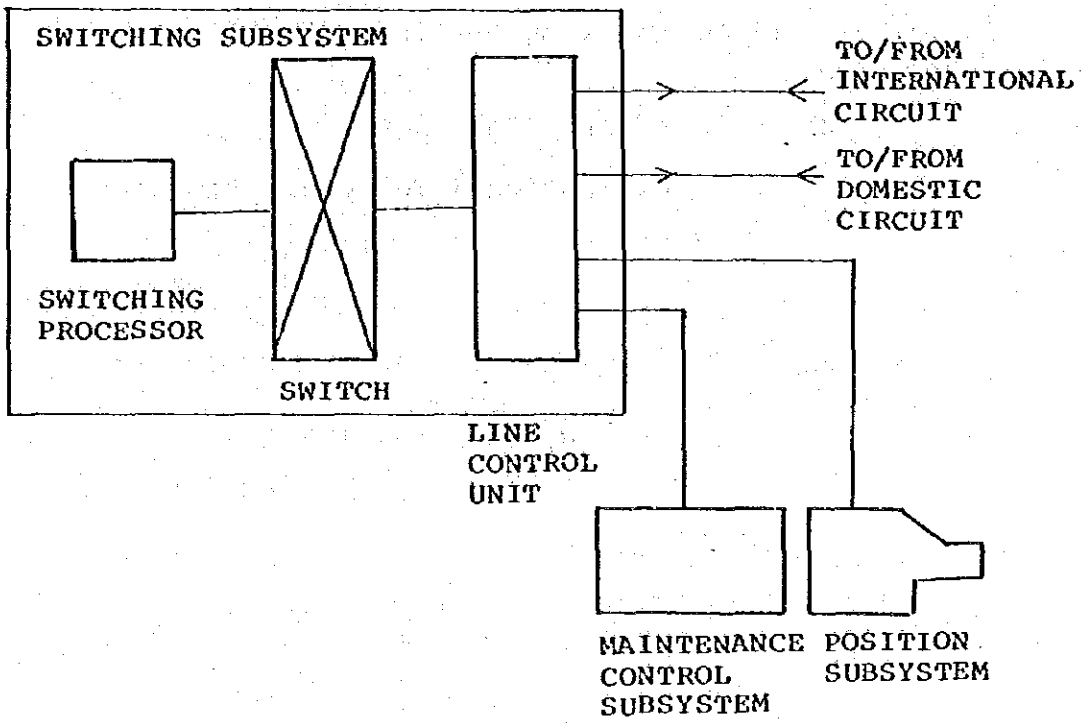


Fig. 4-1 Basic Configuration

4-3 Basic Scheme

4-3-1 Service modes

(1) Classification of calls

a) Originating calls

- Automatic call
- Semi-automatic call
- Manual call

b) Terminating calls

- Automatic terminating call
- Manual terminating call

c) International transit calls
(This service will be provided if necessary)

d) Originating/terminating calls through position

(2) Code and speed of signal

International Telegraph Alphabet (ITA) No.2, 50 bauds

4-3-2 Trunking

Fig. 4-2 shows a trunking diagram of the proposed international telex switching system.

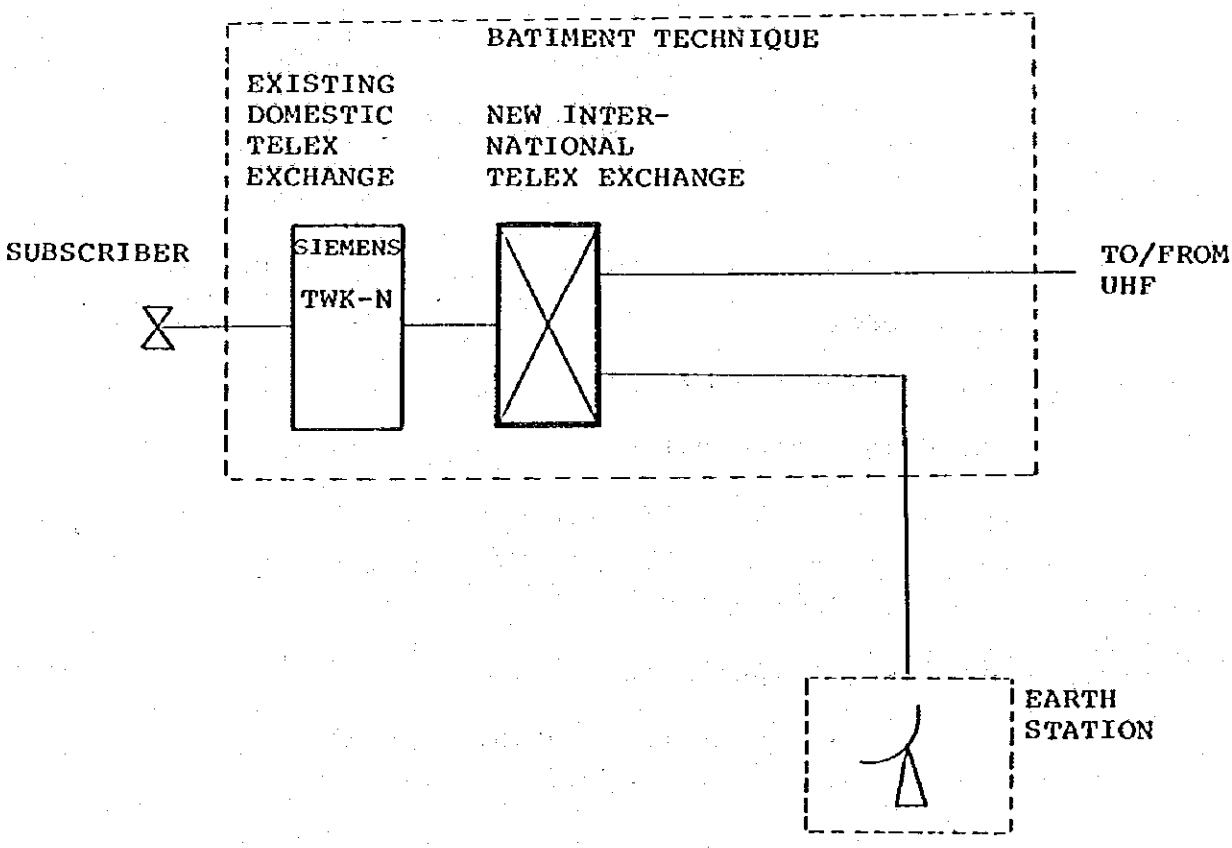


Fig. 4-2 Trunking Diagram

(1) Outgoing selection

a) Both sequential selection and random selection are achievable depending on the route.

b) Alternative routing shall be achievable.

(2) Barring condition

Necessary barring shall be achievable in originating and terminating trunking connections.

(3) Overload countermeasures

a) Overload condition shall be detected by supervising the system operation at all times.

b) Decision shall allow necessary distriction either automatically or manually in the event of overload condition.

4-3-3 Operating Scheme

(1) Operation of subscriber

Details of operation will be decided by mutual agreement between MPC and the contractor.

(2) Functions of operator position

The operator position functions shall be follows.

a) Inrernational call connection

Originating, terminating and transit calls shall be connectable through operator position by request of the subscriber when call connection is not achievable on the full automatic basis.

b) Inquiry and complaint

Shall allow reception and processing of inquiry and claims from subscribers and foriegn stations.

(3) Service codes

The following service codes shall be sent back to the originating subscriber in conformity to CCITT Recommendation F60.

OCC: Subscriber is engaged.
DER: Out of order
NP: The called party is not or is no longer a subscriber
NA: Correspondence with this subscriber is not admitted.
NC: No circuits
NCH: Subscriber's number has been changed
MOM: Wait/Waiting

4-3-4 Call Record

(1) Recorded calls

As a rule, all telex calls shall be recorded in form of detailed recording.

(2) Contents of record

All call connection data shall be recorded on teletypewriter.
The following information shall be contained in the call data.

a) Record number
b) Type of call (Originating/terminating/transit)

c) Class of service
d) Starting time of communication
e) Calling subscriber number of answer-back code (for calls originated in Rwanda)
f) Called subscriber number
g) Incoming trunk group number (for terminating and transit calls)
h) Outgoing trunk group number
i) Chargeable time

4-3-5 Signalling

(1) Inrernational signalling condition

a) International telex signalling condition type A and type B specified in CCITT Recommendation U1 shall be provided.

b) If any other signalling is required, discussion will be made for agreement by MPC and the contractor.

c) CCITT Recommendation U20 (radio circuit) shall not be considered.

(2) Inter-unit signalling

a) From/to VHTG equipment: Double current, ±20mA/±60V

b) From/to domestic exchange: Dobule current, ±20mA/±60V

4-3-6 Maintenance and Test

(1) General requirements

Supervision, testing, and diagnosis shall be automated by hardware and software. Shall facilitete

troubleshooting and preventing maintenance.

(2) Supervision

The following functions shall be provided.

a) Lamp indication and audible alarm indication

Fault in equipment shall be locatable by lamp indication, while giving audible alarm indication simultaneously.

b) Print-out

Fault data shall be printed out on maintenance teletypewriter for recording.

c) Indication of system operating condition

The following items shall be reported to the maintenance personnel by lamp indication, audible alarm indication, or print-out message or a combination of these means.

- Frame fault indication ..... Power failure
  Blown fuse
  Fan fault
  Clock fault
- Faulty equipment indication ... Fault condition of each unit
- Faulty circuit indication
- Traffic overload indication

d) Supervision of international trunk circuit and operator positions

Busy status of each route and the number of requests waiting for operator positions shall be displayed in addition to the above-mentioned indications.

(3) Maintenance, test and diagnosis

a) Diagnosis by diagnosis program
b) Manual test and check by maintenance personnel
c) Connection test of designated trunk circuit

4-3-7 Traffic Control

The traffic handling condition of the system shall be continuously supervised at various points while call processing and shall be reported to maintenance personnel periodically or on his request. The following items shall be the objectives for the observation of service grade, in conformity to CCITT Recommendation F70.

(1) Total number of calls
(2) Number of effective calls for each type of calls
(3) Number of ineffective calls
(4) Occupancy of each trunk group (route)
(5) Occupancy of central processor

4-4 System Specifications

4-4-1 Basic Specifications

(1) Number of trunk lines

Initial stage:	64 lines
Final stage:	120 lines

The above number includes all the international trunk circuits, domestic circuits, positions, test terminals, etc.

(2) Communication speed

50 bauds

(3) Code

ITA (International Telegraph Alphabet) No.2, CCITT Recommendation F1.

(4) Signalling

Type A and Type B, CCITT Recommendation U1.

(5) Switching method

Time division circuit switching

(6) Control method

Stored program control

(7) Receiving distortion margin

46%

(8) Reliability

The system shall be designed to provide such a high reliability as less than 1 hour per 20 years in down time.

(9) Ambient conditions

a) Normal operating condition

Ambient temperature	23°C ± 5°C
Humidity	60% ± 10%

b) Serviceable range

Ambient temperature	0° ∿ 40°C
Humidity	10 ∿ 90%

4-4-2 System Composition

(1) Hardware

a) Switching subsystem

The switching subsystem shall perform telex switching. This subsystem shall consist of switching processor frames or basic frames incorporating the control processor, memories, time division switching units, line control units, etc. Two switching processor frames shall be employed to form a duplicated system to assure high reliability.

b) Maintenance and control subsystem

This subsystem shall consist of maintenance teletypewriter for use for man-machine interface and for issuing charging data and maintenance console for system changeover, supervision and indication of fault, etc., upon occurrence of a fault. Test printers for conducting connection test shall also be included in this subsystem.

c) Position subsystem

This subsystem consists of teletypewriter and route busy display for indicating busy status of trunk groups and the number of the requests awaiting in queue.

(2) List of equipment

The following items of equipment shall be installed.

Item	Q'ty
1) Major Equipment	
a) Switching Processor Frame	2

	Item	Q'ty
b)	Maintenance Teletypewriter	3
c)	Maintenance Console	1
d)	Operator Position	2
e)	Route Busy Display	1
f)	Line Test Frame	1
g)	Test Teleprinter	2
h)	Intermediate Distribution Frame	1

2) Power Supply Equipment*

a)	Inverter	1

*Main power source equipment such as rectifiers and batteries are not included and those installed for the new international telephone switching system shall be used in common.

3) Installation materials and tools	1 lot
4) Test equipment and tools	1 set
5) Spare parts (for 2 years)	1 set

(3) System block diagram

Fig. 4-3 shows a system block diagram of the proposed international telex switching system.

4-4-3 Software Composition

The following programs shall be provided for efficient use of the system.

(1) Execution control program (EP)

EP controls the execution of all application programs and input/output operations.

(2) Fault processing program (FP)

FP analyzes faults, reconfigurates the system depending on the fault, and restarts switching processing.

(3) Call processing program (CP)

CP executes a series of processing ranging from the setting up and clearing of telephone calls.

(4) Administration program (AP)

AP executes commands inputted by maintenance personnel in traffic control and other administrative jobs.

(5) Diagnosis program (DP)

DP executes test for faulty package and locate the fault.

4-4-4 Floor Layout

Refer to the paragraph on the layout plan.

4-5 Scope of Work

4-5-1 Works to Be Performed by the Contractor

The contractor shall be responsible for the following works.

FLD : Floppy Disk Memory
HW : Highway Switch
IDF : Intermediate Distribution Frame
LCU : Line Control Unit
LTF : Line Test Frame
MCSL : Maintenance Console
MTTY : Maintenance Teletypewriter
MM : Main Memory
POS : Position
RBD : Route Busy Status Display
SPU : Switching Processor Unit
TTP : Test Teleprinter

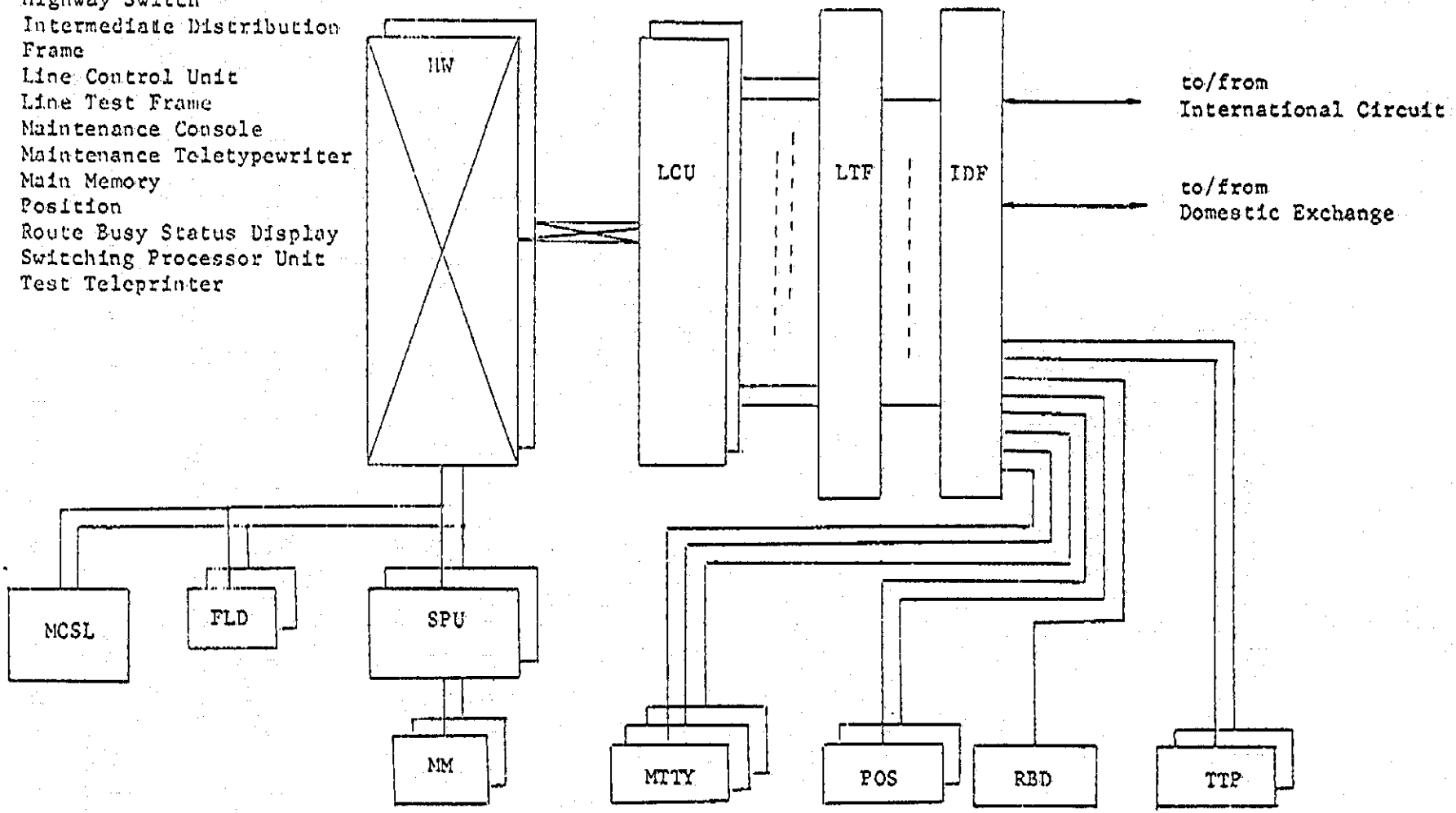


Fig. 4-3 System Block Diagram

(1) Supply of equipment and materials for new facilities (both hardware and software), installation, and testing

(2) Technical documentation

The contractor shall submit manauls, instructions, drawings, etc., written in English, which shall contain sufficient information for maintenance personnel to operate and maintain the system as required.

(3) Training

The contractor shall provide the following kinds of training to engineers assigned by MPC. Training programmes shall be proposed by the contractor and determined by mutual agreement between MPC and the contractor.

a) Factory training

A training for a period of 2.5 months shall be given to 2 trainees by the contractor.

b) On the job training (OJT)

The contractor shall provide OJT at the site for 10 ∿ 20 technical personnel including engineers and operators.

c) Language

All training shall be conducted in English.

d) Textbooks

The contractor shall provide all necessary textbooks for all trainees.

e) Expenses

All expenses including roud-trip air fare and living expenses shall be paid by the contractor.

(4) Assistance in operation and maintenance

Contractor shall provide supervision and engineering support services in operation and maintenance by one engineer sent from the contractor for a period of 12 months after the servic-in of the system.

4-5-2 Works to Be Performed by MPC

MPC shall be responsible for the following works.

(1) Expansion of building (equipment room, operator room and power equipment room) including grounding work and provision of cable holes, lighting and utility power, power distributor, etc.

(2) Expansion or modification of the existing domestic exchange for provision of new circuits with new international switching system

(3) Cable laying and wiring of the existing switching system to the distribution frame of the new international switching system

CHAPTER 5

LAYOUT PLAN AND ENVIRONMENTAL CONDITIONS

Chapter 5 Layout Plan and Environmental Conditions

5-1 Layout Plan

For the installation of the new switching equipment, the following floor space shall at least beprovided in addition to the switching equipment room.

(1) Operator's room
(2) Power supply room
(3) Airconditioner room (can be incorporated in the switching equipment room depending on the scale)
(4) Office room

5-1-1 Basic Requirements

The basic requirements in the design of layout are as follows.

(1) Floor area for future expansion shall be provided.
(2) Equipment layout shall be made in consideration of ultimate capacity and expansion of equipment.
(3) Equipment entrance shall be provided for carrying in equipment without hindrance.
(4) Maintenance area of each equipment shall be set out to allow efficient maintenance and test.
(5) Space for airconditioner shall be provided if it is installed in the same room.
(6) Equipment layout shall be made not to cause long connecting cables.

5-1-2 Basic Layout

An example of layout which meet the above-mentioned basic requirements is shown in Fig. 5-1.

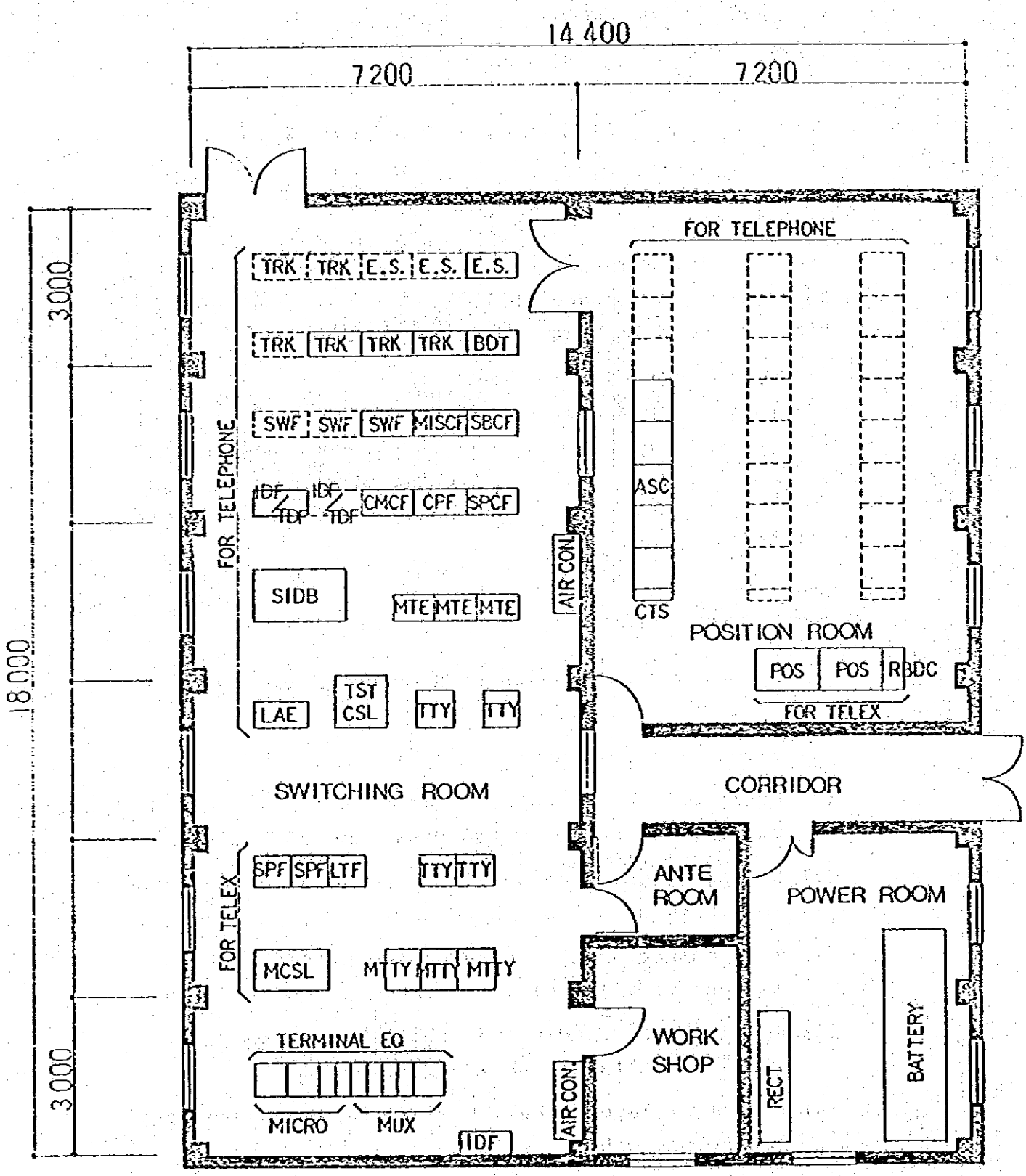


Fig 5-1 An example of layout

SCALE; 1:100

UNIT ; mm

5-2 Power Supply

A non-interrupting 3-phase 380V, 100KVA power shall be supplied.

5-3 Environmental Conditions

For operating the electronic switching system under optimum condition, the system shall be installed in a dustproofed, airconditioned room while meeting the following requirements.

Temperature:	18 ∿ 28°C
Humidity:	40 ∿ 60%
Temperature variation:	less than 5°C/hour

For airconditioner, the following shall be considered.

(1) Heat generation of equipment
(2) Heat generation of maintenance personnel (130 Kcal/person)
(3) Heat generation by lighting fixtures
(4) Heat entering through window panes or/and from adjacent rooms

CHAPTER 6

PERSONNEL PLAN

Chapter 6 Personnel Plan

6-1 Upbringing and Supplement of Personnel

Upbringing and supplement of personnel for handling the electronic switching system is important in proceeeding with this switching system project. The upbringing and supplement of personnel is inevitable for the introduction and smooth operation of the electronic switching system. Personnel plan shall be provided in consideration of not only training upon introducing the system but also operation and maintenance after service-in. A lot of skilled personnel will be required in the fields of system control, operation, maintenance, etc. It is recommended for MPC to prepare a long-term personnel plan to advance proper recruitment plan, positive personnel training and proper personnel administration.

6-2 Training

Establishment of a training system is indispensable for the introduction of the electronic switching system project and operation and maintenance after service-in. Training to be conducted can be classified into the following types from a long-term standpoint.

6-2-1 Factory Training and On-Site Training (to Be Arranged by the Contractor)

Since training is conducted by using equipment, it should ideally be performed at the factory. However, in consideration of the limited period of time, personnel, and expenses, this type of training

to be arranged by the contractor should be conducted at both factory and site. Details of training will be determined through agreement by MPC and the contractor. An example of the contents of training is given below.

(1) Factory training

Contents:	Basic course Engineering course Hardware course Software course Opeation course Maintenance course
Period:	2.5 months
Trainees:	3 persons (Telephone) 2 persons (Telex)

(2) On-site training

Contents:	On-the-job training
Period:	One month
Trainees:	20 ∿ 40 persons (Telephone and telex)

6-2-2 Training in Workshop (To Be Planned by MPC)

Trainees having completed training provided by the contractor or the engineer sent by the contractor to make an instructor will conduct training through daily activities.

6-2-3 Training Outside the Site (To Be Planned by MPC)

Training for new employees and training for

upgrading technical personnel will be conducted at the National Telecommunication Institute (Ecole Nationale des Postes et Télécommunications) and other places. Competent personnel will be sent to the domestic or overseas universities or institutes or overseas organizations specialized in communication engineering.
The trainings of Paragraphs 6-2-2 and 6-2-3 shall be conducted systematically and continuously throughout the year.

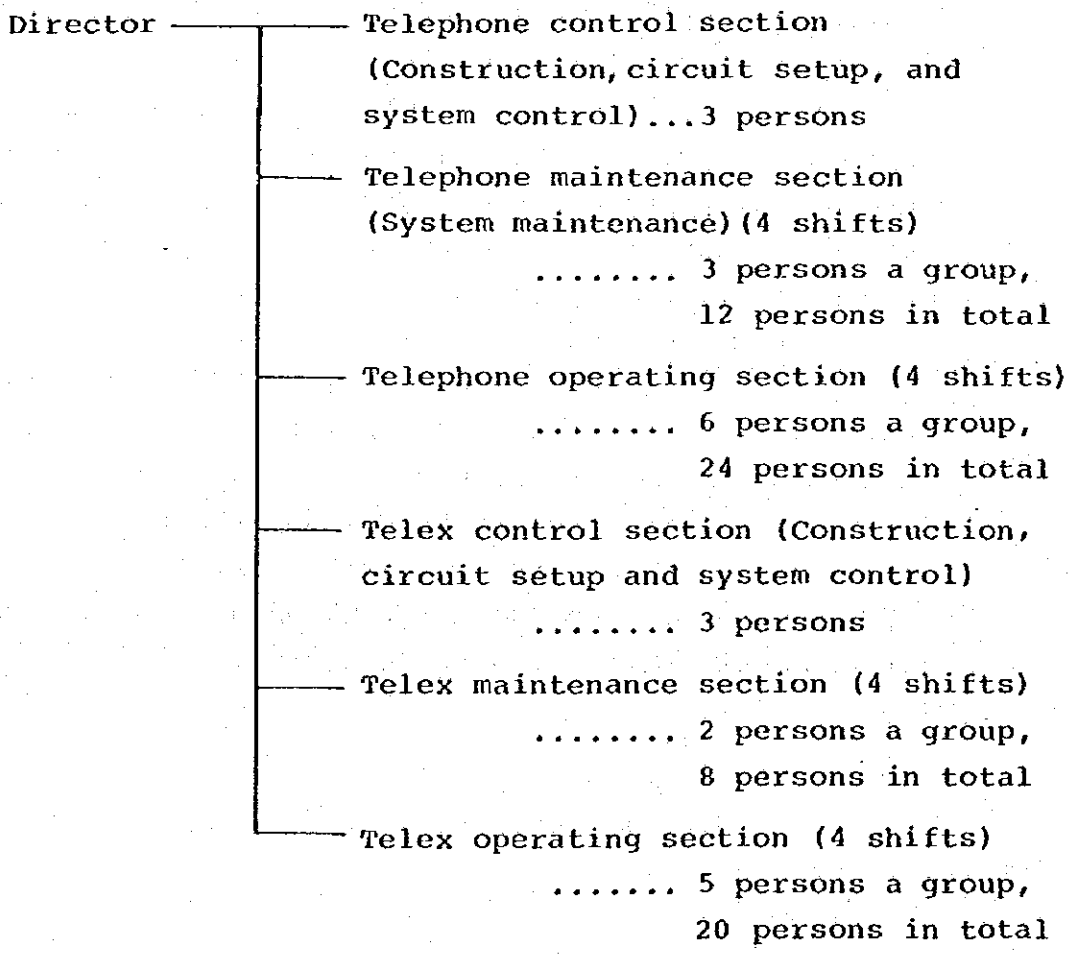
6-3 Organization for the Introduction of New Switching System

The process ranging from the introduction to the construction and commencement of service is not achievable in a short period of time but requires vital promotion in the execution of planning for the introduction, construction, and testing in specific fields.
This requires the establishment of a proper organization for the promotion. Whether the organization for the promotion is strong or not gives a serious influence to the result of implementation of the project as in the upbringing of personnel. Competent personnel with executive faculty, preferably section chief or the like, should be assigned as the leader and necessary authority should be given to him for the promotion of the introduction of the new switching system. Some of the present switching system psersonnel will become the main force for the implementation of the project, and the following personnel will be necessary upon introduction of the switching system.

Project manager:	1
Chief enginner:	1
Engineers and technicians:	5 ∿ 6

6-4 Operation and Maintenance Personnel

After service-in at least 25 engineers and 50 operators will be required for the operation and maintenance of the new switching system to be introduced by this project. The above-mentioned personnel engaged in the promotion of the project and personnel having undergone training arranged by the contractor will become the main operation and maintenance personnel but the absolute number of engineers is not sufficient and it is recommended to rapidly upgrade personnel in the first and second phases before the completion of the project at l' Ecole Nationale des Postes et Télécommunications. Long-term training should still be conducted afterward at l' Ecole Nationale des Postes et Télécommunications and MPC on the basis of OJT. An example of personnel assignment is given below.



6-5 Personnel Recruitment Plan

A number of competent personnel will be required in the field of operation and maintenance for promoting this project and long-term plans after service-in. It is recommended to prepare a personnel plan for each year and positively promote training programs for these personnel employed newly.

CHAPTER 7

RADIO LINKS

Chapter 7 Radio Links

7-1 General

At the time of the previous design study the following three radio links were picked up in connection with this project.

(1) Bâtiment Technique - Mt. Jari Radio Repeater Station (Construction of microwave link)

(2) Mt. Jari Radio Repeater Station - Tonga Radio Repeater Station (Improvement of the existing UHF 400MHz-band link)

(3) Tonga Radio Repeater Station - Butare Telegraph and Telephone Office (Construction of UHF 400MHz-band link)

As a result of the present preliminary design study, it has been determined that the earth station is to be located in Nyanza and the following radio link is to be established for communication with Bâtiment Technique, so that a total of four radio links are to be established.

(4) Earth Station (Nyanza) - Bâtiment Technique (Construction of microwave link)

This chapter describes the basic design of these radio links.

7-2 Outline of System

7-2-1 A 6GHz-band microwave link with a capacity of 120 channels (initially 24 channels) is to be constructed

between the earth station and Bâtiment Technique.

7-2-2 A 6GHz-band microwave link with a capacity of 300 channels (initially 120 channels) is to be established between Bâtiment Technique and Mt. Jari Radio Repeater Station.

7-2-3 The radio equipment and antnena facilities of the existing 400MHz band radio link for domestic communication between Mt. Jari Radio Repeater Station and Tonga Radio Repeater Station are to be improved. The capacity is to be 24 channels.

7-2-4 A 400MHz-band UHF link with a capacity of 24 channels is to be established between Tonga Radio Repeater Station and Butare Telegraph and Telephone office.

7-2-5 A selfsupporting antenna steel tower of 22m is to be constructed at the earth station, that of 32m at Bâtiment Technique, that of 47m at Mt. Jari Radio Repeater Station, and that of 57m at Tonga Radio Repeater Station. A Panza mast of 20m is to be constructed at Butare Telegraph and Telephone Office.

7-2-6 The emergency engine generators of Bâtiment Technique, Mt. Jari Radio Repeater Station and Tonga Radio Repeater Station are to be renewed and improved. The emergency engine generator of Butare Telegraph and Telephone Office is to be improved.

7-3 Works to Be Performed by the Contractor

The contractor of this project shall accomplish the following items of work.

7-3-1 Site Survey

7-3-2 Design, fabrication, transport, installation, adjustment, and testing of equipment to be supplied by the contractor.

7-3-3 Construction of antenna steel tower

7-3-4 Information necessary for foundation work and grounding for the installation of antenna steel tower and power building.

7-3-5 Supply of anchor bolts necessary for installation of antenna steel tower and power building

7-3-6 Other items set out in the specification.

7-4 Works to Be Performed by MPC

MPC shall be responsible for the following works.

7-4-1 Negotiation with adjacent countries if necessary on assignment of frequencies

7-4-2 Foundation work and grounding necessary for installation of antnena steel tower and power building

7-4-3 Provision of floor space for installation of new equipment (including removable of existing equipment)

7-4-4 Provision of construction office, storehouse or place for self-keeping construction materials, vehicles for transportation of construction materials (including drivers and fuel) and unskilled labours and nomination of counterpart among MPC personnel.

7-4-5 Provision of interface distributor with the distributor output terminals being power supply interface point.

7-4-6 It is desirable for MPC to provide dust-proofed equipment in the equipmet room and arrange environmental conditions by modification in the power building for operating radio equipment and others in optimum condition.

7-5 Route and Visibility

7-5-1 Route

Radio links to be established in this project are shown in Fig. 7-1.

7-5-2 Visibility and Antenna Steel Tower

(1) Earth station - Batiment Technique link

Nyanza HF Transmitting Station where the earth station is to be located is about 8km south of Batiment Technique in straight line and about 14km along the road. The site is positioned at an intermediate point on a moderate hill of Nyanza. There is no such building in

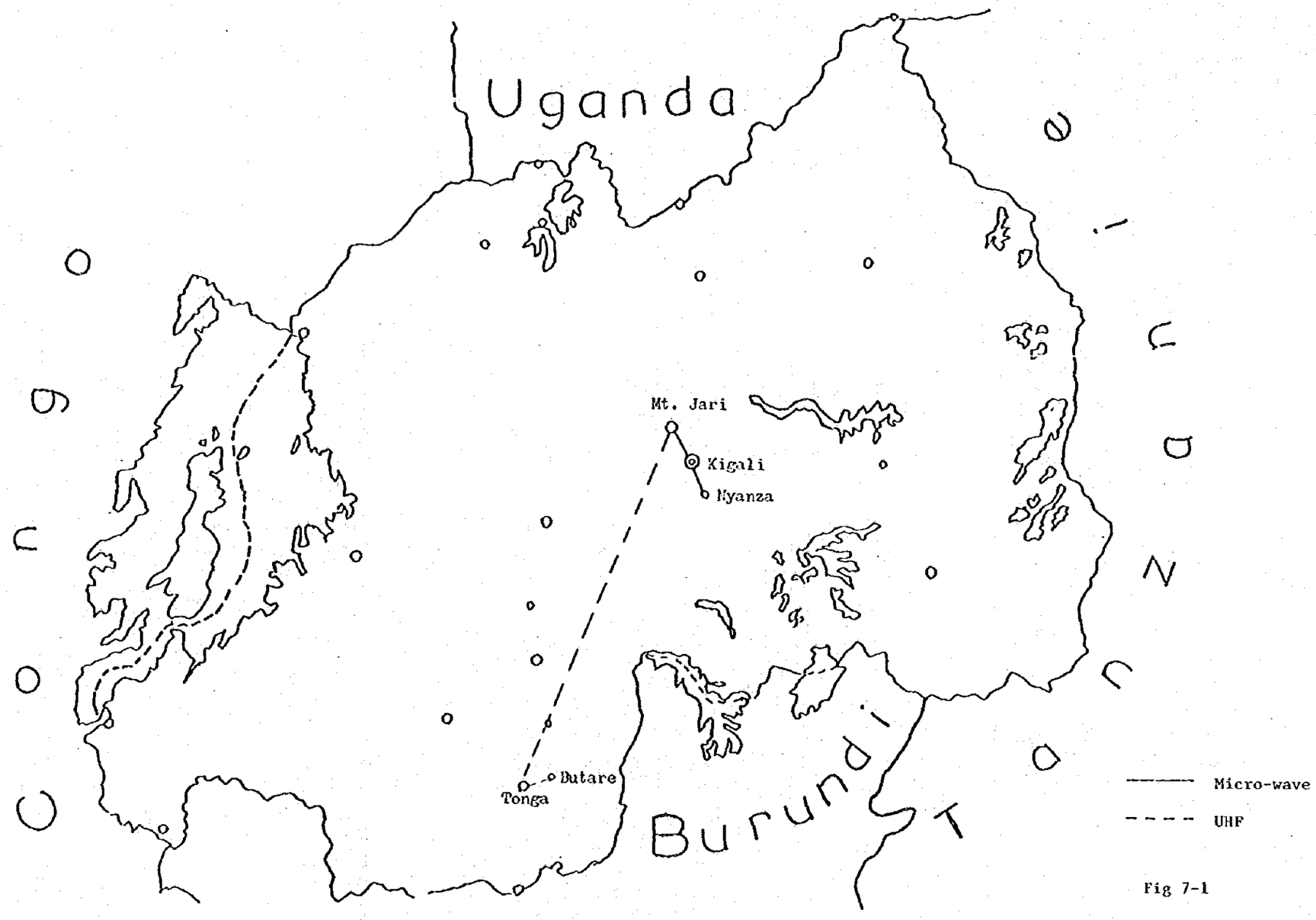
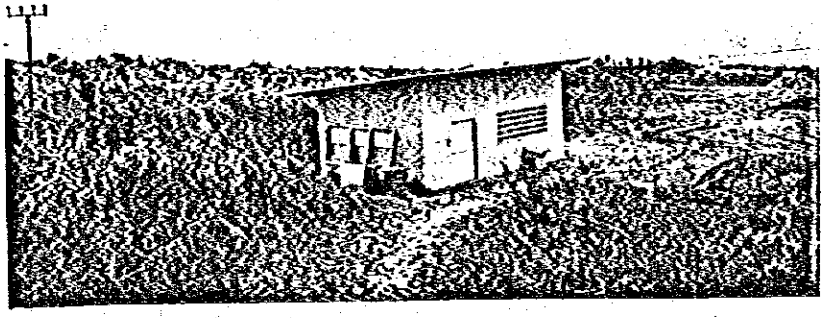

Uganda
Mt. Jari
Kigali
Nyanza
Butare
Tonga
Burundi
Micro-wave
UHF

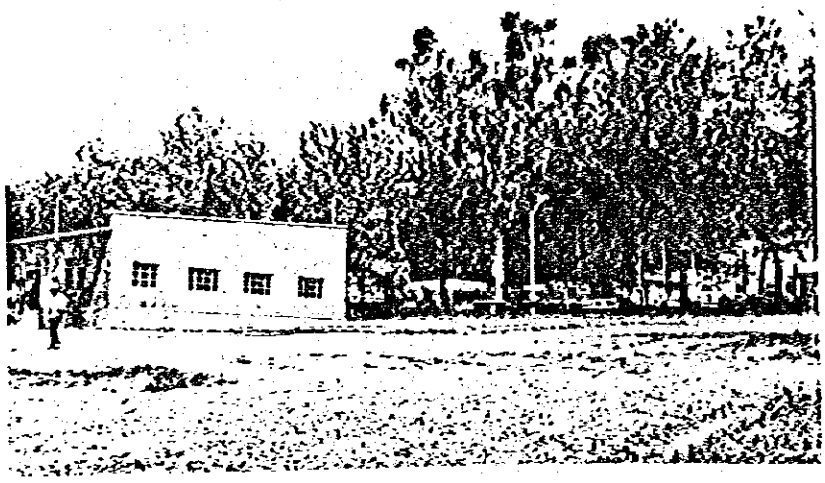
Fig 7-1

the route that may hinder the propagation of radio waves and mirror test resulted to assure the line-of-site condition. Since it can be judged that there is little posibility of constructing high buildings which may hinder the propagation of the radio waves in future too, the adoption of a 22m selfsupporting steel tower for the antenna tower for the microwave link (antenna mounting position: 20m from the ground) is recommended.

Batiment Technique is located nearly at the center of Kigali City and there are in the neighbouring places Central Bank of Rwanda (currently under construction), Hotel des Mille Collines and other buildings but these buildings do not hinder the propagation of radio waves between Batiment Technique and the earth station. However, since this station is located in the busy quarter of Kigali City, it is necessary to consider that high buildings which may hinder the propagation of radio waves may be construted in future (buildings of 5 stories or so should be taken into acount from the present situation of buildings in Rwanda) and the adoption of a 32m selfsupporting steel tower for the antenna tower at Batiment Technique (on which the microwave antenna for Mt. Jari Repeater Station is to be mounted also) is recommended (antenna mounting position: 30m above the ground).



View from proposed earth station site
toward Bâtiment Technique



Proposed antenna steel tower site
at Bâtiment Technique

The profile between the earth station and Bâtiment Technique is shown in Fig. 7-2.

(2) Batiment Technique - Mt. Jari Radio Repeater Station Link

Mt. Jari Radio Repeater Station is located nearly at the top of Mt. Jari (2075m in altitude) about 10km north of Bâtiment Technique in straight line distance. At present, this repeater station is furnished with the receiving equipment of domestic and international HF links and transmitter/receiver equipment of domestic and international UHF radio links.

The result of mirror test performed for the visibility of the link to be established shows that sufficient clearance is achievable even if Fresnel zone of 6GHz is taken into account by setting the antenna of Bâtiment Technique above the trees (about 20m) located about 40m in the direction to Mt. Jari and the antenna of Mt. Jari Radio Repeater Station above 20m. The antenna at Bâtiment Technique is to be mounted on the antenna tower intended for mounting the antenna for the earth station but the direction of the antenna is opposite to the direction of the antenna for the earth station, so that it is recommended to mount the antenna for Mt. Jari Radio Repeater Station at a position 30m from the ground as is the case with the antenna for the earth station.

At Mt. Jari Radio Repeater Station a 42m guyed steel tower for international UHF link is provided which seemed to have a possibility of mounting parabolic antenna. At present, this antenna steel tower mounts one panel of 3mϕ grid parabolic antnena for Tonga Repeater Station (domestic and international

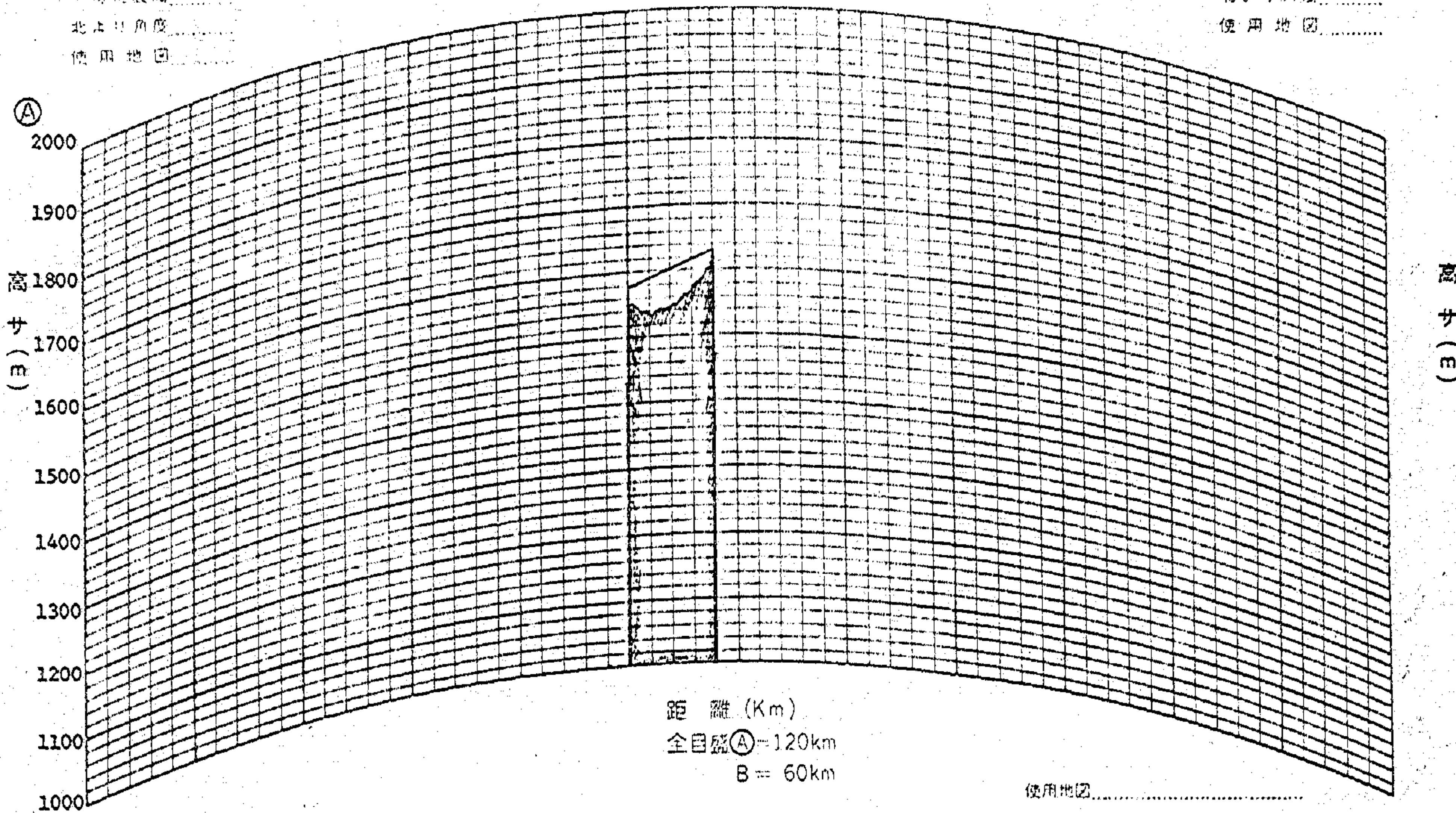
(B.T)

標高 1550 m
空中線地上高 30 m
空中線実効高 ...... m
平均地表高 ...... m
北より角度 ......
使用地図 ......

周波数 6.8 GC
波長 ...... m
実効輻射電力 ...... W
距離 8.0 km
F ...... db
常用電界 Ē ...... db
...... db

(E.S)

標高 1610 m
空中線地上高 20 m
空中線実効高 ...... m
平均地表高 ...... m
北より角度 ......
使用地図 ......



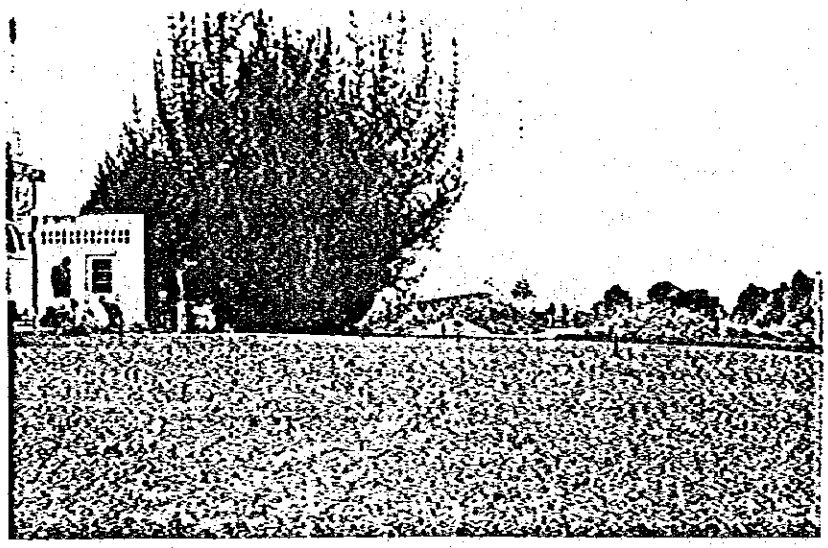
使用地図 ......

第 図 Fig 7-2 ―――― 断面図 原図担当 ...... 写図担当 ...... No.

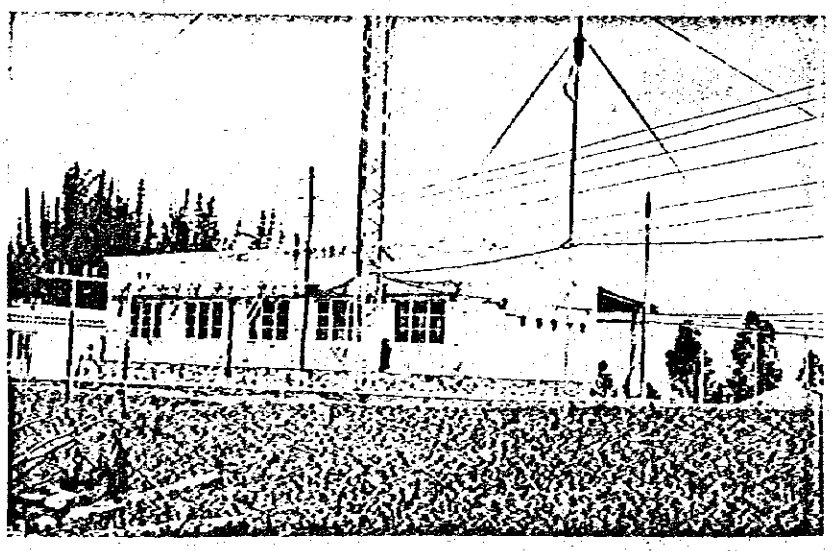
links use it in common) and one panel of 2mϕ grid parabolic antenna for Byumba (international link). However, the result of the present study shows that it is not possible to mount another antenna on this antennna tower because of the strength of the steel tower.

Accordingly, it is necessary to construct an antenna steel tower to mount the parabolic antenna for the microwave for Bâtiment Technique. Since Mt. Jari Radio Repeater Station is to install an antenna for improving the channel quality of the existing 400MHz band link used between it and Tonga radio Repeater Station (at present the antenna tower for the international link is used in common), it is recommended to construct sufficiently high and strong a tower for mounting these two types of antennas.

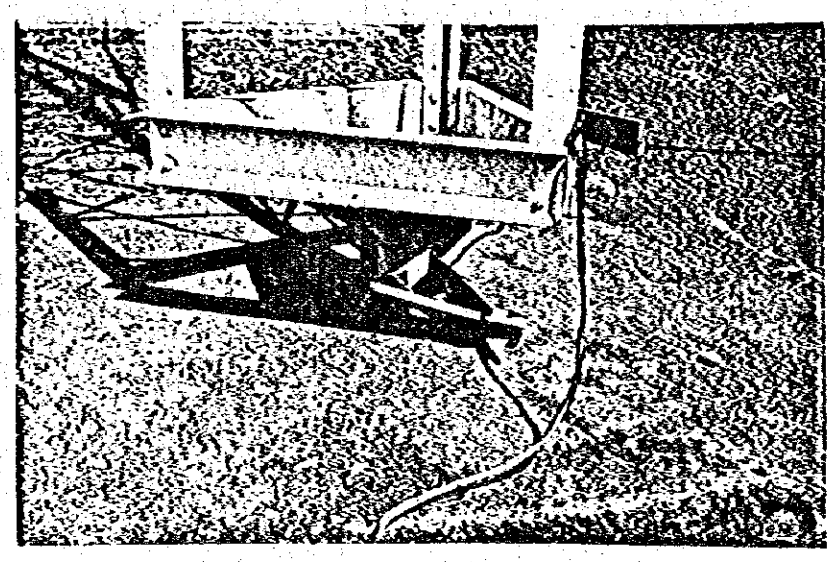
The profile between Bâtiment Technique and Mt. Jari Radio Repeater Station is shown in Fig. 7-3.



Proposed antenna steel tower site at
Mt. Jari Radio Repeater Station viewed
toward Batiment Technique
(The steel tower seen ahead is the transmitting antenna of FM broadcasting and the proposed transmission path lies on the left of the steel tower)



Mt. Jari Radio Repeater Station with existing 42m steel tower



Base of the existing 42m steel tower
at Mt. Jari Radio Repeater Station

(3) Mt. Jari Radio Repeater Station - Tonga Radio Repeater Station Link

Tonga Radio Repeater Station is located near Butare or the second largest city of Rwanda which is located about 100km south of Kigali City. At present radio repeater equipment of an international UHF link and radio equipment (including camera equipment) of a domestic UHF link are installed at Tonga Radio Repeater Station.

At present a 3mϕ grid parabolic antenna is used for both international link and this radio link. A separate antenna is to be installed for the improvement of the channel quality of the radio link. It is recommended to construct an antenna steel tower to mount these antennas. This steel tower to be constructed newly will be 47m (antenna mounting position: 45m) in height,

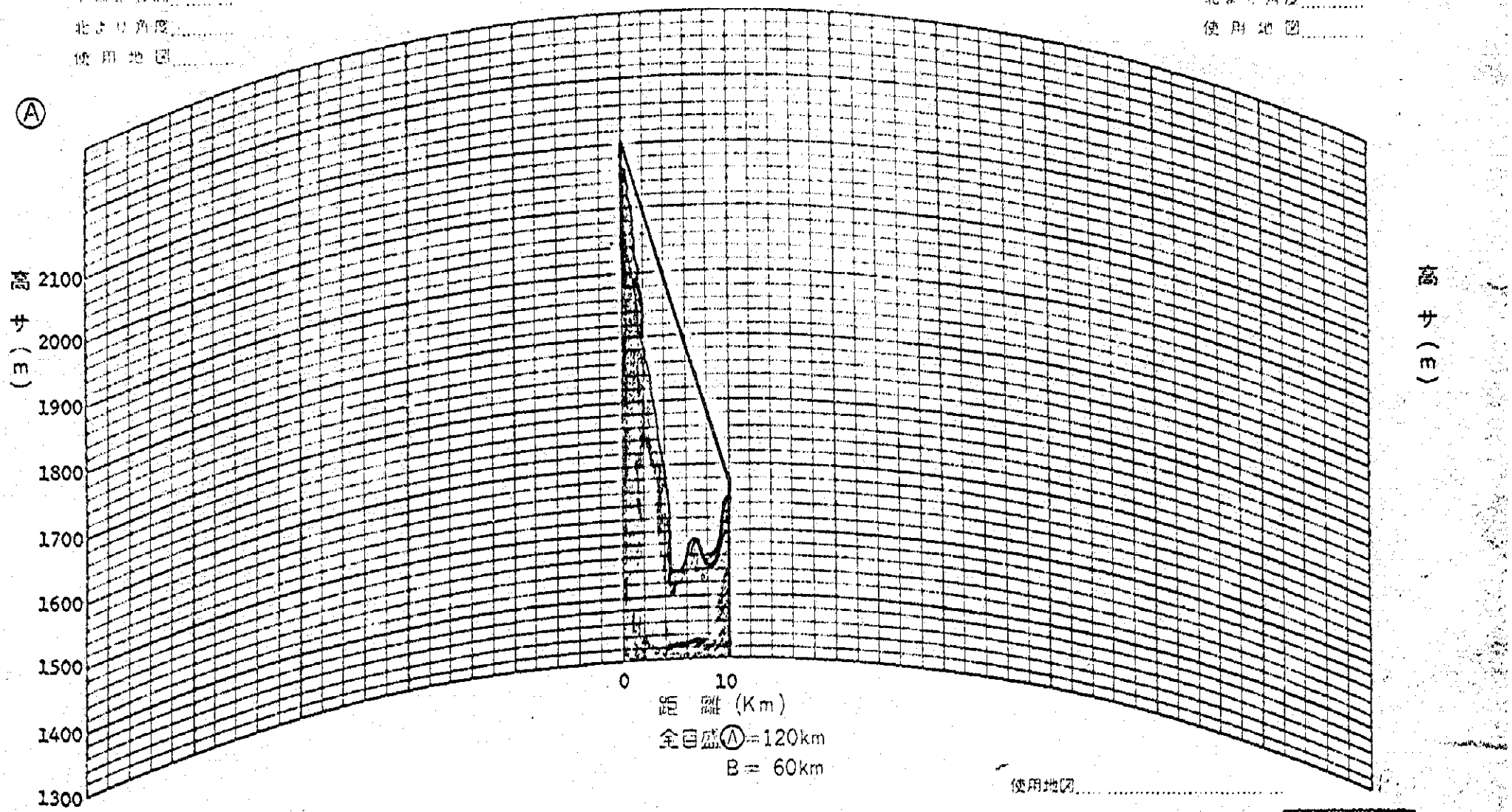
(Mt. Jari)

標　高　2070 m
空中線地上高　30 m
空中線実効高　　m
平均地表高　　m
北より角度
使用地図

周波数　6.8 GHz　　偏波
波長　　m　　給電線損失　　dB
実効輻射電力　　W
距　離　10.0 km　　Back　　dB

(B.T.)

標　高　1550 m
空中線地上高　30 m
空中線実効高　　m
平均地表高　　m
北より角度
使用地図



使用地図

No.

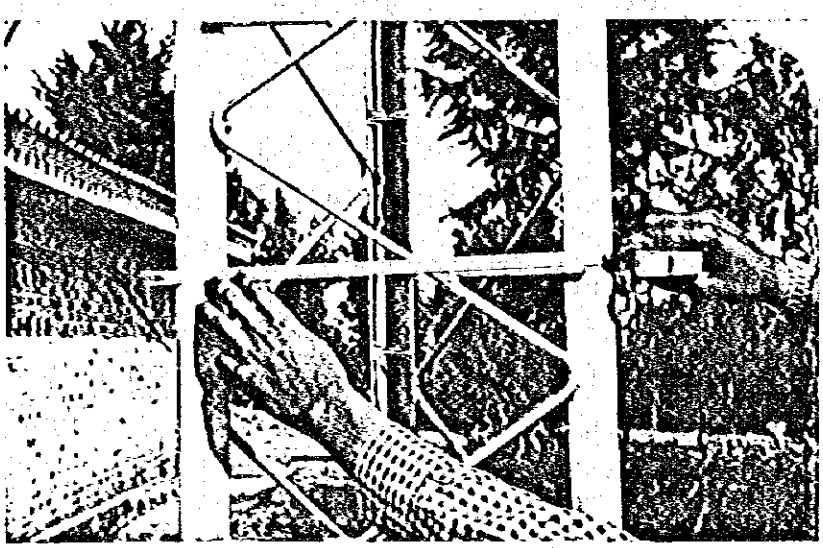
第　図 Fig 7-3 ——— 断面図　原図担当　写図担当

which is nearly as high as the existing steel tower, and be of selfsupporting type because of the site.

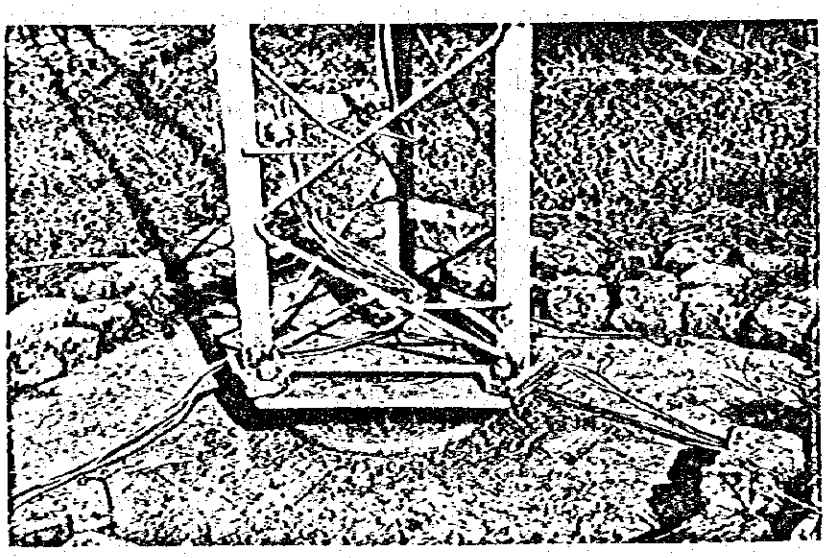
The existing antenna steel tower of Tonga Radio Repeater Station is a 58m guyed steel tower on which one panel of UHF 3mϕ grid parabolic antenna for Mt. Jari Radio Repeater Station (the antenna for international link is used by domestic link also) which is mounted at a position of 56m from the ground and one panel of UHF 1.8mϕ grid parabolic antenna for Ngozi in Burundi (for international link).

It is necessary to erect a parabolic antenna exclusively for domestic link use for the improvement of the channel quality of the link as is the case at Mt. Jari Radio Repeater Station. Through the examination of the strength of the existing antenna steel tower, it has been determined that no more antenna can be mounted on the existing steel tower and it is necessary to construct a new antenna steel tower. The steel tower to be constructed newly will be 57m in height or nearly as high as the existing steel tower and be of selfsupporting type because of the narrow site of the repeater station.

The profile between Mt. Jari Radio Repeater Station and Tonga Radio Repeater Station is shown in Fig. 7-4.



Existing antenna steel tower of
Tonga Radio Repeater Station



Base of existing steel tower of
Tonga Radio Repeater Station

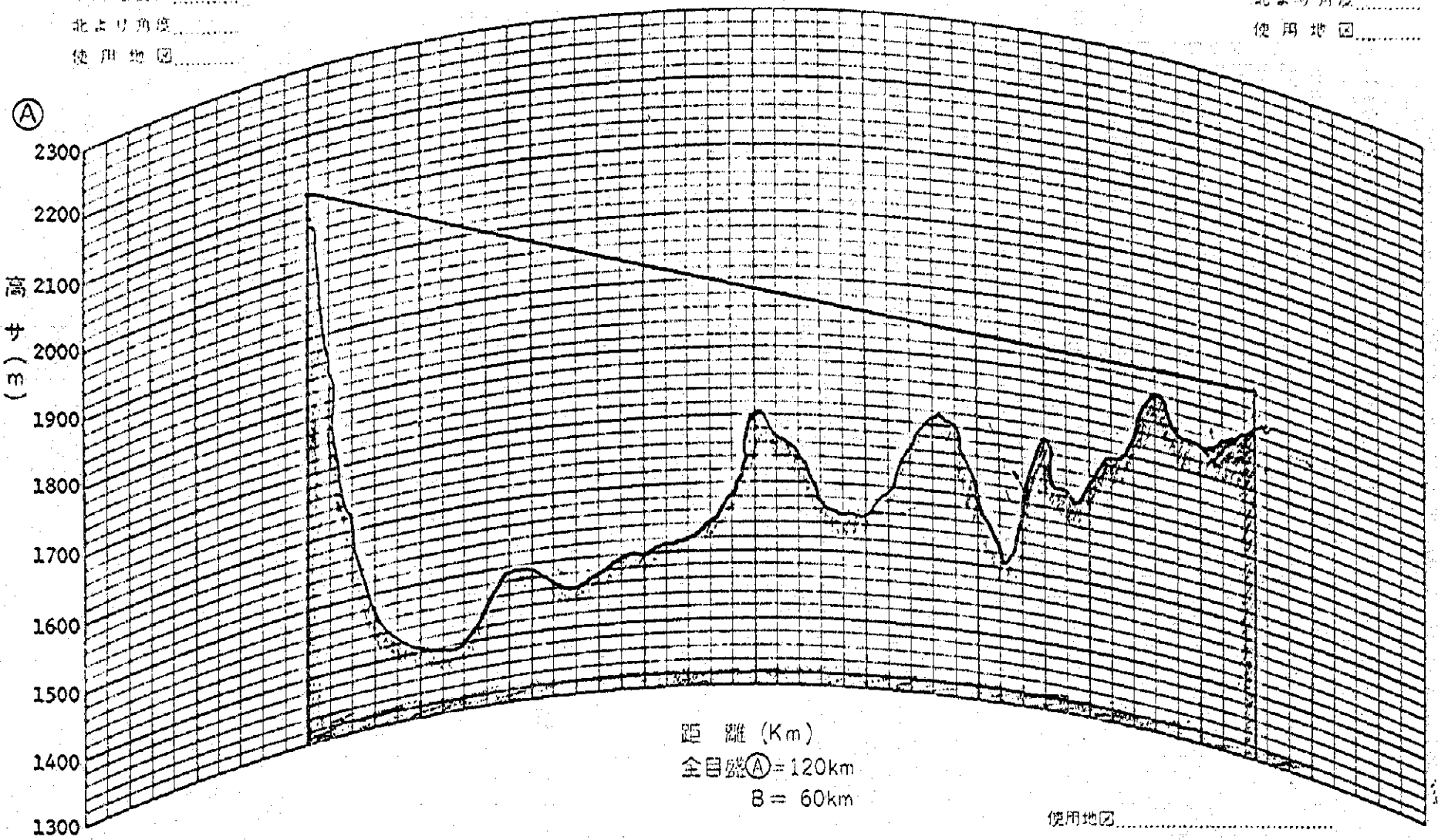
(Mt. Jari)

標 高	2070 m
空中線地上高	45 m
空中線実効高	m
平均地表高	m
北より角度	
使用地図	

周波数	GC	E	db
波長	m	希望強度 E	db
実効輻射電力	W	Eac	db
距離	85.0 km		

(Tonga)

標 高	1790 m
空中線地上高	55 m
空中線実効高	m
平均地表高	m
北より角度	
使用地図	



使用地図

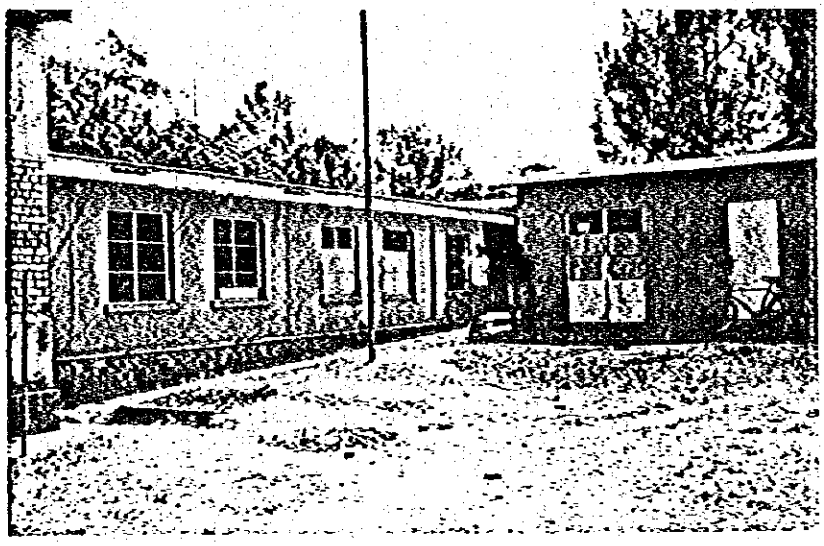
第 図 Fig 7-4 断面図 原図担当 写図担当 No.

(4) Tonga Radio Repeater Station - Butare Telegraph and Telephone Office Link

Butare Telegraph and Telephone Officd is located at the center of Butare City and is at a distance of about 2km from Tonga Radio Repeater Station.
For the visibility between these sites, a complete line-of-sight condition is achievable by setting the antenna above the height of trees (10 ∿ 15m near Butare Telegraph and Telephone Office and Tonga Radio Repeater Station.

Accordingly, it is recommended to mount a Yagi antenna for Butare Telegraph and Telephone Office at a position of 30m on the steel tower to be constructed newly at Tonga Radio Repeater Station. For the antenna tower at Butare Telegraph and Telephone Office it is recommended to construct a Panza mast of 20m since the antenna height of 20m is sufficient and Yagi antenna to be used is compact and lightweight and also since the site of Butare Telegraph and Telephone Office is comparatively narrow.

The profile between Tonga Radio Repeater Station and Butare Telegraph and Telephone Office is shown in Fig. 7-5.



The courtyard of Butare Telegraph and Telephone Office (proposed antenna steel tower site). Radio equipment are to be installed in the right-hand portion of the building in front.

(5) Schematic drawings of antenna steel towers of the respective stations are shown in Fig. 7-6.

7-6 Communication System

7-6-1 Earth Station - Bâtiment Technique Link

This link is a communication link for connecting the earth station with Bâtiment Technique furnished with international telephone and telex exchange systems.

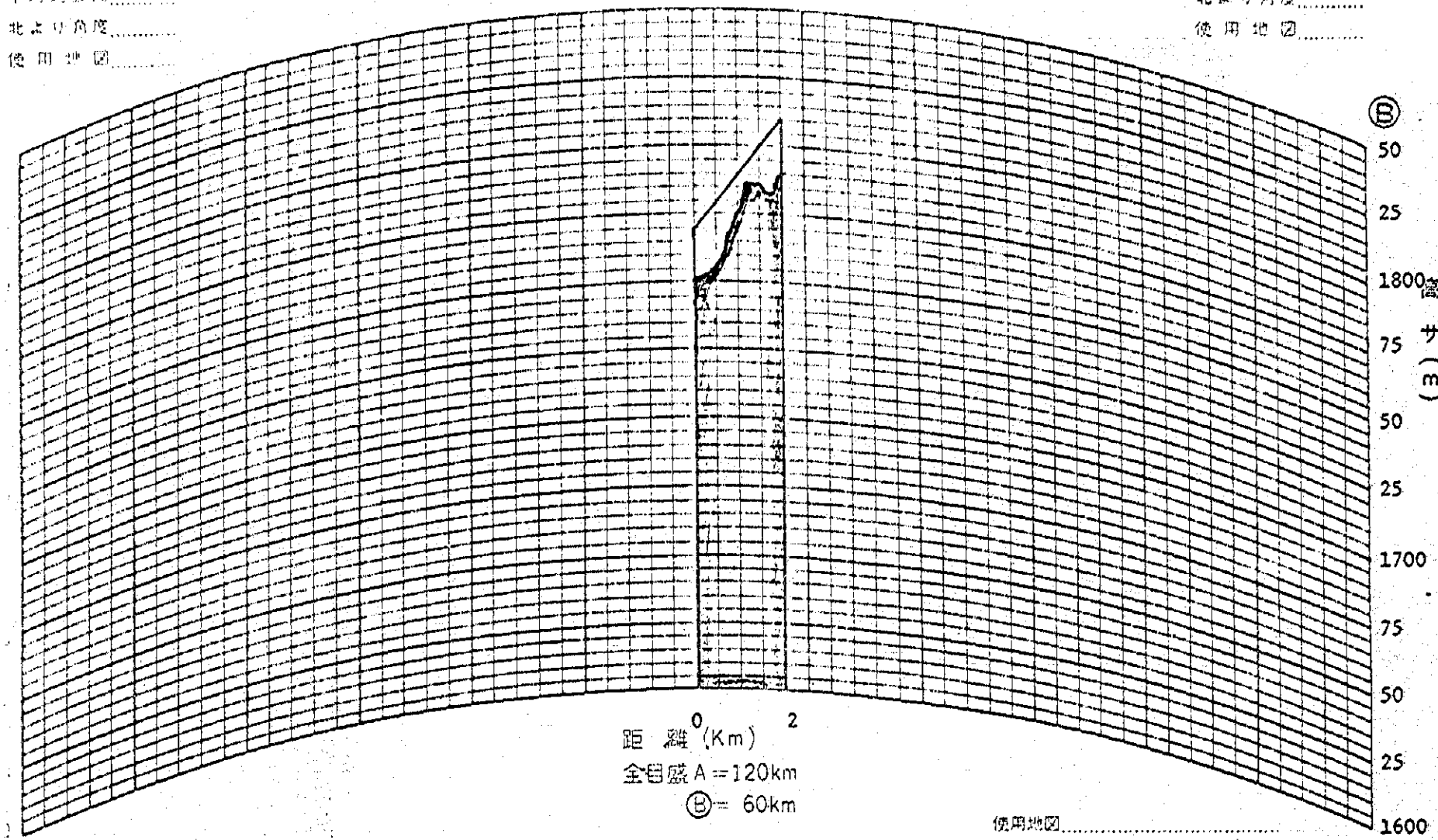
(Butare)

標　高　1750 m
空中線地上高　20 m
空中線実効高　　m
平均地表高　　m
北より角度
使用地図

周波数　400 MHz　　l　　db
波　長　　m　　偏波識別　E　　db
空中線入力　　W
距　離　2.0 km　　Eact　　db

(Tonga)

標　高　1790 m
空中線地上高　20 m
空中線実効高　　m
平均地表高　　m
北より角度
使用地図



使用地図

No.

第　図 Fig 7-5　断面図　原図担当　　写図担当

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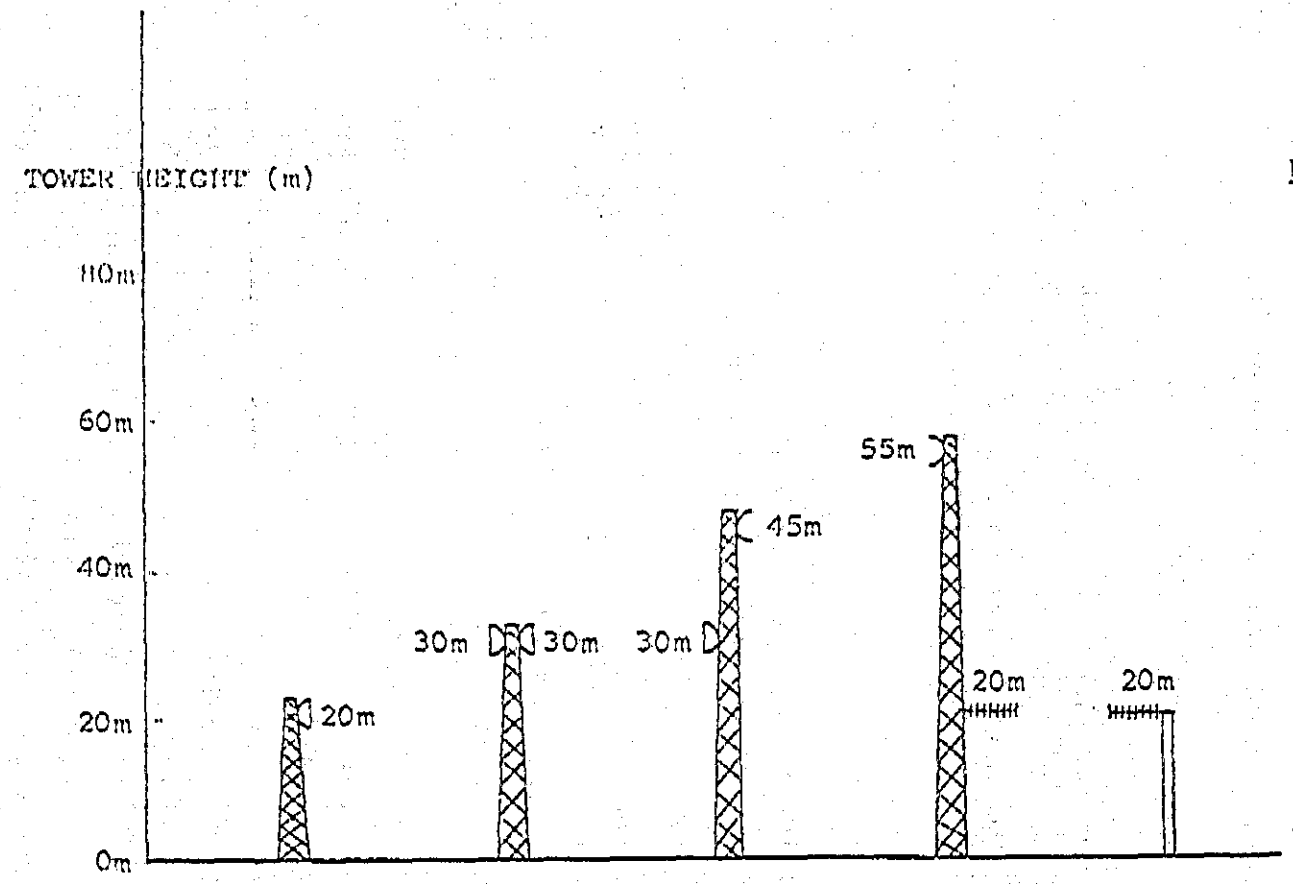
Fig 7-6

ANTENNA SUPPORTING TOWER FOR COMMUNICATION NETWORK RWANDA



LEGEND

- 1.2 m Dia. Parabolic Antenna for Microwave Link
- 3.0 m Dia. Parabolic Antenna for UHF Link (Grid Type)
- 8L Yagi Antenna for UHF Link
- Self Supporting Tower
- Panzer Mast

	EARTH STATION	KIGALI	MT JALI	TONGA	BUTALE
TOWER HEIGHT	22m	32m	47m	57m	20m
ANTENNA HEIGHT	20m	30m/30m	30m/45m	55m/20m	20m

(1) Channel capacity

Since the earth station is to be an INTELSAT Standard B earth station with a final capacity of 60 channels (12 channels in initial capacity), it is recommended to provide a capacity of 120 channels (initially 24 channels) including the channels of the existing HF link (maximum 12 channels).

(2) Radio frequency

It is recommended to employ the 6GHz band (upper band, CCIR 384-2) for which the radio station will not give disturbance to the earth station and Fresnel zone is small to allow the antenna tower to be compact.

(3) System design

An exmaple of system design is given below.

a) Station name	Earth Station - Kigali	
b) Radio frequency	6,770MHz	
c) Hop distance	8km	
d) Antenna height	20m	30m
e) Antenna diameter	1.2m Dia.	1.2m Dia.
f) Antenna gain	36.0dBi	36.0dBi
g) Transmitter output power	27.0dB	
h) Overall gain (6) + (7)	99.0dB	
i) Antenna feeder length	35m	45m
j) Antenna feeder loss	1.8dB	2.3dB
k) Branching circuit loss	3.3dB	
l) Insertion loss	0dB	
m) Path loss (free space)	127.1dB	
n) Overall loss (10+11+12+13)	134.5dB	
o) Receiver input level (8-14)	-35.5dBm	
p) Receiver noise figure	3.5dB	

q)	Signal to FM thermal noise ratio weighted (at top of TP 120CH) under free space condition	93.7dB0P
r)	Squelch level (nominal)	-83.0dBm
s)	Squelch margin (15 - 17)	47.5dB

7-6-2 Bâtiment Technique - Mt. Jari Radio Repeater Station Link

At present a wired line is established between these stations but its deterioration is extreme and system down is caused very often, so that a microwave link is to be established.

(1) Capacity

It is recommended to provide a capacity of 300 channels (initially 120 channels) by taking into acount that the capacity of the existing wired circuit is 86 channels and that there is an improvement and expansion project of the domestic circuit while setting a repeater on Mt. Jari in near future.

(2) Radio frequency

It is recommended to employ the 6GHz band (upperband CCIR, 384-2) because of the advantage in operation and maintenance by the use of radio equipment meeting the same standard as those of the earth station - Bâtiment Technique link in addition to the reason mentioned in the earth station - Bâtiment Technique link.

(3) Repeatering

For repeatering at Mt. Jari Radio Repeater

Station, it is difficult to employ group connection since the baseband frequency allocation of the eixsting equipment is different from the standard Japanese frequency allocation, so that it is recommended to employ channel connection. Accordingly, the existing terminal equipment for international link use will be relocated from Bâtiment Technique to Mt. Jari Radio Repeater Station.

(4) System design

An example of system design is given below.

a)	Station name	Kigali - Mt. Jari	
b)	Radio frequency	6,770MHz	
c)	Hop distance	10.0km	
d)	Antenna height	30m	30m
e)	Antenna diameter	1.2m Dia.	1.2m Dia.
f)	Antenna gain	36.0dBi	36.0dBi
g)	Transmitter output power	27.0dBm	
h)	Overall gain (6) + (7)	99.0dB	
i)	Antenna feeder length	45m	45m
j)	Antenna feeder loss	2.3dB	2.3dB
k)	Branching circuit loss	3.3dB	
l)	Insertion loss	0dB	
m)	Path loss (free space)	129.1dB	
n)	Overall loss (10+11+12+13)	137.0dB	
o)	Receiver input level (8-14)	-38.0dBm	
p)	Receiver noise figure	3.5dB	
q)	Signal to FM thermal noise ratio weighted (at top of TP 300CH) under free space condition	87.8dB0p	
r)	Squelch level (nominal)	-83.0dBm	
s)	Squelch margin (15 - 17)	45.0dB	

7-6-3 Mt. Jari Radio Repeater Station - Tonga Radio Repeater Station Link and Tonga Radio Repeater Station - Butare Telegraph and Telephone Office Link

These links are intended for connecting Capital Kigali and Butare or the second largest city in Rwanda. At present, a 400MHz-band link is provided between Mt. Jari Radio Repeater Station and Tonga Radio Repeater Station and actual transmission test resulted in obtaining a channel quality of 30 ∿ 35dB in S/N ratio but only one of the six channels (capacity: 12 channels) is used because of equipment deterioration. In order to prove this, the radio equipment of the Mt. Jari Radio Repeater Station - Butare Telegraph and Telephone Office link will be renewed to have the performance described in the paragraph on system design.

a)	Station name	Mt. Jari - Tonga	
b)	Radio frequency	450MHz	
c)	Hop distance	85km	
d)	Antenna height	45m	55m
e)	Antenna diameter	3m Dia.	3m Dia.
f)	Antenna gain	19dBi	19dBi
g)	Transmitter output power	40dBm	
h)	Overall gain (6) + (7)	78dB	
i)	Antenna feeder length	60m	70m
j)	Antenna feeder loss	2.5dB	2.5dB
k)	Branching circuit loss	7.2dB	
l)	Insertion loss	0dB	
m)	Path loss (free space)	127.3dB	
n)	Overall loss (10+11+12+13)	139.9dB	
o)	Receiver input level (8-14)	-61.9dB	
p-1)	Signal to FM thermal noise ratio, weighted (at top of TP 24 CH), under free spece condition	63.9dB0p	

p-2)	Combiner gain	3.0dB
p-3)	Signal to FM thermal noise ratio, weighted (at top of TP 24 CH), under free space condition after combiner	66.9dB0p
q)	Squelch level	-94.9dBm
r)	Squelch margin (15 - 17)	33.0dB

(1) Channel capacity

The capacity of the link in service is 12 channels (currently 6 channel units are mounted). The capacity will be 24 channels (initially 12 channels) in consideration of future demand of channels.

7-6-4 Tonga Radio Repeater Station - Butare Telegraph and Telephone Office Link

Since the channel quality degradation of the existing wired circuit is extreme, a UHF radio link is to be established.

(1) Channel capacity

The channel capacity of this link will be 24 channels (initially 24 channels) as is the case with Mt. Jari Radio Repeater Station - Tonga Radio Repeater Station link.

(2) Radio frequency

400MHz is to be used in consideration of the number of channels and future operation and maintenance, as is the case with Mt. Jari Radio Repeater Station - Tonga Radio Repeater Station link.

An example of system design is given below.

a)	Station name	Tonga - Butare	
b)	Radio frequency	450MHz	
c)	Hop distance	2km	
d)	Antenna height	20m	20m
e)	Antnena diameter	8-ele Yagi	8-ele Yagi
f)	Antenna gain	11dBi	11dBi
g)	Transmitter output power	40dBm	
h)	Overall gain (6) + (7)	62dB	
i)	Antenna feeder length	35m	35m
j)	Antenna feeder loss	1.5dB	1.5dB
k)	Branching circuit loss	7.2dB	
l)	Insertion loss	0dB	
m)	Path loss (free space)	91.6dB	
n)	Overall loss (10+11+12+13)	101.8dB	
o)	Receiver input level (8-14)	-39.8dBm	
p-1)	Signal to FM thermal noise ratio, weighted (at top of TP 24 CH), under free space condition	86.0dB0p	
p-2)	Combiner gain	3.0dB	
p-3)	Signal to FM thermal noise ratio, weighted (at top of TP 24 CH), under free space condition	89.0dB0p	
q)	Squelch level	-94.9dBm	
r)	Squelch margin	55.1dB	

7-6-5 The channel plan is shown in Fig. 7-7.

7-7 Emergency Engine Generator

The engine generators of Bâtiment Technique,

Mt. Jari Radio Repeater Station, and Tonga Radio Repeater Station have deteriorated and, at the same time, are not furnished with any automatic starter, so that they are to be replaced with new engine generators with automatic starters. Batteries (including chargers) are also to be provided newly.

7-8 Supervision and Control

Supervisory and control equipment will be installed taking into account that technical personnel reside at the earth station, Batiment Technique and Butare Telegraph and Telephone Office. A block diagram of supervisory and control systems is shown in Fig. 7-8.

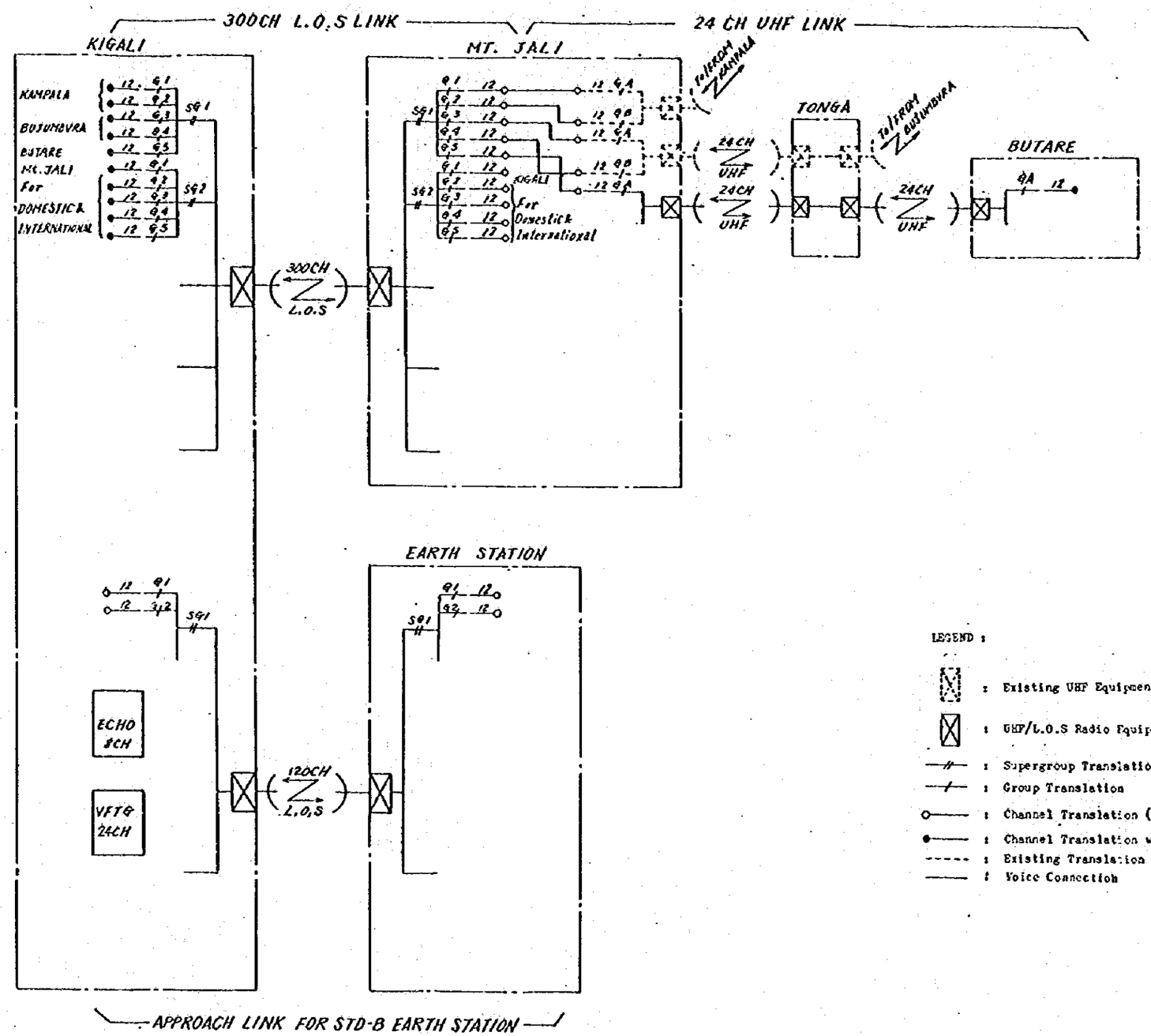
7-9 Major Specifications of Radio Links

7-9-1 General

This paragraph sets out the requirements for the radio links to be constructed in connection with the INTELSAT Standard B earth station to be constructed in Rwanda. Items not specified herein shall conform to CCIR and CCITT Recommendations.

7-9-2 Composition

This system shall consists of the antenna facilities (including steel tower), radio equipment (both in-service and stand-by equipment), carrier terminal equipment, supervisory and control equipment, and power building. An example of system composition is shown in Fig. 7-9.



LEGEND :

- : Existing UHF Equipment
- : UHF/L.O.S Radio Equipment
- : Supergroup Translation
- : Group Translation
- : Channel Translation (4W)
- : Channel Translation with 2W/4W, Ringer
- : Existing Translation
- : Voice Connection

Fig 7-7

CHANNEL PLAN OF TELECOMMUNICATION NETWORK FOR RWANDA P.T.T

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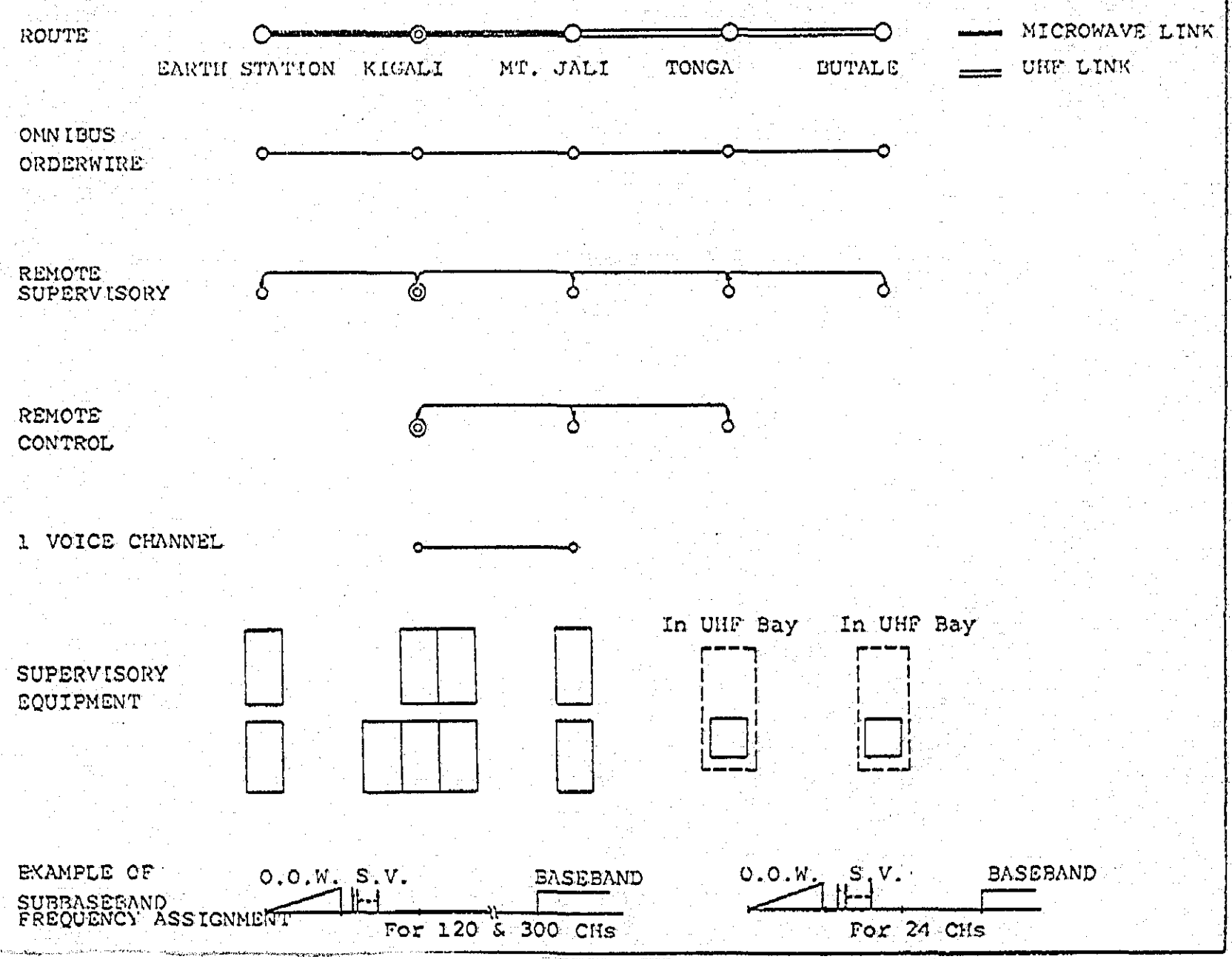
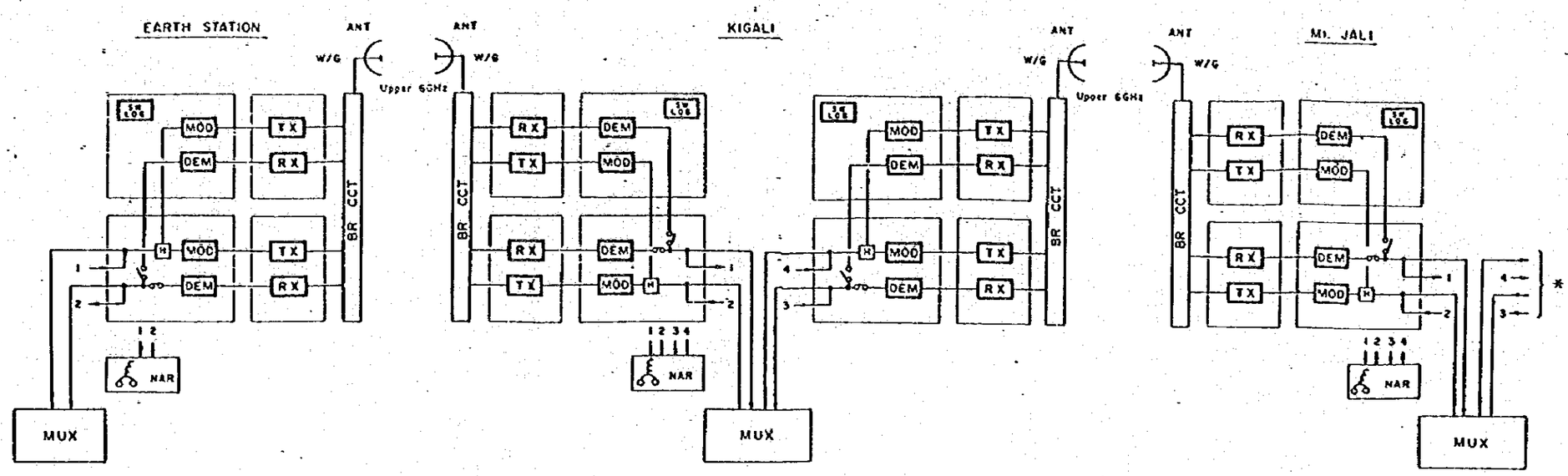
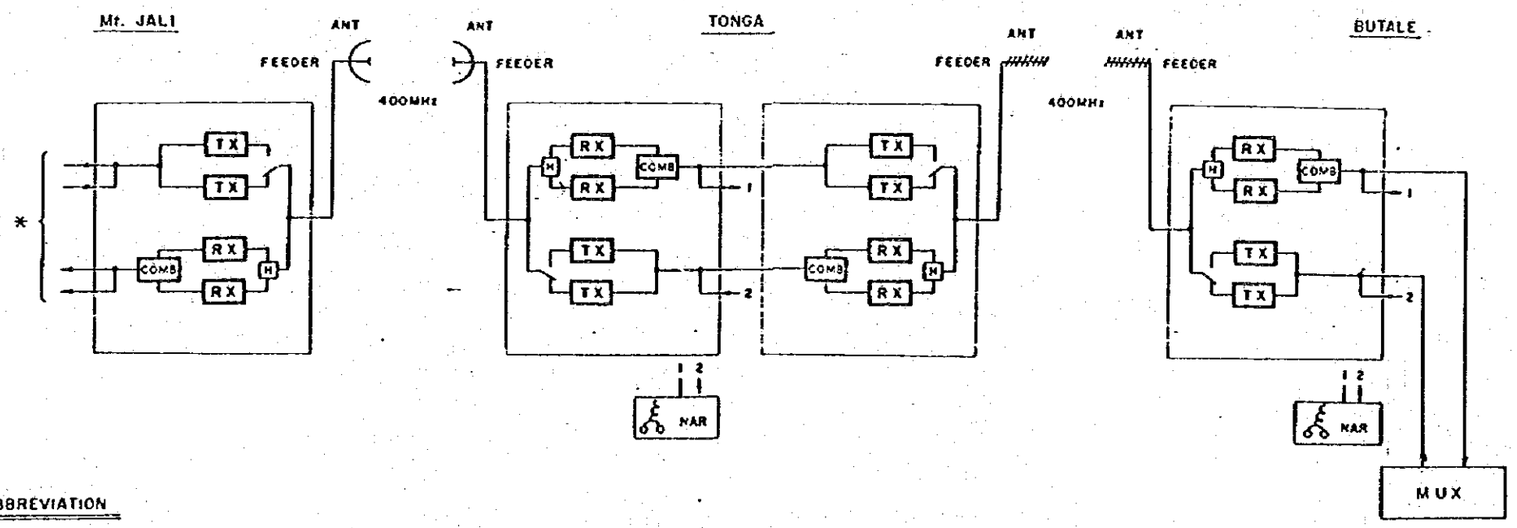
Fig 7-8

SIGNAL FLOW OF SUPERVISORY AND CONTROL SYSTEM



NO. DESCRIPTION





ABBREVIATION

TX : TRANSMITTER
RX : RECEIVER
MOD : MODULATOR
DEM : DEMODULATOR
COMB : COMBINER
NAR : SUPERVISORY & CONTROL EQUIPMENT
ANT : ANTENNA
W/G : WAVEGUIDE FEEDER
FEEDER : COAXIAL FEEDER
MUX : MULTIPLEX EQUIPMENT

STATION	EARTH STATION	KIGALI	MT. JALI	TONGA	BUTALE
HOP DISTANCE	Approx. 8Km	Approx. 10Km	Approx. 85Km	Approx. 2Km	
TOWER HEIGHT	22 m ★	32 m ★	47 m ★	57m★	20m★
ANTENNA HEIGHT	20 m ★	30m★/30m★	30m★/45m★	55m★/30m★	20m★
ANTENNA SIZE	1.2 m ★★	1.2m★★/1.2m★★	1.2m★★/3.0m★★	3.0m★★/8L★	8L★
FEEDER LENGTH	35 m ★	45m★/45m★	45m★/60m★	70m★/45m★	35m★

★ Note : Tower, Antenna Height & Feeder Length are Subject to Change, According to Design of Radio System after Actual Radio Path Survey.

Fig 7-9

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SYSTEM BLOCK DIAGRAM OF RADIO LINK FOR COMMUNICATION NETWORK RWANDA

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7-9-3 Antenna Facilities

(1) Steel towers

The following antenna steel towers shall be erected newly. These steel towers shall meet the requirements set out in Chapter 8 "Civil and Architectural Works Necessary for the Project."

a) Earth station	22m Selfsupporting tower
b) Bâtiment Technique	32m Selfsupporting tower
c) Mt. Jari Radio Repeater Station	47m Selfsupporting tower
d) Tonga Radio Repeater Station	57m Selfsupporting tower
e) Butare Telegraph and Telephone Office	20m Panza mast

(2) Antennas

Antennas shall meet the following specifications seperately.

a) Microwave parabolic antenna

· Frequency range	6,430 - 7,110MHz
· Front-to-back ratio	more than 50dB
· VSWR	less than 1.10

b) UHF Grid parabolic antenna

· Frequency range	335 ∿ 470MHz
· Impedance	50Ω
· Front-to-back ratio	more than 23dB
· VSWR	less than 1.2

c) UHF Yagi antenna

Frequency range	335 ∿ 470MHz
Impedance	50Ω
Front-to-back ratio	more than 10dB
VSWR	less than 1.5

7-9-4 Radio Equipment

Radio equipment shall meet the following specifications.

(1) Microwave radio equipment

a)	Frequency range	6,430 ∿ 7,110MHz
b)	Channel allocation	CCIR Rec. 384-2
c)	Modulation	FM
d)	Channel capacity	
e)	Earth Station - Bâtiment Technique	Capacity: 120 channels (initially 24 channels)
f)	Bâtiment Technique - Mt. Jari Radio Repeater Station	Capacity: 300 channels (initially 120 channels)
g)	Intermediate frequency	70MHz
h)	Frequency deviation	200kHz/CH
i)	Emphasis	CCIR Rec. 275-2
j)	Noise figure	less than 4dB
k)	Local oscillator stability	within ±5ppm
l)	IF input/output impedance	75Ω, unbalanced
m)	IF input/output level	0.3 ∿ 0.5 Vrms
n)	Supply voltage	-24V ± 10%

(2) UHF radio equipment

a)	Frequency range	335 ∿ 470MHz
b)	Modulation	FM
c)	Intermediate frequency	35MHz
d)	Impedance	50Ω
e)	Local oscillator stability	within $\pm 2 \times 10^{-5}$
f)	Noise figure	less than 6dB
g)	Transmitting stability	within $\pm 2 \times 10^{-5}$

h) Channel capacity 24 channels (initially 124 channels)

i) Supply voltage -24V ± 10%

7-9-5 Carrier Terminal Equipment

Connection with the existing equipment shall be accomplished by channel connection while meeting the following specifications.

(1) Voice frequency range (0.3 ∿ 3.4kHz)

a) 2-wire input: +2 ∿ -13dBr, 600Ω, balanced

b) 2-wire output: +4 ∿ -10dBr, 600Ω, balanced

c) 4-wire input: -1 ∿ -16dBr, 600Ω, balanced

d) 4-wire output: +7 ∿ -8dBr, 600Ω, balanced

(2) Basic group band (60 ∿ 108kHz)

a) Channel sending: -36 or -42dBr, 75Ω or 150Ω balanced

b) Channel receiving: -5, -8, -18 or -30dBr, 75Ω or 150Ω, balanced

(3) Basic supergroup band (312 ∿ 552kHz)

a) Group sending: -33, -36, -42 or -45dBr, 75Ω, unbalanced

b) Group receiving: -28, -29 or -30dBr, 75Ω, unbalanced

(4) Baseband (60 ∿ 1,300kHz, 300CH, 60 ∿ 540kHz for microwave)

a) Line sending: -33, -36, -42 or -45dBr, 75Ω, unbalanced

b) Line receiving: -15, -18, -20, -23, -25 or -33dBr, 75Ω, unbalanced

(5) Baseband (for 12 ∿ 108kHz, 24CH, UHF)

a) Line sending: -25 or -45dBr, 75Ω or 150Ω

b) Line receiving: -15 or -20dBr, 75Ω or 150Ω

7-9-6 Supervision and Control

The radio equipment of the earth station, Mt. Jari Radio Repeater Station, Tonga Radio Repeater Station and Butare Telegraph and Telephone Office shall be supervisable at Batiment Technique and the radio equipment of Mt. Jari Radio Repeater Station shall be contollable at Batiment Technique. The method of supervision and control shall be specified in the proposal.

7-9-7 Power Buildings

The following power buildings shall be constructed.

	Q'ty
(1) Batiment Technique	
a) Engine generator (100KVA)	1
b) Battery charger (24V, 30A)	2
c) Batteries (290AH)	1 set
(2) Mt. Jari Radio Repeater Station	
a) Engine generator (12.5KVA)	1
b) Battery charger (24V, 30A)	2
c) Batteries (290AH)	1 set
(3) Tonga Radio Repeater Station	
a) Engine generator (12.5KVA)	1
b) Battery charger (24V, 20A)	2
c) Batteries (130AH)	1 set
(4) Butare Telegraph and Telephone Office	
a) Battery charger (24V, 20A)	2
b) Batteries (130AH)	1 set

The power supply interface point shall be at the distributor output terminals shown in Figs. 7-10 through 7-13 (when there is no existing facility, MPC is to provide).

7-9-8 Overall Characteristics

(1) Channel quality

a) Earth station - Batiment Technique — S/N: more than 60dB

b) Batiment Technique - Mt. Jari Radio Repeater Station — S/N: more than 60dB

c) Mt. Jari Radio Repeater Station - Tonga Radio Repeater Station - Butare Telegraph and Telephone Office — S/N: more than 40dB

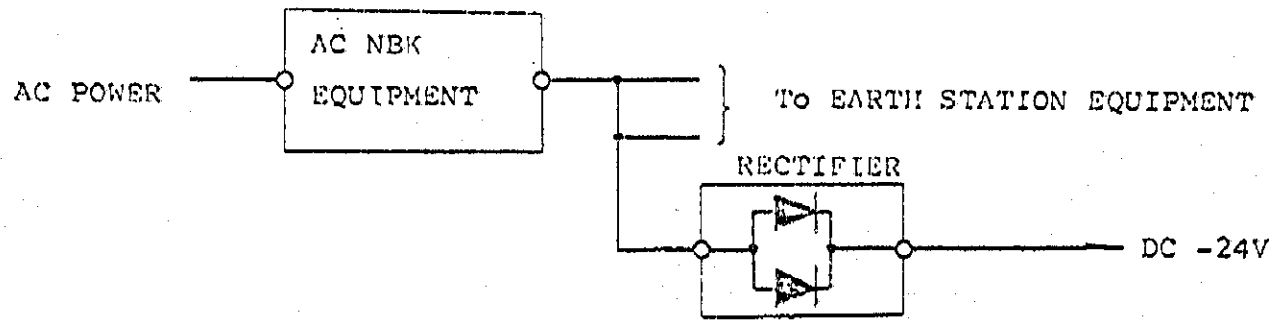
The voice output terminal shall be the measuring terminal.

(2) Overall service rate: more than 99.7%

(3) Design life: Aimed at 15 years or more under normal operation and maintenance

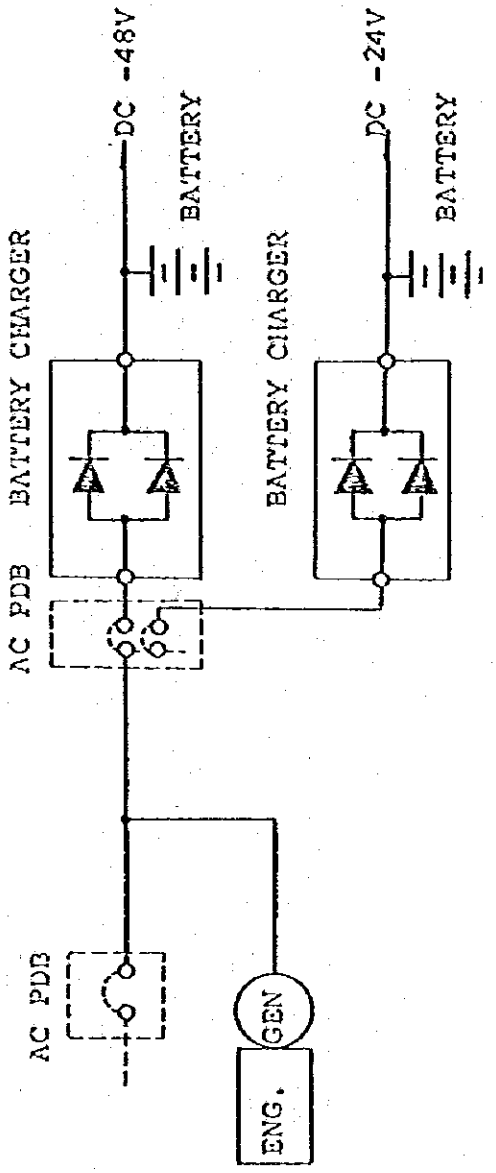
7-9-9 Operating Conditions

Each equipment shall meet the specification in continuous operation under the following conditions.



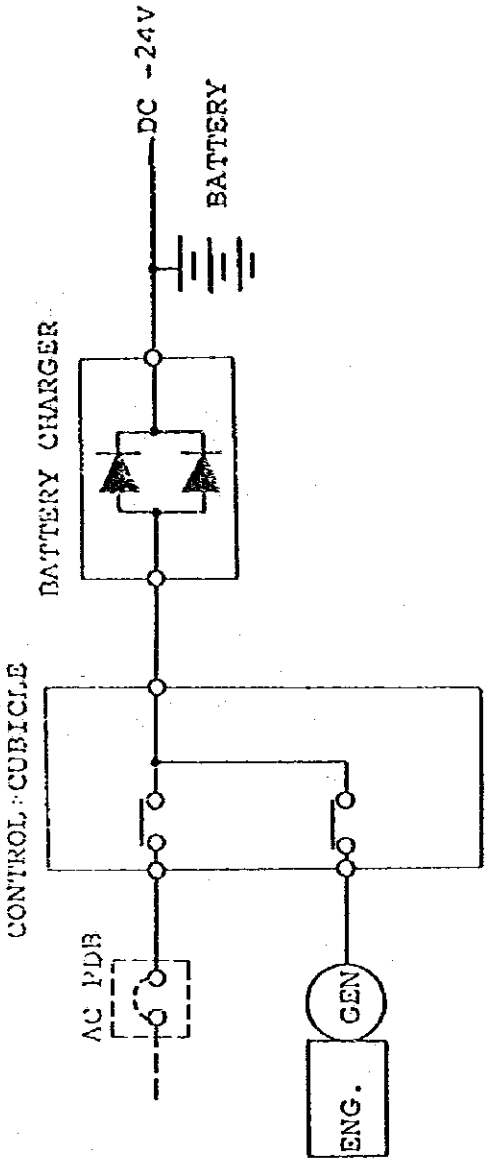
STATION : EARTH STATION

Fig 7-10



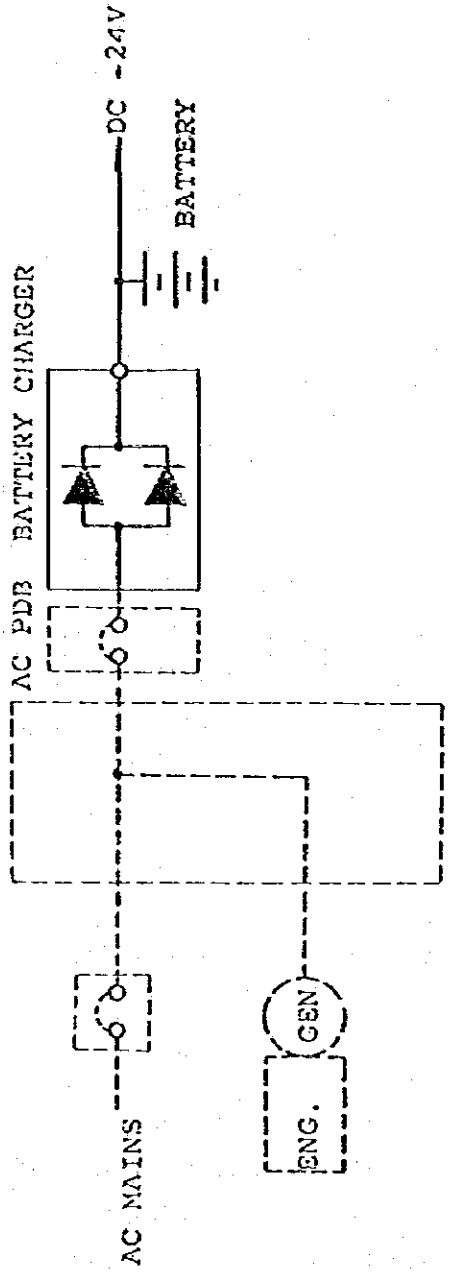
STATION : KIGALI

ENG.	ISSUE 1	
APPD.	Fig 7-11	



STATION : MT JALI, TONGA

ENG.	ISSUE 1	
APPD.	Fig 7-12	



STATION : BUTALE

ENG.	ISSUE 1	
APPD.	Fig 7-13	

	Indoor	Outdoor
· Ambient temperature	0 ∿ 45°C	-10° ∿ 45°C
· Ambient humidity	10 ∿ 90%	0 ∿ 100%

7-9-10 Test Equipment

Test equipment necessary for the test of the radoo system shall be supplied. A list of test equipment shall be given in the proposal.

7-9-11 Accessories

Accessories, spares for service for 2 years, special tools, instruction manuals (English), drawings, test data shall be supplied. A list of these accessories and others shall be given in the proposed.

7-9-12 Others

The contract of this project shall include the following items as well.

(1) Site survey
(2) Construction work and installation (including the supply and transport of construction materials)
(3) Factory inspection and on-site adjustment and test (inspection and test items shall be specified in the proposal)
(4) Supply of information necessary for foundation work of antenna steel towers and power buildings and grouding
(5) Supply of anchor bolts necessary for installation of antenna steel towers and power buildings

CHAPTER 8

CIVIL AND ARCHITECTURAL WORKS NECESSARY FOR THE PROJECT

Chapter 8 Civil and Architectural Works necessary for the Project

8-1 General

8-1-1 Scope

This chapter sets out the basic requirements for the civil and architectural works related to the project. Unless otherwise stated in following paragraphs, the contractor shall prepare implementation specifications based upon this preliminary specification.

8-1-2 Laws, Bylaws and Regulations

The contractor shall comply with laws, bylaws and regulations applicable to design and construction at each locality.

8-1-3 Standard to Be Applied

Design, specification and related works in shop and site shall be simple and economical and conform to the best engineering practice and national standard as amended to date. Examples of applicable standards are those of U.S.A. and Japan.
If the contractor proposes to apply the standards of different nations, he shall be responsible for the application of these standards —— not to cause any contradiction in design criteria, method of calculation, fabrication, erection and related works.

8-1-4 Soil Condition

Allowable bearing capacity, and other mechanical and physical properties of soils at each site shall

be determined by the contractor through sub-soil investigation. However, maximum bearing capacities shall not be greater than 20 t/m^2 for permanent load.

8-1-5 Safety

All works shall be performed in a safe manner. The contractor shall be responsible for providing suitable accommodation and facilities for his employees and the third party.

8-1-6 Cleaning Up

Upon completion of the site works the contractor shall clean up the sites and surrounding property and ensure that all surplus materials and rubbish are removed from there and that the sites are left neat and tidy.

8-1-7 Definitions and Abbreviations

The following definitions and abbreviations are used in this specification for convenience's sake.

Tower:	A structure which is selfsupporting on four leg members.
Antenna:	A structure which is selfsupporting on one leg member assembled by steel pipes.
Antenna and tracking system:	A structure which includes an antenna of cassegrain feed type having a main reflector and a feed combination capable of providing the specified communication and tracking functions.

MPC: Ministere des Postes et des Communications

8-2 Steel Work for Tower and Mast

8-2-1 General

The contractor shall be entirely responsible for design, specifications, fabrication, transportation to Kigali and erection of towers and mast. MPC is to provide electric power and water supply necessary for works at each site.
Unless otherwise specified in Table 1, towers and mast shall be provided with following facilities and appurtenances.

(1) Antenna mount
(2) Working and rest platform
(3) Climbing ladders
(4) Access way where applicable
(5) Vertical and horizontal feeder support where applicable
(6) Lightning protection system
(7) Aircraft obstruction lighting and painting

8-2-2 Design

(1) Stress analysis

The stress analysis of structure and foundation shall take into account the combined effects of dead weight and wind load or seismic load specified in the following paragraphs so that the worst possible combinations are examined such that the worst stress in all

component parts are determined. However, all structures and foundations may not be considered to be subjected to the wind load and seismic load simultaneously. The allowable unit stresses and the combined stresses for all structural members shall not exceed those specified in the applicable national standard.

(2) Design wind velocity

The basic design wind velocity for the calculation of all structures and foundations shall be 27 m/sec or more.

(3) Seismic coefficient

Seismic coefficient taken into account for designing all structures and foundations shall be as follows.

Horizontal seismic coefficient 0.1

Vertical seismic coefficient 0.05

(4) Twist, sway, displacement and signal level degradation

Under the aforementioned wind load or seismic load, twist, sway, displacement and degradation shall not exceed the following values.

Tower

Twist ..... 2 degree
Sway ..... 2 degree
Displacement 1/200
Signal level degradation 3dB

Mast

Twist ..... 5 degree
Sway ..... 5 degree
Displacement 1/100
Signal level degradation 3dB

(5) Material

All steel materials including anchor bolts shall be of structural quality conforming to the national standard. The manufacturers of the steel materials shall provide the certificate concerning their mechanical and chemical characteristics.

(6) Slenderness ratio

Maximum values of slenderness ratio shall be as follows:

Main members in compression:	200
Subsidiary members and members in tension:	250

(7) Minimum thickness of member

All structural members except those of the mast shall not be less than 4mm in thickness.

(8) Connection

All connections between members shall be bolted or factory welded. Notwithstanding stresses are involved or not, any of all connections except those of non-structural members shall have at least two bolts. No bolt on the structure shall be less than 12mm in diameter.
All site connections shall be by nut and bolt fitted with a means provided for locking the nut against loosening and no connections by rivetting and welding at each site shall be acceptable.

In the case of mast, the connection method recommended by the manufacturer may be applied.

8-2-3 Manufacturing and Workmanship

(1) General

All manufacturing and workmanship shall be in accordance with the applicable national standard. Before commencement of the work, the contractor shall submit time schedules indicating every stage of shop-works and site-works.

(2) Quality control and supervision

The contractor shall control the qualities of all materials to be used and shall also supervise the whole works by himself to carry out every work as scheduled.

(3) Trial assembly

The contractor shall provide trial assembly as shop work for confirming the accuracy of fabrication, details of connection and size and position of members assembled, if necessary.

8-2-4 Facilities and Appurtenaces Attached to Tower and Mast

(1) Antenna mount

Each structure shall be complete with antenna mount to which the antenna may be rigidly attached by means of the mount hardware which will be supplied as part of the antenna system. Means for adjusting the antenna in both elevation and azimuth shall be provided if necessary. All antennas shall finally be bolted to the tower or mast.

(2) Working and rest platforms

Working and rest platforms of sufficient area to provide safe conditions shall be provided at each suitable level. The number of platforms required is given in Table 8-1. All platforms except the mast shall be provided with hand-rails, intermediate rails and kick-rails installed respectively at suitable height above the deck level.

(3) Climbing ladders

Steel ladders shall be provided from ground level to the top of each tower and mast. The ladders shall be sufficiently wide and rigid for safe climbing. Each ladder except the mast shall have a safety cage ranging from the level of 2.5m above the ground and from each platform to the top.

(4) Access way

Access way of sufficient area to give safe access to the antenna and other appurtenance shall be provided at each level except the mast.

(5) Vertical and horizontal feeder supports

The feeder support is required to carry the transmission lines to connect the antenna to the radio equipment. The vertical feeder support shall consist of a ladder with rungs not more than 1m apart to which feeder clamps may be fixed. The stringers of the ladders shall be supported by a suitable concrete foundation and the lower portion below approximately 2.5m shall

be unclimbable.
The vertical feeder support shall directly be fixed to the tower structure.
The horizontal feeder support shall be provided between the vertical feeder support and the exterior wall of the radio building. This shall consist of adequate steel piers set in concrete foundations and be furnished with proper covers to protect the feeder from falling objects, if necessary.

(6) Lightning protection system

Towers and mast shall be equiped with an effective lightning protection system to reduce the chances of damage by lightning to the tower structure, radio equipment and antenna system.

The rod tip(s) shall be of such height that all the radio equipment and the lights at the top, where applicable, are included in a 60-degree cone of protection. A grounding network and earth electrodes shall be installed around the tower or mast in such a manner that the resistance value to the ground is to be less than 10 ohms.

(7) Aircraft obstruction lighting and painting

a) General

Obstruction lighting system and painting of towers for aircraft hazard shall be provided at the sites where specified in Table 8-1.
Standards for these obstruction lights and painting of the towers shall be as specified hereinafter and as specified in relevant documents of I.C.A.O. - the International Civil Aviation

Organization - or equivalent specification.

b) Obstruction lighting system

i) A photocell senser shall be provided to automatically switch the lighting system.

ii) In the case of flashing beacon lamps, a flashing relay will be provided to switch on/off the beacon lamp at a rate of 20 - 60 flashes per minutes.

iii) Failure of either or both flashing beacon lamps and one or more of side lamps shall cause a visual alarm indication in the radio building. However, the alarms shall not operate when the lighting system is switched off manually.

iv) Control box shall be mounted in the radio building, and shall include the beam flashing, manual light switches, circuit breakers and alarm relay.

v) The electric cable shall be PVC insulated and of adequate capacity for operation.
Unless otherwise specified, all PVC insulated cables shall be inside heavy gauge steel conduits.

vi) All lamp housings shall be of weatherproof type.

vii) All lamps furnished shall be of long-life type readily available in the event of failure.

viii) The contractor shall provide the suitable number of spare lamps for two years after commencement of service.

c) Painting

Where required to be painted in orange and white bands for aircraft warning, all galvanized steel

surfaces shall be painted except surfaces which are required to be left unpainted, or are paints shall be of first class materials appropriate for painting on steelwork, and the application method of painting shall conform to the recommendation of the approved manufacturer.
The following three coats of paint shall be applied.

- Primary coat
- Intermediate coat
- Finishing coat

The use of any thinner or spray gun shall not be permitted.

8-2-5 Galvanizing

All steel including platform, ladders, feeder supports, nuts and washers and all other steel members used in the structure shall be coated by hot-dip galvanizing after completion of fabrication.
Anchor bolts forming portion on the foundation and mast shall be galvanized down to a distance 10cm below the surface of the concrete.

The zinc coating shall be continuously smooth, clean, of uniform thickness and free from defects. The weights of zinc coating per square meter of actual surface shall average not less than 550 g/m^2. For bolts and other threaded work the coating weights shall average 350 g/m^2 or more.

In the event of any damage to the zinc coated surface during transportation or erection, the damaged portion shall thoroughly be cleaned and painted with an approved cold zinc coating.

Table 8-1 Requirements for Tower and Mast

Site	Type	Height above Ground (m)	Antenna			Aircraft Obstruction		Platform	
			Diameter, Type of Antenna (m)	Installation Height above Ground (m)	Direction	Lighting	Painting	Number of Working Platforms	Number of Rest Platforms
Nyanza (E/S)	Tower	22	1.2	20	Kigali	-	-	1	o
Kigali (B.T.)	do.	32	1.2	30	Nyanza	Side lamps at the top	o	1	1
			1.2	30	Mt. Jari				
Mt. Jari	do.	47	1.2	30	Kigali	do.	o	2	1
			3.0G	45	Tonga				
Tonga	do.	57	3.0G	55	Mt. Jari	Flashing beacon lamps at the top (two sets), side lamps at the middle	o	1	2
			YAGI	30	Butare				
Butare	Mast	20	YAGI	20	Tonga	-	-	o	1

Legend G: Grid antenna E/S: Earth Station o : applied
YAGI: Yagi antenna B.T.: Batiment Technique - : Not applied

8-3 Foundation Work for Antenna Supporting Structure and Others

8-3-1 General

The contractor shall be responsible for the design and quantity surveying of the foundation of antenna supporting structure, shelter, new emergency engine generator and air conditioning equipment. However, construction of the foundations will be done by MPC accurately in size, position and quality to meet the requirements of the specification and drawings furnished by the contractor. The existing emergency engine generator to be substituted with the new one is to be removed by MPC.

8-3-2 Design

Foundation design shall be such that shall match the stresses of structure when subjected to the loads specified in the previous clause and match the static or dynamic stresses of the power or building equipment.

8-3-3 Drawings

Detailed drawings, and execution drawigns where applicable, furnished by the contractor shall include all information necessary for the foundation works.

8-3-4 Equipments for Structural Materials

(1) Cement

All cement to be used shall be normal portlaned cement and shall comply with relevant BS or approved equivalent standard.

(2) Concrete

Concrete to be produced at site shall have suitable workability, plasticity and density. Minimum compressive strength of concrete tested after 28 days shall be 180 kg/cm^2 or more in cylindrical test pieces/or 225 kg/cm^2 or more in cubic test pieces.

(3) Peinforcing Bars

Reinforcing bars are to be of round bars with mechanical properties as given in Table 8-2.

Table 8-2 Mechanical Requirements of reinforcing bars

Yield Point (kg/cm^2)	Tensile Strength (kg/cm^2)	Elongation (%)
2400 or more	3900 - 5300	20 or more

8-3-5 Site To Be Applied

Sites where the foundation of structure or equipment is to be employed are listed in Table 8-3.

Table 8-3 List of Sites Where Foundation of Structure or Equipment Is to Be Employed

Site	Foundation						Remarks
	Tower	Mast	Shelter	Antenna and Tracking System	Power Equipment	Air conditioning Equipment	
Nyanza (E/S)	o		o	o		o	
Kigali (B.T.)	o				o (100KVA)	o	
Mt. Jari	o				o (12.5KVA)		
Tonga	o				o (12.5KVA)		
Butare		o					

o: applied

8-4 Building Construction Work

8-4-1 General

MPC is to be responsible for design and construction of the exchange building at the site of Bâtiment Technique in Kigali and the power building at the site of Earth Station in Nyanza. However, the contractor shall come into contact and cooperate with MPC for designing the buildings and shall also provide and install airconditioning equipment. Detailed information which is necessary for the design and which is to be furnished by the contractor are as follows:

(1) Effective clear heights (for example, distance between floor level and bottom surface of girder or beam)

(2) Size of doors for equipment entry

(3) Finishing materials recommended.

(4) Sizes and positions of openings on walls and trenches for cable installation where applicable.

(5) Sizes and allocations of insert rails or similar facility where applicable.

(6) Recommended facility for being free from dust and soils and/or for airconditioning and ventilation.

(7) Allocation and weights of equipment and design live loads.

(8) Others necessary or recommendatory for building design and for operating and maintenance of the radio equipment.

Unless otherwise stated, any building materials for construction can be used, however, minimum compressive strength of concrete to be used after 28 days should preferably be more than 180kg/cm^2 in cylindrical test pieces or 225kg/cm^2 in cubic test pieces.

8-4-2 Exchange Building at the Site of B.T. Kigali

All structural members including roof slabs,

girders and beams shall be constructed of rigid frame and of reinforced concrete. However, walls can be made of concrete hollowed blocks or similar suitable material.
Draft floor plans are shown in Figs. 8-1 and 8-2.

8-4-3 Power Building at the Site of Earth Station

The foundations including tie-beams and slabs or slabs on soil if applicable shall be constructed of rigid frame and of reinfourced concrete.
Walls can be made of concrete hollowed blocks or similar material.
A draft floor plan of the power building is shown in Fig. 8-3.

8-5 Civil and Earth Work

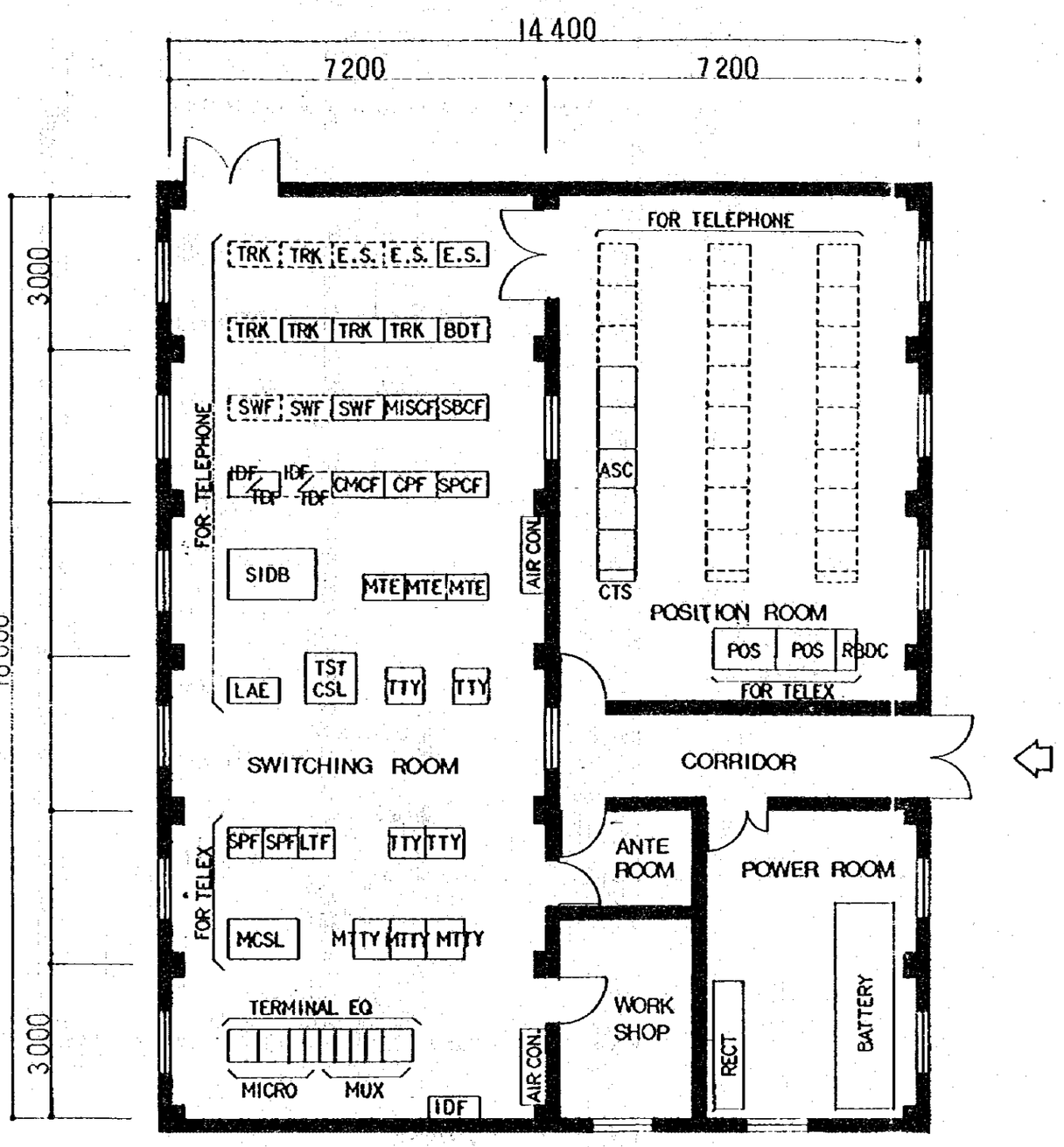
8-5-1 Access Road

MPC shall provided an access road from the proposed site of the earth station to the existing read for use upon construction, transportation and maintenance.

The road shall be 6m in width so as to allow vehicles with crane facility to pass and shall be approximately 250mm in length. This access road shall be completed before commencement of the site works of the project.

8-5-2 Landscaping Work

MPC will be responsible for cutting grass and

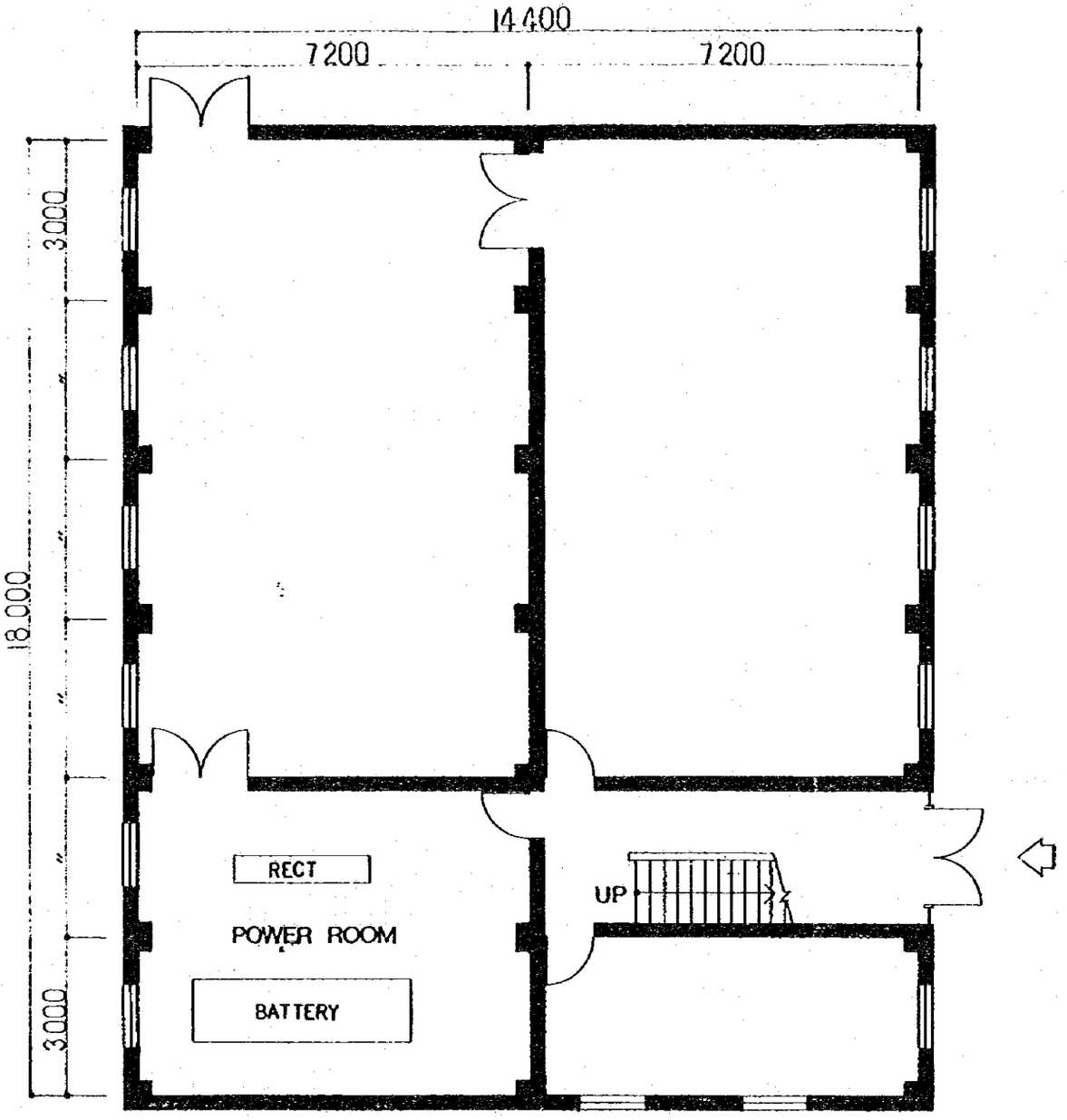


GROUND FLOOR

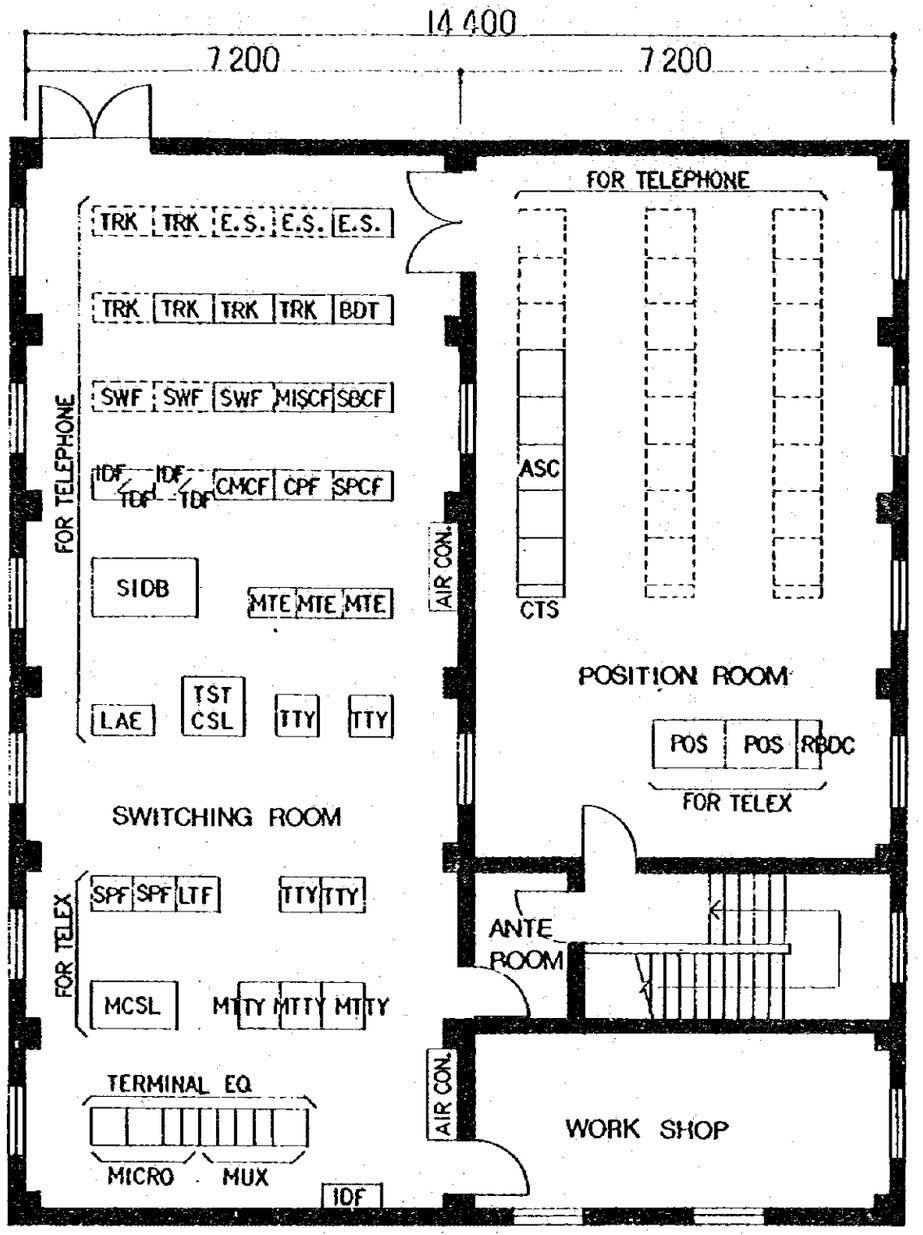
SCALE : 1 : 100
UNIT : mm

DRAFT FLOOR PLAN OF
THE EXCHANGE BUILDING
BÂTIMENT TECHNIQUE,
KIGALI

FIGURE 8-1. ONE STORIED SCHEME



GROUND FLOOR

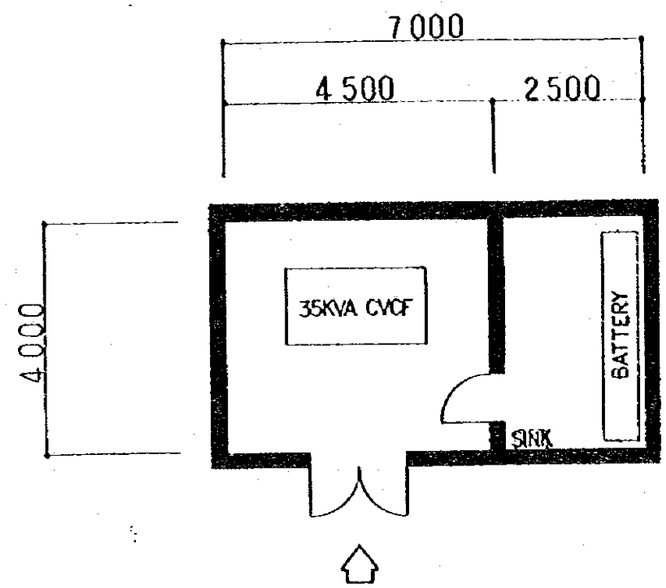


FIRST FLOOR

DRAFT FLOOR PLAN OF
THE EXCHANGE BUILDING
BÂTIMENT TECHNIQUE ,
KIGALI

SCALE ; 1 : 100
UNIT ; mm

FIGURE 8-2. TWO STORIED SCHEME



GROUND FLOOR

DRAFT FLOOR PLAN OF
THE POWER BUILDING
EARTH STATION,
NYANZA

FIGURE 8-3.

plants, and roughly levelling the ground surface at the whole site of the earth station for the purposes of construction, transportation and installation. These works shall be completed before commencement of the site works. Design, specifications, bill of quantities, and detailed drawings of final site planning such as levelling, gardening and allocation of paths and drainage, shall be provided by the contractor. MPC will be responsible for construction to meet the specification and drawings furnished by the contractor. These works at the site shall be commenced after completion of all construction, and installation of all equipment. Draft drawing of final site planning is shown in Fig. 8-4.

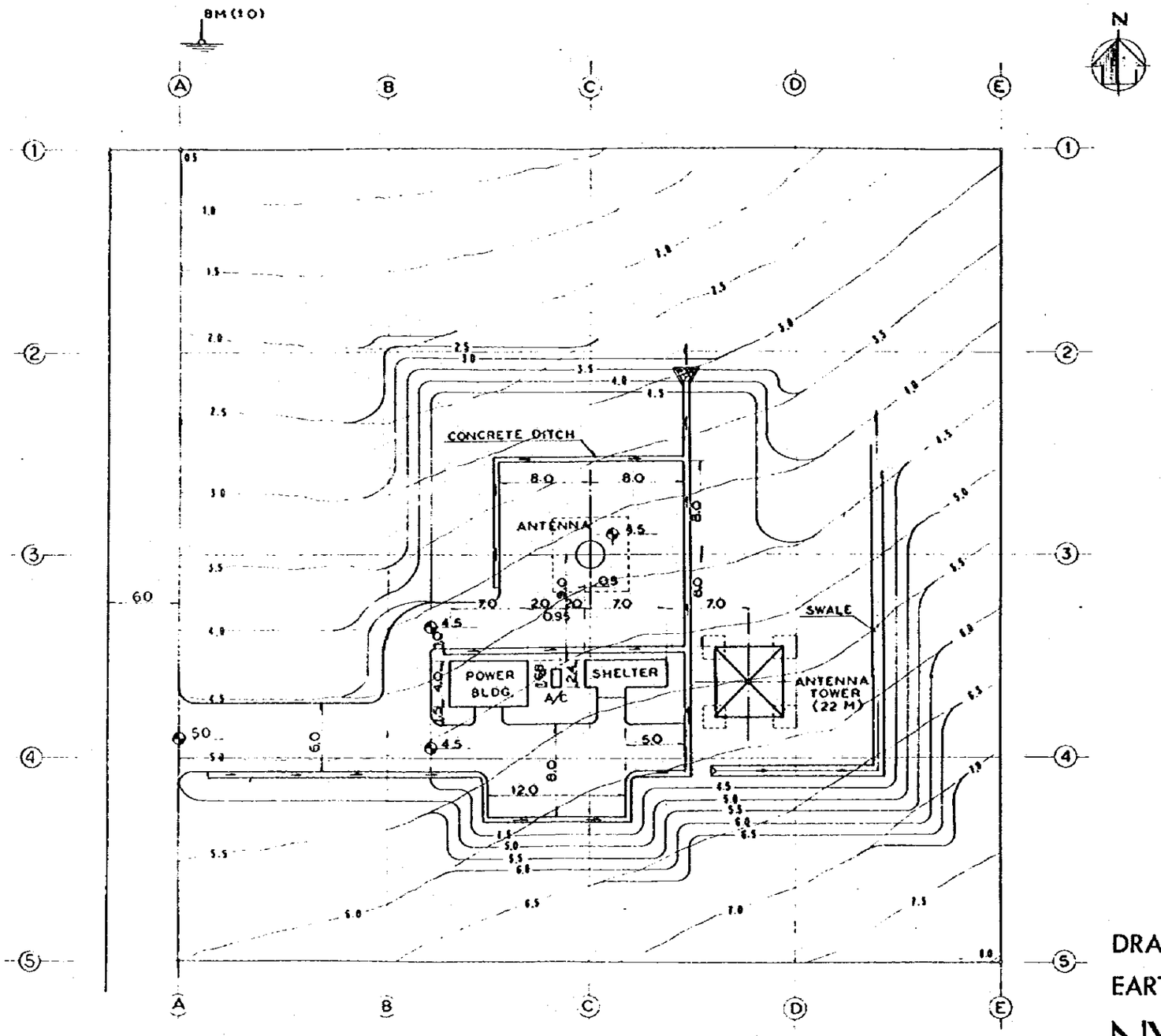
8-5-3 Trench for Power Cable

For the installation of power cable and others, trench made of concrete shall be provided by MPC between the proposed power building and the existing power building in the site of the earth station. The trench shall be satisfactory in capacity and in size for maintenance and sufficiently rigid and durable against any load applied.

8-6 Modification of Existing Building or Room

8-6-1 General

Where radio and power equipment are to be newly installed, MPC shall modify or adapt the building or room for satisfactory operation and maintenance. However, the contractor shall closely come into contact and cooperate with MPC and shall



SITE LAYOUT PLAN

SCALE ; 1 : 400

UNIT ; m

DRAFT SITE LAYOUT PLAN OF EARTH STATION,

NYANZA

FIGURE 8-4.

provide necessary information for design and works.

8-6-2 Examples of Modifications for Adaptation

Some examples of modifications recommended are as follows:

(1) The overall floors and interior walls of the room are to be re-finished with cement sand plaster (trowelled finish) and painting.

(2) The false-ceiling, if installed, is to be re-painted.

(3) The radio equipment room and power room shall be kept clean by sweeping or with mechanical sweeper.

(4) All windows and doors of the rooms shall be kept closed for being free from dust, soil and other deteriorating matters.

(5) Where particularly necessary, anteroom is to be provided by means of partitions with windows and door.

(6) To protect the equipment from excessive temperature rise due to operation, mechanical ventilating system is to be provided, where applicable.

8-6-3 Sites to Be Applied

Sites where modifications for adaptation are to be applied are given in Table 8-4.

Table 8-4 List of Sites to Be Modified for Adaptation

Site	Radio Equipment Room	Engine Room	Battery Room	Remarks
Kigali (B.T.)		o		
Mt. Jari	o	o	o	
Tonga	o	o	o	
Butare	o		o	

o: To be modified for adaptation

8-7 Summary of Civil and Architectual Works at Site

Table 8-5 shows an example of summary of civil and architectual works at site for this project.

Table 8-5. Summary of Civil and Architectural Works at Site (Draft)

Description		Site	Scope of Work: Impl. Design (Cal. Draw. Spec.)	Scope of Work: Construction Work at Site	Scope of Work: Cooperation for Design	Work Schedule at Site	Remark
STEEL WORK FOR TOWER AND MAST	Tower	Nyanza E/S Kigali B.T. Mt. Jari Tonga	○	○			
	Mast	Butare	○	○			
FOUNDATION WORK FOR ANTENNA SUPPORTING STRUCTURE AND OTHERS	A.T.S.	Nyanza E/S	○	●			Quantity surveying shall be done by the contractor.
	Tower	Nyanza E/S Kigali B.T. Mt. Jari Tonga	○	●			
	Mast	Butare	○	●			
	E.E.G.	Kigali B.T. Mt. Jari Tonga	○	●			
	Shelter	Nyanza E/S	○	●			
	A.C.E.	Nyanza E/S Kigali B.T.	○	●			
BUILDING CONSTRUCTION WORK	Ex. Bld.	Kigali B.T.	●	●	○		
	Power Bld.	Nyanza E/S	●	●	○		
CIVIL AND EARTH WORK	Access road	Nyanza E/S	●	●			
	Landscaping	Nyanza E/S	○	●			same as mentioned above
	Trench	Nyanza E/S	●	●	○		
IMPROVEMENT WORK FOR EXISTING BUILDING OR ROOM		Kigali B.T. Mt. Jari Tonga Butare	●	●	○		

Work Schedule at Site: 1980 (3 6 9 12) | 1981 (3 6 9 12) | 1982 (3 6 9)

Abbreviation
- A.T.S. : Antenna and Tracking System
- E.E.G. : Emergency Engine Generator
- A.C.E. : Air Conditioning Equipment
- E/S : Earth Station
- B.T. : Bâtiment Technique
- Ex. Bld. : Exchange Building
- Power Bld. : Power Building
- Impl. Design : Implementation Design.
- Cal. : Calculation
- Draw. : Drawing
- Spec : Specification
- ○ , ▭ : Scope of the contractor.
- ● , ▬ : Scope of MPC

CHAPTER 9

PROJECT IMPLEMENTATION SCHEDULE

Chapter 9 Project Implementation Schdule

This project requires a period of 20 months from the effctuation of the contract to the commencement of service. In order to commence the service by February 1982, it is necessary to start the construction in July 1981. An implementation schedule for the fabrication, transport, installation, testing, etc., of the respective equipment and others is given in Table 9-1. MPC is to accomplish civil and architectural works and others for which MPC is responsible in accordance with the implementation schedule, as follows.

- Civil and architectural works related to radio links ..... by the end of December 1980

- Civil and architecural works related to satellite communication earth station ..... by the end of Marth 1981

- Civil and architectural works related to international switching systems ..... by the end of May 1981

Table 9-1 IMPLEMENTATION SCHEDULE