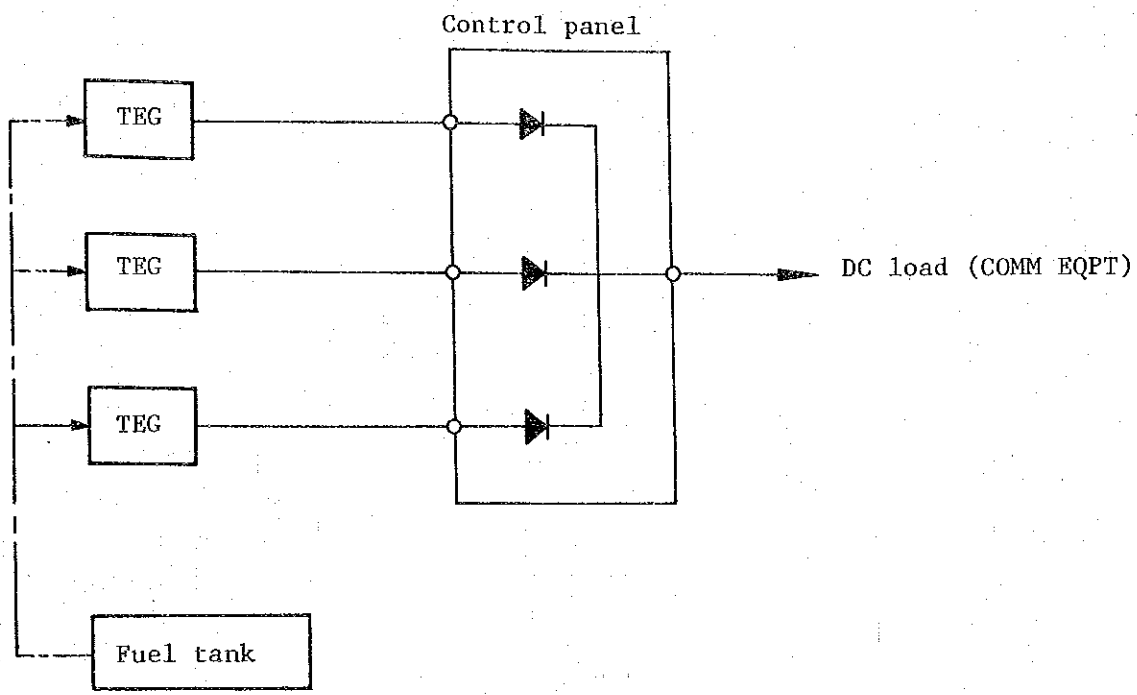


Figure 4-14 Power Supply System using Thermoelectric Generator

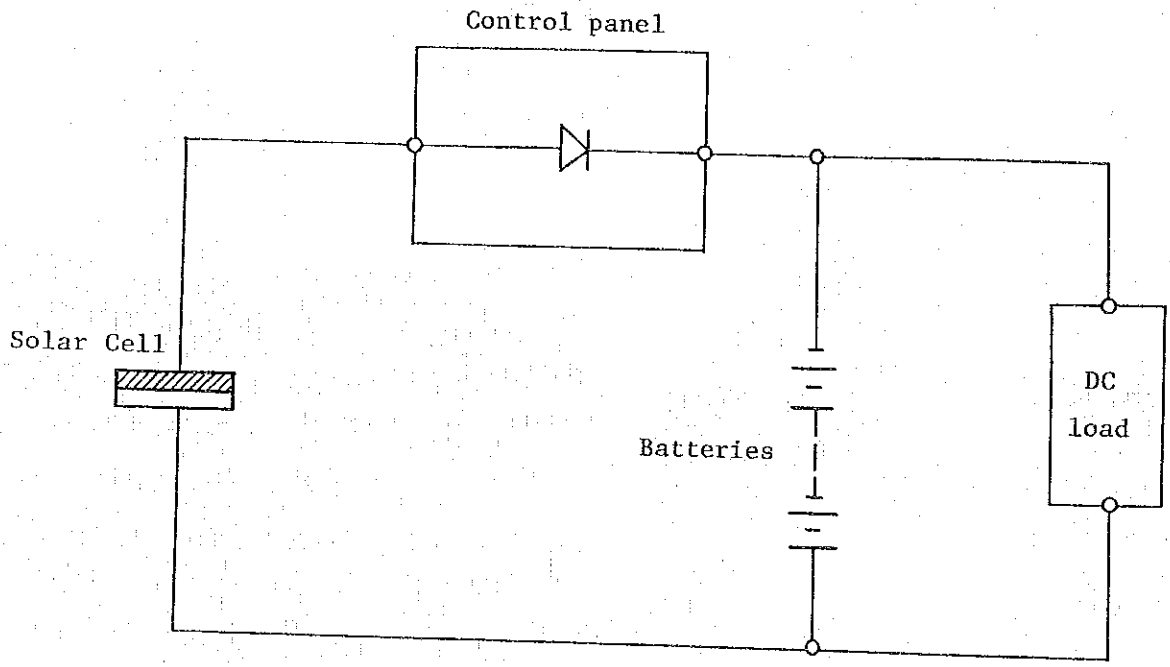


Figure 4-15 Power Supply System using Solar Cells

CHAPTER 5 MAINTENANCE AND OPERATION

Chapter 5 Maintenance and Operation

The maintenance and operation work is to maintain and operate the telecommunications system normally after the completion of its construction in order to supply the desirable service to the users. To evaluate the result of system maintenance and the service status and to make the best use of the findings in all maintenance plans for the improvement of service quality are no less important objectives of the maintenance and operation work.

The ideal service is to reduce the service interruption or the fault rate to the possible minimum. Approaches to the ideal service comprise the design, manufacture and construction of high reliability equipment and system, on one hand, and the effective maintenance work to reduce the fault rate or to improve the service quality, on the other. Items to be taken up in the maintenance work are to be determined in full consideration of the efficiency and quality of the telecommunications system concerned, the policy about the service grade to preserve, the availability of maintenance personnel, and the requests from users. Following are the basic and common maintenance items to be considered in this Project:

(a) To analyze the fault data whereby to discover the weak parts used in the equipment and replace them with reliable parts.

(b) To carry out preventive maintenance by means of periodical tests and inspections of equipment and system.

(c) To carry out the training of personnel and improve their work efficiency in order to reduce faults due to erroneous operations.

(d) To introduce the alarm and supervisory system in order to reduce the time from the occurrence of fault to the discovery thereof.

(e) To reduce the time from the discovery of fault to the report thereof:

i) To setup proper fault reporting procedures

ii) To install necessary order wire telephones.

(f) To reduce the time from the report of fault to the discovery of fault location:

i) To provide the necessary alarm circuit in each equipment and panel whereby to ease the discovery of fault;

ii) To keep in order to standard practices for fault mending and carry out the faultman training;

iii) To make the appropriate system and equipment diagrams.

(g) To reduce the time from the discovery of fault to the recovery of normal service:

i) To adopt spare panels for replacement and maintenance purpose;

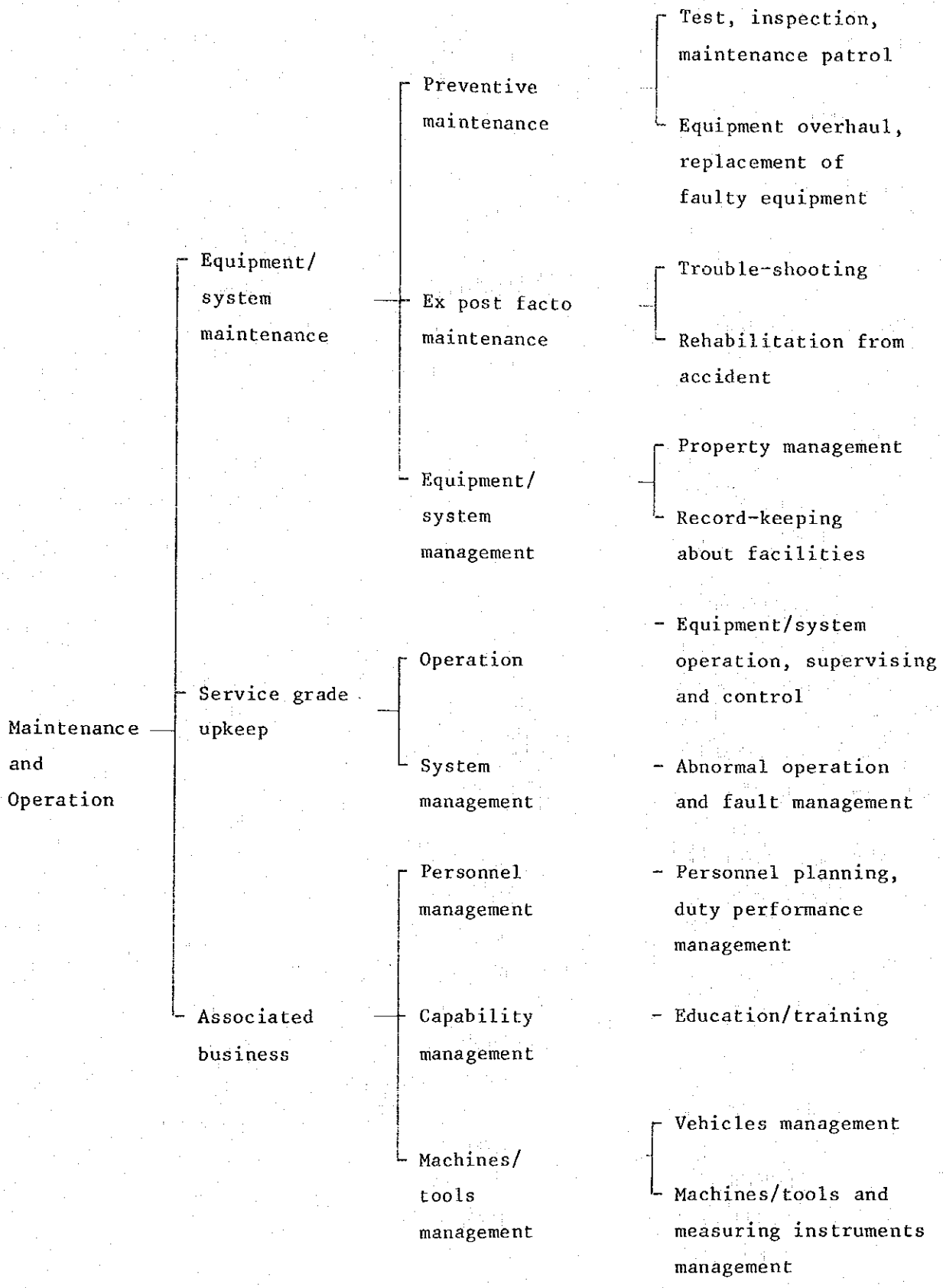
ii) To realize the automatic or manual changeover to the spare system or spare equipment;

iii) To establish the method of maintenance patrols of unattended stations;

iv) To keep fully trained personnel available for trouble-shooting and to keep a constant stock of necessary measuring instruments and proper spare panels, as well as repair parts.

(h) To feed back all kinds of technical information about the equipment and system from the maintenance division to the planning and construction divisions and further to the equipment manufacturers, whereby to initiate the improvement of system performance.

The maintenance and operation work can be divided into the equipment and system maintenance, the service grade upkeep, and the associated business, and each of these three can be further subdivided. The detailed organizational chart of the maintenance and operation work follows:


Maintenance and Operation
Equipment/ system maintenance
Preventive maintenance
Test, inspection, maintenance patrol
Equipment overhaul, replacement of faulty equipment
Ex post facto maintenance
Trouble-shooting
Rehabilitation from accident
Equipment/ system management
Property management
Record-keeping about facilities
Service grade upkeep
Operation
- Equipment/system operation, supervising and control
System management
- Abnormal operation and fault management
Associated business
Personnel management
- Personnel planning, duty performance management
Capability management
- Education/training
Machines/ tools management
Vehicles management
Machines/tools and measuring instruments management

CHAPTER 6 PROJECT COST ESTIMATE

Chapter 6 Project Cost Estimate

The project cost estimate is by the following criteria:

1) That the installation work be carried out on the turn-key basis;

2) That the construction cost be quoted, based on the cost level as of 1982, in consideration of international tender prices and related items for overseas projects in the past;

3) That the following work items be financed by the foreign currency budget and the local currency budget:

a) Foreign Currency Budget Portion

- Radio equipment, remote supervisory and control equipment, carrier multiplex equipment, power plant and antenna system
- Antenna supporting structure
- Equipment shelter
- Installation materials and tools
- Test equipment and spares
- Maintenance vehicles
- Ocean freight and insurance
- Inland transportion (to Lusaka) and customes clearance
- Installation and testing works
- Tower erection and footing works (including shelter basement)
- Site selection re-survey
- In-factory training of PTC staff
- Classroom training in Zambia
- Consultant service

b) Local Currency Budget Portion

- Land procurement and site formation (including fencing)

- Access road construction
- Building construction (Terminal Stations)
- Inland transportation to the sites
- Equipment installation and testing works
- Supervising of civil works
- Consultant service

4) That the construction works be divided into Phase I and Phase II in terms of implementation periods, in consideration of the telephone exchange construction plan, toll traffic forecast and related items.

Tables 6-1 and 6-2 present the Phase I, and Phase II Project costs.

The Phase I construction cost includes the cost of channel units to meeet the circuit requirement as of 1989. The basic facilities, including radio equipment and power plant, are designed to be capable of traffic transmission required in the year 2000.

5) That the project costs be quoted in the Japanese yen currency in all cases, provided that the yen costs be converted, when necessary, into the U.S. dollars and the Zambian Kwacha by the following rates of exchange:

1 U.S. dollar	:	200 Japanese yen
1 U.S. dollar	:	0.848 Kwacha

6) Described below are the conditions by which the construction cost of each radio route is estimated.

(a) Mass Media TV Link

A budget appropriation for construction of the Mass Media TV Links will be provided by the Government of Zambia. The total costs are estimated at approximately one (1) million Kwacha. For station buildings, towers and power plants, the existing facilities are assumed to be utilizable.

i) TV Link between Existing and New TV Studios
For bothway working and protection radio bearers to operate between the existing and new TV studios, one way will be newly established and, for the other one way, the existing TV link (between the existing TV studio and Lusaka T.E) will be transferred.

ii) TV Transmission from Livingstone to Lusaka
Modulator, demodulator and remote control equipment, which are necessary for TV transmission from Livingstone to Lusaka by use of the protection radio bearer, will be newly established.

iii) Protection Radio Bearer between Lusaka T.E and Mwembeshi Earth Station
In the selection between Lusaka T.E and Mwembeshi Earth Station, an additional bothway protection radio bearer for telephone and TV transmission will be established.

iv) Addtion of the remote control and switchover functions for TV signals. These functions will be provided at Lusaka T.E.

Approximately 0.7 million Kwacha is estimated for items i) through iv) above.

v) For the television link between the new Mass Media Center and Lusaka T.E., which is urgently demanded, the cost is estimated at approximately 0.3 million Kwacha.

(b) Station building, tower and power plant construction costs for the undermentioned radio routes are estimated by the conditions stated Table 6-3(1/3 - 3/3).

Table 6-1 Project Cost for Phase - I

	Foreign Currency		Local Currency
	Thousand Japanese Yen	Equivalent Thousand US $	Thousand Kwacha
1. Equipment Work Portion			
a. Lusaka-Copperbelt Route	1,850,000	9,250	830
b. Kasama-Mansa Route * 1	1,492,000	7,460	1,870
c. Kasama-Mbala Route * 2	598,000	2,990	700
d. Kasama-Mporokoso Route	272,000	1,360	410
e. Chipata-Lundazi Route * 3	748,000	3,740	980
f. Sub Total (a+b+c+d+e)	4,960,000	24,800	4,790
g. Survey Cost	37,000	185	-
h. Training Cost	43,000	215	-
i. Total (f+g+h)	5,040,000	25,200	4,790
2. Civil Work Portion			
j. Lusaka-Copperbelt Route	5,000	25	250
k. Kasama-Mansa Route	15,000	75	500
l. Kasama-Mbala Route	10,000	50	250
m. Kasama-Mporokoso Route	10,000	50	50
n. Chipata-Lundazi Route	15,000	75	970
o. Sub Total (j+k+l+m+n)	55,000	275	2,020
p. Survey Cost	34,000	170	-
q. Total (o+p)	89,000	445	2,020
3. Total Cost for Equipment and Civil Work Portion (i+q)	5,129,000	25,645	6,810
4. Consultancy Service	416,000	2,080	240
5. Basic Project Cost (3+4)	5,545,000	27,725	7,050
6. Contingency	388,000	1,940	500
7. Total Project Cost (5+6)	5,933,000	29,665	7,550

Exchange Rate: 1US Dollar = 200 Japanese Yen

1 Kwacha = 1.179 US Dollars

* 1 - Except Kawambwa-Nchelenge Link
* 2 - Except Senga Hill
* 3 - Except Lundazi-Chama Link

Table 6-2 Project Cost for Phase - II

	Foreign Currency		Local Currency
	Thousand Japanese Yen	Equivalent Thousand US $	Thousand Kwacha
1. Equipment Work Portion			
a. Chingola-Solwezi Route	549,000	2,745	810
b. Lundazi-Chama Route	419,000	2,095	600
c. Kawambwa-Nchelenge Link	303,000	1,515	400
d. Sub Total (a+b+c)	1,271,000	6,355	1,810
e. Survey Cost	30,000	150	-
f. Total (d+e)	1,301,000	6,505	1,810
2. Civil Work Portion			
g. Chingola-Solwezi	-	-	-
h. Lundazi-Chama Link	5,000	25	140
i. Kasama-Nchelenge Link	5,000	25	30
j. Sub Total (g+h+i)	10,000	50	170
k. Survey Cost	7,000	35	-
1. Total (j+k)	17,000	85	170
3. Total Cost for Equipment and Civil Work Portion (1+2)	1,318,000	6,590	1,980
4. Consultancy Service	110,000	550	64
5. Basic Project Cost (3+4)	1,428,000	7,140	2,044
6. Contingency	100,000	500	143
7. Total Project Cost (5+6)	1,528,000	7,640	2,187

Exchange Rate: 1US Dollar = 200 Japanese Yen

1 Kwacha = 1.179 US Dollar

Table 6-3 Condition of Cost Estimate for Each Radio Station Sheet 1/3

Name of Stations	Building		Tower		Power Plant				
					Solar Cell System	E/G		Batt/Rect	
	Exist.	Shelt.	Exist.	New		Exist	New	Exist.	New
1. Lusaka-Copperbelt and Chingola-Solwezi Routes									
Lusaka	x		x			x			x
Kamaila	x		x				single		x
Mukumwanji	x		x				single		x
Kabwe	x		x			x			x
Kapiri Mposhi	x		x				single		x
Katanino		x	x				dual		x
Kaloko Hill		x	x				dual		x
Ndola	x		x			x			x
Kitwe	x		x			x			x
Mufulira	x		x			x			x
Chingola	x		x			x			x
Mara		x		x	x				
Kalirele		x		x	x				
Chafukuma		x		x	x				
Solwezi	x			x		x			x
Chisamba	Modify			x		x			x
Chibombo	(x)			x		x			x
2. Kasama-Mansa Mbala, Mporokoso Route									
Kasama	x		x			x			x
Sumina	x		x			x			x
Munkonge		x		x	x				
Musonda		x		x	x				
Luwingu	x			x					x
Mumba		x		x	x				
Bululu		x		x	x				
Yambayamba		x		x	x				
Mansa	x			x		x			x

Table 6-3 Condition of Cost Estimate for Each Radio Station Sheet 2/3

Name of Stations	Building		Tower		Power Plant				
					Solar Cell System	E/G		Batt/Rect	
	Exist.	Shelt.	Exist.	New		Exist	New	Exist.	New
Indu		x		x	x				
Mikolo		x		x	x				
Munyesi		x		x	x				
Mbala	x			x			single		x
Mpulungu	x			x		x			x
Senga Hill	x			x			dual		x
Sambala		x		x	x				
Kafwambe		x		x	x				
Mporokoso	x			x		x			x
Kawmbwa	x			x			dual		x
Kala		x		x	x				
Nchelenge	x			x			dual		x
Mukabi		x		x	x				
Mwense	x			x		x			x
Chala		x		x	x				
Samfya	x			x		x			x
3. Chipata-Lundazi									
Chipata	x		x			x			x
Kanjara Hill	x		x			x			x
Nyakutwa		x		x	x				
New Bwalo		x		x	x				
Mponda		x		x	x				
Lupeta Hill		x		x	x				
Lundazi	x			x			dual		x
(Old Magodi)		(x)		(x)	(x)				
Manda Hill		x		x	x				
Cont'd									

Table 6-3 Condition of Cost Estimate for Each Radio Station Sheet 3/3

Name of Stations	Building		Tower		Power Plant				
					Solar Cell System	E/G		Batt/Rect	
	Exist.	Shelt.	Exist.	New		Exist	New	Exist.	New
Chama South		x		x	x				
Chama	x			x			dual		x
Mpata Hill		x		x	x				
Mfuwe Airport	x			x			dual		x

CHAPTER 7 PROJECT IMPLEMENTATION SCHEDULE

Chapter 7 Project Implementation Schedule

As stated in the preceding Section 6, the construction works for this Project will be divided into Phase I and Phase II. The Phase II starting period should be determined in due consideration of all related items, especially the progress of local telephone exchange construction and the toll traffic growth behaviors.

The order of priority with regard to the route construction is shown in Tables 6-1 and 6-2.

The implementation schedule for this Project is presented in Table 7-1. It is desirable that the Mass Media Television Link should urgently be established separately from Phase I and Phase II, because New Mass Media Center will be completed in November, 1981.

Table 7-1 Construction and Procurement Schedule for Phase - I

Description \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1. Detailed System Design																																	
2. Preparation of Tender Specification																																	
3. Evaluation of Tender Proposal																																	
4. Contract Negotiation and Signing																																	
5. Land Procurement (PTC)																																	
6. Ground Levelling/Land Formation and Access Road Construction																																	
7. Construction of Foundation for Antenna Supporting Structures and Shelters																																	
8. Fabrication:																																	
1) Antenna Supporting Structure																																	
2) Communication Equipment and Power Plant																																	
3) Shelters																																	
9. Transportation																																	
10. Training in Suppliers Country																																	
11. Construction and Installation																																	
1) Erection of Antenna Supporting Structure																																	
2) Construction of Shelters																																	
3) Installation of Communication Equipment and Power Plant																																	
12. Acceptance Tests																																	

Table 7-2 Construction and Procurement Schedule for Phase - II

Description \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1. Detailed System Design																																	
2. Preparation of Tender Specification																																	
3. Evaluation of Tender Proposal																																	
4. Contract Negotiation and Signing																																	
5. Land Procurement (PTC)																																	
6. Ground Levelling/Land Formation and Access Road Construction																																	
7. Construction of Foundation for Antenna Supporting Structures and Shelters																																	
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2) Communication Equipment and Power Plant																																	
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9. Transportation																																	
10. Training in Suppliers Country																																	
11. Construction and Installation																																	
1) Erection of Antenna Supporting Structure																																	
2) Construction of Shelters																																	
3) Installation of Communication Equipment and Power Plant																																	
12. Acceptance Tests																																	

CHAPTER 8 ECONOMIC FEASIBILITY STUDY

Chapter 8 Economic Feasibility Study

8.1 Background of Study

This chapter describes the result of economic studies relating to the equipment replacement in the existing microwave system and UHF system in the Copperbelt area of Zambia, and to the improvement and modification of the television transmission system in the urban area.

This chapter also presents the feasibility assessment with regard to the projected new microwave system construction in the Copperbelt, Northern and Eastern Provinces and new television system in parts of the Copperbelt and the Northern Province of Zambia.

These items constitute an integral part of the Zambian domestic telecommunications trunk network improvement and expansion plan formulated within the framework of the Third Five-Year National Development Plan. The financial analysis of the Project is the main subject of this chapter.

In this connection, the cash flow program relating to the Project implementation has been prepared in the interests of the PTC as the responsible party for the Project and from such cash flow program, the financial internal rate of return has been estimated. The construction work of this Project, is divided into Phase I and Phase II in consideration of the telephone exchange construction program, toll traffic forecast. Return on investment is calculated for all the projected routes (Phase I and Phase II).

Furthermore, return on investment with regard to the selected communication routes having high priorities (aforementioned Phase I) is also estimated.

With respect to the economic analysis of the Project from the socio-economic angle, the social and economic effects of the Project are fully considered.

It is significant to note that the penetration of these services to the rural areas depends to a great extent upon the rapidity of agricultural, commercial and industrial growth of those areas.

Such penetration of the investment effects to the rural areas forms the main strategy of the Third National Development Plan, and will also ensure the enhancement of productivity in Zambian Economy represented by the Copperbelt.

Social and economic data and information required in the said economic studies were quoted mainly from the undermentioned documents.

(a) Data Information for Japanese Feasibility Study 1980 issued by PTC.

(b) Telephone Directory 1980 issued by PTC.

(c) Annual Reports 1975, 1976 published by PTC.

(d) Estimates of Recurrent Income and Expenditure 1980 issued by Accounts Division (Telecommunication) of PTC.

(e) Report and statement of accounts for the year ended December 31st 1979 published by Bank of Zambia.

(f) The National Developemnt Plan 1979-83 issued by Office of the President, Republic of Zambia October 1979.

(g) Capital Estimates 1981 issued by PTC.

8.2 Economy and Telecommunication Sector

1) Zambia, a landlocked country in the southern half of Africa, embraces an area of 752,620 km2.

The population is estimated at 5.65 million (1979), growing by approximately 3 % per annum.

Nearly half the population lives in the Copperbelt Province and in a small corridor along the railway running from the Copperbelt Province, through Lusaka, the Capital, to Livingstone, and is employed in mining, agriculture, commerce and industry, and administrative business.

The remainder of the population, mainly engaged in small scale agriculture, is unevenly scattered over the rest of the country.

Relatively heavy concentrations are found in some limited areas with fair agricultural potential, especially the Luapula and Northern Provinces. The density is extremely low elsewhere. The economy of Zambia is dominated by the copper industry which creates nearly 95 % of exports. It accounts for the major part of Government revenues. GDP per capita was estimated at US$ 583 in 1979.

2) Government objectives in the economic development plan are:

The objectives of the Third National Development Plan (TNDP) will be to promote:

(a) generation of more and fuller employment as a major objective of development and to that end, to adopt technology which is labor - intensive, paying due regard to factor and social needs of the Zambian economy.

(b) diversification of the economic structure in order to reduce the economy's dependence on copper and to undertake a crach economic programme of promoting agriculture, commerce and industry based on use of local raw materials and the establishment of the necessary capital goods industries, and so forth.

Principal objective of the TNDP will also be to promote rural development. The aim of the regional economic developemnt strategy is to redress the lopsided pattern of development caused by the rural-urban disparities and regional unbalances, which is brought about by the predominance of the copper mining industry.

While a mojor objective of the TNDP will be to reduce the relative share of the mining sector in the GDP, this, however, does not mean a decline, in the absolute sense, in the level of activity in the mining sector.

Attention will be focussed on technological improvement in copper mines and on prospecting, exploration and processing of non-copper minerals.

TNDP projects the amounts of mining products in the annual growth rate of 2.5 %.

Attainment of these objectives requires an adequate telecommunications network capable of efficient domestic and international services including television, telex and telegraph services to support administrative, commercial and industrial activities.

The network must cover adequately the wide area over which agricultural and rural population is scattered, in order to allow integration of the population, administration and commerce.

3) Telephone exchanges are not for isolated operation. They must be connected to exchanges in other areas in order to widen the sphere of communication among users.

For this reason, it is necessary to initiate the means by which telephone conversations can be carried from one point to another across the country.

In this connection, PTC plans to inter-link all the provincial centers in the country by high capacity microwave links.

For the telex network, however, no plan for further development is afoot at the moment as adequate spare capacity exists in the network. Demand for this service is confined mainly to urban center.

The present tariff structure on telephone, which is based on metering of local calls, is rather conservative against the recent socio-economic factors in Zambia. In fact, inflationary pressures in Zambia have continued to develop throughout the 1970s and 1980s.

The increase in prices of oil and other imported goods has accelarated the rate of inflation in Zambia. The economic evaluation of the Project is principally performed, based on tariff increase forecasted in the near future. For detail, refer to the description in the following.

8.3 Program and Project

The Third Five-Year National Development Plan prepared by the Governemt of Zambia extends over 1979 through 1983.

For this Project, the schedule envisages the construction work during two and a half years after the contract signing and the cut-over in the midle of 1984.

Meanwhile, the next Five-Year Plan is scheduled after 1984. As regards the Project life after the implementation, there is no specific limitation imposed by the social institution of Zambia.

Therefore, the Project life this time is set at 20 years, patterned after the study report of the International Agency.

Thus, the cashflows program is based on the assumption that the Project comes into service in the middle of 1984 and the service life terminates 20 years after, i.e., in 2003.

The system capacity is projected to satisfy the subscriber traffic demand as of 2000. System expansion during the service life is projected at the sites in 1989 and 1994.

8.4 Cost of Project

The estimated cost of the Project, as summarized below, totals K 41.35 millions (US$ 48.8 millions), including a foreign exchange component of US$ 37.3 million equivalent. Details are given in Table 8-1.

The summary of the Initial Investment follows:

Foreign currency budget portion	Yen	7,461,000,000
	(K	31,615,000)
Local currency budget portion	K	9,737,000
Gross investment	K	41,352,000

It is assumed that, out of the above gross investment, the foreign currency portion will be wholly covered by the long term loan from the Credit and the local currency portion will follow suit by the PTC funds on hand.

In this Project, the building for terminal stations, fencing, access road construction plus inland transportation and equipment installation/ testing expenses, excluding tower construction expenses, are contained in the local currency portion.

The Project related appropreations are as follows:

For the initial year	K	7,589,000
	(Yen	1,317,000,000)

For the second Year	K	24,373,000
	(Yen	4,553,000,000)
For the third year	K	5,925,000
	(Yen	980,000,000)
For the forth year	K	3,465,000
	(Yen	611,000,000)

Parenthesized is the amount of foreign currency disbursement in the form of a long term loan.

The equipment investment breakdown in given in Table 8-1 in the Kwacha equivalent.

The rates of foreign exchange are Kwacha 0.848 to the US dollar (US$ 1.179/K) and Yen 200 to the US dollar.

This report uses the assumption that the equipment investment for system expansion scheduled for 1984-1989 and 1990-1994 will be financed by PTC's international funds as of the time the system expansion is planned.

The working detail of fund procurement will be studied again at the stage of actual planning envisaged several years ahead.

An outline of work budget to finance the scheduled system expansion is shown below.

The disbursement will be made in 1989 and 1994.

In 1989

Local currency budget portion K 449,000

In 1994

Local currency budget portion	K	604,000
Total budget portion		K 1,053,000

8.5 Working Capital

The current account required for the management of telecommunications business on a commercial basis is appropriated as the working capital.

As the result of fact-finding studies with regard to the business management efficiency in the developing countries, and the attainment of the business management specialized in Zambia, the working capital appropriation is made as follows.

1) From the service-in year after the completion of construction work: Proportionate to project revenue increment in each year.

2) The gross balance of working capital appropreated during the project life period is accounted as project revenue, together with the project salvage value, at the termination of project life.

For further detail of the appropreation, refer to Table 8-2.

8.6 Operating Expenses

The operating expenses are composed of direct business expense required for the operation and administration of the telecommunications system constructed and direct expense requied for the maintenance of the system concerned.

1) Operating and Admistrative Expense

The operating and administrative expense required for the system constructed, which mainly consists of personnel and materials expense, is estimated annually based on the expected revenue from the system concerned.

This estimation is derived from our own work experience up to the present and is also based on the result of multilateral studies as to the business management efficiency of PTC. For detail, refer to Table 8-3.

2) Maintenance Expense

The maintenance expense is composed of engine generator fuel expense, replacement parts expense, maintenance service vehicle upkeep expense and maintenance service personnel expense.

In this Project, the maintenance expense is estimated, based on the investment in plant and equipment.

This estimate is in consideration of the maintenance work efficiency which derives from the achievement of maintenance practices of PTC.

And, in the said estimate, a more or less cost increase during the project life period is discounted as a forgone conclusion.

In addition, the aforementioned estimate is set as an annual mean value, taking into account the uptrend of the number of times of repair work to remedy the system performance detrioration, as well as the capability improvement of the maintenance service personnel. For details, refer to Table 8-3.

3) Total Operating Expenses

The total operating expenses consist of the preceding expense categories 1) and 2) put together.

The total operating expenses estimates follows:

(Unit: 1,000 Kwacha)

Initial year - second year	-
3rd year	2636
4th year	5939
5th year	6184
6th year	6917
7th year	7415
8th year	7961
9th year	8140
10th year	8327
11th year	8507
12th year	8692
13th year	8882
14th year	9078
15th year	9280
16th year	9487
17th year	9699
18th year	9919
19th year	10179
20th year	10187
21st year	10195
22nd year	10195

8.7 Project Salvage Value

The project salvage value as of the termination of project life, i.e., 20 years after the system service-in, cannot be accurately estimated.

Here, according to the International Agency study report for reference, the project salvage value is set as 10 % of the amount of equipment investment at the time of project initiation, but for this project, salvage value is accounted as zero.

8.8 Tariffs

Level of tariffs should be adequate to generate a reasonable rate of return and to provide the necessary funds for expansion and improvement of service as long as the forecasted traffic holds true and the effective system management can be expected after the system replacement and expansion by this Project.

The present tariff structure, which is based on metering of local calls (without free calls), is conservative. The current call charge of K 0.080 (US$ 0.094) per call is assumed to be changed, not exceeding the range in practice in many countries. The economic calculation is principally performed, based on an assumption that the long distance call tariffs would be reviewed and adjusted from K 0.080 to K 0.10 in the middle of 1982. As a result, some minor anomalies in the tariff schedule will be eliminated. For further detail, refer to Table 8-4.

8.9 Operating Revenue

The operting revenue to accrue from the implementation of this Project consists of the following revenue categories:

1) Part of telephone service revenue, i.e., the revenue to be distributed at the investment ratio which the toll transmission lines established in this Project occupy in the nationwide telephone network;

2) Telex and telegraph service project revenue to be distributed at the investment ratio which the transmission lines established in this Project occupy in the whole telex and telegraph network;

3) Revenue from the leased circuit for TV relay which the Broadcasting Corporation of Zambia excluding uses for transmission of TV programs.

4) A more detailed explanation follows:

(a) Revenue from Telephone Service

Revenue from telephone service is calculated in consideration of the following items:

i) Call charge by call meter;
ii) Toll call time limit per metering pulse (according to time zones);
iii) Average holding time per call;
iv) Number of service days per year;
v) Traffic breakdown by main call destinations;
vi) Ratio which the length of service sections established in this Project occupies in the whole service area;
vii) Rate of contribution of toll transmission lines to telephone service improvement.

Project revenue from telephone service includes, besides charges on calls to main destinations, such indirect revenues as subscribers premise work charges, standing charges and guarantee money received.

In this study report, the charges on calls to main destinations plus revenue based on the ratio/rate in the items vi) and vii) above constitute the project revenue.

(b) Revenue from Telex and Telegraph Service

Telex and telegraph service comes into practice by use of transmission lines to be improved in this Project.

Therefore, project revenue from telex and telegraph service is estimated in considertion of the rate of contribution of the transmission lines concerned to the telex and telegraph service.

(c) TV Circuit Rental Charge

In this study report, project revenue due to TV circuit rental charge is estimated at Kwacha 280,100 annually.

This estimate is made, based on the TV circuit rental charge already in force in Zambia.

5) Total Operating Revenue

The total revenue from this Project consists of an aggregate of the preceding 1), 2) and 3) revenue categories.

More precisely:

(Unit: 1000 Kwacha)

Initial year	-
2nd year	-
3rd year	4394
4th year	9398
5th year	10164
6th year	10918
7th year	11748
8th year	12659
9th year	12957
10th year	13268
11th year	13568
12th year	13876
13th year	14194
14th year	14520
15th year	14856
16th year	15201
17th year	15275
18th year	15921
19th year	16355
20th year	16368
21st year	16382
22nd year	16382

For detail, refer to Table 8-5.

8.10 Financing

The items proposed to invite the loan are summarized below:

(Cost estimates include equipment costs plus, where applicable, foreign exchange costs of installation.)

(Unit: million Yen)

System equipments	4,676
Consultancy	526
Unallocated	2,259
Total	7,461

8.11 Loan Disbursement

The proposed loan will be disbursed against CIF cost of imported equipment and materials, the foreign cost of services and the ex-factory cost of any locally awarded contract for goods specified under the loan.

Estimated withdrawals from the proposed loan are shown below according to the implementation schedule:

(Unit: 1,000 Kwacha)

1982	K	5,581
1983	K	19,290
1984	K	4,154
1985	K	2,590
Total	K	31,615

Yen portion of the project cost would be made available for the contingency, pursuant to the consultation with the fund agency, for purchase of additional goods or services similar to those already procured under the loan.

8.12 Interest Payment and Loan Repayment

Interest payment and loan repayment are calculated by the following assumption:

- Loan repayment period : 25 years
- Grace period : 7 years
- Interest rate : 4 % per annum

The interest payment and loan repayment plan appears in Table 8-6.

8.13 Cash Flow Statement

1) Cash Inflow

The cash inflow takes account of the following items:

- Operating Revenue
  Telephone, telex and telegraph service revenue and TV circuit rental charge revenue.

- Foreign Investment
  A foreign loan will be invited to produce the foreign currency budget for implementation of this Project.

2) Cash Outflow

The cash outflow takes account of the following items:

- Operating Expense
  Expense for operation, administration and maintenace of the system to be established by this Project.

- Working Capital
  Floating capital for project mangement by PTC.

- Construction Investment

  Investment for system construction by this Project.

- Interest Payment

  Payment of interst accruing to the loan.

- Loan Repayment

  Repayment of loan principal in the stipulated repayment period.

3) Net Cash Flow

Net cash flow is the balance between cash inflow and cash outflow. The cashflow schedule for project implementation appears in Table 8-7.

8.14 Return on Investment (1)

1) Calculation of Financial Internal Rate of Return

The internal rate of return on the Project is defined as the discount rate which equalizes the stream of expected revenues attributable to the Project with equipment investment required for project implementation, operating expense and operating revenue, etc., which are tabulated below.

i) In case of all the projected communication routes (Phase I + Phase II)

(Unit: 1000 Kwacha)

Period	Project Cost	Working Capital	Operating Expense	Operating Revenue	Project Salvage Value	Net Revenue
1st year	7589	-	-	-	-	△ 7589
2nd year	24373	-	-	-	-	△ 24373
3rd year	5925	439	2636	4394	-	△ 4606
4th year	3465	500	5639	9398	-	△ 206
5th year	-	77	6184	10164	-	3903
6th year	-	75	6917	10918	-	3926
7th year	-	83	7415	11748	-	4250
8th year	449	91	7961	12659	-	4158
9th year	-	30	8140	12957	-	4787
10th year	-	31	8327	13268	-	4910
11th year	-	30	8507	13568	-	5031
12th year	-	31	8692	13876	-	5153
13th year	604	32	8882	14194	-	4676
14th year	-	33	9078	14520	-	5409
15th year	-	34	9280	14856	-	5542
16th year	-	35	9487	15201	-	5679
17th year	-	35	9699	15555	-	5821
18th year	-	37	9919	15921	-	5965
19th year	-	43	10179	16355	-	6133
20th year	-	0	10187	16368	-	6181
21st year	-	0	10195	16382	-	6187
22nd year	-	△ 1636	10195	16382	0	7823

Internal Rate of Return: 8.78 %

ii) In case of selected communication routes (Phase I)

(Unit: 1000 Kwacha)

Period	Project Cost	Working Capital	Operating Expense	Operating Revenue	Project Salvage Value	Net Revenue
1st year	7589	-	-	-	-	△ 7589
2nd year	24373	-	-	-	-	△ 24373
3rd year	728	436	2617	4362	-	581
4th year	-	497	5600	9334	-	3237
5th year	-	72	6101	10052	-	3879
6th year	-	75	6771	10798	-	3952
7th year	-	82	7264	11620	-	4274
8th year	449	92	7818	12544	-	4185
9th year	-	29	7992	12834	-	4813
10th year	-	30	8172	13134	-	4932
11th year	-	30	8350	13430	-	5050
12th year	-	31	8533	13735	-	5171
13th year	604	31	8721	14048	-	4692
14th year	-	33	8914	14370	-	5423
15th year	-	33	9112	14700	-	5555
16th year	-	34	9317	15041	-	5690
17th year	-	35	9527	15391	-	5829
18th year	-	36	9743	15751	-	5972
19th year	-	41	9988	16160	-	6131
20th year	-	0	9992	16167	-	6175
21st year	-	0	9996	16173	-	6177
22nd year	-	△ 1617	9996	16173	0	7794

Internal Rate of Return: 11.28 %

2) Sensitivity Analysis

With respect to the project cost, operating expense and operating revenue considered in the calculation of the internal rate of return, the sensitivity analysis has been carried out.

The result of analysis follows:

i) IRR = 7.69 % (Phase I + II), 10.11 % (Phase I)
in case of 10 % increase in project cost

ii) IRR = 7.48 % (Phase I + II), 9.74 % (Phase I)
in case of 10 % decrease in operating revenue

iii) IRR = 6.68 % (Phase I + II), 9.08 % (Phase I)
in case of 10 % increase in operating expense

iv) IRR = 7.65 % (Phase I + II), 9.88 % (Phase I)
in case of two-year delay in project completion

v) In case of unfavorable combination of conditions including;
- 10 % revenue decrease
- 10 % operating expense increase
- 10 % construction cost increase
- Two-year delay in project completion
IRR = 3.80 % (Phase I + II), 6.01 % (Phase I)

8.15 Return on Investment (2)

Financial Internal Rate of Return which is estimated based on the current tariff schedule is as follows:

i) In case of all the projected communication routes
(Phase I + Phase II)
IRR= 6.67 %

ii) In case of selected routes (Phase I)

IRR= 9.11 %

8.16 Shadow Pricing

The economic return on investment is also evaluated by using the border prices. The economic internal rate of return of the Project (Phase I + Phase II) is estimated at 10.38 %.

This indicates that the economic return of the Project as viewed from the national standpoint is more beneficial as compared with the financial return.

8.17 Conclusion

Zambian economic structure and development type was studied. On-going projects and projects planned in the near future regarding domestic telecommunications construction works were also investigated and the traffic demand growth rates were forecasted.

This economic evaluation is based on the economy and the existing and planned facilities of telecommunications, in consideration of the projected communication routes based on the regional development plans in the country.

On an assumption that the projected replacements and expansions of the total transmission systems would be enforced in accordance with the schedule being provided, return on investment between with-project and without-project was financially analyzed.

As the results, return on investment was estimated at 8.78 % for financial internal rate of return. When the Zambian economy and the price escalation are considered, a rise in telephone tariff rate is recommended from the PTC management strategical point of view.

The above percentage is estimated on an assumption that a rise in tariff rate would be introduced into the basic benefit of the project.

By the current tariffs, Internal Rate of Return which is estimated financially, is 6.67 %.

Zambia has been characteristic of typical mono-cultural economy, specialized for mining products exporting. In political aspect, this country has been comparatively stable among sub-saharan african countries. But, in economic aspect, the total amounts of foreign reserve earned by exporting copper products, depend on the copper price decided by the international market.

Almost all the foreign reserve has been applied to the payment of imported food and materials, and so it has been actually insufficient. The copper mining industries have made their products marketing plans according to the international prices decided by LME in London in the previous year. Under the unstable copper prices indicated in the past trend, stable economic growth in Zambia, henceforth cannot be forecasted optimistically.

But the modern mining industries have the potential to become important producers of several kinds of mining products including cobalt. Mining products exporting, henceforth, will have constituted a principal component in Zambian economy.

The principal objectives of the Third National Development Plan (TNDP) is to promote the regional development in the rural area, and improve the economic structure to avoid too much dependence on copper. The aim of the regional economic development strategy is to create employment and improve productivity of agriculture, commerce and industry by diversifying economic structure all over the country. In the domestic telecommunications trunk network improvement and expansion plan, capital replacement between Lusaka and Copperbelt will give an impact to the development of the copper industry.

More precisely, speedy information of the international prices indespensable for planning the copper production schedule and information exchange between each two (2) sites required for enhancement of the productivity, etc., will be able to contribute to obtaining more precise sales schedule and improving the distribution system.

Development of the rural area in accordance with the Third Development Plan will be based on exchange of information between the central area, i.e., Luska-Copperbelt, and the rural area. One of the purposes of communication routes expansion for the northern area is to improve the transportation capabilities of the Tanzania Railways.

The routes for the eastern territory will be essential to the creation of investment incentive and for effective use of the eastern area, the most fertilized agricultural land in Zambia.

As the result, investment efficiency of this Project, that is, return on investment is estimated at 8.78 % financially. This figure indicates earning power for the total assets on the project including foreign loan.

This holds true not only in the aspect of capital cost assumed in the loan conditions of foreign credits but also from the views point of the credit loan between the Government of the Republic of Zambia (GRZ) and the PTC.

The principal project revenue is derived from the improvement of the Lusaka-Copperbelt area which is located in the center of the Zambian domestic industries. And then, though the project revenue was pessimistically estimated, this holds true not only in the aspect of opportunity cost of the capital upkeep by the project promoting organization (PTC) and its loan repayment capability, from the view point of a financing country.

Another economic estimation was performed. Return on investment with regard to the selected communication-routes having high priorities was calculated, and financially estimated at 11.28 %. 9.11 % is estimated based on the current tariffs.

These routes are also planned to be constructed urgently among other communications routes constituting this Project.

The economic return on investment is also evaluated by the border prices. The economic internal rate of return of the Project is estimated at 10.38 % (PhaseI & PhaseII).

This indicates that the higher economic return of the Project on a national point of view is evaluated in comparison with the financial return.

* * *

On-going projects are considerably behind the schedule as of March 1981. Especially, the construction works relating to Direct Exchange Lines are three (3) years behind the schedule. This delay in construction work may result in decrease in potential demand for telephones.

It is expected that PTC will make appropriate arrangements immediately to put the construction works on rail, so that the works can be completed by 1984, when this microwave project is scheduled to be cut over.

It is also expected that PTC will rationalize its management and operate the system completed with better return on assets.

What are to be done for improving the operation/maintenance of the communication system are:

1) To reduce disparities in completion dates of various parts of the on-going projects and this Projects.

   For example, the following were observed with the on-going projects:

   - Exchange offices are completed, but no machines are provided
   - Exchages are provided, but no connected to exchanges of other areas

2) To procure funds (bank loan or self-financing) for timely purchasing of required machines

3) To train technical staff to be engaged in installation, opeartion and maintenance of the equipment and system

4) To provide some vehicles for maintenance and operation, and improve the transportation function, in order to make the system work in order

In conclusion, rationalization of the PTC system management, speedy and on-time construction of the on-going projects will be essential factor to realize satisfactory return from investment on this Project.

Table 8-1 Project Cost

(Unit: 1,000 Kwacha)

	Foreign Currency	Local Currency	Total
1. Equipment Work Portion			
a. Equipments	14,857		
b. Installation Materials	1,725		
c. Maintenance Facilities	1,101		
d. Spares	635		
e. Ocean Freight	1,496		
f. C.I.F. Total	19,814		
g. Installation	6,589		
h. Survey/Training	466		
i. Total	26,868	6,600	33,468
2. Civil Work Portion	449	2,190	2,639
3. Consultancy Service	2,229	304	2,533
4. Contingency	2,068	643	2,711
5. Ground Total	31,615	9,737	41,352

Table 8-2 Working Capital and Project Salvage Value

(Unit: 1,000 Kwacha)

Period (Year)	Working Capital	Project Salvage Value
1	-	-
2	-	-
3	439	-
4	500	-
5	77	-
6	75	-
7	83	-
8	91	-
9	30	-
10	31	-
11	30	-
12	31	-
13	32	-
14	33	-
15	34	-
16	35	-
17	35	-
18	37	-
19	43	-
20	0	-
21	0	-
22	0	0

Table 8-3 Operating Expenses

(Unit: 1,000 Kwacha)

Period (Year)	Operating & Administrative Expense	Maintenance Expense	Total Expenses
1	-	-	-
2	-	-	-
3	2,636	0	2,636
4	5,639	0	5,639
5	6,098	86	6,184
6	6,551	366	6,917
7	7,049	366	7,415
8	7,595	366	7,961
9	7,774	366	8,140
10	7,961	366	8,327
11	8,141	366	8,507
12	8,326	366	8,692
13	8,516	366	8,882
14	8,712	366	9,078
15	8,914	366	9,280
16	9,121	366	9,487
17	9,333	366	9,699
18	9,553	366	9,919
19	9,813	366	10,179
20	9,821	366	10,187
21	9,829	366	10,195
22	9,829	366	10,195

Table 8-4 Telephone Tariffs (1)

SUBSCRIBER TRUNK DIALLING (S.T.D.) CALL CHARGES

S.T.D Calls do not have a 3 minute minimum charge as with trunk calls connected by the operator. Time is bought in metered units of 8 ngwee and the time allowed varies according to distance. The following table shows the time in seconds allowed for each metered unit on calls dialled by subscribers between the exchanges listed.

FROM \ TO	CHAMBISHI	CHILANGA	CHILILABOMBWE	CHINGOLA	CHOMA	GWEMBE	ITIMPI	KABWE	KAFUE	KALOMO	KALULUSHI	KASAMA	KITWE	LIVINGSTONE	LUANSHYA	LUSAKA	MAZABUKA	MONZE	MUFULIRA	MUMBWA	NDOLA	PEMBA	SOLWEZI
CHAMBISHI	U	10	30	30	7.5	7.5	U	20	10	7.5	30	10	U	7.5	30	10	7.5	7.5	30	10	30	7.5	20
CHILANGA	10	U	10	10	20	20	10	20	30	20	10	7.5	10	10	10	U	20	20	10	20	10	20	10
CHILILABOMBWE	30	10	U	30	7.5	7.5	30	20	10	7.5	30	10	30	7.5	30	10	7.5	7.5	30	10	30	7.5	7.5
CHINGOLA	30	10	30	U	7.5	7.5	30	20	10	7.5	30	10	30	7.5	30	10	7.5	7.5	30	10	30	7.5	20
CHOMA	7.5	20	7.5	7.5	U	30	7.5	10	20	30	7.5	6	7.5	20	7.5	20	30	30	7.5	20	7.5	30	7.5
GWEMBE	7.5	20	7.5	7.5	30	U	7.5	10	20	30	7.5	6	7.5	20	7.5	20	7.5	30	7.5	20	7.5	30	7.5
ITIMPI	U	10	30	30	7.5	7.5	U	20	10	7.5	U	10	U	7.5	30	10	10	7.5	30	10	30	7.5	20
KABWE	20	20	20	20	10	10	20	U	20	10	20	7.5	20	7.5	20	20	30	10	20	20	20	10	10
KAFUE	10	30	10	10	20	20	10	20	U	20	10	7.5	10	10	10	30	20	20	10	20	10	20	10
KALOMO	7.5	20	7.5	7.5	30	30	7.5	10	20	U	7.5	6	7.5	20	7.5	20	30	30	7.5	20	7.5	30	7.5
KALULUSHI	30	10	30	30	7.5	7.5	30	20	10	7.5	U	10	U	7.5	30	10	7.5	7.5	30	10	30	7.5	20
KASAMA	10	7.5	10	10	6	6	10	7.5	7.5	6	10	U	10	6	10	7.5	6	6	10	7.5	10	6	7.5
KITWE	U	10	30	30	7.5	7.5	U	20	10	7.5	U	10	U	7.5	30	10	7.5	7.5	30	10	30	7.5	20
LIVINGSTONE	7.5	10	7.5	25	20	20	7.5	7.5	10	20	7.5	6	7.5	U	7.5	10	20	20	7.5	10	7.5	20	7.5
LAUNSHYA	30	10	30	30	7.5	7.5	30	20	10	7.5	30	10	30	7.5	U	10	7.5	7.5	30	10	30	7.5	20
LUSAKA	10	30	10	10	20	20	10	20	30	20	10	7.5	10	10	10	U	20	10	10	20	10	20	10
MAZABUKA	7.5	20	7.5	7.5	30	30	7.5	10	20	30	7.5	6	7.5	20	7.5	20	U	30	7.5	20	7.5	30	7.5
MONZE	7.5	20	7.5	30	30	30	7.5	10	20	30	7.5	6	7.5	20	7.5	20	30	U	7.5	20	7.5	30	7.5
MUFULIRA	30	10	30	10	7.5	7.5	30	20	10	7.5	30	10	30	7.5	30	10	7.5	7.5	U	10	30	7.5	20
MUMBWA	10	20	10	30	20	20	10	20	20	20	10	10	10	10	10	20	20	20	10	U	10	20	10
NDOLA	30	10	30	7.5	7.5	7.5	30	20	10	7.5	30	10	30	7.5	30	10	7.5	7.5	30	10	U	7.5	20
PEMBA	7.5	20	7.5	7.5	30	30	7.5	10	20	30	7.5	6	7.5	20	7.5	20	30	30	7.5	20	7.5	U	7.5
SOLWEZI	20	10	20	20	7.5	7.5	20	10	10	7.5	20	7.5	20	7.5	20	10	7.5	7.5	20	10	20	7.5	U

NOTE: 1. Some Party line and coinbox telephones do not have access to the Subscriber Trunk Dialling (S.T.D.) Network and all trunk calls from these telephones are obtained with the assistance of the operator.

NOTE: 2. LOCAL calls are untimed and charged at one unit.

NOTE: 3. Party line subscribers on Kitwe, Choma, Kalomo, Ndola and Luanshya exchanges have access to the subscribers trunk dialling network. Party line subscribers at other exchanges will have this facility with the commissioning of the new exchanges in their areas.

NOTE: 4. U indicates untimed local call (1 unit).

Table 8-4 Telephone Tariffs (2)

CHARGES FOR CALLS VIA THE OPERATOR

FROM	Z	G	TO: Lusaka, Kafue, Chilanga, Chirundu, Luangwa, Siavonga, Chisamba, Namulundu Gorge		Mumbwa	Kitwe, Ndola, Chingola, Chililabombwe, Itimpi, Kalulushi, Luanshya, Mufulira, Chambishi																				
			Z	1		2				3			4					5		6				7		8		
	Z	G	1	2	1	2	3	1	2	3	1	2	3	4	5	1	2	1	2	3	1	2	1	2	3
Lusaka, Kafue, Chilanga, Chirundu, Siavonga, Chisamba, Luangwa, Namulundu Gorge	1	1		C	E	F	F	E	C	F	P	F	G	G	F	C	E	F	F	E	F	E	E	E	F
Mumbwa		2	C		E	F	F	E	C	E	F	F	G	G	F	C	E	F	G	F	E	C	E	C	E
Kitwe, Ndola, Chingola, Chililabombwe, Itimpi Kalulushi, Luanshya, Mufulira, Chambishi	2	1	E	E		C	E	F	F	F	E	E	F	F	F	C	C	F	F	E	F	E	C	E	F
Mansa, Samfya		2	F	F	C		C	G	F	G	E	E	E	E	E	E	E	F	F	E	G	F	E	E	F
Kawambwa, Nchelenge, Mwense, Mununga		3	F	F	E	C		G	G	G	C	E	E	E	C	F	E	F	F	F	G	F	E	F	F
Livingstone, Zimba	3	1	E	E	F	G	G		C	C	G	G	G	G	G	F	F	G	G	F	E	E	F	F	F
Choma, Namwala, Gwembe, Chisekesi, Mazabuka, Kalomo, Pemba, Monze, Sinazongwe		2	C	C	F	F	G	C		E	G	G	G	G	G	E	F	F	G	F	F	E	F	E	F
Sesheke		3	F	E	F	G	G	C	E		G	G	G	G	G	F	G	G	G	G	E	E	F	F	E
Kasama, Luwingu, Mungwi, Chilubi Island	4	1	F	F	E	E	C	G	G	G		C	C	C	C	F	E	E	E	F	G	G	F	F	G
Mpika, Shiwa Ng'andu		2	F	F	E	E	E	G	G	G	C		E	C	E	E	C	C	C	E	G	G	F	F	G
Mbala, Senga Hill, Mpulungu		3	G	G	F	E	E	G	G	G	C	E		C	C	F	F	F	E	F	G	G	F	G	G
Isoka, Chinsali, Nakonde		4	G	G	F	E	E	G	G	G	C	C	C		E	F	E	E	E	F	G	G	F	G	G
Mporokoso, Kaputa		5	F	F	F	E	C	G	G	G	C	E	C	E		F	E	F	F	F	G	G	F	F	G
Kabwe, Kapiri Mposhi, Chibombo	5	1	C	C	C	E	F	F	E	F	F	E	F	F	F		C	F	F	E	F	E	E	C	F
Serenje, Mkushi, Kanona, Mkushi River		2	E	E	C	E	E	F	F	G	E	C	F	E	E	C		E	E	C	G	F	E	F	F
Chipata, Sinda, Katete, Chadidza, Msoro, Kazimuli	6	1	F	F	F	F	F	G	F	G	E	C	F	E	F	F	E		C	C	G	G	F	G	G
Lundazi, Chama		2	F	G	F	F	F	G	G	G	E	C	E	E	F	F	E	C		E	G	G	G	G	G
Petauke, Nyimba, Mwanjawanthu		3	E	F	E	E	F	F	F	G	F	E	F	F	F	E	C	C	E		G	F	F	F	G
Mongu, Kalabo, Senanga, Limulunga, Lukulu	7	1	F	E	F	G	G	E	F	E	G	G	G	G	G	F	G	G	G	G		C	F	E	C
Kaoma		2	E	C	E	F	F	E	E	E	G	G	G	G	G	E	F	G	G	F	C		E	C	C
Solwezi	8	1	E	E	C	E	E	F	F	F	F	F	F	F	F	E	E	F	G	F	F	E		C	E
Kasempa, Chizera		2		C	E	E	F	F	E	F	F	F	G	G	F	C	F	G	G	F	E	C	C		C
Kabompo, Zambezi, Chavuma, Ikelenge, Mwinilunga, Chitokoloki		3	F	E	F	F	F	F	F	E	G	G	G	G	G	F	F	G	G	G	C	C	E	C	

Z = ZONE

G = GROUP

(1) CHARGE LETTER CONVERSION TABLE:
U.....K 8n local call
B..... 48n for 3 minutes
C..... 72n " " "
E.....1.44n " " "
F.....1.92n " " "
G.....2.40n " " "

(2) CHARGES FOR CALLS BETWEEN THE FOLLOWING EXCHANGES WILL BE 8n (U)
Kitwe-Kalulushi
Kitwe-Chambishi
Itimpi-Chambishi
Lusaka-Chilanga
Chisekesi-Monze
Kitwe-Itimpi
Itimpi-Kalulushi
Chambishi-Kalulushi
Mongu-Limulunga

(3) CHARGES FOR CALLS BETWEEN EXCHANGES IN THE SAME GROUP, 48n FOR 3 MINUTES (B).
Chipata-Mchinji (B) 48n for 3 minutes.

(4) CHARGES FOR CALLS VIA THE OPERATOR
The three minute charge (minimum) for ordinary trunk calls within Zambia is based on group charging.

Table 8-5 Operating Revenue

(Unit: 1,000 Kwacha)

Period (Year)	Telephone, Telex, Telegraph Call Charges (*)	TV circuit Rental Charge	Total Revenue
1	-	-	-
2	-	-	-
3	4,254	140	4,394
4	9,118	280	9,398
5	9,884	280	10,164
6	10,638	280	10,918
7	11,468	280	11,748
8	12,379	280	12,659
9	12,677	280	12,957
10	12,988	280	13,268
11	13,288	280	13,568
12	13,596	280	13,876
13	13,914	280	14,194
14	14,240	280	14,520
15	14,576	280	14,856
16	14,921	280	15,201
17	14,995	280	15,555
18	15,641	280	15,921
19	16,075	280	16,355
20	16,088	280	16,368
21	16,102	280	16,382
22	16,102	280	16,382

(*) The revenue is based on the ratio in percentage of operating revenue expected from the current project to the total telephone service revenue.

Table 8-6 Interest Payment & Loan Principal Repayment Schedule

(Unit: 1,000 Kwacha)

Period (Year)	Foreign Loan	Cumulative Foreign Loan	Repayment of Foreign Loan	Cumulative Instalment	Balance of Foreign Loan	Interest Payment
1	5,581	5,581	-	-	5,581	223.2
2	19,290	24,871	-	-	24,871	994.8
3	4,154	29,025	-	-	29,025	1,161.0
4	2,590	31,615	-	-	31,615	1,264.6
5	-	-	-	-	31,615	1,264.6
6	-	-	-	-	31,615	1,264.6
7	-	-	-	-	31,615	1,264.6
8	-	-	1,756	1,756	29,859	1,194.4
9	-	-	1,756	3,512	28,103	1,124.1
10	-	-	1,756	5,268	26,347	1,053.9
11	-	-	1,756	7,024	24,591	983.6
12	-	-	1,756	8,780	22,835	913.4
13	-	-	1,756	10,536	21,079	843.2
14	-	-	1,756	12,292	19,329	773.2
15	-	-	1,756	14,048	17,567	702.7
16	-	-	1,756	15,804	15,811	632.4
17	-	-	1,756	17,560	14,055	562.2
18	-	-	1,756	19,316	12,299	492.0
19	-	-	1,756	21,072	10,543	421.7
20	-	-	1,756	22,828	8,787	351.5
21	-	-	1,756	24,584	7,031	281.2
22	-	-	1,756	26,340	5,275	211.0
23	-	-	1,756	28,096	3,519	140.8
24	-	-	1,756	29,852	1,763	70.5
25	-	-	1,763	31,615	0	0
Total						18,189.2

Table 8-7 Cash Flow Statement (1)

Cash Inflow

(Unit: 1,000 Kwacha)

Period (Year)	Operating Revenue	Foreign Loan	Funds on Hand	Total Cash Inflow
1	-	5,581	2,008	7,589
2	-	19,290	5,083	24,373
3	4,394	4,154	1,771	10,319
4	9,398	2,590	875	12,863
5	10,164	-	-	10,164
6	10,918	-	-	10,918
7	11,748	-	-	11,748
8	12,659	-	-	12,659
9	12,957	-	-	12,957
10	13,268	-	-	13,268
11	13,568	-	-	13,568
12	13,876	-	-	13,876
13	14,194	-	-	14,194
14	14,520	-	-	14,520
15	14,856	-	-	14,856
16	15,201	-	-	15,201
17	15,555	-	-	15,555
18	15,921	-	-	15,921
19	16,355	-	-	16,355
20	16,368	-	-	16,368
21	16,382	-	-	16,382
22	18,018	-	-	18,018

Table 8-7 Cash Flow Statement (2)

Cash Outflow

(Unit: 1,000 Kwacha)

Period (Year)	Investment in Fixed Assets	Investment Current Assets	Operating Expenses	Repayment of Foreign Loan	Interest on Foreign Loan	Total Cash Outflow
1	7,589	-	-	-	223	7,812
2	24,373	-	-	-	995	25,368
3	5,925	439	2,636	-	1,161	10,161
4	3,465	500	5,639	-	1,265	10,869
5	-	77	6,098	-	1,265	7,440
6	-	75	6,551	-	1,265	7,891
7	-	83	7,049	-	1,265	8,397
8	449	91	7,595	1,756	1,194	11,085
9	-	30	7,774	1,756	1,124	10,684
10	-	31	7,961	1,756	1,054	10,802
11	-	30	8,141	1,756	984	10,911
12	-	31	8,326	1,756	913	11,026
13	604	32	8,516	1,756	843	11,751
14	-	33	8,712	1,756	773	11,274
15	-	34	8,914	1,756	703	11,407
16	-	35	9,121	1,756	632	11,544
17	-	35	9,333	1,756	562	11,686
18	-	37	9,553	1,756	492	11,838
19	-	43	9,813	1,756	422	12,034
20	-	0	9,821	1,756	352	11,929
21	-	0	9,829	1,756	281	11,866
22	-	0	9,829	1,756	211	11,796

Residual Repayment of Foreign Loan : 5,275

Residual Interest on Foreign Loan : 211.3

Table 8-7 Cash Flow Statement (3)

Net Cash Flow

(Unit: 1,000 Kwacha)

Period (Year)	Net Cash Flow
1	-223 (*)
2	-995
3	158
4	1,994
5	2,724
6	3,027
7	3,351
8	1,574
9	2,273
10	2,466
11	2,657
12	2,850
13	2,443
14	3,246
15	3,449
16	3,657
17	3,869
18	4,083
19	4,334
20	4,439
21	4,516
22	6,222

(*) The deficits in the initial and second years amounting to Kwacha 223,000 and Kwacha 995,000, respectively, are to be covered by the PTC funds on hand.