## 4.5 Plan of Satellite Communications Network Configuration and Scope of works of the Project

### 4.5.1 General

This section details the scope of work necessary for the satisfactory accomplishment of both Phase 1 and Phase 2 projects. All technical plans presented herewith are included in the cost estimation of both projects.

### 4.5.2 Plan of Satellite Communications Network Configuration

1) Network Configuration in Phase 1 Project

Figure 4-6 shows a schematic block diagram of the planned satellite communications network in the Phase 1 project.

The A.O.R. earth station will be planned to operate with a Major path II INTELSAT satellite located in the Atlantic Ocean region. At present, three operational satellites are in the A.O.R.. Taking into account satellite traffic loading conditions, INTELSAT has already assigned a Major path II satellite for Zimbabwe.

There are many earth stations now operating through a Major path II/A.O.R. satellite, as listed in the figure. In view of Zimbabwe's traffic requirements, the plan enables the establishment of the satellite communications links with the following countries by both the FDM/FM and the SCPC communications systems:

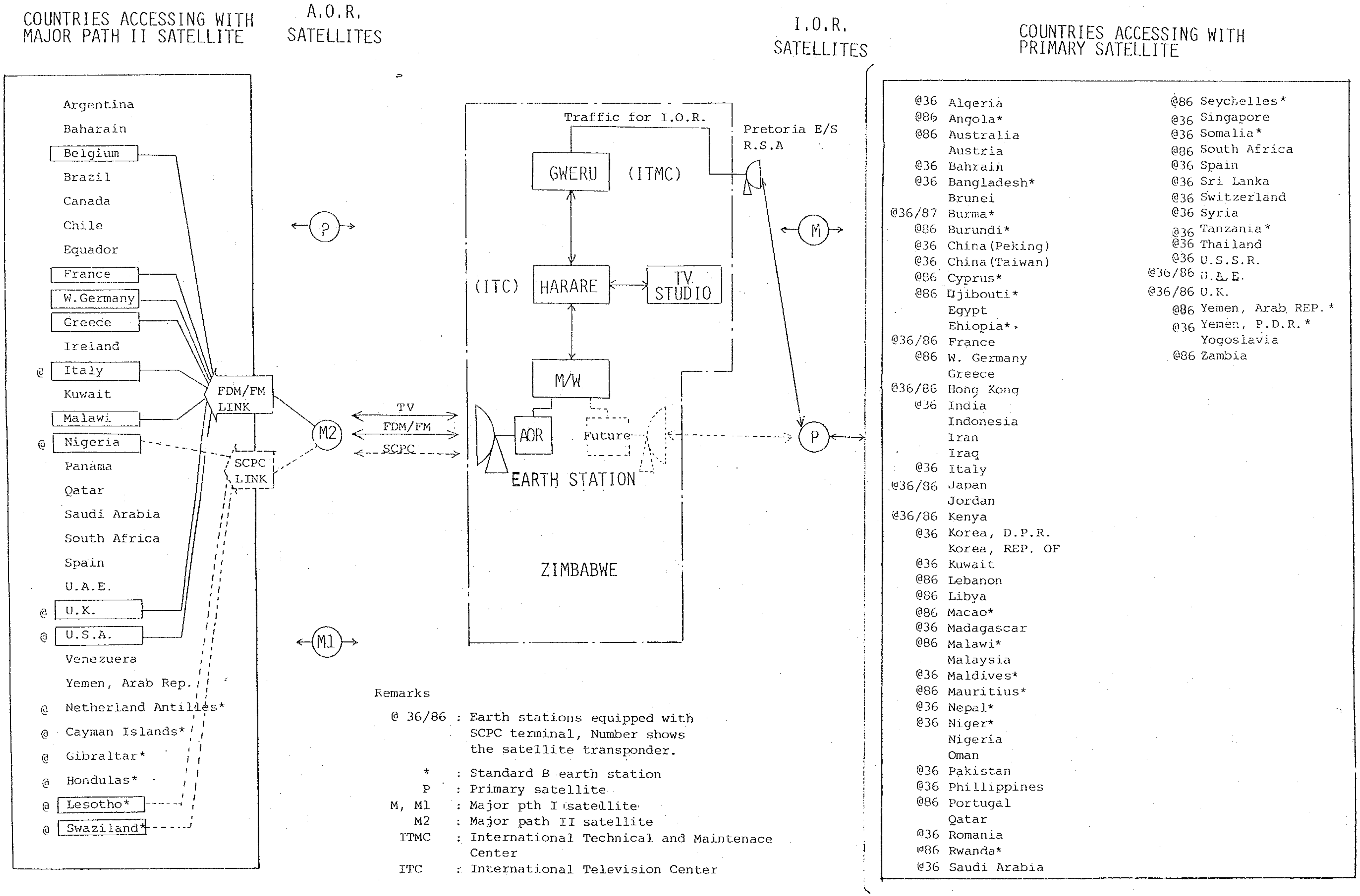



FIGURE 4-6 CONFIGURATION OF ZIMBABWEAN SATELLITE COMMUNICATIONS NETWORK ( PHASE 1 )

| Countries/Destinations | Link Type |
|---|---|
| Belgium | FDM/FM |
| France | FDM/FM |
| W. Germany | FDM/FM |
| Greece | FDM/FM |
| Italy | FDM/FM |
| Malawi | FDM/FM |
| U.K. | FDM/FM |
| U.S.A. | FDM/FM |
| Nigeria | SCPC |
| Lesotho | SCPC |
| Swaziland | SCPC |

It should be clearly noted that coordination with both the administrations concerned and the INTELSAT is required to finalize this plan. Early coordination is essential for establishing the satellite links because the necessary equipments has to be prepared for inclusion in them.

For the international television services, an occasional TV link can be established between those countries listed in the figure on demand basis.

In view of the traffic routing arrangement, most of the existing satellite circuits in Zimbabwe could be transferred from the South Africa to its own telecommunication network, by implementing the A.O.R. earth station in Zimbabwe. However, a small amount of the existing traffic should remain as it now is to maintain the general traffic routing policy in the INTELSAT network, and to avoid services established by double hop link.

To maintain the high-quality of service for satellite communications traffic, it is necessary for the network to establish the ITMC and ITC functions, respectively.

Since the message traffic is destinated at Gweru, the International Technical Maintenance Center (ITMC) must also be there. On the other hand, the International Television Control Center (ITC) must be established at the Harare Center Exchange Building for interface with the ZBC Harare TV Studio.

2) Network Configuration in the Phase 2 Project

Figure 4-7 shows a schematic block diagram of the planned satellite communications network in the Phase 2 project.

The I.O.R. earth station will be planned to operate with a Primary path satellite located in the Indian Ocean region. At present, there are two operational satellite in the I.O.R. However, it is estimated that most probable satellite arrangement for the Zimbabwe's I.O.R. earth station be a Primary path.

There are many earth stations now operating through a Primary path satellite. Based on information given on the traffic demand forecast, planning is made to establish the satellite communications links with the following countries by both SCPC and FDM/FM communications systems:

| Destinations/Countries | Link Type |
|---|---|
| Australia | FDM/FM |
| India | FDM/FM |
| Japan | FDM/FM |
| Hong Kong | SCPC (Transponder 36) |
| Pakistan | SCPC (Transponder 36) |
| Tanzania | SCPC (Transponder 36) |
| U.A.E. | SCPC (Transponder 36) |

It should be noted that coordination with both the administrations concerned and with INTELSAT is required to finalize this plan. And, also noted is that the

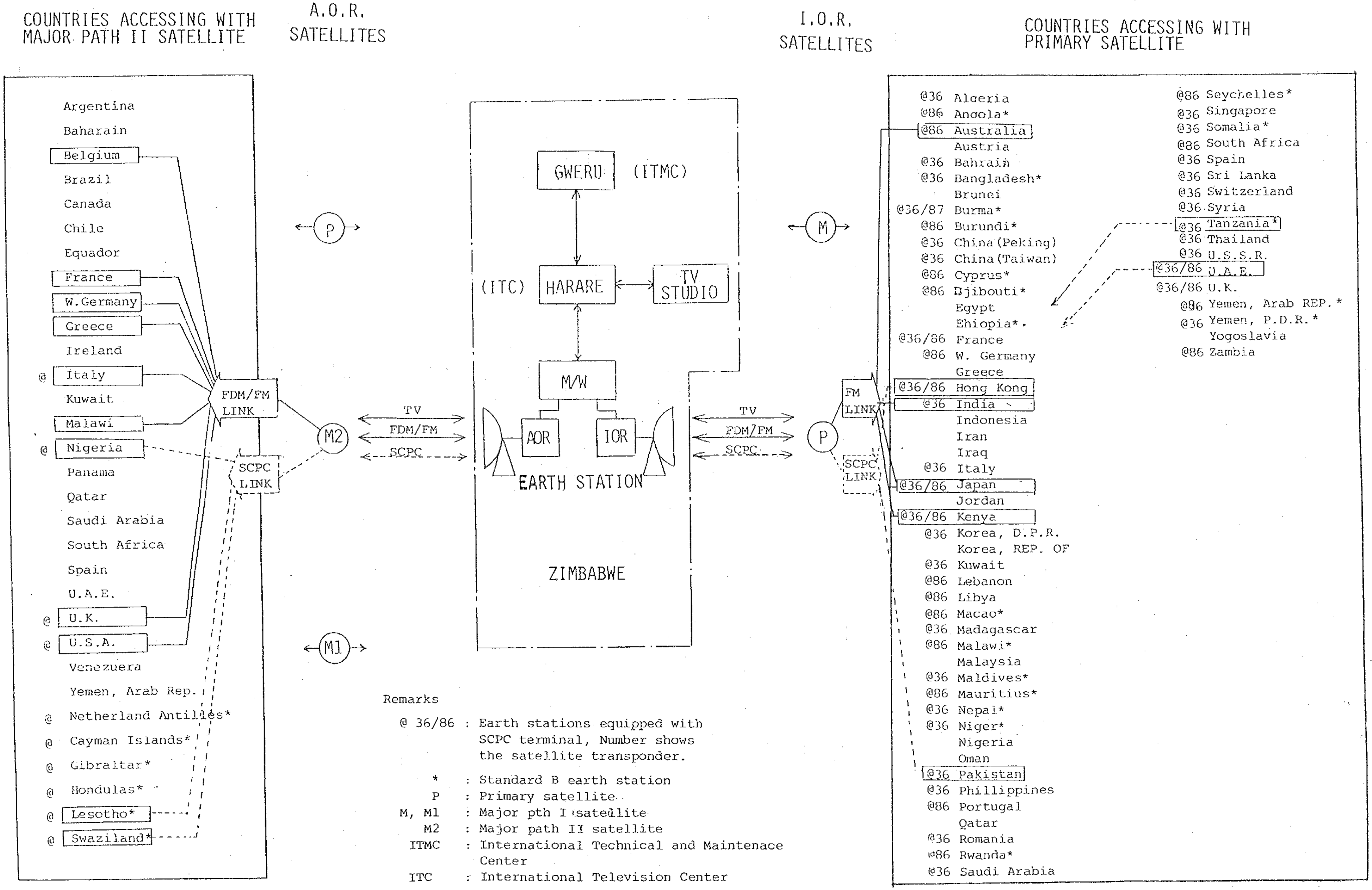



FIGURE 4-7 CONFIGURATION OF ZIMBABWEAN SATELLITE COMMUNICATIONS NETWORK ( PHASE 2 )

latest traffic requirements should be taken into account to finalize satellite link planning when the Phase 2 project is planned later.

For TV services, an occasional satellite TV link can be established between those countries listed in the figure.

By implementing both the Phase 1 and the Phase 2 projects, all satellite communications traffic can be established through Zimbabwe's satellite communications earth stations and its network, on free from the services of a third country.

At present, INTELSAT is intending to adopt the TDMA communications system into the INTELSAT satellite communications network in near future. It will become operational first in the A.O.R. and, then, in the I.O.R. The study team feels that it is too early for Zimbabwe to introduce at present such new means of telecommunications system. However, the study team proposes to take such movements in the INTELSAT network into considerations for the country's future network planning.

### 4.5.3 Detailed Plan of the A.O.R. Earth Station Installation Project (Phase 1 Project)

1) Scope of Works (Civil Work Excluded)

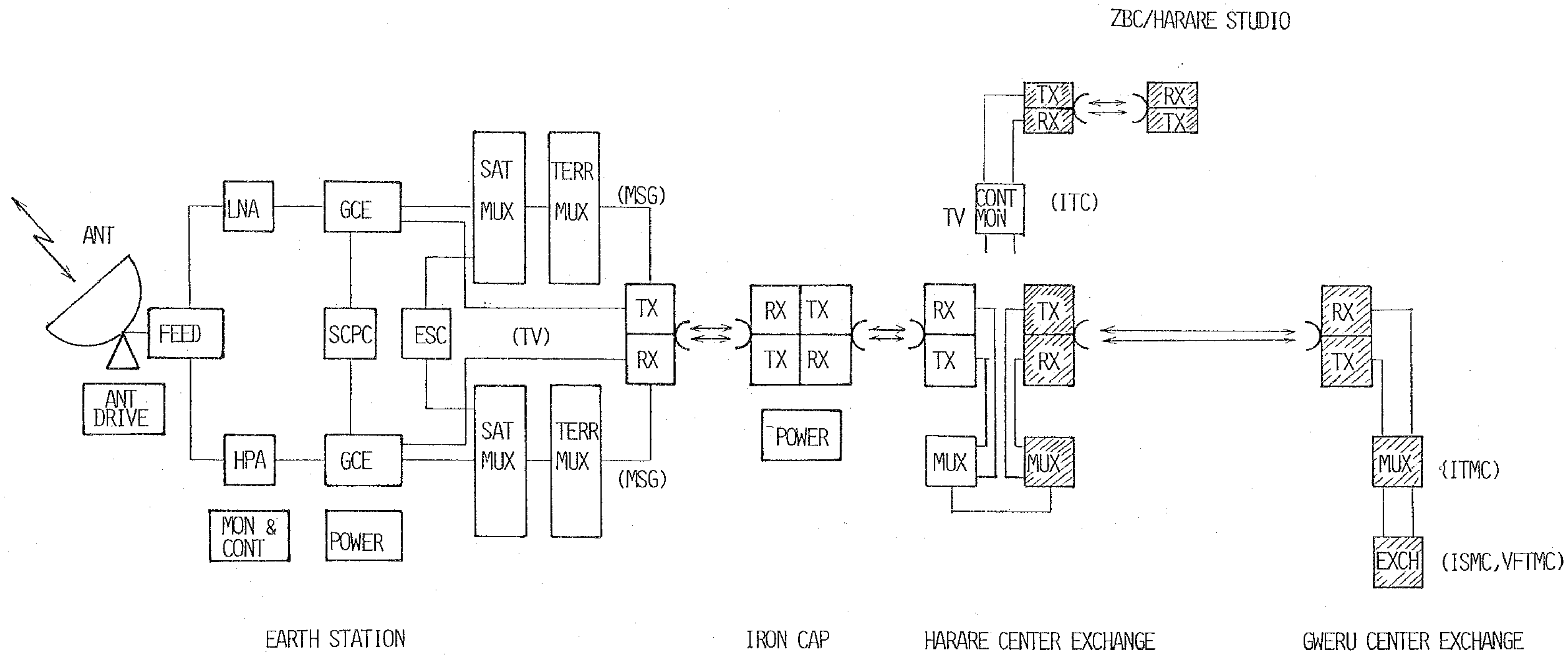
Figure 4-8 shows a schematic block diagram to indicate the range of the Phase 1 project. Summarized, the Phase 1 project must cover the following:

a) Installation of the complete INTELSAT Standard A earth station complex consisting of:

- Antenna Subsystem
- High Power Amplifier Subsystem (HPA)
- Low Noise Amplifier Subsystem (LNA)

□ : EQUIPMENT TO BE COVERED BY THE A.O.R. EARTH STATION INSTALLATION PROJECT

▨ : EXISTING EQUIPMENT OR EQUIPMENT TO BE COVERED BY THE SEPARATE PROJECT




Legend
- ANT : Antenna
- Feed : Antenna Feed Assembly
- LNA : Low Noise Amplifier Subsystem
- HPA : High Power Amplifier Subsystem
- MUX : Multilex/Demultiples Subsystem
- TV/MSG : Television/ Messgage
- TX/RX : Transmitters/Receivers
- EXCH : Exchanger
- SCPC : Single Channel Per Carrier System
- ESC : Engineering Service Circuit Subsystem
- ITC : International Television Control Center
- ITMC : International Technical Maintenance Center
- ISMC : International Switching Maintenance Center
- VFTMC : Voice Frequency Telegraph Maintenance Center

FIGURE 4-8 SCOPE OF WORKS FOR THE A.O.R. EARTH STATION INSTALLATION PROJECT (PHASE 1 PROJECT)

- Ground Communications Equipment Subsystem (GCE)
- Engineering Service Circuit Subsystem (ESC)
- Communication Control, Monitor and Testing Subsystem
- Satellite and terrestrial Multiplex/Demultiplex Equipment Subsystem (MUX)
- Power Supply Subsystem

b) Installation of the terrestrial microwave system between the earth station and the Harare Center Exchange Building, consisting of:

- Antennas, transmitters and receivers at the earth station
- Antennas, transmitters, receivers and a non-break power supply equipment at a repeater station planned at Iron Cap
- Antennas, transmitters and receivers at Harare

c) Installation of the MUX equipment at the Harare Center Exchange building, consistsing of:

- Supergroup Multiplex/Demultiplex equipment for interfacing with the existing MUX equipment

d) Installation of TV control and monitor equipment at Harare Center Exchange Building

It should be noted that the Phase 1 project does not cover any works and facilities necessary for the Gweru Center Exchange Building. It was understood by the study team that all equipment and works necessary for implementing the Gweru was planned to cover by the separate project.

2) Details of the A.O.R. Earth Station Complex

a) Configuration of HPA/LNA/GCE Subsystems

In accordance with a plan shown in Section 5.2, Figure 4-9 shows the proposed configurations of HPA/LNA/GCE subsystems with their details.

The configurations are planned to meet the minimum technical requirements, while seeking for good cost performance, with the following system desing approach:

- Transmitting GCE shall be configured with redundancy, except for TV GCE. Non-redundancy is acceptable for TV equipment since TV service is infrequent and short time in each transmission.

- The HPA subsystem shall be configured with 4 units of HPA, each employing a 3 kW Klystron tube. This allows easy equipment operation as well as efficient spare parts control, especially for a Klystron tube.

  This configuration assures efficient redundancy - 3:1 for the full time message transmission service when no TV transmission service is scheduled.

  In view of the case of meeting emergency operational needs on the HPA subsystem, three of the HPA units will be identical, while one unit will have the capability of remote control frequency tuning.

- The RF combiners shall be designed and configured to enable any HPA unit to be connected to any one of the RHCP and the LHCP antenna ports of the antenna subsystem.

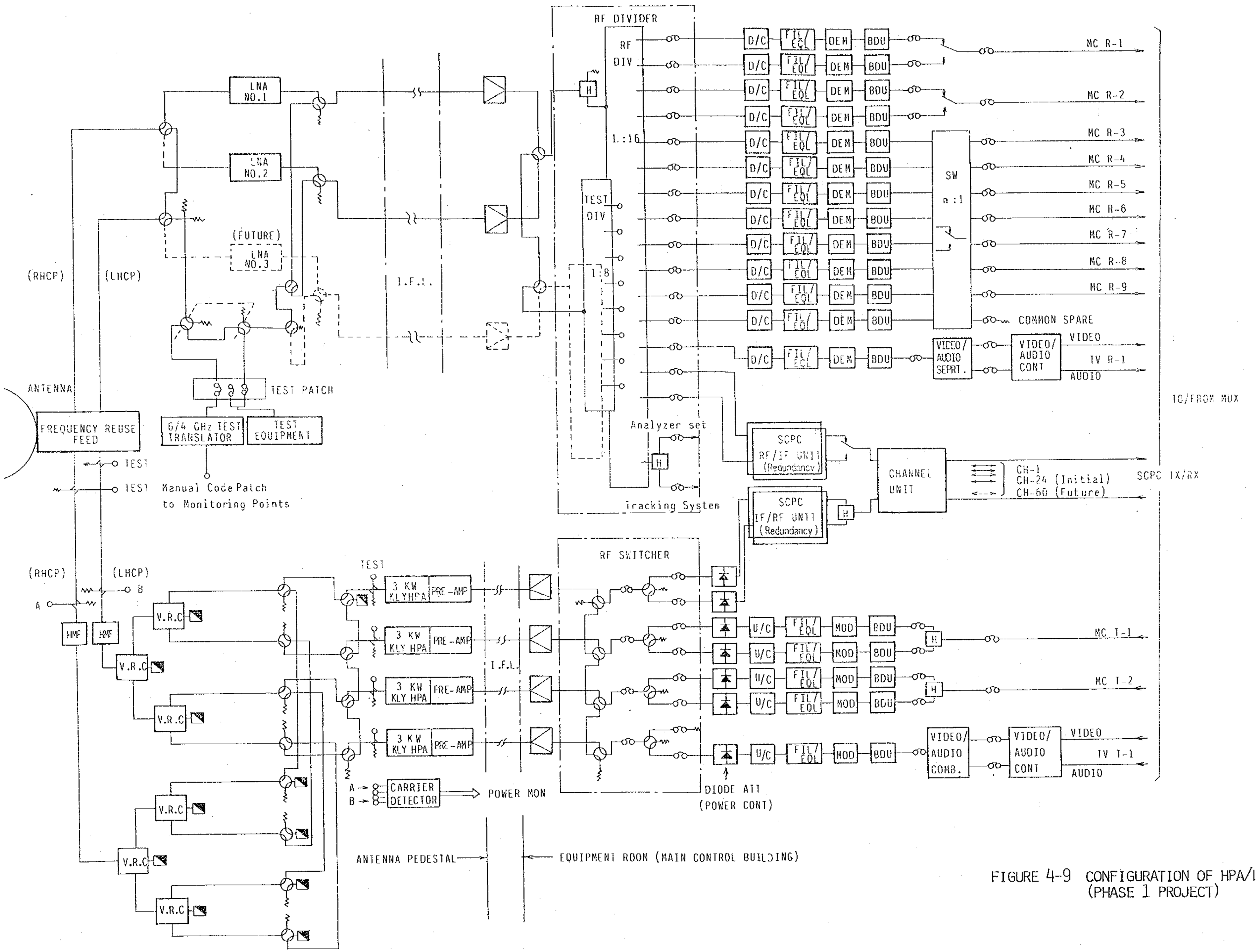



FIGURE 4-9 CONFIGURATION OF HPA/LNA/GCE SUBSYSTEM (PHASE 1 PROJECT)

- A test translator, 6 GHz to 4 GHz, shall be provided for equipments maintenance by the in-station test set-up loop and for monitoring of the operation's own transmitting carrier conditions as required in the INTELSAT specifications.

- The receiving GCE subsystem shall be configured with certain degrees of redundancy. Two major links, U.K. and U.S.A. links, shall be redundant, while the other 7 GCE will have 7:1 redundancy configuration. No-redundancy is acceptable for TV.

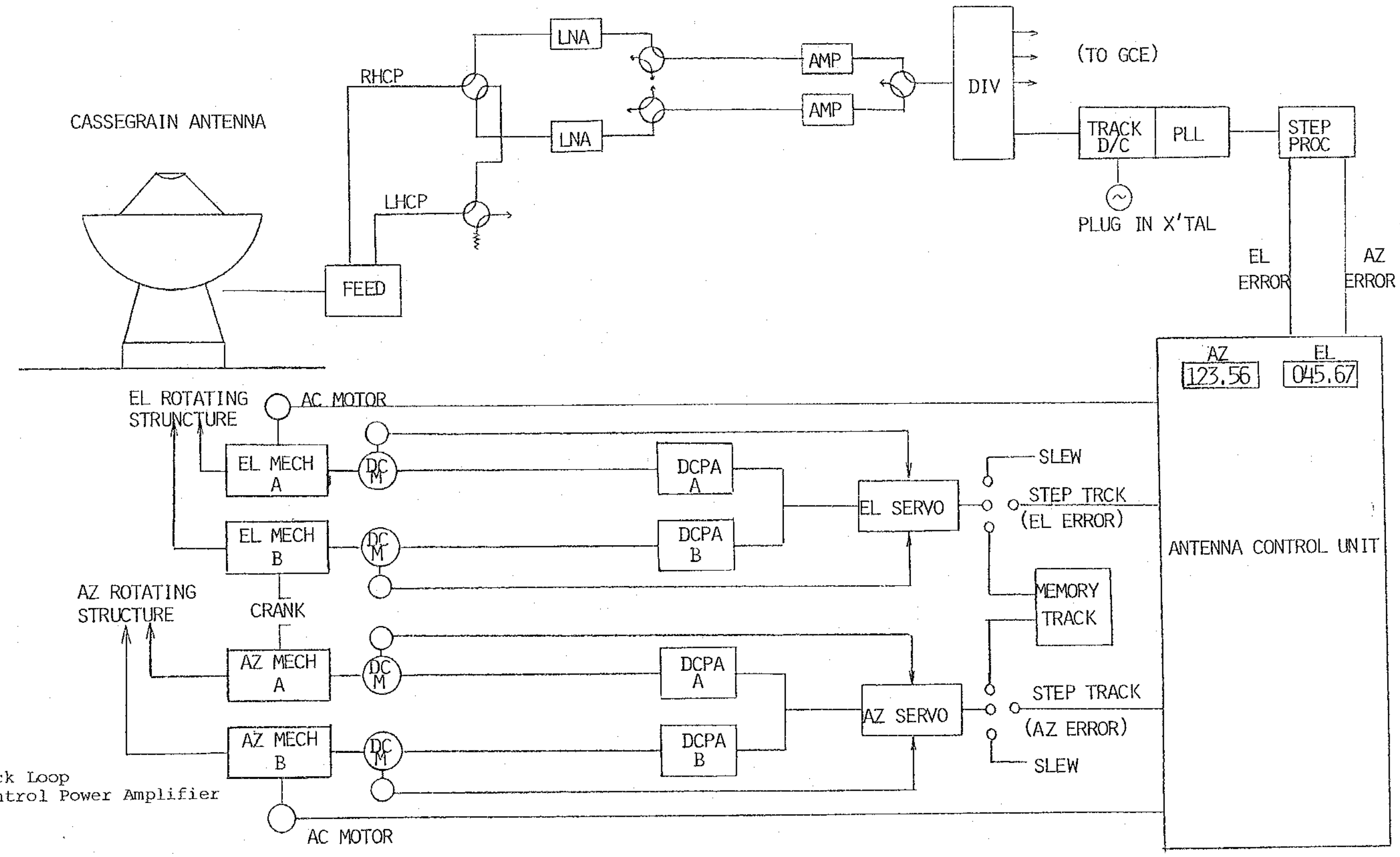
- For the SCPC system, complete redundancy configuration shall be provided on both the IF/RF units and RF/IF units.

- Frequency control function of both transmit and receive GCE subsystem shall be designed by use of wide-band synthesizers, which allows easy operation and maintenance of the equipment when frequency rearrangements are planned by the INTELSAT according to operational plans.

b) Configuration of Antenna Subsystem

Figure 4-10 shows a schematic block diagram of the proposed antenna subsystem. The configurations and functions of the antenna subsystem are planned to meet the minimum technical requirements with good cost performance, and with the following system design approach:

- The antenna shall be a class of 30 to 32 m in diameter employing a Cassegrain antenna with four-reflector guided beam feed configuration and a dual-polarization frequency reuse feed assembly.




PLL : Phase Lock Loop
DCPA : Drive Control Power Amplifier
DC M : DC Motor

FIGURE 4-10 CONFIGURATION OF ANTENNA TRACKING AND SERVO SUBSYSTEM

- The antenna shall be designed to meet the mandatory technical requirements specified by INTELSAT specifications over the frequency band of 5,850 MHz to 6,425 MHz for the earth station transmission and of 3,625 MHz to 4,200 MHz for reception.

- The antenna tracking and servo system shall be designed to achieve high tracking accuracy, maximum slew velocity and wide angle steerability.

  The antenna shall be driven by Thyristor-Leonade and DC electric drive motors employing anti-backlash drive system. The antenna mechanical structure design shall take into account the operational environment, such as wind and rainfall.

- The antenna subsystem shall utilize the step auto tracking system to track the satellite accurately and automatically by receiving any one of four satellite beacon signals to be available from the INTELSAT V and VI satellites.

- Antenna mount shall be Elevation-over-Azimuth with azimuth wheel-on-track system.

c) Configuration of Power Supply Subsystem

Figure 4-11 shows a schematic block diagram of the proposed configuration of the power supply subsystem. The configuration of the subsystem is planned with the following system design approach:

- Except for the antenna drive and servo subsystem, all telecommunications equipment at the earth station shall be supplied through the non-break power supply equipment.

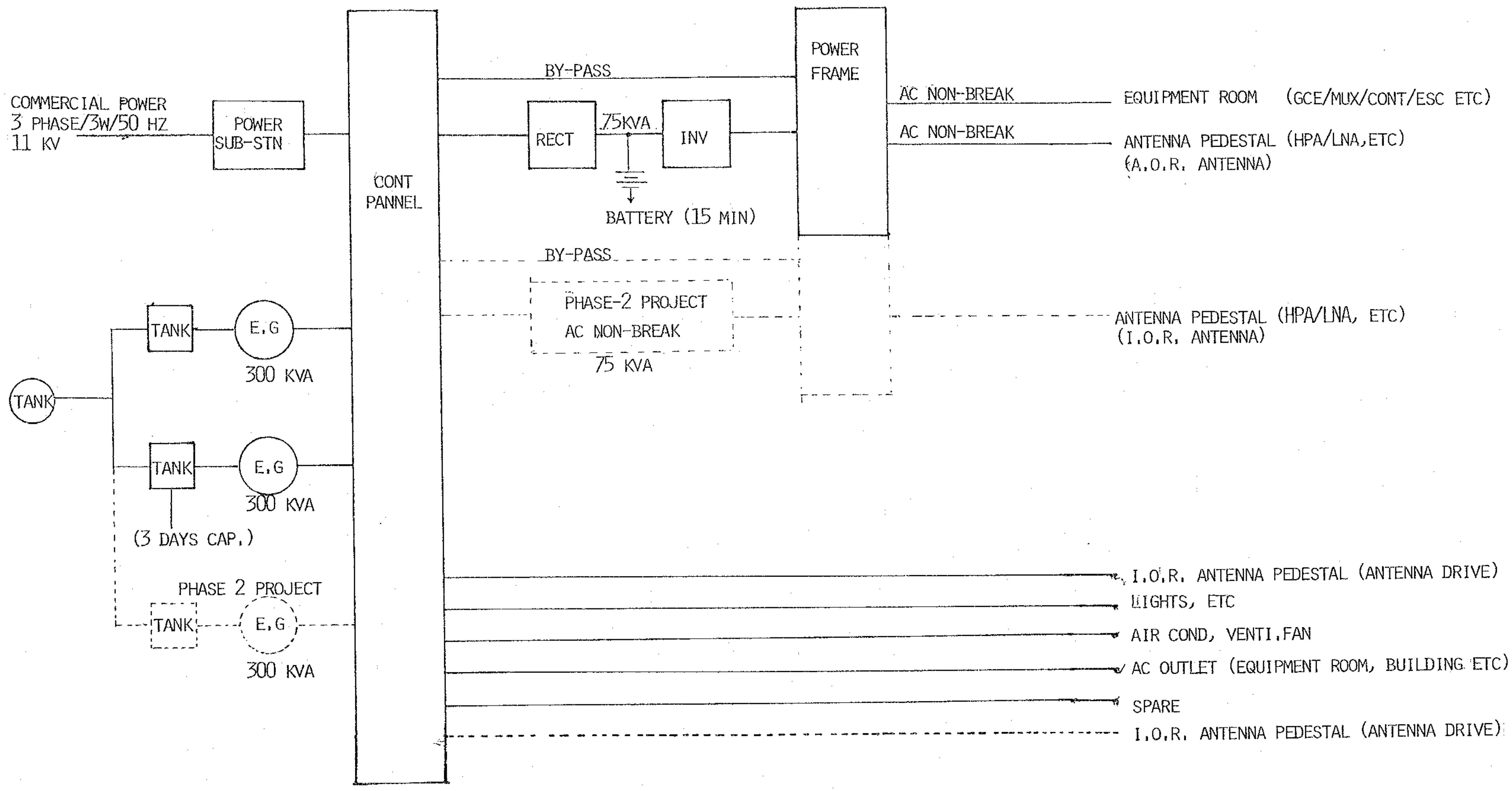



FIGURE 4-11 CONFIGURATION OF EARTH STATION POWER SUPPLY SUBSYSTEM
(PHASE 1 PROJECT)

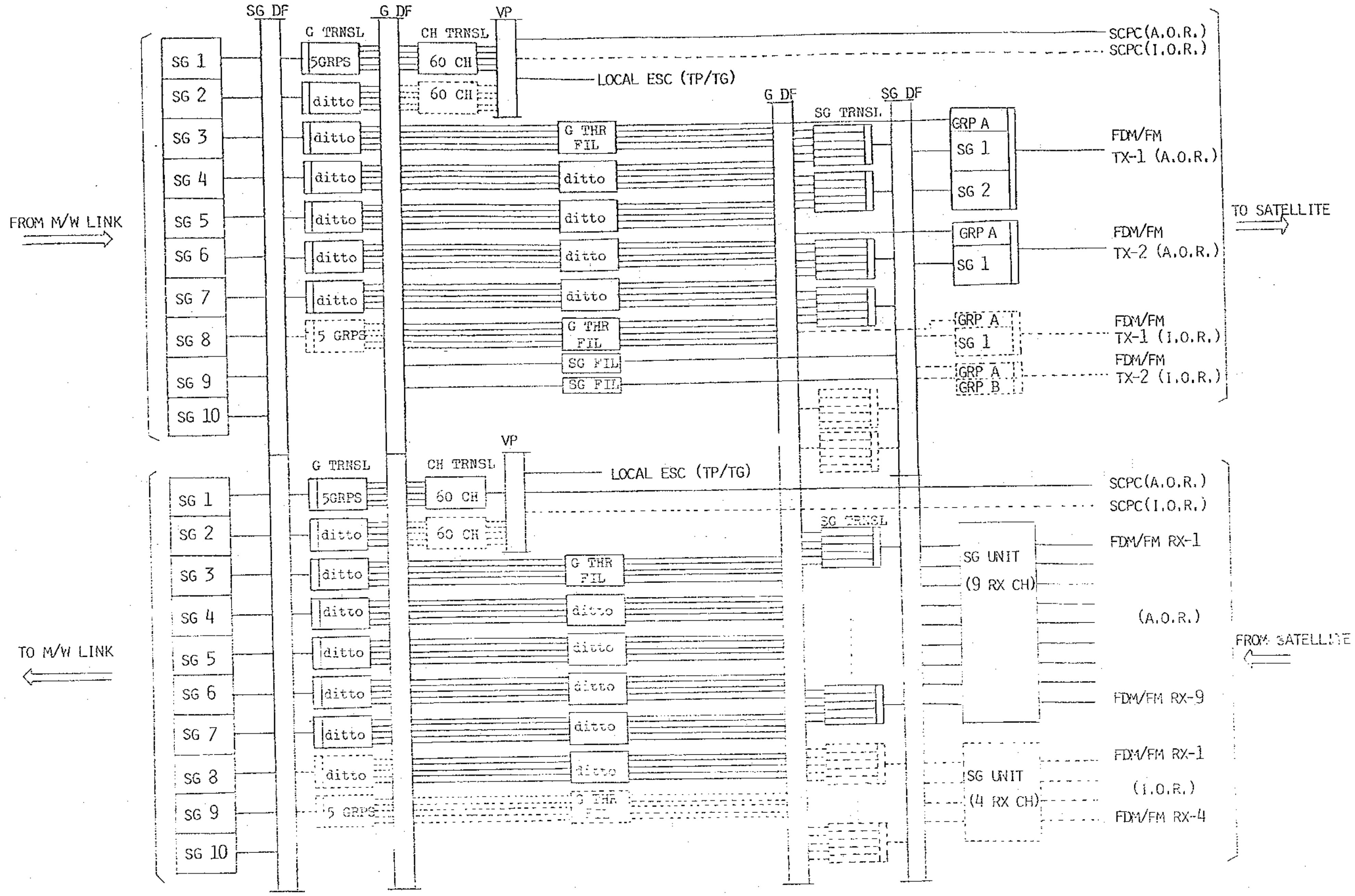
- The non-break power supply equipment shall be designed to sustain by battery alone the load necessary for operating the A.O.R. earth station telecommunications equipment as well the load for GCE, MUX and Control & Monitor equipment of the I.O.R. earth station complex for at least 15 minutes.

- No considerations are given on the load necessary for HPAs and LNAs of the I.O.R. earth station complex. Additional non-break power supply equipment will be installed by the Phase 2 project. However, design considerations have to be given on the Phase 1 project equipment to allow the installation of additional equipment in the Phase 2 project.

- The size of two emergency engine generators shall be determined to cover the load necessary for operating the complete A.O.R. earth station equipment including all station special facilities. Design considerations have to be given on the Phase 1 project generator system to allow installation of an additional generator unit and to configure the 2:1 redundancy operation system at the stage when the I.O.R. earth station complex is implemented..

d) Configuration of the MUX Subsystem

Figure 4-12 shows a schematic block diagram of the proposed MUX subsystem. The earth station MUX subsystem consists of both terrestrial and satellite MUX equipment in view of their functions. The proposed configuration is planned with the following design considerations:




☐ EQUIPMENT TO BE IMPLEMENTED IN THE PHASE 1 PROJECT

⬚ EQUIPMENT TO BE IMPLEMENTED IN THE PHASE 2 PROJECT

FIGURE 4-12 CONFIGURATION OF EARTH STATION MULTIPLEX/DEMULTIPLEX EQUIPMENT (PHASE 1 AND PHASE 2)

- The earth station MUX subsystem shall be able to break down the terrestrial baseband into basic groups and to integrate the necessary baseband systems for the satellite transmitting links on a basic group arrangement basis. No channel level arrangements are made at the earth station, except for the case of SCPC traffic.

- The earth station MUX subsystem shall be able to establish satellite ESC as well as local ESC. The local ESC network shall be established between the earth station and ITMC/Gweru, ITC/Harare and PTC's Head Office.

  The telephone and telegraph service circuits for such offices shall not be established by a duplex system of both speech and data, but with separate circuits for speech and for data channels.

3) Terrestrial Microwave Link System and Interface Conditions at the Harare Center Exchange Building

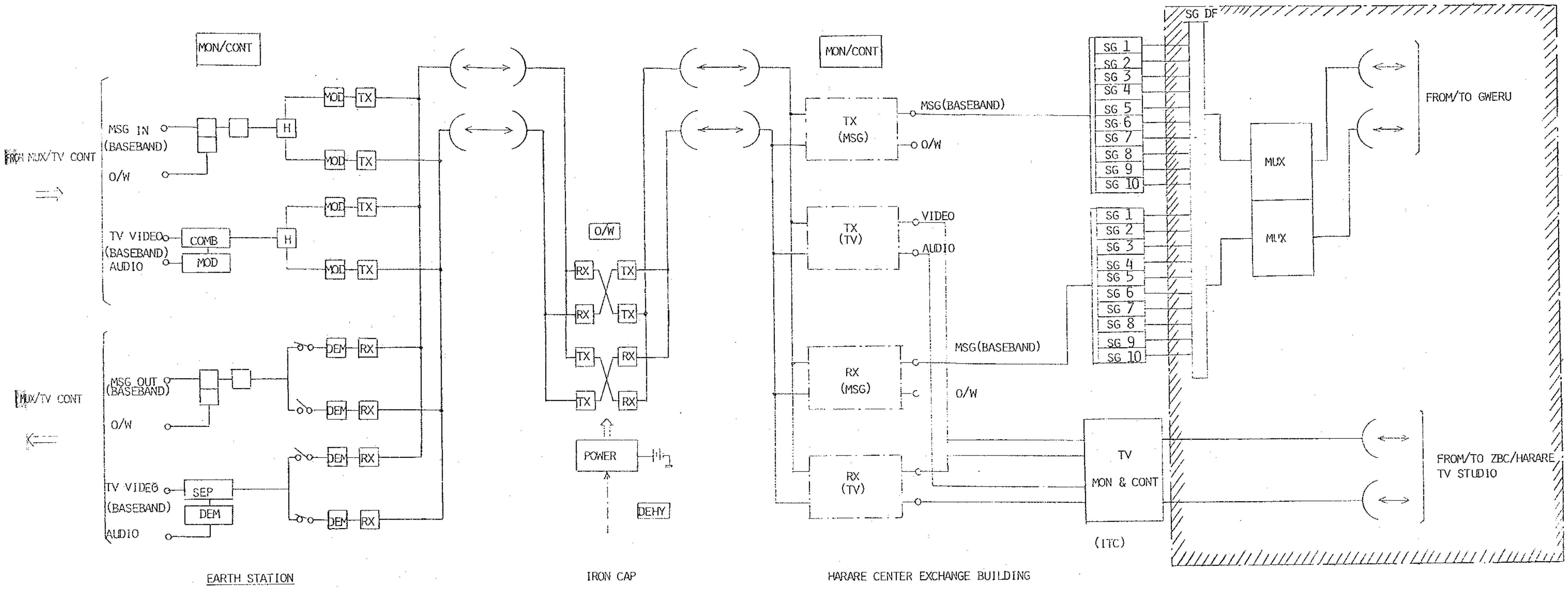
a) Terrestrial Microwave Link System

Figure 4-13 shows a configuration of the microwave link system to be implemented in the Phase 1 project.

The earth station is linked to the Harare Center Exchange Building by two hops of the terrestrial microwave link system having a microwave repeater station at Iron Cap.

The following shows the design considerations of the system:

- The microwave link system shall have two both-way links. One will be used for a full time basis message traffic transmission services, and the other for an occasional TV transmission service;




☐ EQUIPMENT TO BE IMPLEMENTED IN THE PHASE 1 PROJECT

▨ EXISTING EQUIPMENT

FIGURE 4-13 CONFIGURATION OF TERRESTRIAL MICROWAVE LINK AND INTERFACE CONDITIONS AT HARARE CENTER EXCHANGE BUILDING

This configuration will provide a full redundancy for a full time basis message traffic transmission service when no TV services are scheduled.

- The frequency band to be used for the system shall be upper 7 GHz and the outside of the satellite communications frequency bands.

- TV video and audio channels shall be handled on the same microwave link.

- The non-break power supply equipment to be implemented at Iron Cap shall be able to sustain all power loads for 3 days from operating battery alone.

- The non-break power supply for equipment to be implemented at the Harare Building shall be supplied from the existing facility.

b) Multiplex/Demultiplex Equipment and TV Control and Monitor Equipment at the Harare Center Exchange Building

According to the configuration of satellite communications network in Zimbabwe, all message traffic must be extended from the earth station to Gweru. On the other hand, TV video and program audio must be extended to the ZBC Harare TV studio through P.T.C.'s Harare Center Exchange Building.

To this end, the MUX equipment to be implemented in the Phase 1 project at Harare is to interface with the existing MUX equipment.

No special MUX equipment is required in the Phase 1 project to interface with the existing microwave link system for the international television transmission service.

The following shows the interface conditions and other system design approaches to implement the Phase 1 project:

- The MUX equipment to be implemented in the Phase 1 project shall be able to handle the earth station's message traffic at a basic supergroup level for interface with the existing MUX equipment.

- TV video and audio channels shall be interfaced with their baseband signals. The functions to control and monitor both picture and audio qualities shall be provided at the Harare Center Exchange Building to establish its function as International Television Control Center (ITC).

- To contribute to good cost performance of the Phase 1 project, no direct interface at Harare shall be made with the earth station's engineering service circuits. All earth station engineering service circuits shall be extended directly to Gweru as a part of the message traffic for the following offices:

  Earth Station - ITMC/Gwere : 1 TP/1 TG
  Earth Station - ITC/Harare : 1 TP/1 TG
  Earth Station - P.T.C.s Head Office : 1 TG

  ESC for the ITC/Harare and the P.T.C.'s Head Office shall be established by looping only these circuits back at Gweru.

- All equipment power shall be obtained from the existing power supply equipment.

### 4.5.4 Detailed Plan of the I.O.R. Earth Station Installation Project (Phase 2 Project)

1) Scope of Work

Figure 4-14 shows a schematic block diagram which indicates the range of the Phase 2 project. Summarized, the Phase 2 project must cover the following:

a) Installation of the INTELSAT Standard A earth station complex, consisting of the following telecommunications equipment:

- Antenna Subsystem
- High Power Amplifier Subsystem (HPA)
- Low Noise Amplifier Subsystem (LNA)
- Ground Communications Equipment Subsystem (GCE)
- Engineering Service Circuit Subsystem (ESC)
- Communications Control, Monitor and Testing Subsystem
- Multiplex/Demultiplex Equipment
- Expansion of the Power Supply Subsystem

No further work will be required in the Phase 2 project.

2) Details of the I.O.R. Earth Station Complex

a) Configuration of HPA/LNA/GCE Subsystems

In accordance with a plan shown in Section 5.2, Figure 4-15 shows the proposed configurations of HPA/LNA/GCE subsystem with their details.

Configuration is planned to meet the minimum technical requirements, while seeking for good cost performance of the project, in the same way as described for the Phase 1 project.

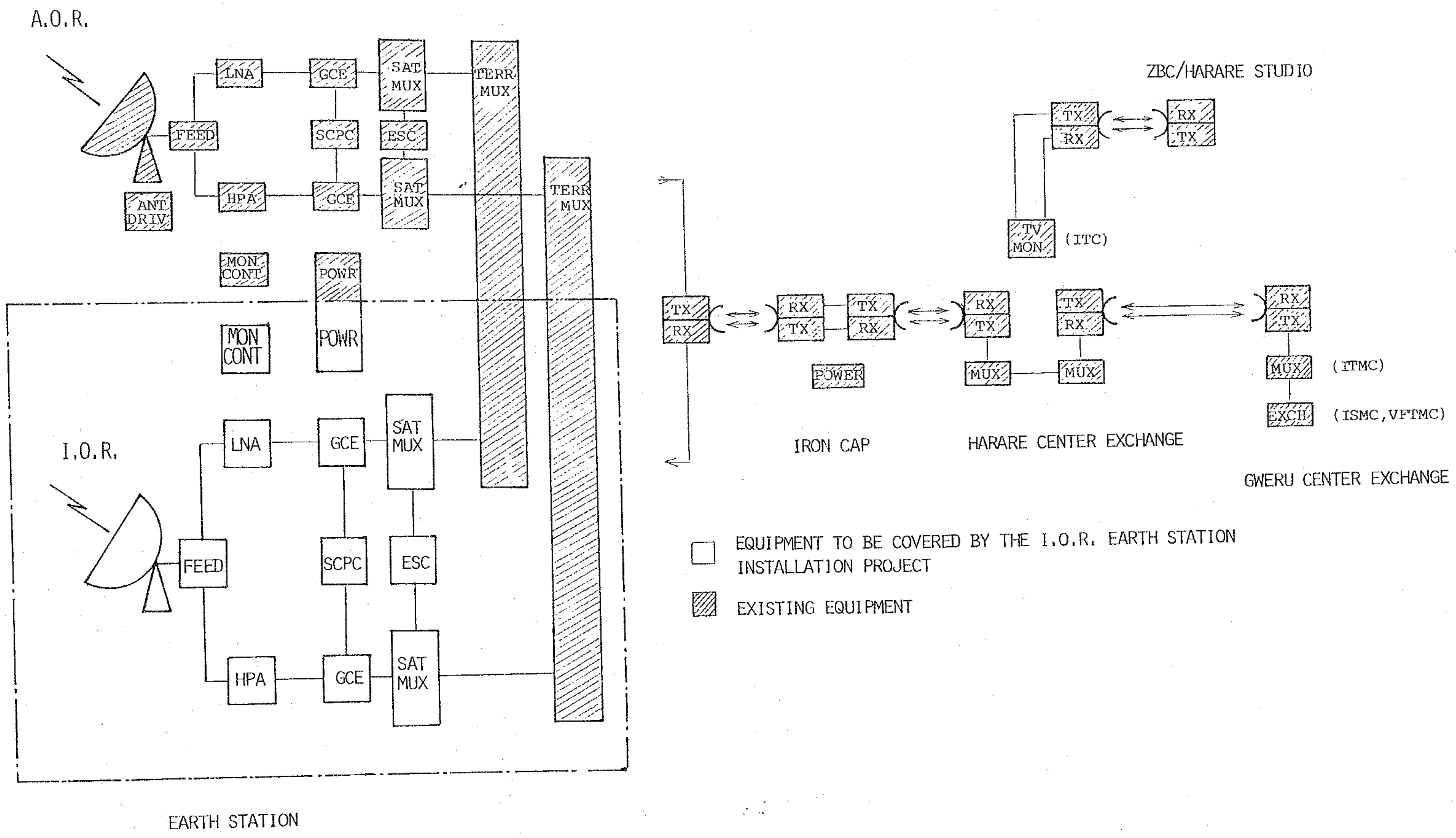



FIGURE 4-14 SCOPE OF WORKS FOR THE I.O.R. EARTH STATION INSTALLATION PROJECT (PHASE 2 PROJECT)

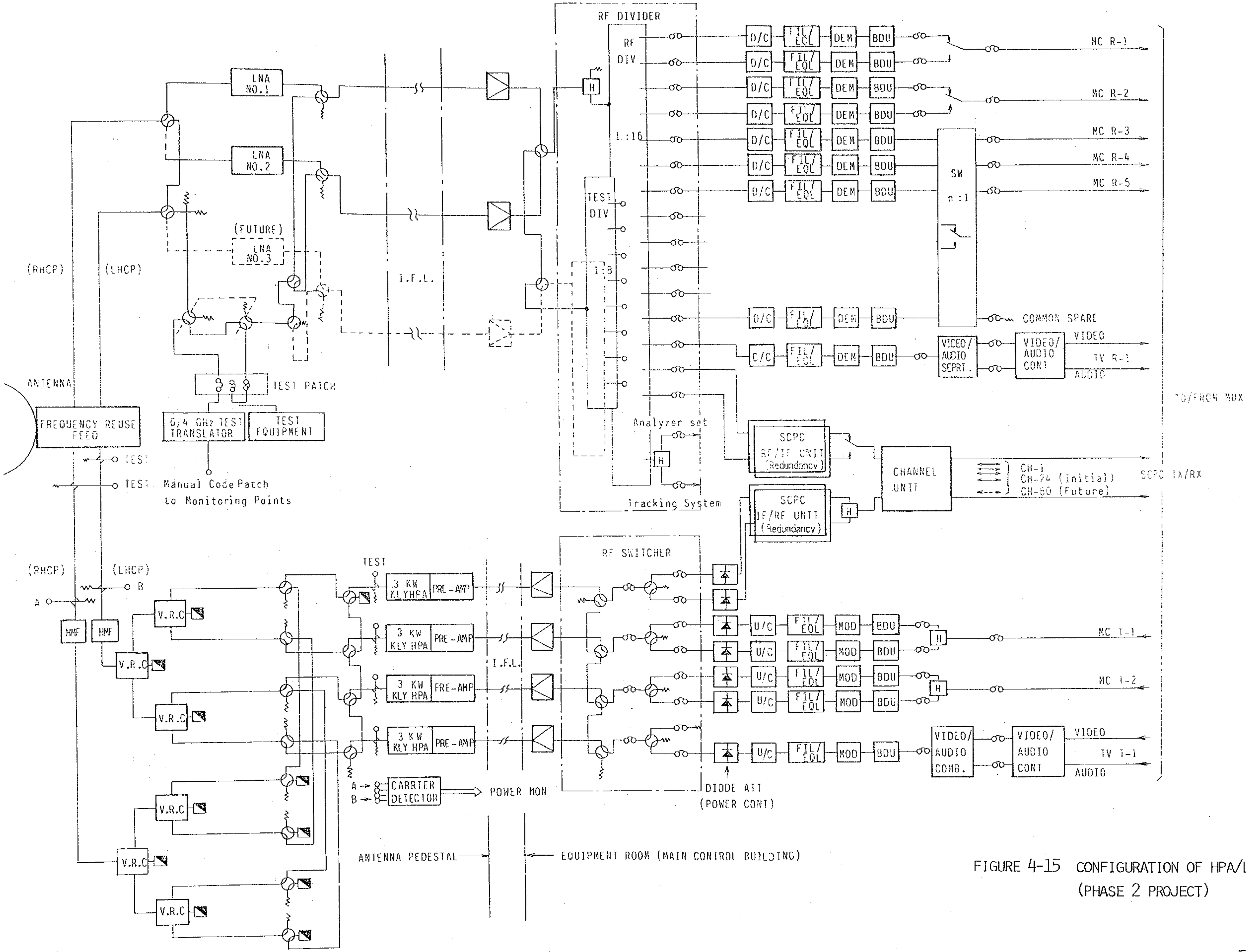



FIGURE 4-15 CONFIGURATION OF HPA/LNA/GCE SUBSYSTEM (PHASE 2 PROJECT)

b) Configuration of Antenna Subsystem

Same as the Phase 1 equipment. (See Figure 10)

c) Configuration of Power Supply Subsystem

Figure 4-16 shows a schematic block diagram of the planned power supply subsystem.

Planning aims to achieve the following system design approach:

- The non-break power supply equipment to be implemented in the Phase 2 project shall be identical to that of the Phase 1 equipment, to assure operational flexibility of the equipment.

- The Phase 2 project shall implement an additional engine generator unit, which is identical to that of the existing unit in size, and shall run three units to form the 2:1 redundancy configuration.

d) Configuration of Satellite MUX equipment

(See Figure 4-12)

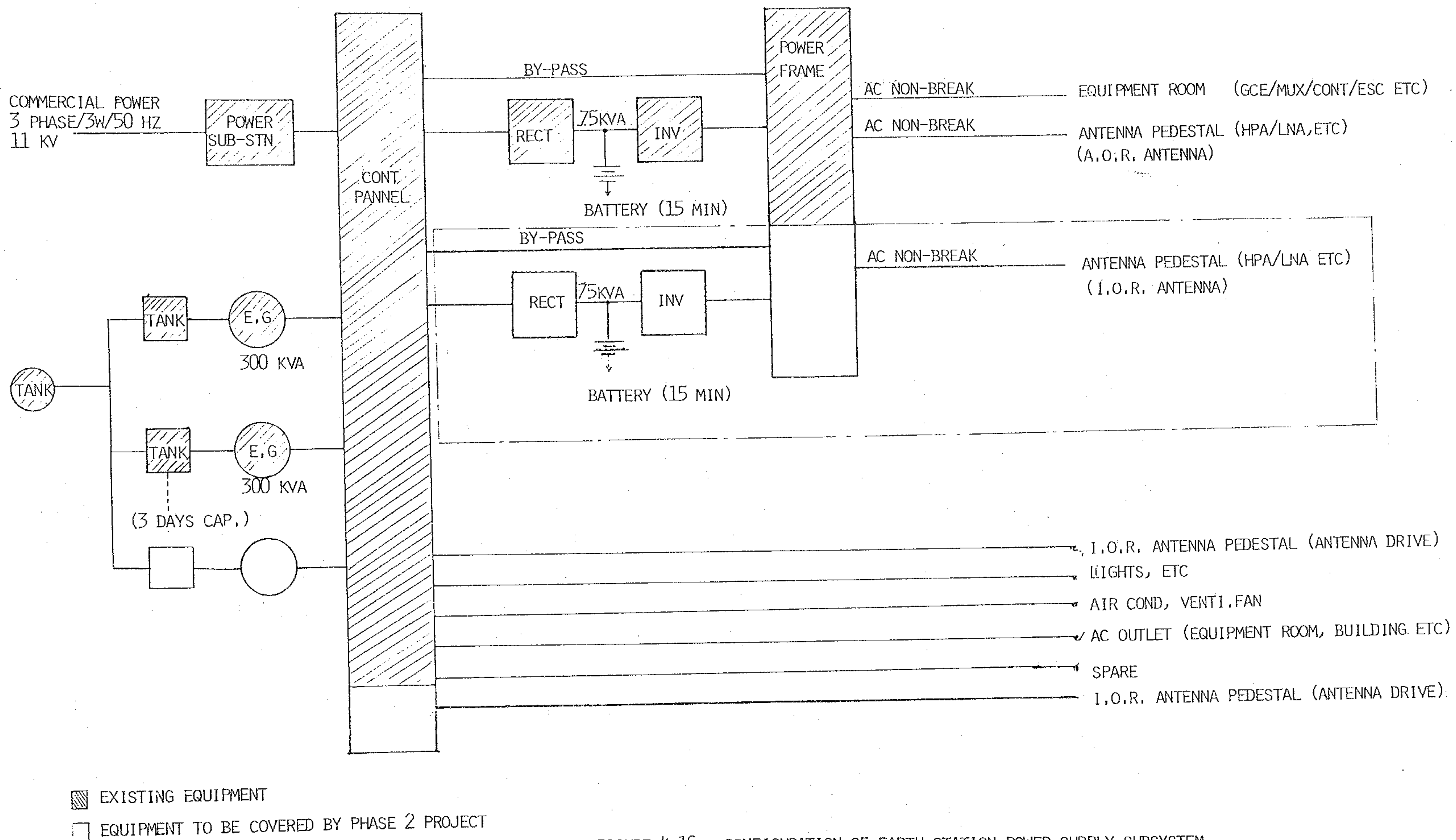



FIGURE 4-16 CONFIGURATION OF EARTH STATION POWER SUPPLY SUBSYSTEM (PHASE 2 PROJECT)

## 4.6 Civil Works

### 4.6.1 Scope of Civil Works

Scope of civil works necessary for installation project of the satellite communications earth station(s) in The Installation Project of INTELSAT Standard A Earth Station is to cover the design and construction of the items described hereinafter.

1) Phase 1 project: Installation Project of A.O.R. Earth Station

(1) Buildings

a. Main building
- housing administration section, telecommunication section and, power and air-conditioning plant section

b. Antenna pedestal building
- bearing a antenna for A.O.R.
- housing equipment

c. Connecting corridor
- connecting main building with antenna pedestal building

d. Gate house

e. Pump house
- for main water supply

f. Staff accomodations (tentative schedule)
- 2 houses for senior staff
- 3 houses for junior staff

(2) Building equipment and facilities

Building equipment and facilities as power distribution, lighting, sanitary and plumbing and light duty ventilation systems.

Works indicated in item (3) below are excluded. No heating system is required.

(3) Special facilities

Facilities to be provided for the special function of the station buildings.

a. Air-conditioning system
Air-conditioning system is to be supplied only to rooms/spaces especially required for the rooms to house telecommunications equipment and electronic parts. No rooms in administration section is to be air-conditioned.

b. Force ventilation system
Rooms for power plant are to be provided with forced ventilation system to meet their requirements.

c. Clock system

d. Fire alarm system

e. Weather station

(4) Steel antenna tower for microwave link system

- A steel truss superstructure of 18 m in high and its concrete foundations.
- Two antennae of 3-4 m in diametre will be mounted.

(5) Grounding and lightning conductor systems

- Grounding systems for building equipment and telecommunications equipment.
- Lightning conductor system for building and tower.

(6) Water supply system

a. A well/borehole
b. Storage system
c. Distribution system

(7) Sewage disposal system

(8) External works

Works outside of the building and not included in items (1) - (7) above. Extent of works is to correspond to the plan of each item of Phase 1 respectively.

a. Grading

b. Service roads

c. Pavement

d. Parking lots

e. Landscaping: turfing, planting, walkways etc.

f. Rain water drainage system

g. Lighting
   - perimeter of building and important areas

h. Concrete foundations for oil tank(s) necessary for emergency diesel engine generators (oil tank(s) will be provided by oil company/supplier)

i. Fences
   - Security fences provided with gate doors
   - Simple boundary fences mainly for preventing cattle intrusion

(9) Miscellaneous works

a. Concrete trenches for cablings and plumbing

b. Concrete foundations for heavy apparatuses

c. Flag poles

d. Signs for buildings/roads

(10) Access road

a. Access roads from public road to site.

(11) Surveys

a. Land surveying of access road and site

b. Survey of water

c. Survey of soil at site

Notes:

1. Commercial electric power will be supplied by Electricity Service Commission (E.S.C.).

   Plant for the main commercial power supply will be also installed in the main building and maintained by E.S.C.

2. Emergency diesel engine generators except concrete foundations, are included in the telecommunications work.

3. Power distribution systems from substation to all building equipment and special facilities in all building are to be included.

4. Capacities of main building equipment should be able to correspond to the phase 2.

5. Land procurement for both the access road and the site is undertaking by P.T.C. and has been planned to finish after soil survey and before entering into the construction contract. Consequently, the accurate locations and land areas of the access road and the site had not been finalized when the Study Team finished field survey.

6. P.T.C. will make a part of survey and design works. However, it seems that a consultant engineers' firm assigned by P.T.C. will execute most of the survey, design and supervising works. P.T.C. is now intending to make the contract of whole project on a full turn

key basis, in this case, design and supervising works as to civil works by main contractor/supplier are to be included.

2) Phase 2 poject: Installation Project of I.O.R. Earth Station

(1) Building

a. Extension of main building

Extenion of only the power section will satisfy the requirements basically. Extension of floor area will be about one half of the existing floor area of the power plant rooms.

Extension of administration section will not be necessary unless the organization of the station is changed sharply.

b. Antenna pedestal building

A new antenna pedestal building for No. 2 antenna shall be constructed. Scale of the building will be the same as to the building for No. 1 antenna. Connecting corridor will not be required specially.

(2) Building equipment and facilities

- Corresponding to the extension and/or new construction of buildings mentioned in item (1) above.

(3) Special facilities

- Corresponding to the extension and/or new construction of buildings mentioned in item (1) above.

(4) Grounding and lightning conductor system

- Corresponding to the installation works by items (1), (2) above and also to telecommunications equipment newly installed.

(5) External works

- External works will be limited to extent of works within the security fences.
- Extension of works indicated in items b, c, e, f, g in 1), (7).

(6) Miscellaneous works

- Required extension of cable trenches and the like.

3) Phase 3 project: Installation Project of No. 3 antenna

Installation plan of the No. 3 antenna is not clarified at this point of time.

However, it is assumed that the following main works might be necessary in the future:

(1) Building

a. Extension of main building

Main building shall be extended as required in all three sections of administration, telecommunications, and power. Partial remodeling of existing rooms/spaces will be also required.

b. A new antenna pedestal building for No. 3 antenna: shall be constructed.

(2) Building equipment and facilities and special facilities

They shall be extended corresponding to the installation works as mentioned in item (1) above.

Depending on the scale and/or the time of extension, some plants will be forced to be reinstalled.

(3) External works, etc.

As the antenna pedestal building for No. 3 antenna will be supposed to be built outside of the existing security fences, the extent of external work will increase according to the location of the building.

#### 4.6.2 Schematic Building Plan

Figure 4-17 shows a schematic building floor plan. This schematic plan is made referring to the opinions of P.T.C. (As to the site layout plan, see 4.4.2)

1) Main building

(1) Main building is to be planned as a complex housing three sections; telecommunications section, power section including air-conditioning plant and administration section.

(2) Scale or floor area of each section is to be planned as follows.

a. Telecommunication section:
will correspond to both the Phase 1 and the Phase 2 projects. Consequently it shall be extended when the Phase 3 project is to be planned.

b. Power section:
will correspond to the Phase 1 project. Consequently it shall be extneded by the Phase 2 project and the Phase 3 project respectively.

c. Administration section:
will correspond to the Phase 1 project. It shall be extended as required by the enlargement of organization of other reasons.

2) Antenna pedestal building

(1) Antenna pedestal building is to be designed to mount an antenna for satellite communications and to house antenna tracking systems. HPA, LNA, electronic workshop and other related facilities.

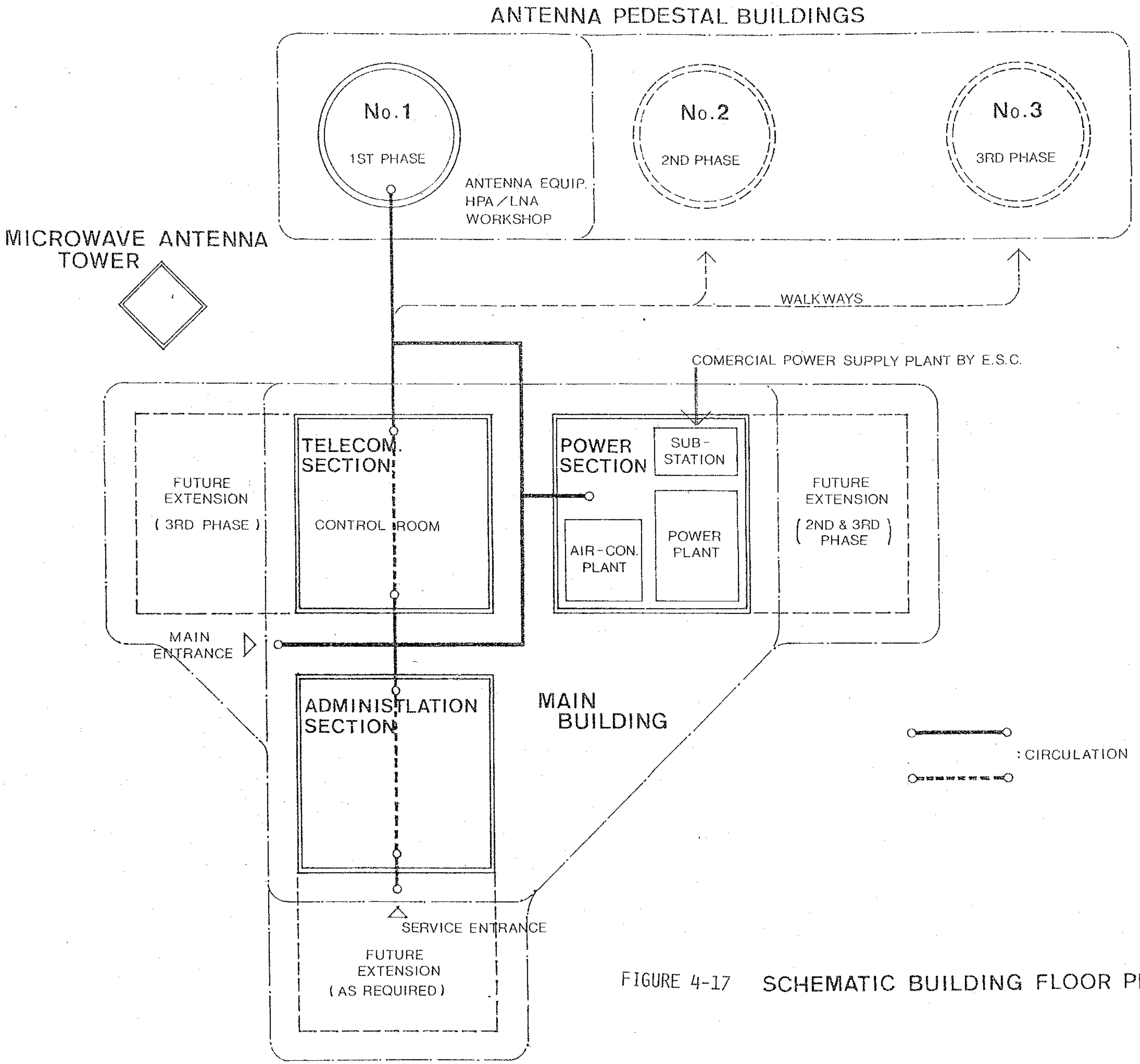



FIGURE 4-17 SCHEMATIC BUILDING FLOOR PLAN

(2) For the Phase 1 project a pedestal building is to be constructed and, for the Phase 2 project and the Phase 3 project one new pedestal building shall be planned respectively.

3) Required rooms/spaces: Phase 1 project

Required rooms/spaces based on the P.T.C.'s plan and results of the study are as follows.

(1) Administration section

a. Receptionist's room

b. Secretary's office

c. Manager's office

d. Senior technician's office

e. Meeting room

f. Library

g. Tea room / Kitchen

h. Restroom

i. Toilets for male and female including shower room

j. Cleaners' storage

(2) Telecommunications section

a. Telecommunications equipment room / control room

b. Antenna equipment room

c. Store /storeman's office

d. Electronic workshop

(3) Power section

a. Emergency diesel engine generator room

b. Inverter room / No-break power supply room

c. Battery room

d. Substation / Commercial main power supply room, maintained by E.S.C.

e. Air-conditioning plant room / interior plant room and exterior plant space

f. Mechanical workshop

(4) Circulation spaces

Entrance hall, corridors and connecting corridors

4) Estimated floor areas: Phase 1 project

Total floor area of each building approximately estimated are as follows.

| | | | |
|---|---|---|---|
| a. | Main building | : | 750 800 sq.m. |
| b. | Antenna pedestal building | : | 220 - 240 sq.m. |
| c. | Connecting corridor | : | 40 - 50 sq.m. |
| d. | Gate house | : | 10 - 15 sq.m. |
| e. | Water pump house | : | 20 sq.m. |

5) Structure of buildings

Considering the functions of the buildings and circumstances of local construction industry, the main building and the antenna pedestal building are to be of single storey reinforced concrete structure. On the other hand, it is reasonable to construct the gate house and the pump house by brick masonry.

6) Building equipment and facilities

Building equipment and facilities are to be designed primarily to satisfy the purposes of usages of the buildings and also to produce the most economical efficiency. Locality of living conditions and customs is also to be considered.

Refer to para. 4.6.1, 1) Scope of Civil Works for Phase 1 project.

### 4.6.3 Staff Accommodations Plan

Although, the plan is not finalized yet, P.T.C.'s plan as to staff accommodation is to provide five houses on the site or in the neighbourhood of the site, as described below:

1) Number of houses

   a. For senior staff: 2 houses

   b. For junior staff: 3 houses

2) Specification, etc.

   a. Floor area of a house:
      - 150 sq.m. for senior staff
      - 50 sq.m. for junior staff

   b. Designs and specifications of P.T.C.'s standard residences will be applied. Main structures of both residences are brick masonry.

Considering the situation that the proposed site for the earth staion is located at some 40 km away from Harare and a car is a only means to attending the station, and also the earth station is active for twenty-four hours, it will be desirable to provide appropriate staff accommodation in the site or in the neighbourhood of the site.

### 4.6.4 Existing Local Circumstances Related to the Civil Works for the Project

1) It is a P.T.C.'s fundamental policy that the civil works for the project are to be undertaken by local contractors under the direction of the main supplier of the telecommunications equipment.

P.T.C. is also considering to make the contract of the installation project on a full turn key basis.

2) Full turn key contract is desirable for the administration of work. However, from the technical viewpoint of abilities of local consulting engineers' firms and construction companies, it will be possible to make a contract of civil works separately.

3) There are many consulting engineers' firms and architects'/ planners' firms in Zimbabwe. Generally speaking, they enjoy their high techniques in their activities as the buildings in Harare giving examples.

Institutes and/or Associations concerned are as follows.

- Zimbabwe Institute of Engineers (ZweIE)
- Institute of Civil Engineers (ICE)
- Institute of Structural Engineers (IStrutE)
- Zimbabwe Association of Consulting Engineers (ZACE)
- Zimbabwe Council of Architects

Ove Arup & Partners (Partners: J.P. Casson, M.B. Noyce), a consulting engineers' firm assigned by P.T.C. has already started the preparative works for the project. The firm has been consulting on installation projects by P.T.C., as telephone exchange buildings, microwave relay station buildings and steel antenna towers. They have some 50 staffs at Harare office and some 20 staff at Bulawayo office. It is fully believed that they have enough capability to consult and engineer the civil works for the project.

4) As to a design of structural construction in Zimbabwe, usually a member of ZweIE will design and get related approvals. When somebody other than the member of ZweIE wants to design himself, he has to register himself with ZweIE (approval of Zimbabwe Coundil of Architects is required), and to submit calculations of design to the authorities concerned.

5) Design document/drawings shall be submitted to the building inspector of related municipality for approal, including the approvals of authorities concerned as fire department, health department etc. It takes from several weeks to 3 month to get approval usually. As the project is a very important project planned by the government, it is expected that the approvals required will be got in very short term.

6) Construction industry of Zimbabwe accounts for only 3% GDP in 1981, i.e. Z$126 millions out of 4,147 millions. However, the levels of construction techniques of constructors are generally high.

Especially the several companies ranked in first category have high ability and also enough capability to undertake the civil works for the project.

High and large modern buildings constructed by local contractors can been seen in Harare.

The most important problems of today's construction industry in Zimbabwe is lack of construction machineries and lack of skilled technician and/or labourers. There is an association of building constructors in each main city called Master Builders Association. Appropriate traders are also have memberships of the association.

7) Almost all important building materials and goods are produced in Zimbabwe.

Main materials/goods to be imported are as follows:

Steel sections except of small sizes, glasses of high quality, aluminium products, interior/ exterior finishing materials of high quality, sanitation fixtures, pigments for paints (paints are domestic products), high-grade hardwares for doors, Lifts, air-conditioning apparatuses, fluorescent lamp tubes, generators, etc.

The buildings to house telecommunications equipment for the project require high reliability, so it is desirable to specify the imported products of high quality instead of the local products for some electrical installations.

It is said that foreign currency portion, i.e. cost for imported goods/materials, out of total construction cost is some 20-25 % for multi-storey office building in Harare. As actual examples, it accounted for some 10 % in case of the extension construction of Harare Centre Exchange Building and 2-3 % in case of recent installation works of microwave relay station buildings.

Foreign currency portions estimated for the civil works for the project are as follows:

| | | |
|---|---|---|
| For buildings and building equipment | : | 5 % |
| For special facilities | : | 80 - 100 % |
| For supervision expences by a Japanese engineer of main contractor | : | 100 % |

8) In Zimbabwe, price of land is very low. The price of the land that P.T.C. has intended to purchase at Mazowe is said some 500 Zimbabwean dollars or less per an acre. Accordingly, the cost for land procurement is a very small account out of total cost for the project, that is to say, some 0.1 %.

## 4.7 Plan of Earth Station Operation and Maintenance Organization

### 4.7.1 General

The manning of the INTELSAT Standard A earth station differs from station to station, and depending on the size of the earth station complex as well as the policies for operation and maintenance.

Based on the job analyses at the INTELSAT Standard A earth station, this section shows the summary of studies made on the earth station operation and maintenance organization applicable for Zimbabwe.

### 4.7.2 Detailed Job Analyses

Annex 1 shows the details of job requirements at the INTELSAT Standard A earth station.

### 4.7.3 Proposed Operation and Maintenance Organization at the Zimbabwe Earth Station

Figure 4-20 shows the proposed operation and maintenance organization at the Zimbabwe INTELSAT Standard A earth station.

Organization consists of:

(a) Station Manager

(b) Assistant Station Manager

(c) Operation Section

(d) Maintenance Section

(e) General Affairs Section

1) Organization of Operation Section

It is proposed that the shift duties shall be with 4 shifts per day, each with the staffs of one shift supervisor and 2 operations technical assistants.

Ideally the shift supervisors shall have some opertional experience in the INTELSAT Standard A earth station. Senior technicians shall be assigned for the duties, after several weeks of operational training at the INTELSAT Standard A earth station.

Operations technical assistants shall have at least 3 years of telecommunications field experiences. They shall be selected from the field of MUX, transmission field ranging from voice frequency to microwave frequency level.

2) Organization of Maintenance Section

Manning requirements for maintenance differ from station to station and rely on the maintenance policies to be adopted for the earth station.

The study team proposes the policies for earth station maintenance cover both corrective maintenance and trouble shooting procedures, so that the earth station can be maintained by sufficient staff to ensure efficiency.

It is proposed that the maintenance duties be covered by one section chief and 10 maintenance technicians, as minimum.

The maintenance section chief shall have wide maintenance experiences in the telecommunications field and be qualified in planning the maintenance activities and controlling the maintenance technicians. The minimum qualification is to have at least 10 years telecommunications field experience.

The maintenance technicians shall be selected from the following telecommunications fields:

- Transmission field ranging from voice frequency and microwave frequency level
- Power plant
- Electronics
- Mechanical/Electronics

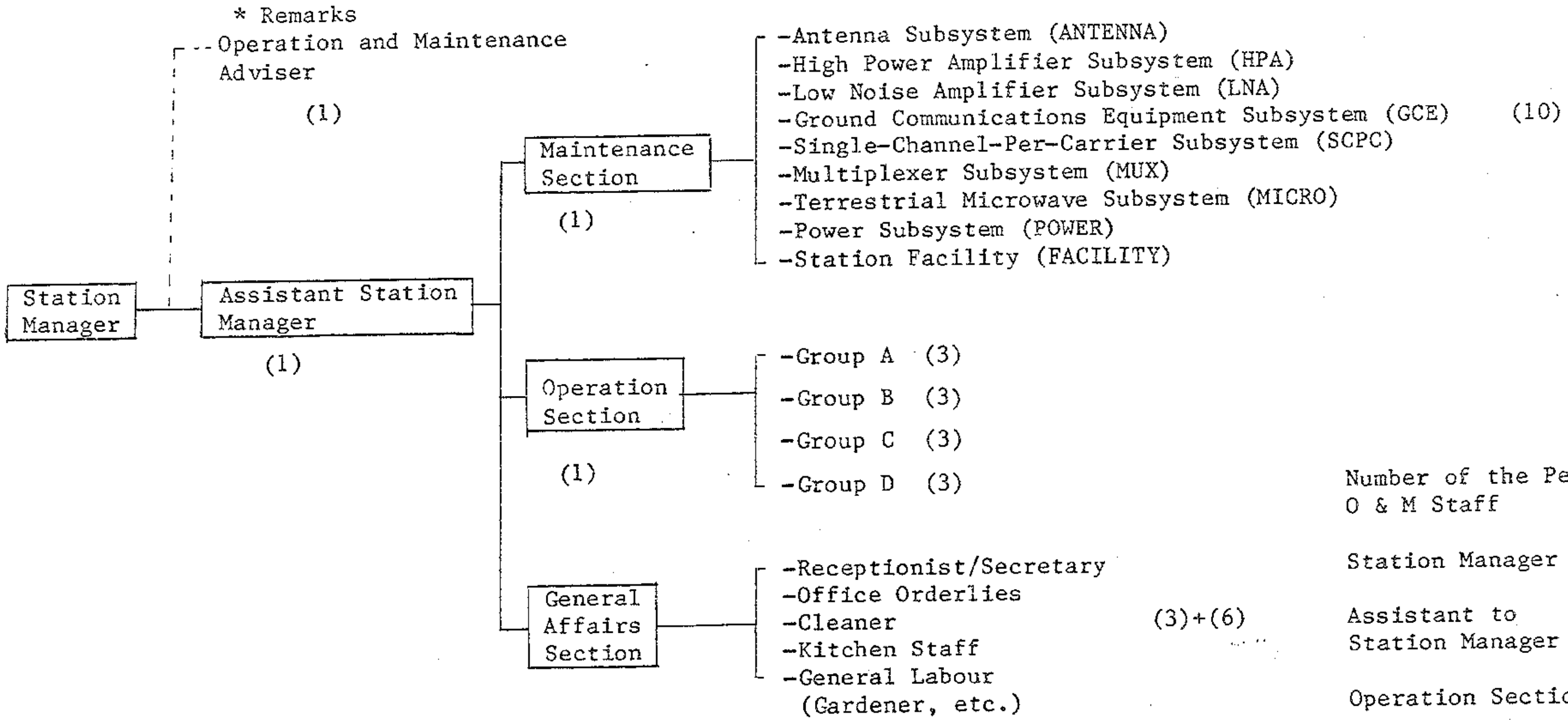
3) General Affairs Section

In running the earth station satisfactorily, a certain numbers of general affairs staffs are necessary. There is no specific technical requirements for the staffs. It is tentatively planned that the general affairs section shall be organized with three administrative officers and 10 unskilled labours for gardening, cleaning, etc.

4) Use of Operation and Maintenance Adviser

It is proposed by the study team that one operation and maintenance adviser be assigned to the earth station on a short term basis. This arrangement shall be limited to a maximum of one or two months: i.e. the minimum period that the local staff could become familiar with day-to-day activities and to establish standard operational and maintenance procedures.

## Figure 4-18 ORGANIZATION CHART - ZIMBABWE EARTH STATION




Number of the Permanent O & M Staff

| | |
|---|---|
| Station Manager | 1 |
| Assistant to Station Manager | 1 |
| Operation Section | 12 |
| Supervisor | (4) |
| Technical Assist | (8) |
| Maintenance Section | 11 |
| Supervisor | (1) |
| Technician | (11) |
| Total | 25 |

Remarsk:

1. Arrangement of operation and maintenance adviser is the temporary requirements for maximum on year.

2. Numbers shown in parentheses (pl) show minimum permanent staff.

# ANNEX 1

## Job Analyses - INTELSAT Standard A Earth Station

1. The Duties of Operation Section

On the basis of 24 hours of operation, the shift duty staff must accomplish the following minimum duties:

a) To watch the circuit condition, testing and control of circuits and take action to restore traffic.

b) Operation, management, testing control for the facilities and simple maintenance work to restore problems arising from equipment failure.

c) The operational work on TV transmission service.

d) Entries in and maintenance of Log. Book

e) Out of Band Noise (OBN), Pilot measurements and coordination with Technical Operation and Control Center (TOCC), INTELSAT Operations Control Center (IOC) in their shift and sending of weekly reports, monthly outage reports, TV completion reports, etc.

f) Establishment or removal of circuits

g) Other occasional duties such as INTELSAT SSOG line-up test together with daytime maintenance staff, etc.

2. The Duties of Maintenance Section

On the basis of normal daytime working duties, the maintenance staff must accomplish the following:

a) Making plans for maintenance, management of the facilities, performance of the maintenance, investigation to improve the facilities and testing of telecommunications equipment.

b) Establishment and acceptance of new facilities, evaluation of the equipment, improvement work and tests, performance of line-up tests.

c) Opening, removing, management, testing and restoration of the circuits.

d) The future operational plan of telecommunications facilities.

e) Maintaining maintenance record and giving necessary operational instruction to operation staff on the equipment.

f) Management of spare parts and measuring equipment.

g) Aid operation staff personnel and take information and regulation from operation staff.

h) Arrangements of restoration plan for emergency failure.

3. The Duties of a Maintenance Supervisor or Engineer

a) Control and supervision of the activities of maintenance staff

b) Planning and organizing maintenance activities

c) Selecting and training staff

d) Ensuring that facilities are provided for maintenance - e.g. spare parts, measuring equipment, documentation availability

e) Ensuring that the performance of the equipment is within prescribed limits.

f) Ensuring that accurate records such as fault records, equipment allocation records and spare parts records etc. are kept.

g) Management of duty hours and leave of maintenance staff

h) Other occasional duties

4. The Duties of the General Affairs Section

a) Handling the documentation and information to staff and coordination with Head Office in P.T.C.

b) Personnel affairs and income

c) Receipt and disbursements, safe keeping and accounting of articles or money

d) Management of stock articles

e) Planning public relations activities

f) Welfare

g) Gardening, cleaning, etc.

## 4.8 Plan of Training Program

### 4.8.1 General

Whenever new equipment is implemented, it calls for the need of training on the part of staffs who participate the implementation works of the project, operating and maintaining the satellite communications system with new knowledge and/or skills.

Training needs will differ depending on the type of staff and functions they are supposed to handle, educational background in the school or the P.T.C.'s training school.

This section outlines a plan of training program which will be applied for staffs who participate with the satellite communications earth station system.

### 4.8.2 Proposed Training Program

Planning of training program is based on a sound systematic approach, and it is comprised of the following courses:

Course 1 : Training to be applied for engineering staff to be participate with the implementation of the project.

Course 2 : Training to be applied for earth station staff responsible for operation and maintenance of the earth station equipment.

### 4.8.3 Course 1 Training

Engineers who will work on the engineering section of the earth station installation project must have a sufficient and deep knowledge on the whole INTELSAT satellite communications system. It is clear that such engineers play an important role in implementing and planning the project. Normally, they will brush-up their knowledge by their own efforts having no training at all.

However, the study team proposes that engineers shall also have training to cover the following areas:

(a) Details of INTELSAT network operations

(b) Theoretical training on the satellite communications system design

(c) Details of system engineering requirements.

(d) Recent and future trends in INTELSAT satellite communications system, and others

This training shall be independent to trainings to be required for the operation and maintenance staff at the earth station. No specific time table is required for planning this training. However, it is suggested that the training shall be completed as early as possible so that all valuable knowledge can be reflected on the implementation of the project.

### 4.8.4 Course 2 Training

This is the training course necessary for staff responsible for earth station operation and maintenance activities. The proposed training consists of three phases of courses:

(a) Phase 1 : Classroom training in Zimbabwe

(b) Phase 2 : In-plant practical training at the Contractor's plant

(c) Phase 3 : On-site on-the-job training in Zimbabwe

1) Phase 1 : Classroom training in Zimbabwe

This training is the basic classroom training to last for approximately four weeks in Zimbabwe. It must consist of the following:

(a) Introduction to the satellite communications system

(b) Outline of an INTELSAT Standard A earth station complex

(c) Outline of INTELSAT satellite segment

(d) Fundamental knowledge on the mathematics, electrical/electronics circuits, microwave propagation, microwave components, modulation technique.

Since the training is planned in Zimbabwe, great advantages are given to the numbers of trainee attending this course.

However, this course shall be completed at the early stage of implemntation phase of the project and lecturers shall be arranged from the contractor or some other organizations.

2) Phase 2 : In-plant practical training at the Contractor's plant

This training is the practical training going into the details of each equipment, and mainly for staff to work on the maintenance duties at the earth station.

The training curriculum shall consist of the following:

(a) Observation and/or short term training at the INTELSAT Standard A earth station to realize the day-to-day operational and maintenance activities at the existing earth station.

(b) Practical hands-on basis equipment training to become familiar with equipment and maintenance procedures.

(c) Attendance to the in-plant acceptance testing together with P.T.C.'s engineers for witness.

The Phase 2 training course shall be two-month run training and be so arranged as to meet the timing for the in-plant acceptance testing. Reasonable number of 5 trainees shall be selected from those attended to the Phase 1 training.

3) Phase 3 : On-site on-the-job training

This training program shall be conducted at the early stage of the on-site in-station loop testing. Details of installation testing and trouble shooting shall be learned through a course of actual on-site installation and testing activities.

There will be no limitation on the number of trainees and its training time period. However, the following areas shall be covered in this training:

(a) Details of testing procedures

(b) Details of trouble shooting

(c) Details of system level operational procedures

(d) INTELSAT SSOG line-up test procedures

(e) Critical and sensitive part of equipment

# CHAPTER 5

# Plan to Install Toll Telephone Exchange Facilities

# Chapter 5. Plan to Install Toll Telephone Exchange Facilities

As a result of an preliminary study, exchanges similar to the international exchange (made by L.M. Ericson) to be installed in Gweru will be installed in Harare and Bulawayo, and the report states that a feasibility study is also to be conducted with these exchanges.

According to the PTC, on the other hand, toll exchanges are to be installed in Harare and Bulawayo.

Therefore, the original plan was changed and a survey was resumed. In order to ascertain the feasibility to install a trunk and junction tandem exchange in Harare and a trunk exchange in Bulawayo, a plan to install trunk telephone exchange facilities is outlined based on the PTC's plan and traffic forecast.

## 5.1 Objective

A plan is established to install a new trunk and junction tandem exchange and a trunk exchange in the capital city of Harare and the second largest city of Bulawayo respectively where the demand for telephone services is high and the existing facilities are in the state of bottleneck so as to improve the telephone service function.

## 5.2 Basic Philosophy for the Project

1) The new exchanges to be installed are digital switches that are easy to be integrated into the future digital telephone network and allow the building to be utilized effectively.

2) The exchange to be installed in Harare is a trunk and junction tandem exchange to which an international exchange function can be added in the future.

3) The exchange to be installed in Bulawayo is a trunk exchange.

4) The capacities of the new exchanges shall accomodate the amount of the traffic anticipated in the year of 1990.

Notes:

Digital Telephone Switching System

Unlike the conventional analog exchange, the digital switching system utilizes the most recent electronic technologies. In addition, since it processes digital signals as they are, it well fits into digital transmission lines. Its functions are controlled by a stored program. The digital switching system offers the following features:

(i) Besides the fact that the exchange itself is a economical system, the entire telecommunication network is also inexpensive because it can be connected directly to digital transmission lines, requiring no analog to digital conversion.

(ii) The space it occupies is less than that of the analog exchange.

(iii) Digital integration allows the speech quality to be improved.

(iv) Various types of new services can be offered with ease.

(v) It offers not only telephone services but also data and picture transmission services. In the future it can be upgraded into an information network system (INS), a versatile integrated information telecommunication system that can provide a variety of services based on digital telecommunication technologies.

A digital switching system that has the above characteristics will perform pivotal roles in the telecommunication network of the future as a large number of countries has installed them. As a matter of fact, 70% of the developing countries have already introduced or decided the introduction of this system. It is therefore desirable for this country to install the system, aiming at a new telecommunication network to be built in the future.

## 5.3 Process of Implementation

### 1) Installation

The present Central Exchange Building in Harare is as shown in Figure 5.1. The subscribers accomodated in exchange unit 1 are transferred to exchange unit 5 and unit 1 is removed later.

A trunk and junction tandem exchange is to be installed in the space (about 560 $m^2$) occupied by unit.1

A space(38m x 11m = 418 $m^2$) is available in the Ground floor in the Central Exchange Building in Bulawayo. A trunk exchange is to be installed here.

The construction range of both station is from MDF containing a jumper toward exchange, and includes installation of a false floor.

### 2) New network configuration

Introduction of toll switch at Harare and Bulawayo requires a hierarchy and efficient network configuration. Figure 5-2 shows new network configuration.

3) Outline of exchange

(1) Trunk & junction tandem exchange in Harare

Fugure 5-2 shows the scale of switching facility and signalling system. Toll operator's positions installed are 20 sets. Table 5-1 shows the arrangement of local switches to make an interface with other local switches all circuits all are designed as an analog system.

(2) Trunk exchange in Bulawayo

Figure 5-4 shows the scale of switching facility and signalling system. Toll operator's positions installed are 2 sets. Table 5-2 shows the arrangement of local switches to make an interface with other local switches understand. The circuit all is designed as an analog system.

## 5.4 Training

Training of maintenance personnel confines 10 men for a maintenance and operation training course of 2 months on site, and 4 men for a technical training course of 6 months at supplier site.

Training of 25 oprators is confined to 2 weeks course on site.

## 5.5 Installation Schedule

This project is put into practice according to Table 5-3.

## 5.6 Power Supply and Air Conditioning

Table 5-4 shows the conditions of a power supply and air conditioning arranged by Zimbabwe.

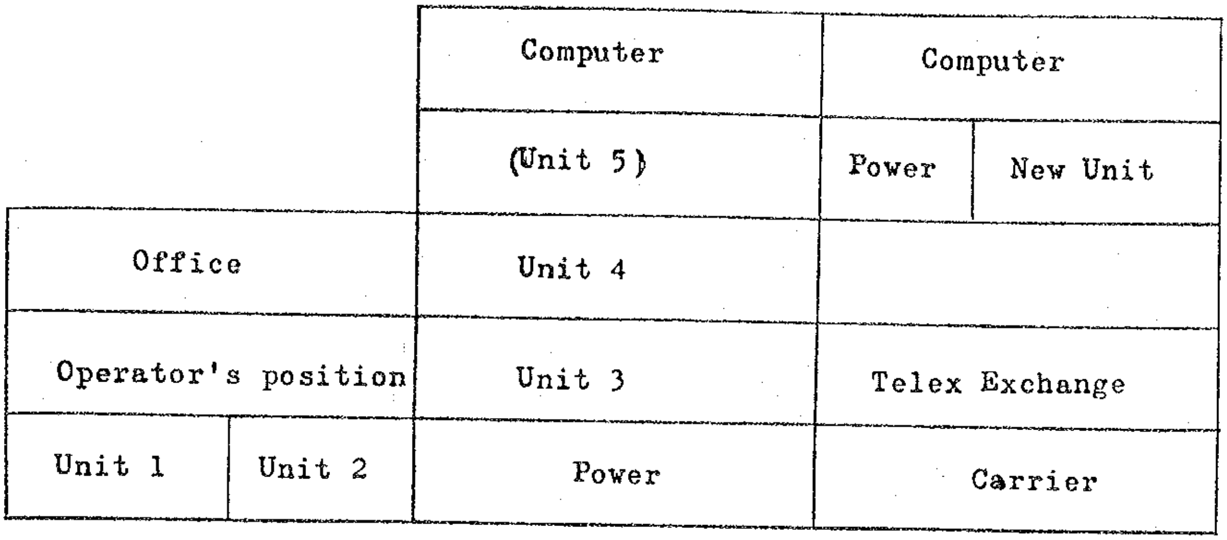



Fig. 5-1 Existing facilities in Harare Central Exchange Building.

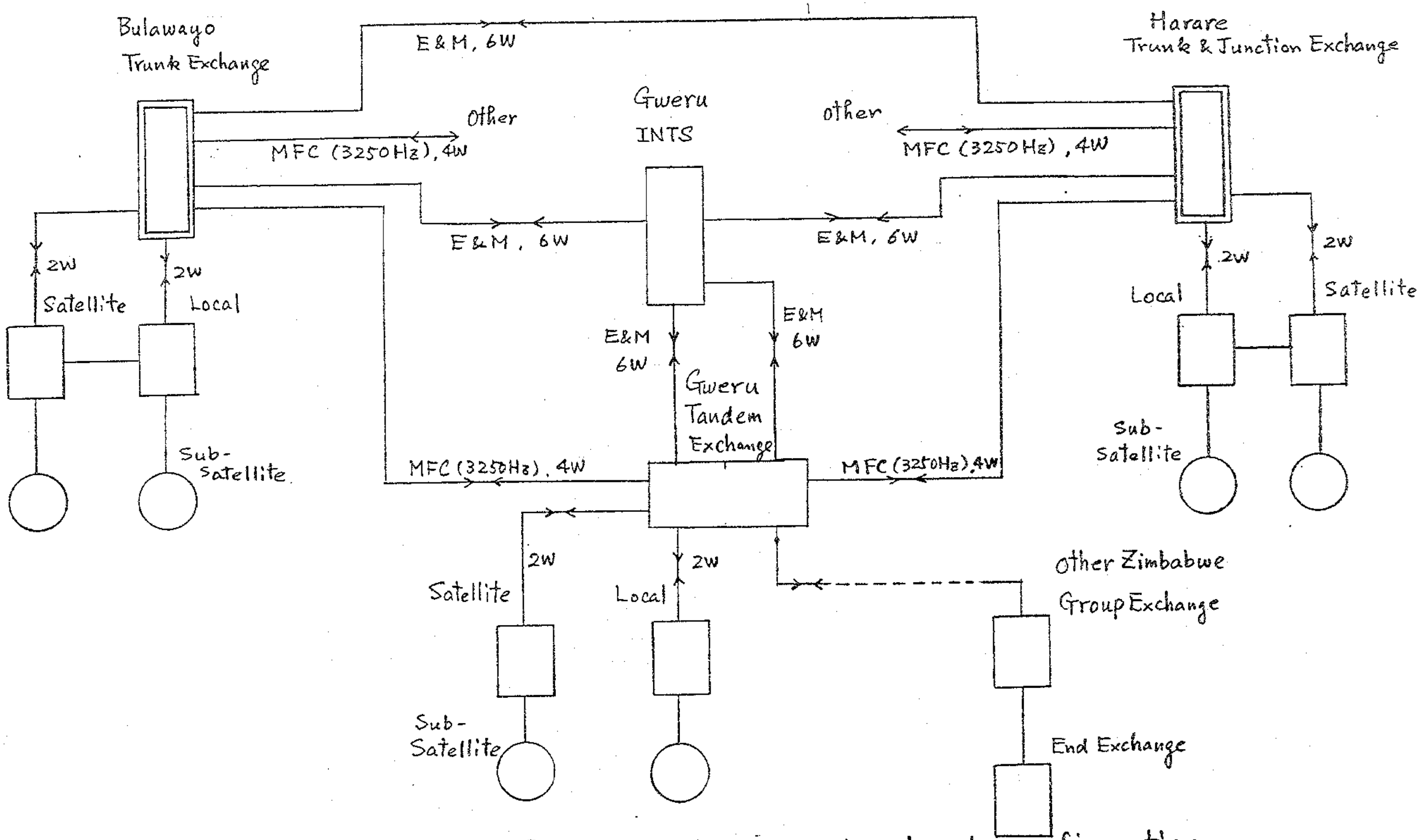



Fig. 5-2 Principal exchanges and network configuration

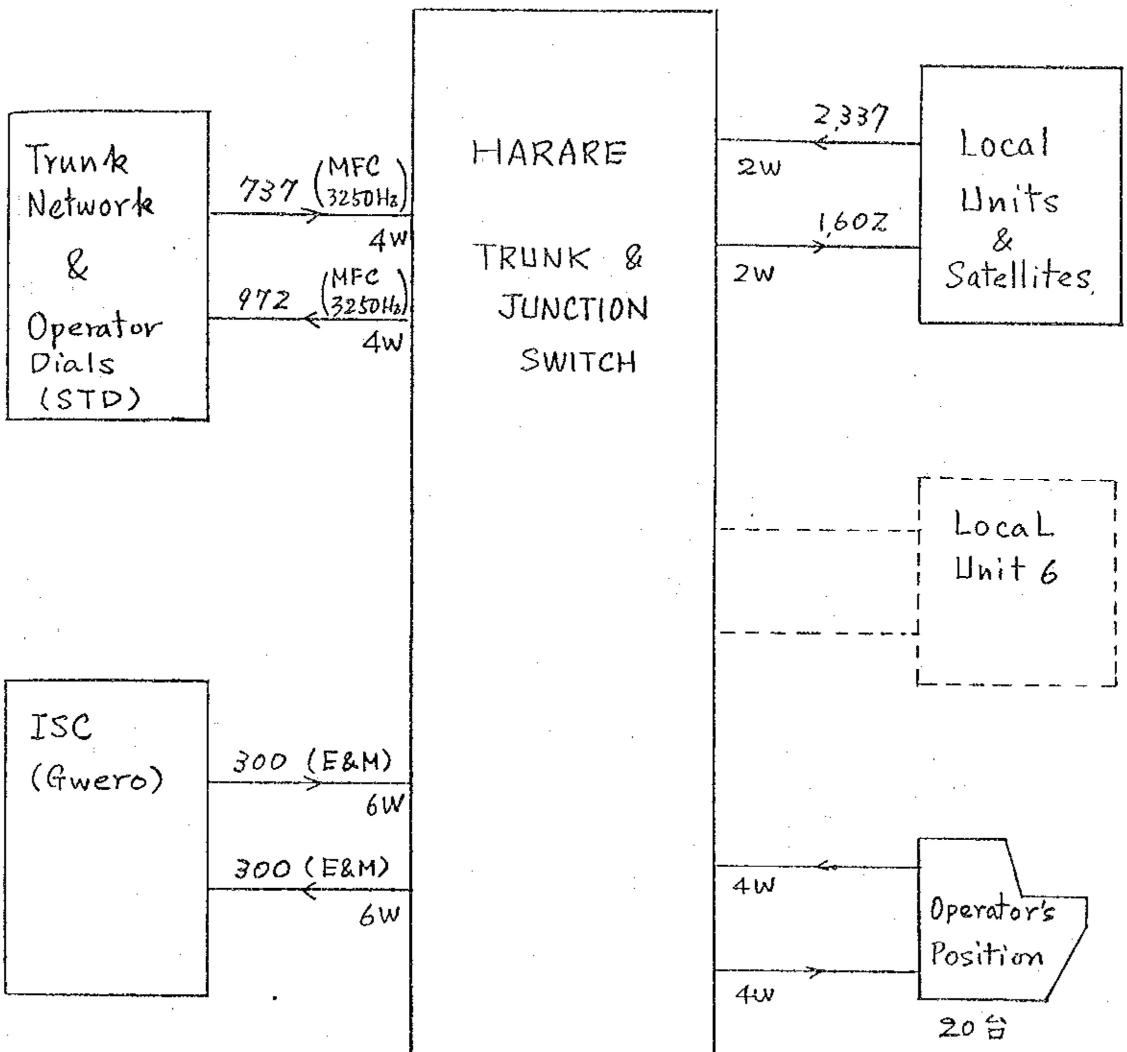



Fig. 5-3. Brief configuration of Trunk & Junction Tandem Switch in Harare

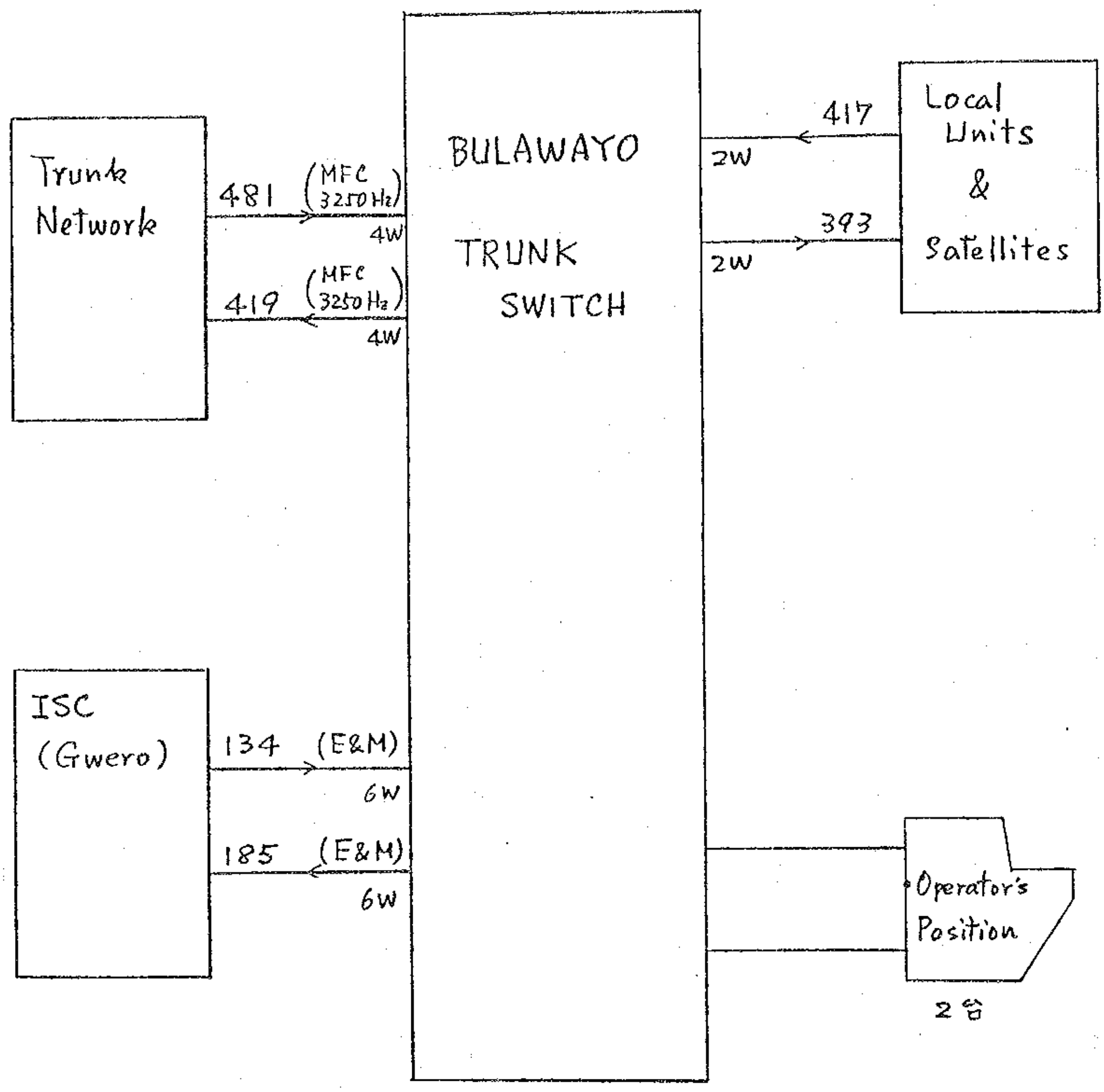



Fig. 5-4. Brief configuration of Trunk Switch in Bulawayo.

Table. 5-1 Existing exchanges in Harare

| Exchange | | Type | Capacity | Waiting List |
|---|---|---|---|---|
| Harare Main | Unit 1 | SxS, Uni-selector | 8,200 | 1,011 |
| | Unit 2 | SxS, Uni-selector | 1,300 | |
| | Unit 3 | SxS, Strowger | 10,000 | |
| | Unit 4 | SxS, Strowger | 7,800 | |
| | Unit 5 | SxS, EMD | - - - | |
| Avondale | | SxS, | 6,100 | 193 |
| Borrowdale | | SxS, | 1,500 | 29 |
| Highlands | | SxS, | 3,600 | 50 |
| Cranbone | | SxS, | 2,000 | 50 |
| Waterfalls | | SxS, | 270 | 0 |
| Southerton | | SxS, | 5,060 | 1,708 |

Table. 5-2 Existing exchanges in Bulawayo

| Exchange | Type | Capacity | Waiting List |
|---|---|---|---|
| Bulawayo Main | SxS, | 19,000 | 3,500 |
| Queensdale | SxS, | 1,000 | |
| Hillside | SxS, EMD | 3,500 | - - - |
| Donington | planning | 5,000 | - - - |

Table 5-3 Installation Schedule

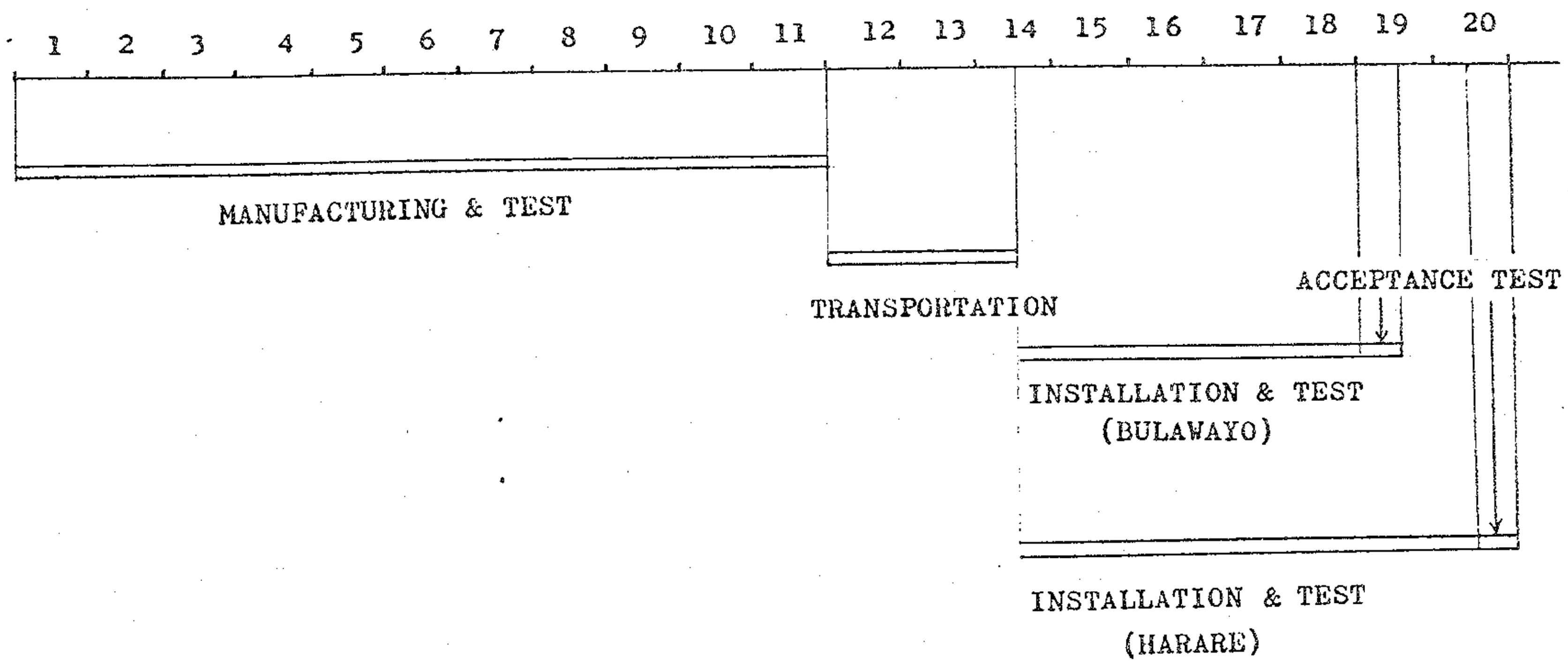


Table 5-4 Power Supplies and Air Conditioning

| ITEM | OFFICE | HARARE | BULAWAYO |
|---|---|---|---|
| POWER | Current consumption (A) | 1,150 | 450 |
| | Battery (4 hours, AH) | 6,800 | 2,600 |
| | Generator (KVA) | 200 | 78 |
| Air-conditioner (Kcal/H) | | 105,000 | 45,000 |

# CHAPTER 6

## Plan of Implementation Schedule

## Chapter 6. Plan of Implementation Schedule

### 6.1 General

Implementation planning for both the A.O.R. earth station installation project and the I.O.R. earth station installation project will greatly rely on the P.T.C.'s policy for the projects.

The A.O.R. earth station installation project is feasible from various technical aspects, and it is justified that implementation of this project be planned as soon as possible.

On the other hand, it is estimated that the I.O.R. earth station installation project will become technically feasible by the end of 1988.

This section shows the implementation plan of both earth station projects in Zimbabwe.

### 6.2 Proposed Implementation Plan

Figure 4-18 shows the timings and schedules of both earth station installation projects.

The A.O.R. earth station installation project is planned to be completed by the end of 1984. To accomplish this, it is necessary for the project to enter into contract by the middle of 1983.

On the other hand, the I.O.R. earth station installation project is planned tentatively to be completed by the end of 1988.

In seeking for the best timing to start the I.O.R. earth station installation project, the following planning approaches have been made by the study team:

1) From the point of traffic demand forecast for countries situated in the coverage of the I.O.R. satellite, it is technically justified that implementation of INTELSAT Standard A earth station project will become feasible at around the end of 1988.

However, implementation of Standard B earth station project is feasible at any time.

2) There are two possible technical arrangements as follows:

a) First Approach

Implementation of the A.O.R. Standard A earth station facility and the I.O.R. Standard B facility by the end of 1984.

b) Second Approach

Implementation of the A.O.R. Standard A earth station facility by the end of 1984 and the I.O.R. Standard A earth station facility by the end of 1988.

3) The first approach has an advantage that all traffic can be established by country's own telecommunications facilities and own network, and no traffic routing is needed.

However, there are great disadvantages in cost performance. Project cost must be increased by 50% to cover the cost necessary for a Standard B earth station facility. Also, the Standard B complex should be replaced by the Standard A earth station complex at around the end of 1988.

4) The second approach is the best overall, although for a small amount of traffic temporary routing through the Pretoria earth station is needed. In planning the I.O.R. standard A earth station project, there are several great advantages:

a) Sufficient operational and maintenance experience can be obtained for running the A.O.R. earth station facility. Various useful experience can be reflected on the system design of the I.O.R. earth station installation project.

b) Good cost performance for the whole project

6.3 Detailed Implementation Schedule

Figure 4-19 shows the details of a standard major milestone schedule in implementing and establishing the INTELSAT Standard A earth station in Zimbabwe. This schedule can be applicable for both the A.O.R. and the I.O.R. earth station installation projects.

The total schedule covers 18 months and includes both the time necessary for implementing the facility in accordance with technical specifications, and that for establishing the satellite communications links for Zimbabwe.

It is noted that this schedule differs project to project as well as contractor to contractor, in general. More design lead time might be needed for the contractor if new development efforts are required to meet the specifications. Less time might be acceptable if project requirements are smaller than estimated.

However, it should be clearly noted that the model contract to implement the INTELSAT Standard A earth station facility does, in general, not include works and services to be required for establishing the satellite links unless it is specified by the user.

1) A Flow of Various Major Events

Chart 1 shows a typical flow of various major activities including coordination procedures with INTELSAT.

P.T.C. is requested to have the various steps of coordination not only with the contractor, but also with the INTELSAT organization, on time.

2) Control of Implementation Schedule

To establish the satellite communication system in Zimbabwe, it is important for the project to consider the following:

(a) Progress status of the implementation work should be controlled by means of a monthly progress status report and/or meetings with the contractor.

(b) It shall be noticed that implementation of civil works tends to be behind schedule. By the time of the scheduled commencement of installation works by the telecommunications work, civil works relating to the rooms/spaces to house telecommunications equipment, power plants and other related systems shall be completed.

(c) Among the various works included in civil works, works preceding the actual site works as preparation of design documents, approval of P.T.C. thereupon and contracts between the main contractor and local subcontractors tend to be bottlnecks in implementation of the whole civil works. Accordingly, it is desirable that P.T.C. will make surveys necessary for the designs, as land surveying, soil survey and water survey, and compile in the tender documents and that P.T.C. will prepare, by the co-operation of the local consulting engineer already assigned by P.T.C., the requirements to the tenderers as much as concrete and make the proposals to be offered by tenderers as little as possible.

(d) Close coordination with INTELSAT is needed to schedule and conduct such as the INTELSAT mandatory verification test to be made on the antenna subsystem and SSOG line-up test to establish the satellite communications links with the satellite.

(e) Traffic cut-over plan shall be established to transfer the existing satellite communications traffic from R.S.A. routing to the Zimbabwe earth station routing.

Chart 6.1 GENERAL FLOW CHART FOR EARTH STATION IMPLMENTATION

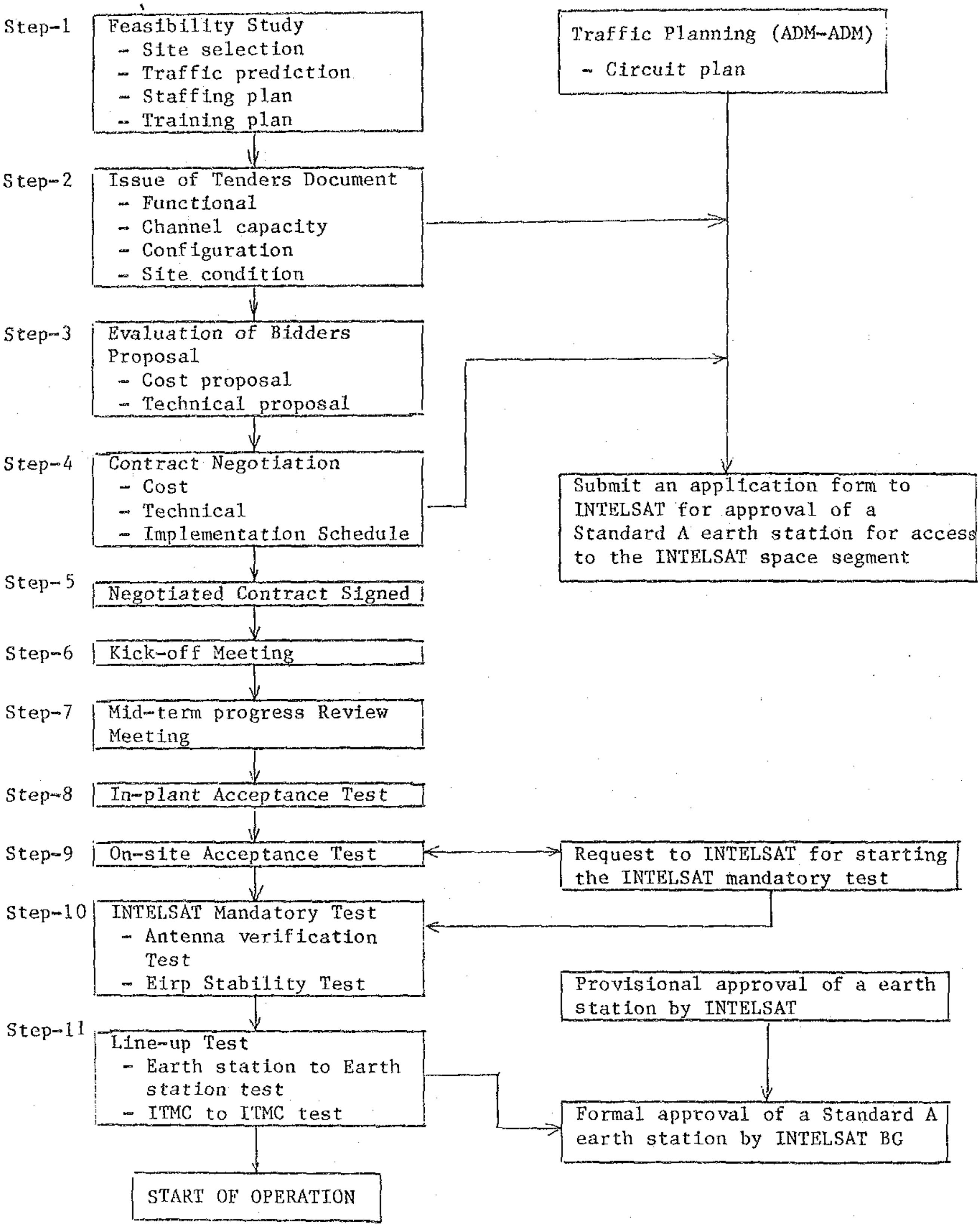
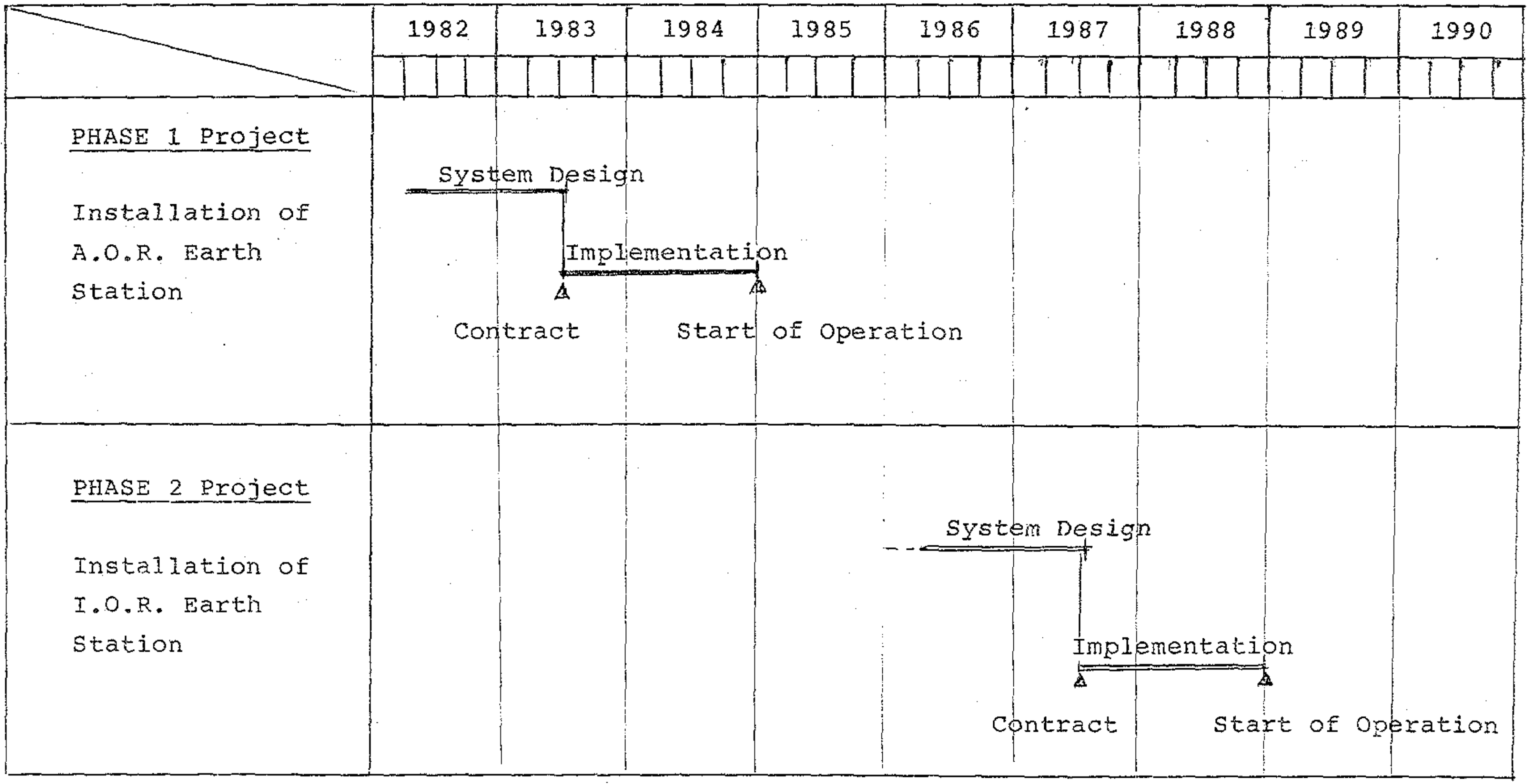


Figure 6-1 Proposed Implementation Schedule

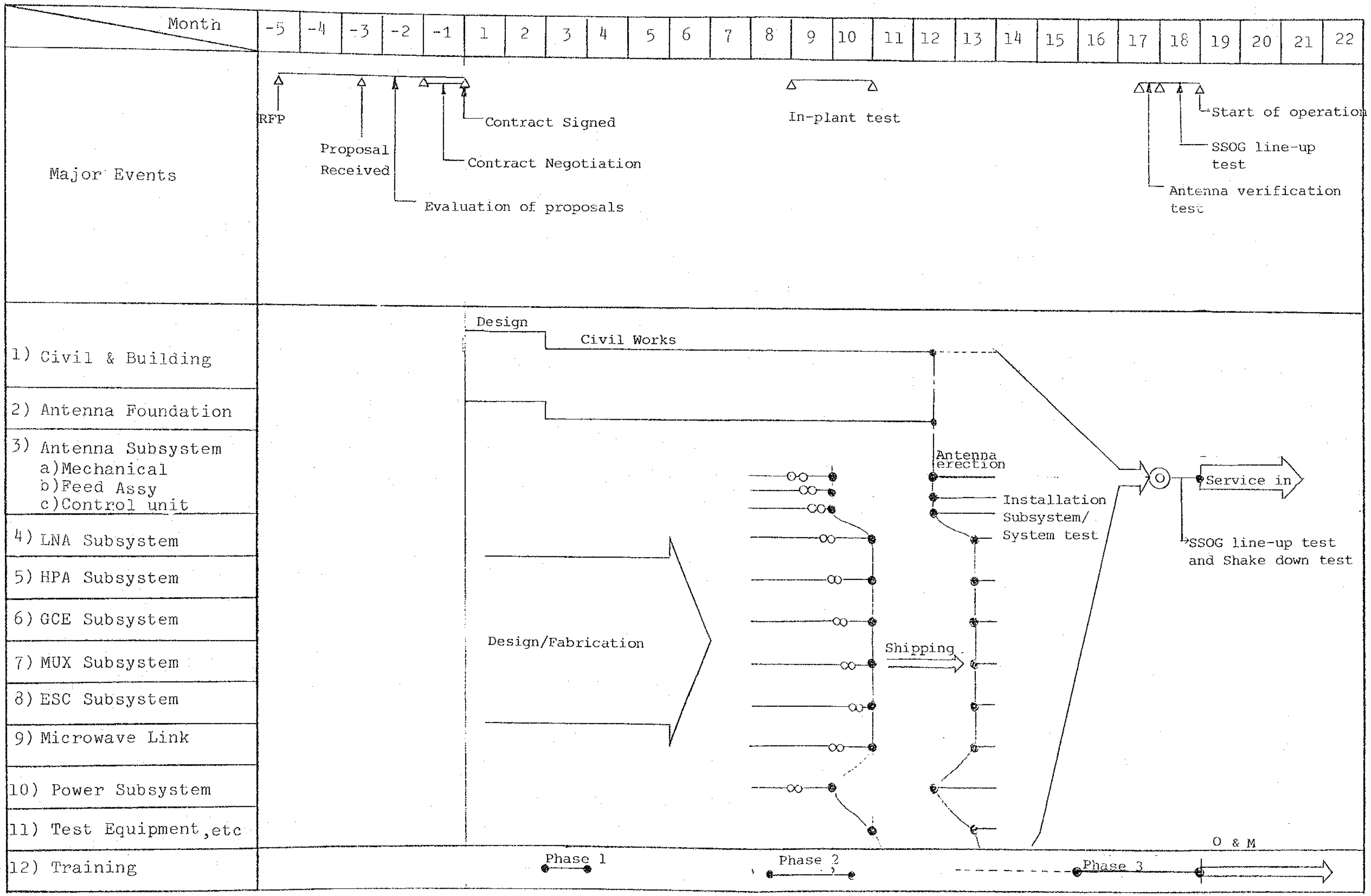



Legend

A.O.R. : Atlantic Ocean Region

I.O.R. : Indian Ocean Region

FIGURE 6-2 MAJOR MILESTONE SCHEDULE



# CHAPTER 7

# Projct Cost Estimation

## Chapter 7. Project Cost Estimation

### 7.1 General

Various factors must be taken into account in estimating the costs necessary for satisfactorily implementing Phase 1 project and Phase 2 project.

The cost of implementing Phase 1 project could be estimated based on the present market prices with a certain degree of accuracy. Conversion Unit of Both currencies is used, as 1 Z$ equal to 250 Yen, in the report.

However, the cost for Phase 2 is especially difficult to estimate accurately at present. The calculation of various escalation factors is needed to project the cost for implementing Phase 2.

This section presents summaries of the cost estimation made on Phase 1 project and that for Phase 2. The cost estimation on the toll exchange system presents also in section 5, at a present price rate.

### 7.2 Summary of Cost Estimation

Table 7-1 and Table 7-2 show the summaries of the estimated costs necessary for implementing Phase 1 project by the end of 1984 and Phase 2 project by the end of 1988, respectively.

In both cases the costs listed in tables show the price at the stage of completion of each project.

It should be clearly noted that no operational costs of the facility are included in tables.

### 7.3 Cost Breakdown for Phase 1 Project

In general, the cost necessary for implementing Phase 1 project will greatly rely on the technical requirements specified for the project. It will also differ Contractor to Contractor for the project.

However, the cost of Phase 1 project is estimated on following areas:

- Cost of telecommunications equipment and its associated materials
- Costs associated with works and services for the project
- Cost necessary for civil works
- Cost necessary for consulting services

1) Cost of Equipment and Materials

The cost is estimated based on the technical requirements planned in Section 5, of Chapter 4 and all prices indicated herewith are average market price and in effect for Phase 1 project.

| | Descriptions | CIF Harare, Zimbabwe (Unit 1,000 Yen) |
|---|---|---|
| (a) | Antenna and Tracking Subsystem ........... | 450,000 |
| (b) | Low Noise Amplifier Subsystem ............ | 28,000 |
| (c) | High Power Amplifier Subsystem ........... | 120,000 |
| (d) | Ground Communications Equipment Subsystem | 165,000 |
| (e) | SCPC Terminal Equipment Subsystem ........ | 77,000 |
| (f) | Communications Control, Monitor and Testing Subsystem ..................... | 70,000 |
| (g) | ESC Equipment ........................... | 60,000 |
| (h) | MUX Equipment Subsystem at Earth Station and Harare Center Exchange Building ..... | 200,000 |
| (i) | Terrestrial Microwave Link Subsystem .... | 150,000 |
| (j) | Power Supply Subsystem at Earth Station . | 135,000 |
| (k) | TV Monitor and Control Equipment at Harare ITC ............................. | 18,000 |
| (l) | Boresight Test Facility ................ | 15,000 |
| (m) | Test Equipment ......................... | 100,000 |
| (n) | Spare Parts ............................ | 70,000 |
| (o) | Documentation .......................... | 50,000 |
| (p) | Installation Materials ................. | 90,000 |
| | Total | ¥1,798,000 (unit 1,000 Yen) |

2) Cost of Works and Services

| Descriptions | | (Unit 1,000 Yen) |
|---|---|---|
| (a) | Installation and Testing ................. | 430,000 |
| (b) | Project Control and Management ........... | 100,000 |
| (c) | Training ................................. | 50,000 |
| (d) | Operation and Maintenance Support ........ | 20,000 |
| | Total | ¥600,000 |

(Unit 1,000 Yen)

It is noted that cost of training covers both costs necessary for the classroom training in Zimbabwe and the in-plant training for 5 trainees in Japan. The cost of air fares, hotel bills and travelling expenses necessary for the in-plant training in Japan are included, but excluding salaries, private communications costs, etc.

Also, the cost of operational and maintenance support services covers the costs necessary for the INTELSAT SSOG line-up test and the minimum of three months of on-site shake down test.

3) Cost of Civil Work

| Descriptions | | (Z$: Zimbabwean dollar)<br>(¥ : Japanese Yen) |
|---|---|---|
| (a) | Total Construction Cost excluding the cost in item (b) | Z$1,580,000 and ¥64,000,000 |
| (b) | Fees and Expences for Designs and supervisions including Consulting Fees | Z$ 180,000 and ¥36,000,000 |
| Total | Local Currency Portion ....... | Z$1,760,000 |
| | Foreign Currency Portion ..... | ¥100,000,000 |

Note: Foreign Currency portion in the Total Construction Cost is estimated at the exchange rate of 250 Japanese Yen to one Zimbabwean dollar.

The conditions and bases of the cost estimation are summarized as follows:

- The construction cost is estimated based on unit prices of materials and/or price data, which was obtained during the field survey in Harare from November to December, 1982, under cooperation of P.T.C. and a consultant engineer assigned by P.T.C.

  However, partial costs and/or prices were surveyed in the Japanese market.

- For contingency purposes, a 10 percent of allowance is included to the total construction cost.

- Escalation of construction costs is presupposed as follows:

  (i) Escalation from November 1982 to mid-1983 will be of 20%. This figure was set by assuming that annual escalation ratio during the construction period would be 30% as assumed by a local consultant in Zimbabwe.

  (ii) Escalation during the construction period, from the time of contract to the time of completion, will be of 10 %. This figure was set with due consideration for payment conditions.

- Scope of work will be as described in paragraph 4.6.1, 1) "Scope of Civil Work, Phase 1 project".

- Professional fee for design and supervision by the local consultant was set according to the local standards as follows:

(i) 12.5 % of the construction cost in relation with the building construction.

(ii) 5 % of the construction cost in relation with the remaining works.

It is presupposed that the contract of the project will be full turn key system, so the costs for the design, mainly of antenna pedestal building, and for the supervision at site by the main contractor including the travelling and living expences to and at the site are to be allowed.

- Foreign currency portion to the total cost was estimated as follows:

  (i) 5 % of building construction cost excluding special facilities.

  (ii) 80-100 % of installation cost for special facilities.

  (iii) 100 % of cost/expences for design and supervision by the main contractor.

4) Cost of Consulting Services

Since the P.T.C. staff have no experience in satellite communications system, it is proposed by the study team that the P.T.C. consider the use of the Consultant for the project. Although most of necessary works might be accomplished by the P.T.C.'s own efforts, the proposed consulting services should take care of the following major activities for the project:

- Advice on the evaluation of the in-plant test data
- Advice on the evaluation of the on-site acceptance test data

The cost is estimated based on average market price and average grade of technical experiences. Following are estimated prices:

| | (Unit=1,000 Yen) | |
|---|---|---|
| - Advice on the in-plant test | 4,000 | *1 |
| - Advice on the on-site test | 10,000 | *2 |

Note: *1: The consultants live in the same country as suplier and Fulltime service dates are about 40 daysx2 men

*2: Accomodation fee and commuting at the on-site test will be paid by P.T.C. Estimated testing duration is 2 months.

## 7.4 Cost Breakdown for the Phase 2 Project

Since the Phase 2 project is planned to be implemented by the end of 1988, it seems to be too early for the project to be estimated accurately. Estimations of various escalation factors are needed to estimate the cost for the Phase 2 project.

The study team estimated the cost necessary for implementing Phase 2 project based on the present market prices established in Phase 1 project.

In estimating the cost at the stage of implementation, the following assumptions have been made:

Assumption-1 : Escalation factor related to the cost of equipment and materials is estimated to be seven (7) percent per year.

Assumption-2 : Escalation factor related to the cost of manpower is estimated to be ten (10) percent per year

Assumption-3 : Escalation factor related to the cost of civil works is estimated to be twenty (20) percent per year

Assumption-4 : Technical requirements are in accordance with a plan shown in Section 5 of Chap. 4.

Assumption-5 : No consulting services are required for implementing Phase 2 project

1) Cost of Equipment and Materials

| | Descriptions | CIF Harare, Zimbabwe (Unit 1,000 Yen) | |
|---|---|---|---|
| (a) | Antenna Subsystem | 585,000 | |
| (b) | Low Noise Amplifier Subsystem | 36,000 | |
| (c) | High Power Amplifier Subsystem | 156,000 | |
| (d) | Ground Communications Equipment | 214,500 | |
| (e) | SCPC Terminal Equipment | 100,100 | |
| (f) | Communications Control, Monitor and Testing | 91,000 | |
| (g) | ESC Equipment | 13,000 | (Note 1) |
| (h) | MUX Equipment at Earth Station | 182,000 | (Note 2) |
| (i) | Power Supply Subsystem | 130,000 | (Note 3) |
| (j) | Test Equipment | 130,000 | (Note 4) |
| (k) | Spare Parts | 91,000 | |
| (l) | Documentation | 65,000 | |
| (m) | Installation Materials | 117,000 | |
| | Total | 1,911,000 | |

(Unit 1,000 Yen)

Note 1 : Cost necessary for expanding the Phase 1 equipment

Note 2 : Present price is estimated to be the 70% of Phase 1 project

Note 3 : Cost for expanding the Phase 1 equipment, and the present price is estimated to be about 30% less than that to be required for Phase 1 project.

Note 4 : Cost equals Phase 1 project for renewal of the Phase 1 equipment.

2) Cost of Works and Services

| Descriptions | (Unit 1,000 Yen) |
|---|---|
| (a) Installation and Testing .................. | 627,800 |
| (b) Project Control and Management ........... | 146,000 |
| (c) Operation and Maintenance Support ........ | 29,000 |
| Total | ¥802,800 |

(Unit 1,000 Yen)

3) Cost of Civil Work

| Descriptions | (Z$: Zimbabwean dollar)<br>(¥ : Japanese Yen) |
|---|---|
| (a) Total Construction Cost excluding the cost in item (b) | Z$ 750,000<br>and<br>¥30,000,000 |
| (b) Fees and Expences for Designs and supervisions including Consulting Fees | Z$ 90,000<br>and<br>¥ 7,000,000 |
| Total Local Currency Portion ....... | Z$ 840,000 |
| Foreign Currency Portion ..... | ¥ 37,500,000 |

Note: Foreign Currency portion in the Total Construction Cost is estimated at the exchange rate of 250 Japanese Yen to one Zimbabwean dollar.

## 7.5 Cost Estimation for Toll Exchange

The cost estimation required to this project is shown in the Table 7-3 for Harare and Bulawayo.

The conditions of cost calculation is as follows.

1) An exchange rate is taken as 1 Zimbabwe dollar = 250 yen.
2) A price is year of 1985
3) The training course in supplier site includes an air fare and stay expense.

Table 7-1 ESTIMATED COST FOR THE A.O.R. EARTH STATION INSTALLATION PROJECT (PHASE 1 PROJECT)

(UNIT CONVERSION: Z$1 = ¥250)

| ITEMS \ CURRENCY | | ORIGINAL PRICE (JAPANESE YEN OR ZIMBABWEAN DOLLAR) | JAPANESE CURRENCY (JAPANESE YEN) | ZIMBABWE CURRENCY (ZIMBABWEAN DOLLAR) |
|---|---|---|---|---|
| EQUIPMENT AND MATERIALS | | ¥1,798,000,000.- | 1,798,000,000.- | 7,192,000.- |
| WORK AND SERVICES (CIVIL WORK PORTION EXCLUDED) | | ¥ 600,000,000.- | 600,000,000.- | 2,400,000.- |
| CIVIL WORKS | TOTAL | Z$ 2,160,000.- | 500,000,000.- | 2,160,000.- |
| | FOREIGN CURRENCY PORTION | (¥ 100,000,000.-) | (100,000,000.-) | (400,000.-) |
| | LOCAL CURRENCY PORTION | (Z$ 1,760,000.-) | (440,000,000.-) | (1,760,000.-) |
| CONSULTING SERVICE | | ¥14,000,000.- | 14,000,000.- | 56,000.- |
| GRAND TOTAL | | ¥2,512,000,000.-<br>(Z$ 10,048,000.-)<br>and<br>Z$ 1,760,000.- | 2,952,000,000.-<br>* 2,512,000,000.- | 11,808,000.- |

Note: *, exclude local currency portion

Table 7-2 ESTIMATED COST FOR THE I.O.R. EARTH STATION INSTALLATION PROJECT (PHASE 2 PROJECT)

(UNIT CONVERSION: Z$1 = ¥250)

| ITEMS / CURRENCY | | ORIGINAL PRICE (JAPANESE YEN OR ZIMBABWEAN DOLLAR) | JAPANESE CURRENCY (JAPANESE YEN) | ZIMBABWE CURRENCY (ZIMBABWEAN DOLLAR) |
|---|---|---|---|---|
| EQUIPMENT AND MATERIALS | | ¥1,911,100,000.- | 1,911,100,000.- | 7,644,400.- |
| WORK AND SERVICES (CIVIL WORK PORTION EXCLUDED) | | ¥ 803,000,000.- | 803,000,000.- | 3,212,000.- |
| CIVIL WORKS | TOTAL | Z$ 990,000.- | 247,500,000.- | 990,000.- |
| | FOREIGN CURRENCY PORTION | (¥ 37,500,000.-) | ( 37,500,000.-) | (150,000.-) |
| | LOCAL CURRENCY PORTION | (Z$ 840,000.-) | (210,000,000.-) | (840,000.-) |
| GRAND TOTAL | | ¥2,751,600,000.-<br>(Z$ 11,006,400.-)<br>and<br>Z$ 840,000.- | 2,961,600,000.-<br>* 2,751,600,000.- | 11,846,400.- |

Note: *, exclude local currency portion

Table 7-3 COST ESTIMATION

| ITEM | DESCRIPTION | HARARE | | BULAWAYO | | REMARKS |
|---|---|---|---|---|---|---|
| | | MILLION YEN | 1,000 ZIMBABWE$ | MILLION YEN | 1,000 ZIMBABWE$ | |
| A. | HARDWARE | | | | | |
| | 1. EXCHANGE EQUIPMENT | 588 | 2,364 | 192 | 768 | Including MDF |
| | 2. OPERATOR'S POSITION | 51 | 204 | 12 | 48 | Including Controller |
| | 3. MAINTENANCE PARTS | 25 | 100 | 25 | 100 | |
| | 4. INSTALLATION MATERIALS | 29 | 116 | 18 | 72 | Including FALSE FLOOR materials |
| | 5. DOCUMENTS | 5 | 20 | 5 | 20 | |
| | 6. MAINTENANCE TOOLS AND TEST EQUIPMENT | 9 | 36 | 9 | 36 | |
| B. | SERVICE | | | | | |
| | 1. INSTALLATION AND TEST | 74 | 296 | 24 | 96 | |
| | 2. MAINTENANCE SUPPORT | 28 | 112 | 28 | 112 | |
| | 3. TRAINING | 113 | 452 | 55 | 220 | SITE: 10 engineers x 2 months<br>TOKYO: 4 engineers x 6 months<br>SITE: 25 operators x 2 weeks |
| | TOTAL (A+B) | 922 | 3,688 | 368 | 1,472 | |

# CHAPTER 8

# Economic Evaluation

## Chapter 8. Economic Evaluation

### 8.1 Introduction:

This Chapter intends to evaluate the installation of an international telecommunication earth station and the introduction of toll exchanges as a part of the preparation and expansion project of the telecommunication project in the Republic of Zimbabwe by analyzing the project from a point of view of the cost/benefit and examining their financial and economic effectiveness.

To be concrete, the following 3 items of this project are planned.

(1) Installation of satellite communication earth station for the Atlantic Ocean (For AOR)

(2) Installation of satellite communication earth station for the Indian Ocean (For IOR)

(3) Introduction of toll exchanges in Harae City and Bulawayo City

According to the agreement with the Republic of Zimbabwe about the above 3 items, the following 2 plans are analized to mainly find the internal financial rate of return as discussed below.

Plan I. Installation of AOR earth station and IOR earth station.

Plan II. Installation of AOR earth station and IOR earth station, and introduction of exchanges.

The economic analysis made by quantitatively measuring the economical and social effect and role of the international telecommunication encounters with the difficulty in measuring the benefit of international telecommunication and a fact that the method of analysis of its cost/benefit is not yet established. Therefore, first, the expected utility of the international telecommunication is described.

## 8.2 Project and Precondition for the Analysis:

The year and period of construction of each sub-project are already referred to in this report. However, the starting time of operation is according to the calendar year; the earnings are calculated from the beginning of 1985 for AOR Earth Station, from the beginning of 1989 for IOR Earth Station, and from the beginning of 1986 for the toll exchanges.

Regarding the period of operation, there are no definite provisions under the system of the Republic of Zimbabwe. In the case of a telecommunication project, the durable years of the telecommunication equipment are often set of 20 years after the practice of the World Bank. In the present case, the durable years are set to 15 years. This is estimated for the following reasons.

(1) The design life of the system concerned is 15 years.

(2) When taking into consideration the remarkable and accelerating progress of the telecommunication technology in the recent years, the durable years of 20 years are too long.

In the analysis by the internal rate of return, the earnings are estimated over the whole period of the durable years of the system after the start of operation from the starting year of construction, and integrated through conversion of them into the present value by the discount rate. Therefore, fluctuation of such economic elements as price increase, the present rate system, etc. is not taken into account. It is also assumed that there is no change in the utilizing pattern of the service.

## 8.3 Earnings:

If this project is executed, it is expected that the earnings of the international communication field including international telephone, telex and telegraph, as a whole, will be increased. In the traffic demand forecast, the most of the demand is estimated to come from the international telephone, so that it is reasonably possible to class an increase in the earnings from the international telephone with the earnings from this project. Accordingly, if only the increase in earnings expected from the international telephone is considered the operating earnings of this project, the figures shown in the following table can be calculated.

(Unit: 1000Z$)

| YEAR | PLAN I | PLAN II |
|---|---|---|
| 1984 | - | - |
| 1985 | 3,700 | 3,700 |
| 1986 | 4,716 | 6,329 |
| 1987 | 5,614 | 8,696 |
| 1988 | 6,744 | 10,723 |
| 1989 | 10,696 | 16,096 |
| 1990 | 11,764 | 17,626 |
| 1991 | 12,588 | 18,862 |
| 1992 | 13,464 | 20,173 |
| 1993 | 14,406 | 21,563 |
| 1994 | 15,413 | 23,115 |
| 1995 | 16,492 | 24,699 |
| 1996 | 17,293 | 26,080 |
| 1997 | 18,149 | 27,529 |
| 1998 | 20,200 | 30,234 |
| 1999 | 21,182 | 31,929 |
| 2000 | 6,182 | 17,685 |
| 2001 | 6,182 | 6,182 |
| 2002 | 6,182 | 6,182 |
| 2003 | 7,571 | 7,571 |

8.4 Expenditures:

The expenditures involved in this project consist of three items, such as the initial investment, working capital and operating cost.

(1) Initial investment:

The evaluation of the expenses necessary for executing the project is as stated in this report. The outline of the evaluation is as given below.

(Unit: 1000 Z$)

| | PLAN I | PLAN II |
|---|---|---|
| For foreign currency | 18,128 | 23,288 |
| For domestic currency | 2,745 | 2,745 |
| Total amount of investment | 20,873 | 26,033 |

The evaluation of the sum of investment is made on the assumption that the foreign currency is disbursed in a full amount by a long-term loan and, the domestic currency, disbursed in a full amount from the fund on hand of PTC.

The disbursements planned for this project are as given in the following table.

(Unit: 1000Z$)

| YEAR | PLAN I | PLAN II |
|---|---|---|
| 1984 | 11,808 | 16,968 |
| 1988 | 9,065 | 9,065 |

(2) Working capital:

In the case of the telecommunication industry, the working capital is usually within 10% to 30% of the yearly turnover.

In this evaluation, it is estimated that 30% of the sum of yearly earnings is the working capital taking into consideration the operation size, etc.

After 2 years from the start of the service, 30% of the changed amount in comparison with the previous year will be appropriated to the working capital corresponding to the increase or decrease in the income.

Since this capital can be recovered in a full amount at the end of the operation period; in the final fiscal year, it is recovered and added up to the earnings.

(3) Operating cost:

The operating cost consists of the maintenance expense and the working management expense.

a) Maintenance expense: The maintenance expense is the upkeep expense required for making the equipment work normally during the operating period. Although it may somewhat increase, yet it can be estimated with reference to the operating efficiency and the value according to the past record. Generally, the maintenance expense is considered proportional to the size of the equipment investment, so that a fixed amount is appropriated for the maintenance expense every year.

b) Working management expense: This expense is classified into two expenses, one of which is a direct business expense for management and operation of the business activities caused by the execution of this project, and the other is an indirect expense caused by the execution of this project such as an increase in the expenses for the domestic communication equipment, etc. It is considered that the working management expense tends to often increase with expansion of the business. Referring to the collected data and the size of estimated income, 35% of the yearly earnings is appropriated to the direct business expense, and 12% thereof, appropriated to the indirect business expense.

## 8.5 Payment and Repayment of Loan:

The sum of the foreign currency for the loan and the years of repayment of the loan are given in the following table.

(Unit: 1000Z$)

| YEAR | PLAN I | PLAN II |
|---|---|---|
| 1984 | 10,048 | 15,208 |
| 1988 | 8,080 | 8,080 |
| Total | 18,128 | 23,288 |

The plan of the repayment of the loan and the payment of the interest is given in between Table 8-1 and Table 8-4.

This plan of repayment is based on the calculation made under the following precondition.

| | | |
|---|---|---|
| Period of repayment | : | 30 years |
| Grace period | : | 10 years |
| Interest | : | 3.5% annually<br>a term-end payment |

## 8.6 Effect of Investment:

1) Concerning AOR Earth Station plus IOR Earth Station (See the following Plan I Table)

2) Concerning AOR Earth Station plus IOR Earth Station plus Toll Exchange (See the following Plan II Table)

# PLAN I

(Unit: 1000Z$)

| Year / Item | Income | Expenditure | | | Profit |
|---|---|---|---|---|---|
| | | Installation Cost | Working Capital | Maintenance & Operating Cost | |
| 1984 | | 11,808 | | | -11,808 |
| 1985 | 3,700 | | 1,110 | 2,358 | 232 |
| 1986 | 4,716 | | 305 | 2,836 | 1,575 |
| 1987 | 5,614 | | 270 | 3,258 | 2,086 |
| 1988 | 6,744 | 9,065 | 339 | 3,788 | -6,448 |
| 1989 | 10,696 | | 1,186 | 6,061 | 3,449 |
| 1990 | 11,764 | | 320 | 6,562 | 4,882 |
| 1991 | 12,588 | | 247 | 6,950 | 5,391 |
| 1992 | 13,464 | | 263 | 7,361 | 5,840 |
| 1993 | 14,406 | | 282 | 7,804 | 6,320 |
| 1994 | 15,413 | | 302 | 8,278 | 6,833 |
| 1995 | 16,492 | | 324 | 8,784 | 7,384 |
| 1996 | 17,293 | | 240 | 9,161 | 7,892 |
| 1997 | 18,149 | | 257 | 9,563 | 8,329 |
| 1998 | 20,200 | | 615 | 10,527 | 9,058 |
| 1999 | 21,182 | | 294 | 10,989 | 9,899 |
| 2000 | 6,182 | | -4,500 | 3,525 | * 7,157 |
| 2001 | 〃 | | 0 | 〃 | 2,657 |
| 2002 | 〃 | | 0 | 〃 | 〃 |
| 2003 | 7,571 | | -2,271 | 4,178 | * 5,664 |

I. R. R. 20.60

The asterisk (*) represents that the recovery of the working capital is made in the year concerned.

# PLAN II

(Unit: 1000Z$)

| Item / Year | Income | Expenditure | | | Profit |
|---|---|---|---|---|---|
| | | Installation Cost | Working Capital | Maintenance & Operating Cost | |
| 1984 | | 16,968 | | | -16,968 |
| 1985 | 3,700 | | 1,110 | 2,358 | 232 |
| 1986 | 6,329 | | 789 | 3,991 | 1,549 |
| 1987 | 8,696 | | 710 | 5,105 | 2,881 |
| 1988 | 10,723 | 9,065 | 608 | 6,057 | -5,007 |
| 1989 | 16,096 | | 1,612 | 8,997 | 5,487 |
| 1990 | 17,626 | | 459 | 9,715 | 7,452 |
| 1991 | 18,862 | | 371 | 10,296 | 8,195 |
| 1992 | 20,173 | | 393 | 10,913 | 8,867 |
| 1993 | 21,563 | | 417 | 11,566 | 9,580 |
| 1994 | 23,115 | | 465 | 12,295 | 10,355 |
| 1995 | 24,699 | | 475 | 13,040 | 11,184 |
| 1996 | 26,080 | | 414 | 13,689 | 11,977 |
| 1997 | 27,529 | | 435 | 14,369 | 12,725 |
| 1998 | 30,234 | | 812 | 15,641 | 13,781 |
| 1999 | 31,929 | | 508 | 16,437 | 14,984 |
| 2000 | 17,685 | | -4,273 | 9,329 | * 12,629 |
| 2001 | 6,182 | | -3,451 | 3,923 | * 5,710 |
| 2002 | 〃 | | 0 | 〃 | 〃 |
| 2003 | 7,571 | | -1,855 | 4,178 | * 5,248 |

I. R. R. 22.53

The asterisk (*) represents that the recovery of the working capital is made in the year concerned.

3) Sensitivity analysis:

Assuming the circumstance that the construction investment, operating cost and operating income become disadvantageous by 10%, respectively, the sensitivity analysis is made, the result of which reveals that the internal rate of return (I.R.R) is as given in the following table.

| | Plan I | Plan II |
|---|---|---|
| Where the construction investment increases 10% | 19.0 | 20.9 |
| Where the operating income decreases 10% | 15.9 | 17.9 |
| Where the operating cost increases 10% | 18.1 | 20.0 |
| Where the above three conditions occur simultaneously | 11.9 | 13.9 |

8.7 Financial Evaluation:

When judging the financial effectiveness according to the abovementioned investment effect and sensitivity analysis, a high earning rate of 11.9 can be obtained even in the most pessimistic sensitivity analysis. Therefore, the conclusion can be drawn that this project is quite feasible from the financial point of view.

8.8 Economy and International Communication of Zimbabwe:

According to the component ratio by segments of the economy of Zimbabwe, agriculture accounts for 12.4%, mining industry, 7.9%, manufacturing industry, 24.8% and banking and service business, 29.9%. The percentages of the manufacturing industry and the tertiary industry are very much high comparing with those in neighboring countries. Particularly, since 1965, the imposition of economic sanction on South Rhodesia has caused remarkable progress of the manufacturing segment of substitutes of imported goods. This has created a well balanced economic situation in Zimbabwe unlike the monocultural character peculiar to other African countries.

The ratio of import to export in GDP (Gross Domestic Products) indicates that the economy of Zimbabwe depends greatly on the foreign trade with export of about 25% and import of 22% on the average in the past 10 years. The exported goods are diversified and the intermediate goods are available in the country of Zimbabwe. This makes its foreign trade advantageous. On the other hand, the trade between the Republic of South Africa and Zimbabwe accounts for 18% of its sum in export to the former, and as high a figure as 30% of the sum in import from the former. It is a weak point of Zimbabwe economy that the dependence on the Republic of South Africa is great. Particularly, in the transportation segment, the dependence on the Republic of South Africa becomes greater. This clearly envisages the circumstance under which Zimbabwe is placed.

In the international telecommunication segment which can be said to be an international transportation of information field, the Republic of Zimbabwe is also placed under the same circumstance. The telephone communications accounting for about 75% of the whole international telecommunication incoming to and outgoing from the Republic of Zimbabwe are handled through the Republic of South Africa. Therefore, the international communication of the country of Zimbabwe depends upon the communication situation of the Republic of South Africa. This means that the international communication of Zimbabwe has not yet been independent.

With a great dependance on the foreign trade, the Republic of Zimbabwe is driven by the necessity for overseas economic development. Therefore, in view of the fact that heighboring countries of SADCC such as the Republic of Malawi, etc. having closer relations with Zimbabwe in the recent years have already been equipped with the earth station in their countries, respectively, it is to be a matter of cource to install the earth station for international telecommunication.

Telecommunication is not only the infrastructure of the society of a country, but also it has, so to speak, an infrastructure-like role of infrastructure. Therefore, its national and social benefit or the so-called external economies are great that are indirect effect which cannot be measured. On the other hand, the expenses necessary for execution of this project are almost limited to the amount of investment, and the social expenses or the external diseconomies which are unable to be measured can be said to be almost none. Therefore, it is possible to expect with ease that an internal economic rate of return higher than the internal financial rate of return can be obtained.

## 8.9 Conclusion:

In this Chapter, the discussion is limited to the aspect of earnings of the international telephone in the project, and the analysis is made focusing on the financial aspect. In the financial analyses of projects concerning the international communication in the past, high rates of return are uniformly shown. The financial analysis in this report is not an exception. In the project of AOR Earth Station and IOR Earth Station (Plan I), a high rate of return of 20.60% is obtained, and in the project of AOR Earth Station, IOR Earth Station and Toll Exchanges, a high rate of return of 22.53% is obtained. It is judged that this project is financially feasible because of this high rate of return.

Telecommunication functions effectively only when the highly technical system is integrally and organically provided with certain conditions in the three fields of transmission, exchange and equipment. In this sense, this project is significant not only in the international communication, but also in the preparation for the basis of other international communication business; thus, it is possible to say that the project is of a high priority.

The Republic of Zimbabwe which is about to attain the third year after its independence intends to make further economic development and self-reliance and growth of the nation under the national development plan. The country tries to achieve internationally a true independence by getting rid of the great dependance on the Republic of South Africa. It is desired that this project should be executed as soon as possible because its execution is most urgently needed.

Table 8-1 Interest Payment & Loan Principal Repayment Schedule

(Unit: 1,000 Z$)

| Period (Year) | Foreign Loan | Cumulative Foreign Loan | Repayment of Foreign Loan | Cumulative Instalment | Balance of Foreign Loan | Interest Payment |
|---|---|---|---|---|---|---|
| 1984 | 10,048 | 10,048 | - | - | 10,048 | 352 |
| 1985 | - | 10,048 | - | - | 10,048 | 352 |
| 1986 | - | 10,048 | - | - | 10,048 | 352 |
| 1987 | - | 10,048 | - | - | 10,048 | 352 |
| 1988 | 8,080 | 18,128 | - | - | 18,128 | 634 |
| 1989 | - | - | - | - | 18,128 | 634 |
| 1990 | - | - | - | - | 18,128 | 634 |
| 1991 | - | - | - | - | 18,128 | 634 |
| 1992 | - | - | - | - | 18,128 | 634 |
| 1993 | - | - | - | - | 18,128 | 634 |
| 1994 | - | - | 906 | 906 | 17,222 | 603 |
| 1995 | - | - | 906 | 1,812 | 16,316 | 571 |
| 1996 | - | - | 906 | 2,718 | 15,410 | 539 |
| 1997 | - | - | 906 | 3,624 | 14,504 | 508 |
| 1998 | - | - | 906 | 4,530 | 13,598 | 476 |
| 1999 | - | - | 906 | 5,436 | 12,692 | 444 |
| 2000 | - | - | 906 | 6,342 | 11,786 | 413 |
| 2001 | - | - | 906 | 7,248 | 10,880 | 381 |
| 2002 | - | - | 906 | 8,154 | 9,974 | 349 |
| 2003 | - | - | 906 | 9,060 | 9,068 | 317 |
| 2004 | - | - | 906 | 9,966 | 8,162 | 286 |
| 2005 | - | - | 906 | 10,872 | 7,256 | 254 |
| 2006 | - | - | 906 | 11,778 | 6,350 | 222 |
| 2007 | - | - | 906 | 12,684 | 5,444 | 191 |
| 2008 | - | - | 906 | 13,590 | 4,538 | 159 |
| 2009 | - | - | 906 | 14,496 | 3,632 | 127 |
| 2010 | - | - | 906 | 15,402 | 2,726 | 95 |
| 2011 | - | - | 906 | 16,308 | 1,820 | 64 |
| 2012 | - | - | 906 | 17,214 | 914 | 32 |
| 2013 | - | - | 914 | 18,128 | 0 | 0 |

Tabel 8-2 Cash Flow Statement (1)

Cash Inflow

(Unit: 1,000 Z$)

| Period (Year) | Operating Revenue | Foreign Loan | Funds on Hand | Total Cash Inflow |
|---|---|---|---|---|
| 1984 | - | 10,048 | 1,760 | 11,808 |
| 1985 | 3,700 | - | - | 3,700 |
| 1986 | 4,716 | - | - | 4,716 |
| 1987 | 5,614 | - | - | 5,614 |
| 1988 | 6,744 | 8,080 | 985 | 15,809 |
| 1989 | 10,696 | - | - | 10,696 |
| 1990 | 11,764 | - | - | 11,764 |
| 1991 | 12,588 | - | - | 12,588 |
| 1992 | 13,464 | - | - | 13,464 |
| 1993 | 14,406 | - | - | 14,406 |
| 1994 | 15,413 | - | - | 15,413 |
| 1995 | 16,492 | - | - | 16,492 |
| 1996 | 17,293 | - | - | 17,293 |
| 1997 | 18,149 | - | - | 18,149 |
| 1998 | 20,200 | - | - | 20,200 |
| 1999 | 21,182 | - | - | 21,182 |
| 2000 | 10,455 | - | - | 10,455 |
| 2001 | 9,633 | - | - | 9,633 |
| 2002 | 6,182 | - | - | 6,182 |
| 2003 | 9,426 | - | - | 9,426 |

PLAN I

Table 8-2 Cash Flow Statement (2)

Cash Outflow

(Unit: 1,000 Z$)

| Period (Year) | Investment in Fixed Assets | Investment Current Assets | Operating Expenses | Repayment of Foreign Lean | Interest on Foreign Loan | Total Cash Outflow |
|---|---|---|---|---|---|---|
| 1984 | 11,808 | - | - | - | 352 | 12,160 |
| 1985 | - | 1,110 | 2,358 | - | 352 | 3,820 |
| 1986 | - | 305 | 2,836 | - | 352 | 3,493 |
| 1987 | - | 270 | 3,258 | - | 352 | 3,880 |
| 1988 | 9,065 | 339 | 3,788 | - | 634 | 4,761 |
| 1989 | - | 1,186 | 6,061 | - | 634 | 7,881 |
| 1990 | - | 320 | 6,562 | - | 634 | 7,516 |
| 1991 | - | 247 | 6,950 | - | 634 | 7,831 |
| 1992 | - | 263 | 7,361 | - | 634 | 8,258 |
| 1993 | - | 282 | 7,804 | - | 603 | 9,595 |
| 1994 | - | 302 | 8,278 | 906 | 571 | 10,057 |
| 1995 | - | 324 | 8,784 | 906 | 539 | 10,553 |
| 1996 | - | 240 | 9,161 | 906 | 508 | 10,815 |
| 1997 | - | 257 | 9,563 | 906 | 476 | 11,202 |
| 1998 | - | 615 | 10,527 | 906 | 444 | 12,492 |
| 1999 | - | 294 | 10,989 | 906 | 413 | 12,602 |
| 2000 | - | 0 | 3,525 | 906 | 381 | 4,812 |
| 2001 | - | 0 | 3,525 | 906 | 349 | 1,255 |
| 2002 | - | 0 | 3,525 | 906 | 317 | 1,223 |
| 2003 | - | 0 | 4,178 | 906 | 286 | 5,370 |

Residual Repayment of Foreign Loan: 9,068

Residual Interest on Foreign Loan: 1,430

Table 8-2 Cash Flow Statement (3)

Net Cash Flow

(Unit: 1,000 Z$)

| Period (Year) | Net Cash Flow |
|---|---|
| 1984 | -352 (*) |
| 1985 | -120 |
| 1986 | 1223 |
| 1987 | 1734 |
| 1988 | 11048 |
| 1989 | 2815 |
| 1990 | 4248 |
| 1991 | 4757 |
| 1992 | 5206 |
| 1993 | 4811 |
| 1994 | 5356 |
| 1995 | 5939 |
| 1996 | 6478 |
| 1997 | 6947 |
| 1998 | 7708 |
| 1999 | 8580 |
| 2000 | 5643 |
| 2001 | 8378 |
| 2002 | 4959 |
| 2003 | 4056 |

(*) The deficits in the initial and second years amounting to Z$ 352,000 and Z$ 120,000, respectively, are to be covered by the PTC funds on hand.

Table 8-3 Interest Payment & Loan Principal Repayment Schedule

(Unit: 1,000 Z$)

| Period (Year) | Foreign Loan | Cumulative Foreign Loan | Repayment of Foreign Loan | Cumulative Instalment | Balance of Foreign Loan | Interest Payment |
|---|---|---|---|---|---|---|
| 1984 | 15,208 | - | - | - | 15,208 | 532 |
| 1985 | - | - | - | - | 15,208 | 532 |
| 1986 | - | - | - | - | 15,208 | 532 |
| 1987 | - | - | - | - | 15,208 | 532 |
| 1988 | 8,080 | 23,288 | - | - | 23,288 | 815 |
| 1989 | - | - | - | - | 23,288 | 815 |
| 1990 | - | - | - | - | 23,288 | 815 |
| 1991 | - | - | - | - | 23,288 | 815 |
| 1992 | - | - | - | - | 23,288 | 815 |
| 1993 | - | - | - | - | 23,288 | 815 |
| 1994 | - | - | 1,164 | 1,164 | 22,124 | 774 |
| 1995 | - | - | 1,164 | 2,328 | 20,960 | 734 |
| 1996 | - | - | 1,164 | 3,492 | 19,796 | 693 |
| 1997 | - | - | 1,164 | 4,656 | 18,632 | 652 |
| 1998 | - | - | 1,164 | 5,820 | 17,468 | 611 |
| 1999 | - | - | 1,164 | 6,984 | 16,304 | 571 |
| 2000 | - | - | 1,164 | 8,148 | 15,140 | 530 |
| 2001 | - | - | 1,164 | 9,312 | 13,976 | 489 |
| 2002 | - | - | 1,164 | 10,476 | 12,812 | 448 |
| 2003 | - | - | 1,164 | 11,640 | 11,648 | 408 |
| 2004 | - | - | 1,164 | 12,804 | 10,484 | 367 |
| 2005 | - | - | 1,164 | 13,968 | 9,320 | 326 |
| 2006 | - | - | 1,164 | 15,132 | 8,156 | 285 |
| 2007 | - | - | 1,164 | 16,296 | 6,992 | 245 |
| 2008 | - | - | 1,164 | 17,460 | 5,828 | 204 |
| 2009 | - | - | 1,164 | 18,624 | 4,664 | 163 |
| 2010 | - | - | 1,164 | 19,788 | 3,500 | 123 |
| 2011 | - | - | 1,164 | 20,952 | 2,336 | 82 |
| 2012 | - | - | 1,164 | 22,116 | 1,172 | 41 |
| 2013 | - | - | 1,172 | 23,288 | 0 | 0 |

Tabel 8-4 Cash Flow Statement (1)

Cash Inflow

(Unit: 1,000 Z$)

| Period (Year) | Operating Revenue | Foreign Loan | Funds on Hand | Total Cash Inflow |
|---|---|---|---|---|
| 1984 | - | 15,208 | 1,760 | 16,968 |
| 1985 | 3,700 | - | - | 3,700 |
| 1986 | 6,329 | - | - | 6,329 |
| 1987 | 8,696 | - | - | 8,696 |
| 1988 | 10,723 | 8,080 | 985 | 19,788 |
| 1989 | 16,096 | - | - | 16,096 |
| 1990 | 17,626 | - | - | 17,626 |
| 1991 | 18,862 | - | - | 18,862 |
| 1992 | 20,173 | - | - | 20,173 |
| 1993 | 21,563 | - | - | 21,563 |
| 1994 | 23,115 | - | - | 23,115 |
| 1995 | 24,699 | - | - | 24,699 |
| 1996 | 26,080 | - | - | 26,080 |
| 1997 | 27,529 | - | - | 27,529 |
| 1998 | 30,234 | - | - | 30,234 |
| 1999 | 31,929 | - | - | 31,929 |
| 2000 | 21,958 | - | - | 21,958 |
| 2001 | 9,633 | - | - | 9,633 |
| 2002 | 9,633 | - | - | 6,182 |
| 2003 | 9,426 | - | - | 9,426 |

PLAN II

Table 8-4 Cash Flow Statement (2)

Cash Outflow

(Unit: 1,000 Z$)

| Period (Year) | Investment in Fixed Assets | Investment Current Assets | Operating Expenses | Repayment of Foreign Lean | Interest on Foreign Loan | Total Cash Outflow |
|---|---|---|---|---|---|---|
| 1984 | 16,968 | - | - | - | 532 | 17,500 |
| 1985 | - | 1,110 | 2,358 | - | 532 | 4,000 |
| 1986 | - | 789 | 3,991 | - | 532 | 5,312 |
| 1987 | - | 710 | 5,105 | - | 532 | 6,347 |
| 1988 | 9,065 | 608 | 6,057 | - | 815 | 16,545 |
| 1989 | - | 1,612 | 8,997 | - | 815 | 11,424 |
| 1990 | - | 459 | 9,715 | - | 815 | 10,989 |
| 1991 | - | 371 | 10,296 | - | 815 | 11,482 |
| 1992 | - | 393 | 10,913 | - | 815 | 12,121 |
| 1993 | - | 417 | 11,566 | - | 815 | 12,798 |
| 1994 | - | 465 | 12,295 | 1,164 | 774 | 14,698 |
| 1995 | - | 475 | 13,040 | 1,164 | 734 | 14,679 |
| 1996 | - | 414 | 13,689 | 1,164 | 693 | 15,960 |
| 1997 | - | 435 | 14,369 | 1,164 | 652 | 16,620 |
| 1998 | - | 812 | 15,641 | 1,164 | 611 | 18,228 |
| 1999 | - | 508 | 16,437 | 1,164 | 571 | 18,680 |
| 2000 | - | 0 | 9,329 | 1,164 | 530 | 11,023 |
| 2001 | - | 0 | 3,923 | 1,164 | 489 | 5,576 |
| 2002 | - | 0 | 3,923 | 1,164 | 448 | 5,535 |
| 2003 | - | 0 | 4,178 | 1,164 | 408 | 5,750 |

Residual Repayment of Foreign Loan: 11,648

Residual Interest on Foreign Loan: 4,282

Table 8-4 Cash Flow Statement (3)

Net Cash Flow

(Unit: 1,000 Z$)

| Period (Year) | Net Cash Flow |
|---|---|
| 1984 | -232 (*) |
| 1985 | -300 |
| 1986 | 1017 |
| 1987 | 2349 |
| 1988 | 3243 |
| 1989 | 4672 |
| 1990 | 6637 |
| 1991 | 7380 |
| 1992 | 8052 |
| 1993 | 8765 |
| 1994 | 8417 |
| 1995 | 10020 |
| 1996 | 10120 |
| 1997 | 10909 |
| 1998 | 12006 |
| 1999 | 13249 |
| 2000 | 10935 |
| 2001 | 4057 |
| 2002 | 647 |
| 2003 | 3676 |

(*) The deficits in the initial and second years amounting to Z$ 232,000 and Z$ 300,000, respectively, are to be covered by the PTC funds on hand.

Appendix

# AOR Earth Station Project

(Unit: 1000Z$)

| Item / Year | Income | Expenditure | | | Profit |
|---|---|---|---|---|---|
| | | Installation Cost | Working Capital | Maintenance & Operating Cost | |
| 1984 | | 11,808 | | | -11,808 |
| 1985 | 3,700 | | 1,110 | 2,358 | 232 |
| 1986 | 4,716 | | 305 | 2,836 | 1,575 |
| 1987 | 5,614 | | 270 | 3,258 | 2,086 |
| 1988 | 6,744 | | 339 | 3,788 | 2,617 |
| 1989 | 7,417 | | 202 | 4,105 | 3,110 |
| 1990 | 8,158 | | 222 | 4,453 | 3,483 |
| 1991 | 8,731 | | 172 | 4,723 | 3,836 |
| 1992 | 9,340 | | 183 | 5,009 | 4,148 |
| 1993 | 9,995 | | 196 | 5,308 | 4,491 |
| 1994 | 10,694 | | 210 | 5,645 | 4,839 |
| 1995 | 11,443 | | 225 | 5,997 | 5,221 |
| 1996 | 12,244 | | 240 | 6,373 | 5,631 |
| 1997 | 13,100 | | 257 | 6,776 | 6,067 |
| 1998 | 14,018 | | 275 | 7,207 | 6,536 |
| 1999 | 15,000 | | -4,206 | 7,669 | *11,537 |

I. R. R. *21.62*

The asterisk (*) represents that the recovery of the working capital is made in the year concerned.