2-6 International Circuits

Cairo - Aswan - Abu Simbel microwave system to be constructed by this project is to handle not only the national traffic in Egypt but the international traffic also.

National traffic forecast and calculation of circuits required to cater for that traffic were made in the preceding paragraphs. This paragraph deals with international traffic forecast and calculation of circuits required to carry international traffic.

2-6-1 International Traffic Forecast by ARENTO

Telephone traffic forecast as of 1984 made by ARENTO and the number of circuits required to relieve the traffic are given in Table 2-6-1.

According to Table 2-6-1, international telephone traffic as of 1984 is approximately 950 Erlangs, and the circuits required, including standby circuits, total 1,600.

Out of that international telephone traffic, the traffic assumed to flow via Cairo - Abu Simbel microwave system is to/from the undermentioned countries.

Somalia:	0.87 erl.	5 circuits
Sudan:	47.90 erl.	64 circuits
Ethiopia:	0.87 erl.	5 circuits
Kenya:	0.87 erl.	5 circuits
Total	50.51 erl.	79 circuits

Table 2-6-1 (1/2) Traffic Data of International Calls

Total Circuits: 1,600 (1984)

System	No. of Circuits	Traffic (erl)	System	No. of Circuits	Traffic (erl)	Note
CCITT No.5						
England	78	59.8	Mauritania	5	0.87	
Spain	9	3.15	Ethiopia	5	0.87	
France	70	52.4	Kenya	5	0.87	
Belgium	5	0.87	Naigeria	5	0.87	
Holland	5	0.87	Turkey	5	0.87	
Skandenavia	9	3.13	Iran	5	0.87	
W. Germany	51	36.1	Pakistan	5	0.87	
E. Germany	9	3.13	India	5	0.87	
Rumanien	9	3.13	China	5	0.87	
Austria	9	3.13	Hong-Kong	5	0.87	
Switzerland	47	32.5	Japan	5	0.87	
Yougoslavia	9	3.13	Israel	9	3.1	
Cyprus	9	3.13				
U.S.A.	78	59.8	Total	1,010	660.8	
Canada	18	9.65	Spare	112		
Australia	9	3.13	Grand Total	1,122	660.8	
Iraq	27	16.1				
Jordan	27	16.1				
Kuwait	56	40.6				
Bahrein	56	40.6				
Qatar	38	25.5				
Imaratt	92	71.9				
Oman	5	0.87				
Saudi Arabia	128	104.9				
Yemen "Sanaa"	9	3.13				
Yemen "Aden"	5	0.87				
Somalia	5	0.87				
Sudan	64	47.9				
Algeria	5	0.87				
Morrocco	5	0.87				

Table 2-6-1 (2/2)   Traffic Data of International Calls

System	No. of Circuits	Traffic (erl)	System	No. of Circuits	Traffic (erl)	Note
CCITT No.4	OG-IC	OG - IC	R2		OG - IC	
Lybia	36-75	23.8 -57	Syria	14- 21	6.61-12.10	
Tunis	7-7	1.96- 1.92	Lebanon	29- 42	18.65-29.89	
USSR	5-6	0.87- 1.35	Italy	23- 42	13.65-29.89	
Total	48-88	26.58-60.27	Greece	41- 82	29.01-66.29	
Spare	6-10		Total	107-187	67.92-138.17	
Grand Total	54-98	26.58-60.27	Spare	11-21		
			Grand Total	118-208	67.92-138.17	

The traffic above accounts for about 5% of the total international telephone traffic. The circuits also account for about 5% of all international telephone circuits.

2-6-2 International Telephone Traffic Forecast by Years

From the forecasted international traffic as of 1984, the international calling rate per subscriber can be known as

$$953.74 \text{ erl.} \div 1,183,078 \doteqdot 0.00081$$

Usually, the local calling rate per subscriber trends to descend as the telephone density ascends. (Refer to ITU: "Local Network Planning.")

Such calling rate downtrend is the case with the toll and international calling rates also. However, in case where the automatic toll and international telephone service plans are in progress, the calling rate downtrend does not seem to appear conspicuously.

Hence, for international telephone traffic forecast in each year of forecast, this time, the international calling rate per subscriber of 0.00081 Erlangs is used. Gross international calling traffic in each year of forecast follows:

1991	1,633 erl.
2001	3,513 erl.

Egypt - Sudan traffic ratio to gross international calling traffic will not vary broadly as long as the world relations continue as they are. Hence, Egypt - Sudan calling traffic in each year of forecast can be forecasted as follows:

1991	82 erl.
2001	176 erl.

2-6-3 International Circuits Required by Years

Based on the traffic forecasts by years made in the preceding paragraph, the international circuit requirements are forecasted. The number of circuits required in each year of forecast can be obtained by

$$N = N_1 + N_2$$

where

N : Number of circuits required in each year of forecast

N_1 : Number of circuits for telephone service

N_2 : Number of circuits for non-voice communication services

The formula whereby to obtain N_1 follows:

$$En\ (A) = \frac{\frac{A^n}{n!}}{\sum_{i=0}^{n} \frac{A^i}{i!}} \quad \text{(Erlang B formula)}$$

where

$En\ (A)$: Allowable call loss rate (to be 0.01 from Table 2-6-1)

A : Basic traffic + overload traffic (20% of basic traffic)

n : Number of circuits required

N_2 is the sum total of circuits required for telex, telegraph and data communication services.

In the forecast, this time, N_2 is set at 30% of required circuits for telephone service. This decision is made in consideration of non-voice communication service circuits installed in Egypt, as well as the worldwide trend of demand for data communication service.

Calculation results by years are:

1991	151 circuits
2001	344 circuits

CHAPTER 3
FDM MICROWAVE
COMMUNICATION NETWORK PLAN

3. FDM Microwave Communication Network Plan

3-1 Outline of Microwave Communication Network

Microwave communication network envisaged in this project is composed of Opera Exchange, Cairo, as radio terminal, Ramses Exchange as carrier terminal, and Abu Simbel Exchange near the national boundary with Sudan as route terminal. After Ramses, the route traverses Upper Egypt along the Nile and proceeds by way of Aswan before reaching Abu Simbel.

This microwave route constitutes an integral part of Pan-African Telecommunications Network Plan. As such, it is to be extended into Sudan and to be operated as an international system in the future.

Between Abu Simbel terminal exchange and the border with Sudan, one through repeater station is to be newly established so that the system can be easily linked with the Sudan side microwave station.

In Upper Egypt, four tubes of coaxial cables are installed between Cairo and Aswan, providing two coaxial systems, each with capacity for 960 telephone channels. LDC service in this section is now available through these coaxial cables. When the microwave system is constructed by this project, two communication routes - cable and radio routes - can be realized in Upper Egypt. By this means, service performance can also be improved.

Furthermore, when the microwave system carrier terminal is installed in the existing coaxial cable system terminal, one system can relieve the other should either system fall into trouble. This very fact plus peculiar radio propagation characteristics were taken into consideration in Cairo - Aswan section station site selection.

Between Aswan and Abu Simbel, a highway (distance: approx. 300 km) is presently under construction. For about 50 km from Aswan and Abu Simbel, respectively, the paved road has already been completed. However, about 200 km long intermediate section consists of road marking only so that the whole road cannot as yet be distinctly indicated on the map. (The completion is scheduled two years after.)

The area from near the middle point of the section to Abu Simbel is spotted with 30 - 70 m high hills. this fact could be known by the crossing of desert in the section during field survey. Hence, for station site selection in this area, further detailed survey will be necessary after the highway completion.

In the section between radio terminal (Opera Exchange) and carrier terminal (Ramses Exchange) in the municipality of Cairo, the circuit formation is to be carried out, using both radio and cable systems. This is at the request of ARENTO and for the purpose of service performance improvement.

In Aswan area, because of necessity to clear the ridge between R_{16} and Aswan Branch (as seen in the profile map), the design is so made that Aswan Branch site be chosen atop the hill with an elevation of 180 m, and that Aswan Branch be directly connected to R_{17}, the first repeater station in Aswan - Abu Simbel section where the elevation measures 200 m. Therefore, Aswan Branch is to become radio terminal to function as branch station and to be connected to Aswan coaxial terminal by radio branch link.

3-2 Frequency Assignment Plan

The projected microwave system is to operate as the national backbone system and, at the same time, as an international system also. Hence, in this microwave system, 6 GHz band (upper) radio frequency (RF) channel arrangement, as per CCIR Rec. 384-2, will be used.

For radio circuit between Opera Exchange (radio terminal) and Ramses Exchange (carrier terminal) in the municipality of Cairo, 15 GHz band RF channel arrangement should preferably be used. This is to avoid radio interference because at Ramses Exchange a large number of PCM trunk circuits of 11 GHz band are used at present.

Meanwhile, 15 GHz band RF channel arrangement is only reported by CCIR Report 607-1. Way of use of point frequency is not mentioned. Therefore, the standard RF channel arrangement used by NTT, Japan, is adopted.

In the section between Aswan Branch station that requires branch circuit from 6 GHz band main microwave route and Aswan (carrier terminal) also, 15 GHz band frequency should preferably be used.

When high frequency band, such as 15 GHz band, is used, attenuation due to rainfall poses a problem.

For attenuation due to rainfall, radio propagation distance is a parameter. In the microwave system planned this time, the propagation distance is short; furthermore, in Egypt, the precipitation, i.e., the cumulative distribution of rainfall intensity per minute, is extremely small and does not exert an influence on system performance at all.

Since the high frequency band is used, the projected microwave system can transmit 2,700 telephone channels per RF channel. This fact will be effective a great deal in solving the future trunk call increase in Cairo or, more precisely, between Opera Exchange and Ramses Exchange.

3-3 Transmission Capacity

Transmission capacity of each section of the projected microwave system route is provided below.

(1) For Cairo - Aswan section, transmission capacity is of 1,800 channels for national service link and international service link, respectively.

(2) For Aswan - Abu Simbel - Sudan border international link, transmission capacity is of 960 channels. However, in view of the connection of frequency comparing pilot (to Aswan and Aswan branch circuits), the actual use of frequency is in SG 2 - SG 16 (900 channels) band.

(3) For (1) above, frequency arrangement and channel capacity are to be based on CCITT Rec. G 423, Figure 6, and for (2) above, on the same recommendation, Figure 4.

3-4 Basic philosophy of Transmission Routing

The basic philosophy of transmission route setting in this microwave system consists of the following considerations:

(1) To calculate and install the number of channels required for mutual connections among nine major cities of Upper Egypt (Beni Suef, El Minya, Asyut, Sohag, Qena, Luxor, Aswan, Abu Simbel and Faiyoum) and for connection between the area centering upon each city mentioned and the areas north of Cairo (Tanta, Ismailia, etc.), based on the traffic forecast as of 1991.

(2) To convert the calculated number of channels by 10 VF for 1 G and to accommodate all newly installed channels in this microwave route, in principle.

(3) To separate about 50% of links interconnecting eight cities (the abovementioned nine cities minus Abu Simbel) from the existing Cairo - Aswan coaxial cable route and to accommodate those links in this microwave route.

(To the above arrangement, ARENTO agreement has been obtained. However, for 50% separation of all links from the existing route and accommodation thereof in this microwave route, arrangement could not be made completely. The reason is that the existing inter-city links are not exactly appropriate in number when each city population and inter-city distance, as well as office hierarchy, are considered.)

(4) To accommodate in this international microwave channel 15 SG x 1 out of 15 SG x 2 in Cairo - Asyut section as national transmission route, and to make SG connection in Aswan for the other 15 SG x 1 to be used as international transmission route and extend it to Abu Simbel - Sudan.

3-5 Interconnection of Existing Transmission Routes

(1) National transmission route out of this microwave system is to be so arranged that at eight terminal exchanges (Cairo-Ramses, Beni Suef, El Minya, Asyut, Sohag, Qena, Luxor and Aswan), interconnections at SG, G and voice stages will become possible.

(2) Implementation of this project makes it necessary to increase collateral transmission routes to/from north of Cairo and to/from Faiyoum. ARENTO should formulate implementation plans for those transmission routes as early as possible. (Required cost for construction of those collateral transmission routes is not included in the cost of this project.)

(3) Between Opera and Ramses Exchanges, Cairo, two transmission routes, i.e., coaxial cable and radio routes, are to be established, and both routes are to be baseband-connected. By this means, mutual relief between the two routes by automatic changeover when trouble develops in either route becomes possible.

3-6 Radio Propagation Path, Antenna and Tower Height

3-6-1 Radio Propagation Path

In the case of microwave system planned this time, the system route extends along the Nile, one of the biggest rivers in the world. Therefore, the most part of system route consists of smooth spherical earth propagation path, as seen in the profile map (ANNEX 3-14).

Field survey was made for the following items, using a map of 1/100,000 scale obtained at the time of survey:

(1) Accident of earth in each propagation hop

(2) Clearance between cliffy hills on both sides of Nile basin (green belt zone), and radio path

(3) Height and kind of trees in each propagation hop

(4) Height of buildings in urban area

(5) Whether the area where the type of structure or its height is restricted exists or not

(6) Wehther structures/places of historical importance, as well as tourism related restrictions, exist or not

Where necessary, at-site measuring was carried out, using theodolite.

Mirror test of visibility was not made. This was because the propagation path is smooth spherical earth for the most part and the distance of each propagation hop is nearly 40 km.

Therefore, at the time of project implementation, more detailed field survey by use of more detailed maps should be carried out as far as possible, in order to make sure of topographic features of radio propagation path once again.

3-6-2 Antenna and Tower Height

Generally, radio propagation suffers serious influences from variations of meteorological conditions (temperature and humidity) on radio path. This is because of the intrinsic character of radio propagation.

The projected microwave system is to be constructed in the belt form granary zone in Nile basin, where the specific heat varies from that in the surrounding desert. In this area, atmospheric conditions near ground surface (especially less than 50 m from ground surface) are considered to change to no small degree according to seasons and between day-time and night-time.

This time, the most part of propagation path consists of smooth spherical earth where reflected wave attenuation cannot be expected. Hence the strict requirement for propagation.

For this reason, the system design must be the economically optimum design based on accurate study to meet actual field conditions and having a proper margin to propagation requirements taken into account. Thus, during the field survey, utmost efforts were exerted to obtain meteorological data of Egypt and measured propagation data on OBTF's 2 GHz Cairo - Aswan microwave system, but in vain due to the time shortage of data preparation by the authorities concerned.

Such being the circumstances, the following considerations were made in determining propagation distance, antenna size, antenna height and tower height:

(1) To set the standard propagation distance at 40 km.

(2) In some sections, propagation distance may be reduced to less than 40 km. Such sections include Luxor - Aswan section where the Nile meanders and the section where the terminal station should co-exist with the existing coaxial terminal and both are to be mutually connected.

(3) To set antenna height in urban area at 40 m at the lowest.

(4) In the case of K = 4/3 and propagation distance = 40 km, radio path height be 50 m or more above ground surface.
In this connection, antenna height be so determined as to secure field intensity in the first Fresnel zone at K = 2/3, with antenna heights at both neighboring sites increased by 10 m.
However, when necessary propagation data can be obtained in the future, antenna height and tower height may be reduced accordingly, based on such data.

(5) To determine antenna size in consideration of the system being 6 GHz band backbone microwave system, as well as radio interference and thermal noise in smooth spherical earth propagation path.

Antenna mounting position and tower height, and type of antenna required are illustrated in ANNEX 3-12. For tower, structural selection is to be made by the following criteria:

(1) To select self-supporting type tower at each site between Cairo and Aswan, where land available is restricted.

(2) To select guyed tower at each site south of Aswan except Abu Simbel and at four sites in Aswan - Cairo section where as large land as required can be obtained.

3-7 Site Selection and Related Requirements

3-7-1 In addition to the previously described basic philosophy of site selection, there also are important items to be studied for radio propagation. Those items belong to the economic and social aspects of site selection; they include land procurement, transport facilitation, and road making. Concerning those items, ARENTO presented requests to be considered during the field survey for site selection. Sites selected do primarily satisfy the conditions required of radio propagation. At the same time, the selection reflects top care rendered to the following points:

(1) Sites be the places where ARENTO's existing facilities can be utilized to the greatest possible extent.

(2) Sites be the Government/ARENTO owned lands as far as possible.

(3) Sites be the locations that allow maximum utilization of existing roads, thus minimizing the need for new road construction.

3-7-2 The following description is about the status quo of the existing exchanges scheduled to be used in this project, as well as the aspects wherein those exchanges require special attention. Also described are such affairs of newly selected sites. (Refer to ANNEX 3-15)

(1) Ramses Exchange (Cairo)

Ramses Exchange constitutes the center of toll transmission system. Almost all main transmission terminals in Egypt are accommodated in Ramses Exchange. Therefore, in the initial plan, the radio terminal by this project was to be established in Ramses Exchange, but this plan had to be reconsidered.

First, the existing tower does not hold sufficient strength to allow additional antenna mounting. Second, the construction of new tower on the roof of exchange building is difficult. Third, when antenna is established on the roof of exchange building, the required antenna height can hardly be secured because of high building construction possibilities in the urban sector of Cairo City, so that the antenna site may have to be moved to another place in the future.

Hence, the radio terminal by this project is to be established in Opera Exchange (Cairo) instead of Ramses Exchange. For the reasons mentioned above, Ramses Exchange is used for establishing the carrier terminal.

1) Site

The site of Ramses Exchange is in the urban sector of Cairo City. Two buildings occupy the site almost completely. Hence no land space to spare.

2) Tower

Two towers exist on the roof of the newer building.

On one of the two towers is mounted the antenna (3.3 mø) for linking Ramses Exchange with the satellite system earth station (Maady Station). On the other tower are mounted 12 antennas for 11 GHz band PCM system for local trunking.

Out of the two towers, the former is not designed to allow additional antenna mounting. the latter is fully occupied, leaving no space for additional antenna mounting.

3) Equipment to be Installed

Equipment to be installed in Ramses Exchange comprise a full set of 15 GHz band radio equipment, a full set of antennas, a full set of carrier equipment and a full set of power supply equipment.

For antennas, space for establishment can be found on the exchange building roof. Tower housing section leaves space for installation of radio equipment, but the final selection of place for installation is up to ARENTO. Carrier equipment should preferably be installed in idle space of the room where the carrier equipment of microwave system to Alexandria is installed.

Power supply equipment is also to be installed independently. However, investigation about the place for installation could not be made because the time for such investigation was not available.

(2) Opera Exchange (Cairo)

Opera Exchange is presently the terminal exchange of microwave system to Alexandria. The exchange building is 27 storied. For roof-top antenna, a height of 70 m or more can be secured. Roof-top antenna establishment is possible.

1) Site

Opera Exchange, like Ramses Exchange, is located in the central part of Cairo City's urban sector. The exchange building utilizes the site to the maximum. Hence no land space to spare.

2) Tower

Tower does not exist. The exchange building is such in construction that antenna establishment on the roof is possible. Therefore, the antenna to be used in this project can be established on the roof. However, for structural details of antenna mounting, through study prior to project implementation is required.

3) Equipment to be Installed

Equipment to be installed in Opera Exchange comprise a full set of 6 GHz band and 15 GHz band radio equipments, a full set of antennas, a full set of carrier equipment and a full set of power supply equipment.

Transmission system equipment should preferably be installed in idle space of the room in tower housing section where the existing equipment is installed; however, decision could not yet be made at the time of field survey. Hence, for final selection of place for installation, ARENTO is requested to make further investigation prior to the implementation of this project.

(3) R_1 Station

For the next repeater station from the city section of Cairo, consideration is necessary to select such site where the radio propagation path can maintain sufficient height and where the terms of location are effective to satisfy radio propagation characteristics.

1) Site

The site is in the earth desert adjoining the highway that directly connects Cairo and Faiyoum. The site is completely the Government owned land. As large land space as necessary can be obtained.

2) Tower

Since the sufficiently large site land can be obtained, guyed tower is used.

3) Equipment to be Installed

Station building is to be newly constructed. Radio equipment and power supply equipment are to be installed in the station. For station details, such as construction, refer to Paragraph 3-12.

4) Others

Since the site adjoins the highway, there is no need for road making. However, because of the surrounding earth desert, access road to the site may have to be covered with sand.

Commercial power supply to the site cannot be expected at the present stage but will be available in the not long future. For, along Cairo - Faiyoum highway, the industrial complex formation plan is being implemented gradually.

(4) R_2 Station

1) Site

The site is in the earth desert near Soft El Sharkeia. Since the site is the Government owned land, there is no difficulty in the required land procurement.

2) Tower

As in the case of R_1 Station, guyed tower is used. Availability of sufficiently large site land is the reason.

3) Equipment to be Installed

The station building is to be newly constructed as is the case with R_1 Station. However, because of possible commercial power availability, power supply equipment to be installed differs in type from the equipment for R_1 Station.

4) Others

As of the present, commercial power is available at Soft El Sharkeia, so that power line extension for about 500 m to the station site is necessary.

(5) Beni Suef Exchange

1) Site

The existing exchange site leaves no idle land space at all. The exchange building itself is surrounded by other buildings. However, a privately owned land, about 35 m x 45 m large, exists, striding over the road to the exchange building entrance. This land is not used now, so that it must be procured.

2) Tower

The exchange site is not the Government owned land. Hence, to utilize the land effectively, tower is to be self-supporting type tower. Compared with guyed tower, self-supporting type tower provides greater mounting space for various kinds of antennas and greater ease for feeder mounting. When used at the terminal exchange in urban sector, it can be utilized effectively in many ways in the future.

3) Equipment to be Installed

Land where to construct tower lies 60 - 80 m away from the existing exchange building so that the radio building where to install radio equipment is to be constructed near the tower. Same is the case with power supply equipment building also. Carrier equipment is to be installed in idle space of the carrier equipment room in the existing exchange building. Sufficiently large space for additional installation is available in the existing carrier equipment room.

Since radio equipment and carrier equipment are to be installed in separate buildings, connection between these equipments is to be baseband connection by use of coaxial cable.

4) Others

For power supply, commercial power is utilized. Power supply system is from newly built power equipment building to radio equipment and carrier equipment.

(6) R_3 (Ekfes) Station

1) Site

The site is the well leveled, Government owned land. There is no difficulty to the procurement of land where to construct station building and tower.

2) Tower

The site, though the Government owned land, is small sized. Hence, for tower, self-supporting type tower is used.

3) Equipment to be Installed

Station building is to be newly constructed. Radio equipment and power supply equipment are to be installed in the station.

4) Others

Commercial power supply is available. Although the site location is distant from the highway and the branch road to the site is not paved, the road itself is 4 - 5 m wide so that no impediment is found to equipment and material transport to the site.

(7) R_4 (Heloa) Station

1) Site 2) Tower 3) Equipment to be Installed 4) Others	Same as in the case of R_3 Station

(8) El Minya Exchange

1) Site

Front and back sides of exchange building face the road. Exchange building is L shaped when viewed from the front. Idle land space of about 33 x 28 m lies in the inner yard between exchange building and Post office.

2) Tower

The site is the inner yard so that, to use the land effectively, self-supporting type tower is used. As the result of tower height at this exchange being reduced to the possible minimum, tower heights at R_4 Station and R_5 Station are necessarily increased.

3) Equipment to be Installed

Installation space for both radio equipment and carrier equipment can be obtained in the existing carrier equipment room. For power supply equipment, installation space remains undecided. ARENTO is requested to make further investigation of exchange building and find installation space for power supply equipment.

4) Others

Power supply system is so designed that it can utilize commercial power supply. Land space where to construct tower is the inner yard so that, at the time of tower construction, there is need for land protection by sheathing, etc., so as to prevent trouble.

(9) R_5 (Derouwa) Station

1) Site

The site is the Government owned land. There is no difficulty to the procurement of land where to construct station building and tower. However, the site is presently the farmland so that it requires ground leveling to some extent.

2) Tower

The site, though the Government owned land, is small sized. Hence, for tower, self-supporting type tower is used.

3) Equipment to be Installed

Station building is to be newly constructed. Radio equipment and power supply equipment are to be installed in the station.

4) Others

Commercial power supply is available. The site location is distant from the highway and the branch road to the site is not paved. However, the branch road is 4 - 5 m wide so that no impediment is found to equipment and material transport to the site.

(10) R_6 (Baruto) Station

1) Site 2) Tower 3) Equipment to be Installed 4) Others	Same as in the case of R_5 Station

(11) Asyut Exchange

1) Site

The site itself is relatively large sized, but many buildings are already constructed on it. At the back of building where the existing carrier equipment is installed, idle land space that can be used, this time, is available. This land space is about 24 x 20 m large.

2) Tower

Spare land space at the site is small. Hence, for tower, self-supporting type tower is used. In the system design, tower height is reduced to the possible minimum.

3) Equipment to be Installed

Land where to construct tower is about 40 m separated from the existing exchange building. Out of all facilities in the existing exchange building, the existing carrier equipment room is farthest located from tower site. Therefore, building where to install radio equipment and power supply equipment should be constructed on the same site as tower. For connection between radio equipment and carrier equipment, which will be installed in separate buildings, connection between carrier equipment and radio equipment is to be adopted by using coaxial cable. Power supply to carrier equipment is from newly constructed exchange building.

4) Others

Same as in the case of Beni Suef Exchange.

(12) R_7 (El Diweir) Station

1) Site	Same as in the case of R_6 Station
2) Tower	
3) Equipment to be Installed	

Note: The site requires banking because its ground level is lower than the road surface.

4) Others

Commercial power supply can be utilized if the power line is extended for about 600 m to the station. Road to the station, though not the main road, is the well maintained, paved road, about 5 m wide.

(13) R_8 (El Tilihat) Station

1) Site
2) Tower
3) Equipment to be Installed

Same as in the case of R_7 Station (items 1)–3) above)

4) Others

Commercial power supply is available. Road to the station is paved for the most part though partly not paved. Road width is 4 - 5 m. Hence no difficulty to equipment and material transport to the station.

(14) Sohag Exchange

1) Site

The existing exchange building completely occupies the site. The site itself is in urban sector. The surrounding area is thickly settled with roads and buildings. No idle land space at all where to construct tower.

Tower site selected is the Government owned land distant from urban sector. This Government owned land is 2 - 3 km separated from the existing exchange building. The site is about 60 x 40 m large.

2) Tower

Self-supporting type tower proportional to the size of site is used.

3) Equipment to be Installed

Since the tower site is 2-3 km distant from the existing exchange building, building where to install radio equipment and power supply equipment must be newly constructed near the tower.

Carrier equipment is to be installed in the carrier equipment room in the existing exchange building. connection between carrier equipment and radio equipment is to be baseband connection using coaxial cable.

Power supply equipment to carrier equipment must be installed in the existing exchange building. ARENTO is requested to make necessary investigation and select proper place for installation of power supply equipment, prior to implementation of this project.

4) Others

Commercial power supply is available at tower site and in the existing exchange building. tower site faces the paved highway, but the ground level at tower site is lower than the road surface. Hence the need for tower site banking.

(15) R_9 (Abydos) Station

1) Site

The site is an earth desert land located on a hill south of Seti I Catheral relics with a village in between. The site itself is the Government owned land and is sufficiently large.

2) Tower

Since the site is fufficiently large, guyed tower is used.

3) Equipment to be Installed

Station building is to be newly constructed. Radio equipment and power supply equipment are to be installed in the station.

4) Others

Commercial power supply is available. Road from the highway to the relics is the well maintained, paved road. From the relics to tower site, road is narrow, traversing the village. However, no specific difficulty to equipment and material transport to tower site is anticipated. Nevertheless, this road may not allow easy passage of large vehicles, such as crane trucks, so that thorough re-investigation must be made prior to implementation of this project.

(16) R_{10} (El Qsar) Station

1) Site

The site is located beside a small sandstone hill. Therefore, land formation will be necessary. The site itself is the Government owned land so that the expropriation is not difficult.

2) Tower

Self-supporting type tower proportional to the size of site is used.

3) Equipment to be Installed

Same as in the case of R_9 Station.

4) Others

Commercial power supply is available if the power line is extended from the nearby village. Power line extension required is for about 500 m.

(17) Qena Exchange

1) Site

Idle land space, about 30 x 20 m large, lies beside the existing exchange building.

2) Tower

since the site is limited in size, self-supporting type tower is used.

3) Equipment to be Installed ⎫ Same as in the case
4) Others ⎭ of El Minya Exchange

(18) R_{11} (Hegaza) Station

1) Site

The site is the Government owned land. There is no difficulty to procurement of land where to construct station building and tower.

2) Tower

To utilize the site effectively, self-supporting type tower is used.

3) Equipment to be Installed

Station building is to be newly constructed. Radio equipment and power supply equipment are to be installed in the station.

4) Others

Commercial power supply is available. Road to Hegaza is the well maintained, paved road.

(19) Luxor Exchange

1) Site

The existing exchange site leaves no idle land space at all. The exchange building itself is surrounded by other buildings and roads. However, the Government owned land exists, looking on to the road along the Nile. This land is about 1.6 km far from the existing exchange. It requires land formation by banking.

2) Tower
3) Equipment to be Installed
4) Others

} Same as in the case of Sohag Exchange

(20) R_{12} (Nag Khamis) Station, R_{13} (Isna) Station, R_{14} (El Soayda) Station

These three repeater stations basically share the same requirements as R_{11} (Hegaza) Station. Differences are that R_{13} (Isna) Station site requires land formation by banking and R_{12} (Nag Khamis) Station site requires land formation by cutting. When the cutting is carried out, consideration in excavation is required to prevent water leak from nearby canal.

(21) R_{15} Station

1) Site

The site is selected from the angle of radio propagation. In this area, rocky hills approach to the Nile. The site selected is on hill-top where access road to be constructed can be shortest in length and where radio propagation requirements can be satisfied. The site itself is the Government owned land.

2) Tower

Since the site is on rocky hill-top and large land space cannot be obtained, self-supporting type tower is used.

3) Equipment to be Installed

Station building is to be newly constructed. Radio equipment and power supply equipment are to be installed in the station.

4) Others

Commercial power supply is not available. Access road to the site, about 700 m in length, must be constructed from the middle part of the hill where the highway proceeds. For land formation at the site, hill-top rock excavation is necessary.

(22) R_{16} Station

1) Site

The site is on mild desert hill. The site itself is the Government owned land. Sufficiently large land space can be procured.

2) Tower

Since large land space can be procured at the site, guyed tower is used.

3) Equipment to be Installed

Same as in the case of R_{15} Station.

4) Others

Commercial power supply is not available. Since the site is on desert hill, land formation and access road construction are necessary. to the flat land near the hill, about 5 m wide paved road proceeds, branching from the highway.

(23) Aswan Branch

1) Site

In order that the radio propagation path can clear the ridge on the way to R_{16} Station (refer to Paragraph 3-1), Aswan Branch site is selected on a hill with an elevation of 180 m. Rocky hill-top requires reformation intended for land formation.

2) Tower

For effective use of hill-top site and because of a large number of antennas that must be mounted as is the case with branching station, self-supporting type tower is chosen.

3) Equipment to be Installed

Radio equipment to be installed at this branching station comprises two sets of 6 GHz band terminal type equipment (1 RF 1,800 CH for transmission to Cairo and 1 RF 900 CH for transmission to Abu Simbel) and one set of 15 GHz band equipment (1 RF 2,700 CH) for transmission to Aswan.

Carrier equipment to be installed is the type that performs 1,800 CH and 900 CH large bundle connections. This is because radio equipment baseband alignment varies from equipment to equipment, so that necessary minimum conversion must be made for the purpose of interconnections among equipment.

Power supply equipment to be installed is the type that is useful when commercial power supply is not available.

4) Others

Rocky hill-top site necessitates access road construction. Road construction work will be necessary for a distance of about 1 km.

(24) Aswan

1) Site

The site is on the Nile embankment in urban sector of Aswan City. Except on the front side that faces the road, the site is surrounded with buildings. No vacant land space at all inside the site limits.

2) Tower

Considering locational relationship with Aswan Branch, antenna mounting frame of roof-top type or equivalent will be fully serviceable. However, careful study of city planning must be made prior to project implementation in order to see whether high buildings will be constructed or not in the direction toward distant exchange. Based on findings in such study, the height of antenna mounting frame must be determined.

3) Equipment to be Installed

Radio equipment and carrier equipment are to be installed in the existing carrier equipment room. For power suply equipment, place for installation remains undecided. ARENTO is requested to make necessary investigation prior to project implementation so as to determine the installation place.

4) Others

Commercial power supply is available.

(25) Through Repeater Stations between Aswan Branch and Abu Simbel

1) Sites

Site selection for through repeater stations between Aswan Branch and Abu Simbel remains pending at the present stage. (Refer to Paragraph 3-1.) The reason is as follows:

Between Aswan and Abu Simble and between Abu Simbel and Wadi Halfa, road construction is presently in progress. For Aswan - Abu Simbel route, completion is scheduled for 1984 and for Abu Simbel - Wadi halfa route, the target year of completion is 1986. Therefore, the site selection should rather be made through field re-survey at the time the whole road route has been defined, because such site selection will suit the actual situation.

Field survey, this time, was made by car trip from Aswan to Abu Simbel. The finding is that for 50 km from Aswan and for 50 km from Abu Simbel the pavement work has already been completed and the work is now underway for the intermediate section of about 200 km.

The road route proceeds in the entire desert. Under this geographic condition, reflection coefficient is assumed to be in the neighborhood of 0.7. The desert is composed of mild slopes formed by a succession of hills, each with an elevation of about 200 m above sea level. Although no sharply accidented topography is found, the section from the middle part of desert toward Abu Simbel is spotted with relatively high mountains from 30 m to 70 m. This fact deserves utomost care in the site selection for through repeater stations.

2) Tower

Since the whole area is the desert and sufficiently large land space can be procured for each site, guyed tower is used.

3) Equipment to be Installed

In this section, transmission volume is small so that power consumption required is also small. Hence, for power supply system, solar battery system is advantageous by reasons of low cost and easy maintenance.

Equipment to be installed are basically designed to suit solar battery system for power supply. Consequently, equipment is to be installed in shelter type building.

4) Others

This section is completely uninhabited so that commercial power supply is not available. In view of small transmission volume, solar battery system is to be adopted for power supply as referred to above. No trouble with equipment and material transport to each site once the earlier mentioned Aswan - Abu Simbel and Abu Simbel - Wadi Halfa roads are completed.

3-8 System Configuration

3-8-1 Transmission System Configuration

(1) Transmission system configuration in the microwave system to be realized by this project is described in the Annex 3-8.

In order to facilitate interconnection with and changeover to/from the existing systems, this transmission system is to be composed of SG instead of MG. System design is in accordance with CCITT Rec. G 423, Figure 4 and Figure 6.

(2) Connection at each terminal exchange on Cairo - Asyut - Aswan - Abu Simbel route is to be 15 SG connection as far as possible. This is to accomplish economical system engineering and to prevent deterioration of transmission performance.

3-8-2 Microwave System Configuration

(1) System configuration of the projected microwave system appears in Annex 3-5. In this system configuration, ARENTO request is taken into full consideration. At the same time, it is based on the agreement between ARENTO and JICA survey team.

System configuration breakdown by types of component stations follows:

1) Existing MUX Terminals
(Cairo Ramses, Beni Suef, El Minya, Asyut, Sohag, Qena, Luxor, Aswan)

At these MUX terminals, telephone signal transmission/receiving is made between additionally installed channel translating equipment and existing switching equipment. Also at these MUX terminals, the existing coaxial cable system and this microwave system are interfaced so that one can take over the other in case of need.

Abu Simbel terminal is to have the same function as the above MUX terminals. However, at present, the telephone office does not exist yet so that the telephone office construction will be carried out, keeping pace with the implementation of this project.

2) Telephone & Television Baseband Terminals
(Cairo-Opera, Asyut, Aswan Branch, Aswan)

These baseband terminals are to be so arranged that TV signal branching/insertion can be made easily. Asyut and Aswan Branch, however, will be so arranged that usually both will operate by IF band connection and, when required, will carry out TV signal branching/insertion also.

Cairo-Opera and Aswan Branch are the terminals where 6 GHz band microwave system and 15 GHz band microwave system are interconnected.

3) Telephone Baseband & Television IF Switching Radio Terminals
(Beni Suef, El Minya, Sohag, Qena, Luxor, Abu Simbel)

At these terminals, TV signal is relayed by IF band while telephone signal connection is by baseband.

4) IF Through Repeaters
(R_1, R_2, R_3 (Ekfes), R_4 (Heloa), R_5 (Derouwa), R_6 (Baruto), R_7 (El-Diweir), R_8 (El-Tilinat), R_9 (Abydos), R_{10} (El-Qsar), R_{11} (Hegaza), R_{15}, R_{16}, R_{17}, R_{18}, R_{19}, R_{20}, R_{21}, R_{22})
All these are through repeaters where both telephone signal and TV signal are relayed via IF band.

(2) Control and Supervisory Functions

Control and supervisory functions of this microwave system consist of the following classifications:

1) Omnibus order-wire telephone function
2) Express order-wire telephone function
3) Remote supervisory function
4) Remote control function
5) Protection switchover control function

Omnibus order-wire telephone is for use between the attended terminal and unattended stations under its control. It will be so arranged that the call-out can be made by office selective tone signal and by speaker also.

Express order-wire telephone is for use between the terminals. System control is the purpose.

Remote supervisory function is to make centralized supervision of operating status of unattended station equipment at the supervisory station. Remote control function is to control unattended station equipment operation in accordance with instructions from the Supervisory and Control Station.

Station by station itemization of supervisory and control objects must be finalized before project implementation in due consideration of the maintenance system to be adopted.

Protection switchover control function is for automatic switchover from the working system to the protection system in case the former fails to operate normally. This switchover by manual control must also be possible. The switchover is to take effect by means of detection of pilot off and noise increase. Function diagram by stations appears in Annex 3-5.

(3) Centralized Supervisory System

The centralized supervisory system is to make centralized supervision of the operating status of all stations established by this project. For this purpose, the system must be able to indicate on the display the operating status of each station, and this indication by display must be logical and automatic. All faults, itemized by types and hours, are automatically recorded. Statistically assorted fault records can be effectively utilized in the maintenance and operation of the projected microwave system after its service commissioning.

The optimum place where to install the centralized supervisory system is Opera (Cairo) Exchange. Opera Exchange is the terminal of the existing (Alexandria bound) microwave system and, at the same time, the terminal of the microwave system to be constructed by this project. It will be effective for the existing microwave system also to be connected to the centralized supervisory system by means of signal interface adjustment.

3-9 Intra-Office Equipment Layout

Annex 3-6, 3-7 present a typical example of intra-office equipment layout at each component station of this projected microwave system.

3-10 Radio Transmission System Design and Transmission Performance

Real circuit standards providing for transmission performance of radio transmission system - out of international basic trunks by frequency division multiplex telephone system - are specified in CCIR Rec. 395-2. This project also will be implemented, based on this CCIR recommendation.

Transmission performance standards for international TV circuit to be realized by this project are governed by CCIR Rec. 555 and Rec. 567. Sound signal that is transmitted simultaneously with video complies with CCIR Rec. 402-2 and Rep. 289-3 thoroughly.

Main contents of recommended standards that are essential for system design, this time, are quoted below in excerpts.

3-10-1 Telephone Circuit

(Allowable telephone circuit noise at relative 0 dB point)

(1) for 50 km $\leq$ L $\leq$ 840 km

1) 3 LpW + 200 pW one-minute mean power for more than 20% of any month

2) 47,500 pW one-minute mean power for more than (280/2,500) x 0.1% of any month when L is less than 280 km, or more than (L/2,500) x 0.1% of any month when L is greater than 280 km.

(2) for 840 km < L $\leq$ 1,670 km

1) 3 LpW + 400 pW one-minute mean power for more than 20% of any month

2) 47,500 pW one-minute mean power for more than (L/2,500) x 0.1% of any month

3-10-2 TV Circuit

Luminance signal measured by the method specified in CCIR Rec. 567 and effective noise value must not be less than the standard values shown below.

(1) 57 dB for more than 20% of a month

(2) 45 dB for more than 0.1% of a month

3-10-3 Circuit Quality

Parameters of equipment to be used in radio system of this project are not yet determined. This time, the study was made as to whether the aforementioned standard values could be satisfied or not, based on the parameters of equipments now commonly used, in the existing Cairo - Aswan telephone circuit.

Study results appear in Annex 3-9 and Annex 3-10. Equipment parameters are identified in Annex 3-11.

Noise that is generated in the microwave circuit is divided, according to the cause, into thermal noise, interference noise and distortion noise. Usually, these three noise categories are equally distributed in the standard system design. Thermal noise value shown in Annex 3-9 fully satisfies one-third of the objective value, so that the allowable range of the other two noise values can be expanded.

For this study, distortion noise, which is inherent in the equiment concerned and which is determined by the number of channels installed and the number of hops, was set at 40 pW/hop. The bases of this distortion noise value were twofold: first, the equipment capacity of 1,800 channels, this time, and second, the maximum six hops per baseband section of this project.

Interference noise is not a matter of serious concern. For, in this project, radio interference that takes place is the self-interference only, except in Cairo area. For over-reach also - more often than not, it poses a problem in the long distance, straight line transmission route on smooth spherical earth, due consideration is made in the site selection, as seen in Annex 3-3.

Presented in Annex 3-4 is locational relationships between the satellite system earth station circuit which, in Cairo area, uses the same frequency band as in this project, and Cairo - Alexandria circuit. Locational relationships among stations involved indicate that the interference resulting from the use of the same frequency band is negligibly small.

From the foregoing description, it can be assumed that the overall noise value satisfies the allowable limit. However, prior to project implementation, re-study must be made, based on all system parameters that will be finally determined by that time.

Short break rate calculation results in Annex 3-10 are from effective reflection coefficient of $\rho e = 0.6$ or thereabouts for smooth spherical earth section and of $\rho e = 1$ for section where reflection point lies on the Nile. For Rayleigh fading probability (P_R), equivalent Rayleigh fading probability (P_{Re}) is adopted in almost all sections.

Equivalent Rayleigh fading probability includes the apparent increment of Rayleigh fading probability on the real circuit. Such apparent increment occurs, influenced by reflected wave and by long term variations of radio field strength median.

In the section between R_{12} (Nag Khamis) and R_{13} (Isna), Rayleigh fading probability versus equivalent Rayleigh fading probability ratio exceeds 100. Correlation formula follows:

$$P_{Re} = K \cdot P_R + K_1 \cdot (1 - P_R)$$

$$K = 1/\{1-\sqrt{P_R}\ (2-0.96\ P_R{}^{1/4})\}$$

$$K_1 = U.e^{-U(1+\rho e^2)}.Io(2U.\rho e)$$

$$U = \frac{1.22\sqrt{1-x}}{x(1-1.04x + x^2)}$$

$$X = \sqrt{2\ P_R - P_R}$$

When $U\rho e \leq 3$,

$$I_o = \frac{1}{2U\rho e}\{1 + (U\rho e)^2 + \frac{(U\rho e)^4}{4} + \frac{(U\rho e)^6}{36} + \frac{(U\rho e)^8}{576} + \frac{(U\rho e)^{10}}{14400} + \frac{(U\rho e)^{12}}{51840}\}$$

When $U\rho e > 3$,

$$I_o = \frac{1}{2U\rho e} \cdot \frac{2U\ e}{\sqrt{4\pi U\rho e}}\{1 + \frac{1}{16U\rho e} + \frac{3^2}{2(16U\rho e)^2}\}$$

Probability (%) concerning item 2) of (1) and (2) is

a. When $\rho e < 0.3$,

$T = 2P_R \times (No/47500) \times 1/D$

b. When $\rho e \geq 0.3$,

$T = P_{Re} \times (No/47500) \times 1/D$

where

T : Probability of mean noise per minute to exceed 47,500 pW

N_o: Thermal noise in each section

D : Improvement effect by diversity

Baseband sections where space diversity is to be applied and the number of such sections, as obtained from short break rate calculation results, are identified in Annex 3-10.

For TV circuit, specific study about transmission performance is not made. Reasons are that TV circuit in this project is of analog system, and that the circuit with capacity for 960 or more telephone channels per RF performs quite well for TV signal transmission.

For Aswan - Abu Simbel section, site selection is not made by reason of road situation. From the viewpoint of transmission performance, there is need to ascertain whether space diversity is adopted or not, and, if it is adopted, the number of hops concerned. Road length between Aswan and Abu Simbel is about 300 km so that six hops, each with a distance of 40 - 45 km, are considered to be appropriate for this section.

The whole section is in the desert. Therefore, the short break rate, roughly calculated by reflection coefficient of $\rho = 0.7$, is estimated at 0.003% or thereabouts per hop. Selection is made for hops where to apply space diversity, in order that the short break rate in one baseband section of less than 280 km will meet 0.0112% recommended by CCIR.

3-10-4 Transmission Performance

Transmission performance of this system is to comply completely with relevant CCITT recommendation and existing coaxial cable system parameters.

3-11 Power Supply System

Selection of optimum power supply system is important for radio communication system to maintain high reliability. Such power supply system must be selected with emphasis on low engineering cost and ease of operation and maintenance.

3-11-1 Where Commercial Power Supply is Available

In case where commercial power supply is available, full floating battery system is most advantageous economically. This system allows easy maintenance also. However, as a remedy against commercial power failure, standby engine generator equipment must be installed.

Commercial power supply that can be utilized in this project is 3-phase, 4-wire, 380 V $^{+10\%}_{-15\%}$, 50 Hz $\pm 4\%$. Therefore, AVR must be installed. Annex 3-20 presents a typical example of this type of power supply system.

3-11-2 Where Commercial Power Supply is Not Available

In case where commercial power supply is not available, either of the following power supply systems is used:

(1) Full floating system

In this system, 2 - 3 engine generators are operated alternately to generate AC power. This AC power is converted to DC power by storage battery plus rectifier equipment and is supplied to communication loads.

Advantages of this system follow:

1) Storage batteries can be kept in full charged condition at all times. Hence their long life.

2) AC power supply to AC loads is possible.

Among disadvantages are heavy wear and tear of rotary section of engine due to continuous operation, large fuel consumption, and necessity for frequent overhauls.

This system can be operated at high efficiency economically when DC loads are 700 W or more. A typical example of this system appears in Annex 3-21.

(2) Alternate charge-discharge system

This system supplies DC power from storage batteries charged by engine generator operation for a certain length of time. Then, storage batteries are re-charged. This charge-discharge function is by alternate operation of two sets of rectifier equipment and storage batteries.

This system holds these advantages:

1) Since power supply to loads is from storage batteries, supplied power does not include noise ripple.

2) Operating time of engine can be reduced, compared with full floating battery system. Hence fuel consumption economy and engine life extension.

Disadvantage is that repeated charge-discharge operations cause the life of storage batteries to diminish.

The economical operation zone of this system is in 300 - 700 W of loads.

(3) Thermo-electric system

This system is a system to obtain electric energy directly from temperature variations.

Main advantages are:

1) Since rotating parts are not used, mechanical wear and tear are minimum.

2) Capacity increase is easy because installed units have only to be increased.

3) Because of small size and light weight, installation is easy.

4) Equipment reliability is high.

For disadvantage, it must be pointed out that light oil or gas supply as fuel is essential.

In this project, DC loads at stations where commercial power supply is not available are 700 W or more and 150 W or less. When DC load is 150 W or less, solar battery system is more advantageous than this thermo-electric system.

(4) Solar battery system

When solar battery system is adopted, solar battery capacity must be determined, based on sunshine intensity forecast data for the area concerned. A safe assumption is that the required sunshine intensity is about 10 times the DC load.

For holding time of solar battery, at least 10 days are necessary to make up for no-sunshine time during night and rainy days.

A typical example of solar battery system appears in Annex 3-22.

Advantages of this system are:

1) Fuel supply is not necessary. Hence no need for fuel tank. Access road cost can also be economized because fuel transport by tank lorry is not required.

2) Solar battery life is semi-permanent, so that maintenance cost is extremely small.

There is disadvantage also. That is to say, when DC load is 150 W or more, solar battery system necessitates initial cost to be considerably higher than in other system.

3-11-3 Optimum Power Supply System

In this project, optimum power suply system applicable to stations where commercial power supply is available, is the system described in Paragraph 3-11-1. Following is the optimum power supply system proposed for stations where commercial power supply is not available:

1) At stations where DC load exceeds 700 W, full floating system by alternate operation of two engine generators is optimum. Meanwhile, the main maintenance station should preferably be provided with mobile engine generator equipment that can be dispatched to the station where its engine generators are being overhauled.

2) At stations where DC load is less than 150 W, solar battery system is optimum. The main maintenance station should be provided with mobile power supply equipment combined with charging equipment that can be dispatched to the station where solar battery storage capacity has declined due to bad weather, etc.

3-12 Buildings, Towers and Roads

3-12-1 Utilization of Existing Buildings and Site Lands

(1) Existing Buildings and Towers

1) Existing buildings, whereof the usability study was made this time, are nine telephone exchange buildings and coaxial cable system terminal stations. Nine telephone exchanges are located between at Cairo and Aswan, i.e., Opera, Ramses, Beni Suef, El Minya, Asyut, Sohag, Qena and Luxor, plus Aswan City.

2) In this project, very high towers are used for mounting of antennas for main transmission system. These high towers, if built on existing station building roof-top, are sure to exert unwholesome influence on buildings themselves because their structural strength is not great enough to endure the load. Hence, antenna towers for main transmission system will not be built on existing building roof-top.

3) Existing tower at Ramses Exchange lacks strength to allow antenna mounting for main transmission system. For this purpose, existing tower at Opera Exchange will be used.

4) On existing Ramses and Aswan City exchange building roof-top, antenna towers for 15 GHz system, each 5 m or so in height, will be newly built. For these antenna tower erections, full study about structural strength of existing exchange buildings is essential.

(2) Land Space for Tower Erection at Existing Exchange Sites

1) At existing El Minya and Qena Exchange sites, if the sub-buildings are withdrawn, land space for tower erection can be obtained. However, the tower site selection requires full prior study of the present facilities and land arrangement, as well as the future arrangement plan.

2) At existing Asyut Exchange site, if a part of materials depot is withdrawn, land space for tower erection can be obtained. In this case, a new building where to install radio equipment must be constructed at tower site. Actually, for tower site selection, full prior study is required about the present facilities and land arrangement and the future arrangement plan.

3) At existing Beni Suef, Sohag and Luxor Exchange sites, land space for tower erection cannot be obtained.

(3) Utilization of Equipment Rooms in Existing Exchange Buildings

1) At the earlier mentioned nine telephone exchanges, vacant floor space of existing carrier equipment room can be utilized for installation of radio equipment and carrier equipment required in this project. However, for final selection of installation space for new equipment, full prior study of the present facilities and floor layout and the future layout plan is the prime requisite.

2) Power supply system for equipment to be newly installed by this project in the aforementioned nine existing telephone exchange buildings must be newly established. There is need for determining the place where to accommodate power supply system.

(4) Equipment to be installed in existing exchange buildings and tower sites are as follows:

Exchange	Tower Site	Radio Equipment	Carrier Equipment	Power Supply System
Opera	To utilize existing tower	○$^{\Delta}$	○	○
Ramses	Δ	Δ	○	○
Beni Suef	-	-	○	○
El Minya	○ (H: 70 m)	○	○	○
Asyut	○ (H: 70 m)	○*	○	○
Sohag	-	-	○	○
Qena	○ (H: 75 m)	○	○	○
Luxor	-	-	○	○
Aswan	Δ	Δ	○	○

Δ : For 15 GHz system

○*: To be installed in newly constructed building at existing exchange site

3-12-2 Buildings to be Newly Constructed

(1) Repeater Stations Where New Building Construction is Required

1) Repeater stations where station buildings must be newly constructed total 28. They comprise 5 terminal stations of Beni Suef, Asyut, Sohag, Luxor and Abu Simbel, plus Aswan Branch and 22 through repeater stations.

2) For Asyut terminal station site, part of existing Asyut Exchange site can be used. For the remaining 27 repeater stations, sites must be newly procured.

(2) Composition and Type of New Building

1) Composition and type of new buildings to be adopted in this project must be determined in consideration of comments on merits and demerits, as well as related factors, of each composition and type, and based on overall evaluation of all those comments.

2) Construction practices that may possibly be adopted in this project are twofold. One is the prefabrication practice that merely joins together or assembles factory manufactured construction members and parts at each station site. The other is the conventional practice that finishes blank materials or factory processed parts into complete structure at each station site.

Also used these days is the shelter type housing for equipment. In this case, equipment installation in the housing is carried out at the factory.

(3) Shelter Type Housing

1) In the case of telecommunication system construction at such places where topographic and meteorological conditions are harsh or places difficult of access, field work must be rationalized to the utmost. Developed and commonly used for this purpose is the shelter-type equipment housing.

2) The shelter-type equipment housing is so composed that the equipment installed in the shelter can be protected from undesirable influence from external environment.

3) The shelter comprises two types. One is the factory manufactured container type. The other is the prefabrication type that is factory manufactured and to be assembled at work site.

4) In many cases, the container type shelter has the equipment installed in the container at the factory. As the container itself is becoming larger and larger sized, the optimum method of transport that fits the state of roads must be studied. At the same time, the lifting method requires special consideration about the surrounding land space.

5) The prefabrication type does not require large sized vehicle for transport. However, the shelter assembly and equipment installation in the shelter take more time than in the case of container type. Furthermore, in the prefabrication type, not a few splicing works must be performed at the field, and the shelter utility depends vitally upon the splicing workmanship. Hence the need for elaboration in splicing work.

(4) Equipment Room Design

1) The equipment room must have sufficient floor space not simply for equipment installation but for maintenance and repair/replacement work also.

2) The equipment room must keep temperature and humidity at required levels for normal operation of equipment installed.

3) The equipment room fittings must be air tight and dust proof.

4) Through repeater stations must be the unattended type. Hence no need for night duty room.

5) Equipment size and mounting method sometimes differ according to manufacturers. Hence the need for circumspection concerning equipment room size and floor layout.

6) The equipment room floor level must not be lower than the road surface in front of the site.

(5) New Building Classification

	Communication Equipment		Power Supply Equipment		No. of Stations	Remarks
	Radio	Carrier	EGx1	EGx2		
Terminal Station (1)	○	□	○	-	3	Sohag, Luxor, Abu Simbel
" (2)	○	□	-	-	2	Beni Suef, Asyut*
Branch Station	○$^{\Delta}$	○	-	○	1	Aswan Branch
Through Repeater (1)	○	-	○	-	13	In Cairo-Aswan section, other than R1,R15,R16
" (2)	○	-	-	○	9	R1,R15,R16, R17,R18,R19, R20,R21,R22

□: Amplifier stop supervising only

Δ: For 15 GHz system

*: Inside existing exchange site

3-12-3 Towers

(1) Composition and Type

1) Tower is divided into self-supporting type and guyed type. The former can be erected at narrow site but requires large volume of steel material. The latter requires large site for erection but the steel requirement is smaller than that of the former.

2) In this project, guyed towers are planned at 10 places, i.e., R-1, R-2, R-9 and R16 plus 6 through repeaters south of Aswan Exchange. For these repeater stations, the large site procurement is considered to be possible. For 20 other towers for main transmission system and 2 towers for 15 GHz system, self-supporting type is planned.

(2) Tower Classification

Height (m)	5	45	50	60	70	75	80	85	90	95	100	Total
Self-supporting type	2	1	3	0	3	3	2	1	1	2	4	24
Guyed type	0	0	1	1	0	0	6	1	0	0	1	10
Total	2	1	4	1	3	3	8	2	1	2	5	32

3-12-4 Roads

(1) Repeater Stations Where Road Construction Is Required

1) At repeater station sites located in the Nile green belt zone between Cairo and Aswan, existing general roads can be used. Hence no need for road construction.

Out of repeater sites in the desert, the sites that face existing general roads and the sites where existing general roads are not available but topography allows motor tours do not require new road construction.

Repeater sites where full scale road construction is required are R-15, R-16 and Aswan Branch sites. R-15 and Aswan Branch sites are on rocky mountains, so that road construction and ground leveling are considered to involve no small difficulty.

2) In the area south of Aswan, highway construction is still being continued, so that the site selection was not made. This area is the desert and, after the completion of highway now under construction, sites can be selected, where desired, along the highway. Therefore, in this project, no road construction is considered to be necessary. In consideration of the progress of highway construction, the site selection can be made and whether access roads are required or not can also be determined.

(2) Access Roads

1) Access roads to repeater sites do not need to be constructed in the scale of general roads. They are only to provide convenience for construction works by this project and for maintenance itinerary by ARENTO staff after the construction works are over and equipment installation in buildings has been completed.

2) Access roads to repeater sites to be constructed in this project have only to meet the following requirements:

   a) Effective road width: 4 m

   b) For curved section, minimum radius of center line of road be 10 m. For hair pin curve section, this minimum radius may be reduced to 8 m.

   c) Longitudinal slope of road be 10%. Only in short section of 100 m or thereabouts, longitudinal slope may be sharper than 10%.

CHAPTER 4

MAINTENANCE AND TRAINING

Chapter 4 Maintenance and Training

4-1 Maintenance

Maintenance business is to take over the microwave system after the completion of its construction and to maintain and operate the system in good condition and thus provide stable service at all times. An accurate knowledge about system status is required of maintenance personnel so that, in the event of system malfunction or equipment failure, they can take remedial action promptly and effectively.

Ideally speaking, maintenance must completely eliminate, or at least minimize, service interruption or, more precisely, fault outbreak as the cause of service interruption. The following description is about the principle and organization of maintenance to attain such purpose.

4-1-1 Maintenance Methodology

Maintenance is divided into two major categories. They are preventive maintenance and trouble-shooting.

(1) Preventive Maintenance

For preventive maintenance in radio section, noise measuring during system operation, as provided for in CCIR Rec. 398-3, is preferable. This method is to measure out-band noise on both sides of baseband at the time of busy-hour traffic during system operation.

When the channel where noise is measured is near the baseband, the measured noise figure allows estimation of in-band noise at a considerably approximate value. Therefore, insofar as the measured noise figure complies with the standard value for service, equipment tests in the items relating to noise characteristics are omitted.

However, for some kinds of equipments, tests by noise characteristics cannot be the sole means of preventive maintenance. The following list presents test and inspection items required for preventive maintenance:

- Preventive maintenance
  - Periodical inspection
    - Antenna, feeder, tower
      - ... Visual inspection
    - Component equipments of main transmission route
    - Control equipment and order wire
    - Power supply equipment
      - ... Inspection of major items of measurement (such as current and voltage levels)
  - Periodical test and adjustment
    - Tower ... Partial painting, guy tension
    - Transmitting and receiving equipments
      - ... Alarm test, meter calibration
    - Modulation and demodulation equipments
      - ... Alarm test
    - Control and supervisory equipment
      - ... Alarm test, transfer test
    - Carrier equipment
      - ... Alarm test, transfer test, frequency calibration
    - Power supply equipment
      - ... Alarm test, remote control test, equalizing charge

As for the period by which to practice preventive maintenance, initially the short period and later the long period in accordance with the effect of earlier maintenance are preferable. In both cases, equipment reliability must be well examined.

(2) Trouble-shooting

Almost all equipments are so designed that, in case of system breakdown, operation will be automatically changed over to standby system or equipment so that the actual service can continue without interruption.

There are exceptions where such automatic operation changeover cannot be expected. Therefore, in the event of system/equipment failure, the first thing to do is to locate where fault originated and replace faulty panel with a spare panel promptly so as to restore normal system/equipment operation.

Tests to be carried out for trouble-shooting are as follows:

- Trouble-shooting
  - Transmitting and receiving equipments
    ... Micro-IF amplitude frequency characteristic check, AGC and SQL tests, transmitting output power measurement
  - Modulation and demodulation equipments
    ... Baseband amplitude frequency characteristic check, linearity test, level adjustment
  - Control and supervisory equipments
    ... Level adjustment, S/N measurement, manual/automatic operation changeover test
  - Carrier equipment
    ... Frequency characteristic measurement
  - Power supply equipment
    ... Manual and automatic operation tests

Remarkable progress of IC and LSI technology, these days, is contributing a great deal to the improvement of equipment reliability. At the same time, trouble-shooting also has come to require special technology. From now forward, the fundamental mode of trouble-shooting is to replace panels or units/modules while arranging with manufacturers for repair of faulty panels.

Besides, in not a few cases, field repair is required. In such cases, the following matters will have to be considered:

1) Suitability discrimination between manufacturer repair and field repair

2) Field repair work flow

3) Necessary equipment for trouble-shooting

4) Number of repair parts to be held in stock

5) Trouble records and filing thereof

6) Trouble-shooting itinerary

(3) Other Maintenance Business

Management business else than the foregoing - mainly technical - maintenance business is also included in the maintenance business in a broad sense. Such management business comprises the following:

1) Manpower management, i.e., manpower planning and duty performance management

2) Capability management, i.e., training business

3) Facilities management, i.e., property (equipment, instruments/tools, panels, vehicles, etc.) management

4-2 Number of Maintenance Personnel

The number of personnel required for maintenance of this microwave system is given in Table 4-1. Personnel listed in the table include responsible person of each division, engineers (to assume duty, including maintenance itinerary, by staggered shifts), accountant and property custodian.

Table 4-1 ARENTO Maintenance Personnel Distribution

Terminal	Maintenance Personnel					Vehicle
	Radio	Carrier	Power	Administ-ration	Total	
Cairo:						
Opera	5	0	1	1	7	1
Ramses	2	3	1	1	7	1
Beni Suef:						
Radio	4		1	1	6	1
Mux		2	1	1	4	1
El Minya	4	2	2	2	10	2
Asyut:						
Radio	4		1	1	6	1
Mux		2	1	1	4	1
Sohag:						
Radio	4		1	1	6	1
Mux		2	1	1	4	1
Qena	4	2	2	2	10	2
Luxor:						
Radio	4		1	1	6	1
Mux		2	1	1	4	1
Aswan:						
Radio	4	1	1	1	7	1
Mux	2	3	1	1	7	1
Abu Simbel	4	2	2	2	10	2
Total	41	21	18	18	98 *(80)	18

Note: *(80) is the total number of technical personnel.

4-3 Maintenance Organization

This microwave system is composed of 10 attended terminal stations and 22 unattended stations.

The attended terminal stations are these 10: Cairo, Beni Suef, El Minya, Asyut, Sohag, Qena, Luxor, Aswan Branch, Aswan and Abu Simbel.

Cairo terminal is in the capital city and, as such, assumes cardinal position with various routes concentrated. Hence, in Cairo terminal, centralized supervisory and control equipment is to be established in order that the operating conditions of all stations including unattended stations, in the whole system can be known whenever required.

At Aswan Branch, the system branches in three different directions. Besides, being located near the border with Sudan, Aswan Branch assumes as important a position as Cairo terminal in the management of operation of the whole system.

Therefore, in this report, Cairo terminal and Aswan Branch are called Maintenance Control Stations.

Other attended terminals are called Maintenance Stations. The rest are unattended stations.

The Maintenance Control Station manages system operation as a whole. For this purpose, it formulates the schedule of periodical system/equipment tests and inspections, assorts and analyzes data obtained in such tests and inspections, and, where necessary, makes plans for remedial actions. By these means, it maintains the whole system in good status at all times.

Furthermore, the Maintenance Control Station takes initiatives and makes decisions concerning all affairs relating to the maintenance of the whole system.

The Maintenance Station assumes responsibilities for maintaining in workable condition its own facilities, as well as facilities of unattended stations under its control. Like the Maintenance Control Station, it is duty bound to formulate the periodical test and inspection schedule and take related actions by its own discretion.

4-4 Training

Out of 80 personnel on the technical maintenance staff (refer to Paragraph 4-2), 40 are to receive overseas training and the remaining 40 domestic training. Common maintenance personnel totaling 18 are also to receive domestic training.

Maintenance staff training will be administered according to the arrangement described below.

4-4-1 Overseas Training

Overseas training is given to personnel who have the fundamental knowledge about telecommunications. Training period is three months.

Subjects of training are:

- o Radio engineering based on system design
- o Remote supervisory and control system
- o Power supply system
- o Demonstration training

4-4-2 Domestic Training

(1) Technical maintenance staff who earlier received overseas training act as main instructors in domestic training besides the contractor's instructor. They give training on the subjects they themselves were trained about.

At the same time, demonstration training is also given, using the dummy microwave system composed of equipments identified below. Demonstration training period is three months.

The following equipment is used to compose one terminal to terminal link:

1) 1,800 CH equipment

Telephone channel (with modulation/demodulation equipment and order wire equipment)

... 1 link

CTV channel (with modulation/demodulation equipment)

... 1 link

Standby channel (with modulation/demodulation equipment)

... 1 link

Control equipment

... 1 link

Remote supervisory equipment

... 1 link

Video/sound combiner and separator equipment

Video/sound supervisory and control desk

2) Carrier equipment

15 SG translating equipment

SG translating equipment

G translating equipment

Channel translating equipment

Carrier supply equipment

Distribution frame (SG/G/ch)

Sound distribution frame

2 W/4 W equipment

3) Measuring apparatus

Full set of measuring instruments/tools for all aforementioned equipment

4) Power supply equipment (full set)

Diesel generator, 20 kVA

AVR

Rectifier

Battery

(2) Training of common maintenance personnel is given for one month on the following subjects:

- o Telecommunications in general
- o Inventory management (property in stock control)
- o Science of statistics
- o Operations research

CHAPTER 5
PROJECT IMPLEMENTATION PROGRAM

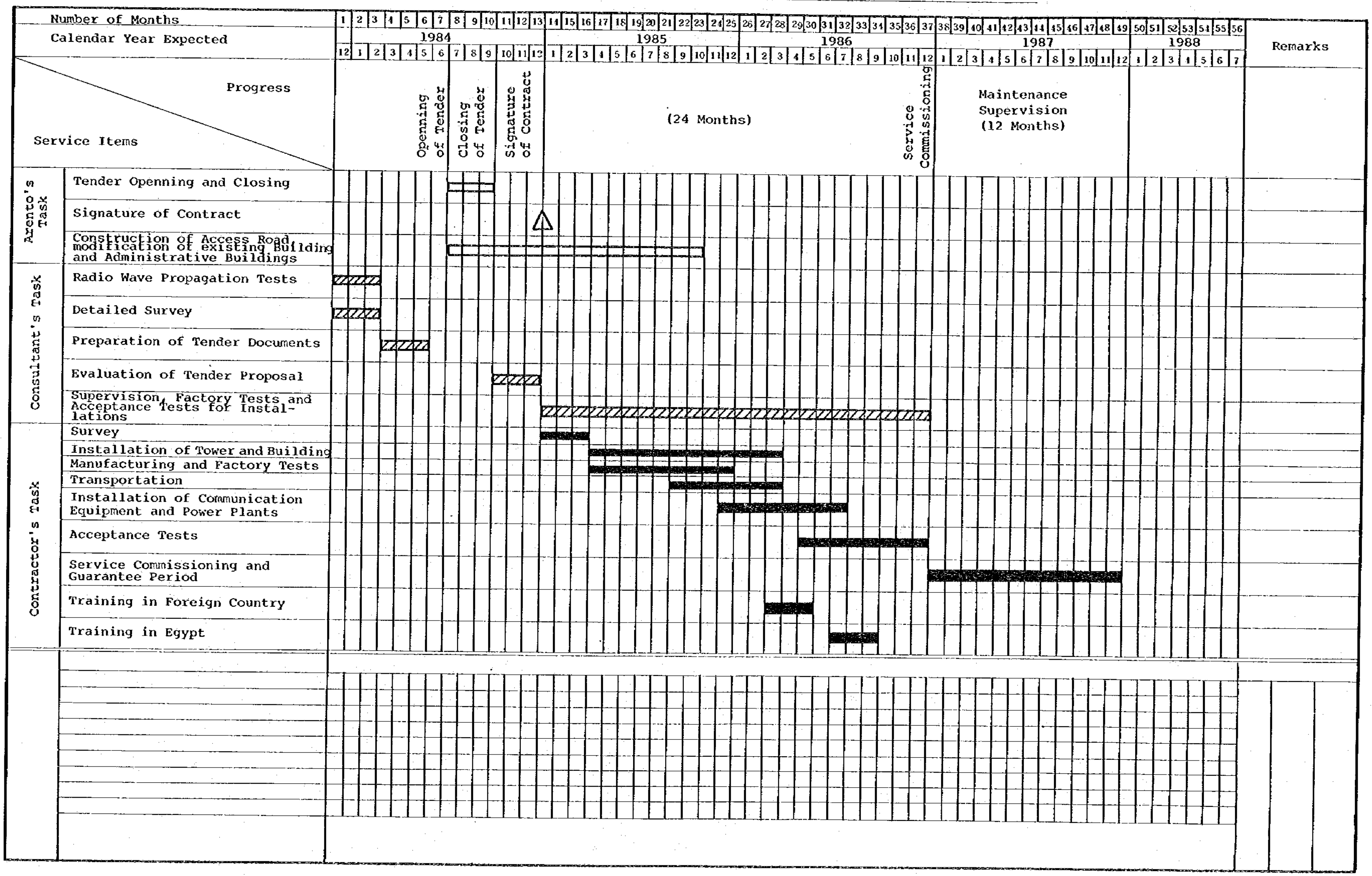
Chapter 5 Project Implementation Program

Construction Work Schedule for implementation of this project appears in Table 5-1. ARENTO's Consultant's and Contractor's work assignments are identified in the project implementation program.

As a precondition to project implementation, ARENTO must complete land acquisition prior to the signing of contract with Contractor.

For exchange/station buildings, the major premise is to adopt shelter type buildings. If ARENTO is to prepare station buildings at its responsibility, possibilities loom large for six months to one year time lag for project implementation.

Table 5-1 Implementation Schedule of the Project



CHAPTER 6

PROJECT COST ESTIMATE

Chapter 6 Project Cost Estimate

Terms and conditions of project cost estimate are as follows:

(1) Construction work is to be executed on turn-key basis.

(2) Project cost estimate is as of the end of 1984. In this cost estimate, international tender prices in the past overseas projects, as well as related data, are to be duly considered.

(3) Cost disbursement is to be made, divided into foreign currency and domestic currency portions as specified below.

1) Foreign currency portion

- Radio equipment, remote supervisory and control equipment, carrier terminal equipment, power supply equipment and antenna system
- Towers
- Equipment storage shelters
- Work materials and tools
- Measuring equipment
- Spare parts and stocks
- Maintenance vehicles
- Marine transportation cost and insurance cost
- Installation work cost and test/adjustment cost
- Tower construction cost and tower foundation work (including shelter foundation work) cost
- Field survey cost
- Overseas training cost
- Domestic training cost

- Maintenance guidance cost
- Consultant fee
- Contingency

2) Domestic currency portion

- Inland transportation cost and customs fee
- Land procurement and ground leveling cost
- Road construction cost
- Building (office and guardsmen's room only) construction cost and existing building improvement cost
- Consulting fee
- Equipment installation and test/adjustment cost
- Tower and shelter foundation work cost

(4) All costs of project implementation are to be calculated in Japanese yen. Conversion to U.S. dollars and Egyptian pounds is by the following rate of exchange:

1 U.S. dollar = 0.82 Egyptian pound = 230 yen

Therefore, 1 Egyptian pound = 280 yen

(5) For equipment installation, shelter type buildings are to be constructed in all cases. In this connection, supposing that ARENTO would construct, at its expense, reinforced concrete structures wherein to install equipment, the required cost was estimated. In this case, the total building cost amounts to approximately 1.25 million Egyptian pounds.

(6) For section where space diversity is to be adopted, cost estimate was made on the basis stated Chapter 3 paragraph 4.

However, this might be changed later, when detailed propagation data are obtained.

For example, if it is found that the space diversity is to be provided for all the hops, additional 450 million yen will be required.

Furthermore, if it is found that tower height could be reduced by certain range, this will cause curtailment of approximately 150 million yen.

Project implementation cost breakdown is presented in Table 6-1.

Table 6-1 Project Cost Estimate

Unit: Million Yen

No.	Item \ Currency	Foreign Currency	Local Currency	Total
1	System Facilities Cost			
	1) Equipment 2) Installation Materials 3) Maintenance Facilities 4) Demonstration Equipment for Training 5) Spares 6) Shelters FOB Total	4,763 254 139 127 189 638 6,110	- - - - - -	4,763 254 139 127 189 638 6,110
	CIF Total	6,415	-	6,415
2	Inland Transportation & Customs clearance		119 (425)	119
3	Installation cost of Main Equipment	1,018	113 (403)	1,131
4	Training	120	100 (357.1)	220
5	Cost for civil work 1) Tower 2) Shelter 3) Access road 4) Cable Trenching 5) Building Modification	 830 299 90 	 200 (714.2) 70 (250) 167 (596.4) 48 (171.4) 101 (369.7)	 1,030 369 167 138 101
6	Consultancy Service	430	144 (5.4.2)	574
7	Contingency	920	100 (378.5)	1,026
8	Total	10,122	1,168 (4,171.4)	11,290

Note: Figures shown in parentheses express thousand Egyptian Pounds (LE).

1 LE = 280 Japanese Yen

CHAPTER 7

ECONOMIC EVALUATION

Chapter 7 Economic Evaluation

7-1 Financial and Economic Analysis of Project

(1) Background of the Analysis

This chapter makes the cost benefit study with regard to the investment in Cairo - Aswan - Abu Simbel Microwave Network Construction Project by the operating entity of project, ARENTO. The study is made from the financial and economic viewpoints.

The project is to be completed as system at the beginning of 1987. The investment feasibility study comprises three phases. They are:

1) To formulate the program of the financial analysis for ARENTO as the operating entity.

2) To estimate the financial internal rate of return of the investment by means of analysis of the profit ratio of total liabilities and net worth, and to study the earning power of the investment in relation to the project loan repayment.

3) To estimate the net profit to net worth ratio of the investment and to study the net worth creation capability of ARENTO.

Based on the findings in the analysis of the foregoing items 1) through 3), the cost benefit study of the project investment is made.

(2) Project Loan and Estimation of Rate of Return

1) Program and Project

Based on the implementation plan of the project, which constitutes an integral part of the national development plan formulated by the Government of Egypt, the necessary program for income and expenditure management with regard to this investment is made hereunder.

The assumptions are:

a) The construction work period be 2 years after the signing of contract with the contractor, and the system be completed to begin service at the beginning of 1987.

b) The life time of the system projected is assumed to be 15 years. No specific institutional requirement in the country is envisaged, so that the projects are to be dedicated to the replacement of obsolete facilities with up-to-date facilities supported by the high technology after the service life of the system.

Therefore, the program is projected on prospect that the new instalment is partly serviced in 1987, and the system will terminate in 15 years ahead.

c) The system capacity is estimated, mainly based on telephone traffic and in consideration of the existing status of facilities. Multiplex carrier equipment is to have sufficient capacity to meet the forecasted traffic demand as of 1991.

d) Additional system improvement to cater for the growth of telephone demand is to be carried out by ARENTO during the service life of the system.

e) Necessary expansion of multiplex carrier equipment is to be planned and put into practice by ARENTO.

2) Initial Investment

The initial investment required for the planning and the implementation is shown in Tables 7-1 and 7-2.

The external portion and the internal portion respectively total as follows:

	(*) (Egyptian Pounds at 1984 prices)
- Foreign Funds :	36,149,000
- Local Funds :	4,172,000
Total Initial Investment:	40,321,000

(*) Egyptian Pound is abbriviated to "LE" hereunder.

Out of the required total initial investment, the external portion is to be procured wholly by the long term loan from the foreign financial institution. For the internal portion, the procurement from ARENTO's equity portion is basically assumed to be possible.

The following costs are paid out of the long term foreign loan:

- Cost for equipment and materials required for initially provided facilities in the project

- Part of equipment installation work cost and civil work cost
- Expenses for factory training in manufacturer's country
- Consulting service fees pertaining to production of tender specifications, evaluation of tender proposals, assistance in contract negotiations and supervision to installation work

The following costs are paid out of ARENTO's equity portion:

- Expenses for inland transportation and customs clearance
- Part of installation work cost and civil work cost
- Expenses for classroom training in Egypt
- Part of consulting service fees

The currency exchange rates of LE 0.82 to US$1 and ¥230 to US$1 are used.

3) Working Capital

When the telecommunications service entity is a single enterprise, the necessary current accounts for system management are appropriated as the working capital.

In the case of this project, the working capital is constituted as stated below. This is the result of investigation of ARENTO's financial capability as a business operating entity from various factors including the telephone tariff collecting system.

After completion of the construction work and starting the service, each year's operating revenue increase as compared with the preceding year revenue is summed up on the capital account.

At the time the system life terminates, the gross working capital balance during the system life period is appropriated as minus cost accounts of capital, together with the salvage value of the fixed assets. Refer to Table 7-3.

4) Operating Expenses

a) Operating and Administrative Expenses

Operating and administrative expenses consist of direct expenses required for the management for operation of the system constructed.

b) Maintenance Expense

Maintenance expense comprises spare parts cost, maintenance vehicle cost, etc.

Maintenance expense is estimated as the necessary cost for maintaining the required scale of facilities constructed. In the cost estimate is considered a more or less cost rise during the system life period. Also considered are the maintenance work efficiency and the past records of maintenance in ARENTO.

c) Gross Operating Expense

Operating expenses are a sum of the preceding items a) and b). Refer to Table 7-4.

5) Salvage Value of Fixed Capital

The salvage value of the fixed capital at the time of its termination (15 years after the service-in) is not of the nature that can be accurately calculated. However, this time, it is estimated at 10% of the amount of equipment investment at the time of the service commissioning, and is included in the operating revenue at the final year. Refer to Table 7-3.

6) Tariffs

Tariff level with regard to telecommunications service is assumed to be modestly raised.

For the new telecommunication tariff system to be determined with the coming into practice of this project, the assumption is set. Refer to Table 7-5.

7) Operating Revenue

The operating revenue that results from the coming into practice of this project investments consist of the following items.

Revenue during the service life of the system, originating from new equipment investment:

- Revenue from long distance call service
- Revenue from international call service
- Revenue from rental charge for the leased circuits
- Revenue from rental charge for leased color TV line
- Revenue from other long distance transmission services

The assumption is that this system constructed contains plan to use for telex and telegraph services part of facilities improved and expanded.

Items to be considered as variables in the estimation of revenue from telephone service include the following, beside the system facilities improvement plan:

- Telephone tariff plan
- Holding time of telephone users
- Telephone traffic between exchanges
- Mean value of busy hour traffic per subscriber
- Telephone facilities utilization efficiency

The gross operating revenue of this system constructed is the sum of the foregoing revenue items. Refer to Table 7-6.

8) Project Loans

The itemized project loan estimate comprises the aggregate value of equipments of all kinds required for the implementation of the project including tools and equipments procured by the local industry. Loan is also applied partially for installation of these equipments, as well as the consultant service fee.

89% of necessary fund sources are procured by foreign loan.

The remaining 11% is composed of such equity portion as funds on hand.

9) project Loan Disbursement

The requested project loans will be disbursed during the construction work period in accordance with the work schedules.

The loan portion covering the procurement of equipment by import will be disbursed in the CIF value. The loan portion covering services will be disbursed in the foreign currency equivalent.

Shown below are the project loan disbursements estimated in the local currency.

(Unit: LE '000)

1982:	-	1987:	611
1983:	-	1988:	-
1984:	-	1989:	-
1985:	8,121	1990:	-
1986:	27,417	1991:	-
	Total		36,149

The currency to be used in the project loan disbursement is the currency of the loan financing country. The terms of disbursement can be determined between the parties concerned pending prior approval and permission by the authorized institution of the loan financing countries.

The payment for procured goods is to be made upon fulfilment of order, in principle. Ordinarily, such payment is to be settled against shipment of the goods concerned.

The payment for services provided is to be made upon completion of each service, in principle, at the reasonable determined rate. Where necessary, advance payment is made.

As regards the construction work contingencies which are included in the project loan amount disbursed as per above, it is possible to appropriate such contingencies as construction costs in case where they are used to pay for the purchase of additional goods in practically the same way as the payment for equipment/materials to be procured by the loans when the construction work actually gets underway. Such arrangement, however, requires prior negotiations with and approvals of the loan financing institution.

10) Interest Payment and Loan Repayment

From the viewpoint of facilitation of interest payments and loan repayments, it is desirable that the project loan be long term, low interest loans.

For interest payments and loan repayments, the following conditions are considered:

		(1)	(2)	(3)
1)	Repayment Period	20 years	25 years	30 years
2)	Grace Period	5 years	7 years	10 years
3)	Interest Rate	11%	5%	4%

The fund procurement and payment are estimated based on the condition (2). Refer to Table 7-7.

11) Subsidy Grant from National Treasury

The Government of Egypt annually grants subsidy to the telecommunications business. Here, the subsidies considered to be pertinent to the implementation of this project are assumed during the period of the construction.

1 year: 4,000,000 (Unit: LE)

2 year: 4,000,000

The estimate total subsidy grant during the project life period amounts to LE 8,000,000.

12) Analysis of Profit Ratio of Total Liabilities and Net Worth

Net revenue by years: (Unit: LE '000)

1	2	3	4	5	6
-5,307	-26,160	780	3,547	4,247	4,551
7	8	9	10	11	12
4,880	4,921	4,921	4,921	4,921	4,921
13	14	15	16	17	
4,921	4,921	4,921	4,921	9,555	

Financial Internal Rate of Return: 10.4%

An equation used for the calculation of IRR is shown in Table 7-9.

13) Analysis of Profit Ratio of Net Worth

From the viewpoint of public utility cost guarantee, the profit as opportunity cost of the net worth is analyzed.

The findings are as follows:

- In case without Additional Equity defined as subsidy from Government
  Profit ratio of net worth = 24%

14) Sensitivity Analysis

Sensitivity analysis is made on the assumption that when the system constructed by project comes into operation in the future, the construction investment and operating revenue evaluations in the financial analysis will be realized in the pessimistic direction from the viewpoint of project finance.

- In case where the construction investment increases by 10%:
  Financial Internal Rate of Return = 6%
- In case where the operating revenue decreases by 10%:
  Financial Internal Rate of Return = 6%
- In case where the construction investment increases by 10% and the operating revenue decreases by 10%:
  Financial Internal Rate of Return = 5%

7-2 Evaluation of Project

(1) Rate of Return Analysis

Rate of Return	*With Government* Subsidy (ARENTO Equity Addition)	Without Government Subsidy
1. Financial Internal Rate of Return -Tariff increase 10%/ 2 years -Tariff increase 11%/ 2 years	10%	7% 8%
2. Sensitivity Analysis (in case of Tariff increase 10%) -The construction investment increase by 10% -The operating revenue decrease by 10% -The construction investment increase by 10% and the operating revenue decrease by 10%	8% 8% 7%	6% 6% 5%
3. Profit Ratio of Net Worth (Equity Portion) (in case of Tariff increase 10%)	-	24%
4. Economic Internal Rate of Return (*) (in case of Tariff increase 10%)	-	8-10%

(*) Economic Internal Rate of Return was not calculated due to the lack of the actual data and information, so that the value to be expected is given as 8-10% without Government Subsidy in the above table.

1) Financial Internal Rate of Return

The investment aimed at an integral development of rural areas shows no short-term financial return.

The financial internal rate of return of 7.2% is not exactly as high as desired with satisfaction when viewed from the angle of capital cost within the operating entity, as opportunity cost.

However, when subsidy grant totalling to LE 8,000,000 from the national treasury is available, the financial internal rate of return will improve to higher rate that is considered to be sound enough to ensure a full internal reserve required to keep the capital going.

The financial internal rate of return would be improved to 10.4% with the subsidy grant from Government.

The financial internal rate of return quoted above is an estimate from the optimum new tariff system. This new system derives from composite studies of telecommunications systems as public utility and all requirements from the viewpoints of national economy, with an eye to thorough modification of the existing complicated tariff system.

2) Profit Ratio of Net Worth

The profit ratio of net worth 24% by far exceeds the financial internal rate of return obtained by the profit rate method.

As shown above, the earning power of equity portion of ARENTO, 24% remains satisfactory in view of the stability of equity position, even in case where the additional equity, based on the subsidy grant from Government totalling to LE 8,000,000, is not considered.

In conclusion, the stability of the equity position could be fully ensured under the soft loan conditions.

3) Preconditions prior to Rate of Return Analysis

a) The existing cable system in the whole country would be rehabilitated to operate fully by the time of service commissioning.

b) The microwave system newly provided can cater fully for the traffic demand that increases, as telephone switching line units increase with other projects.

c) The exchange capacities in the project area are assumed to be expanded during the system life to fulfill 100% of demand by years for subscriber's line units, meanwhile 80% of their line units provided in the exchanges is considered as working lines.

d) The shortage on the common control equipment, the intermediate stage of SXS type and so on in the existing exchanges can be compensated by other projects, so that the traffic congestion in the busy hour would be improved.

e) Both local and toll calling rates do not change "with and without project".

f) The traffic demand does not decrease, after the telephone tariff system is reviewed based on the Egyptian economy and adjusted reasonably.

g) The assumption applies to the effect that the system constructed in the project aims in part to contribute to telex and telegraph services.

h) Additional provision of the carrier terminal equipment to cater for the growth of traffic demand is excluded from the study objective of costs/benefits to be estimated during the project life.

(2) Telecommunication Tariff

The establishing the telecommunications tariff system, the following considerations are essential:

From the viewpoint of self-supporting accounting of telecommunications service, the tariffs must be such as to ensure the fair cost indemnity.

The tariffs must be at a level where fair surplus can square fair cost, and, for this purpose, a fixed internal reserve must be maintained. This is to enable telecommunications service to respond fully to the national expectation about its performance as a basic infrastructure, and also to stabilize the telecommunications business management.

Here, in consideration of the public needs from the viewpoint of national economy, in addition to the foregoing requirements, the telecommunications tariff system deemed to be fittest for the system implementation is postulated hereunder.

The unit prices level of the costs requisite for the project is assumed to increase by 5-15% per annum macroscopically under price devaluation.

Based on the above-mentioned way of thinkings, tariff levels to be adopted in the near future are studied microscopically from the viewpoint of guarantee of a fixed internal reserve and public utility and then assumed to be increased by 10% with two years, which is modest.

Table 7-1 Cost Estimate (at 1984 price) (Unit: LE '000)

Description	Foreign Portion	Local Portion	Total
1. System Facilities Costs			
FOB Total	21,821	-	21,821
CIF Total	22,911	-	22,911
2. Inland Transportation & Custom Clearance	-	425	425
3. Installation Cost	3,636	404	4,040
4. Training	425	357	782
5. Supervision of Maintenance	-	-	-
6. Cost for Civil Work	4,354	2,093	6,447
7. Consulting Service	1,536	514	2,050
8. Contingency	3,286	379	3,665
9. Grand Total	36,149	4,172	40,321

Note: No cost escalation is considered in each figure.

Table 7-2 Disbursement Plan (Unit: LE '000)

Year	Cost Estimate		
	Foreign	Local	Total
1985	8,121	1,186	9,307
1986	27,417	2,743	30,160
1987	611	243	854
1988	-	-	-
Total	36,149	4,172	40,321

Table 7-3 Working Capital & Project Salvage Value

(Unit: LE '000)

Period (Year)	Working Capital	Project Salvage Value
1	-	-
2	-	-
3	869	-
4	531	-
5	104	-
6	112	-
7	121	-
8	0	-
9	0	-
10	0	-
11	0	-
12	0	-
13	0	-
14	0	-
15	0	-
16	0	-
	-1,737	-2,897

Table 7-4 Operating Expenses

(Unit: LE '000)

Period (Year)	Operating & Administrative Expenses	Maintenance Expenses	Total Operating Expenses
1	-	-	-
2	-	-	-
3	1,738	103	1,841
4	2,799	121	2,920
5	3,007	157	3,164
6	3,231	184	3,684
7	3,474	210	3,764
8	3,474	290	3,764
9	3,474	290	3,764
10	3,474	290	3,764
11	3,474	290	3,764
12	3,474	290	3,764
13	3,474	290	3,764
14	3,474	290	3,764
15	3,474	290	3,764
16	3,474	290	3,764
17	3,474	290	3,764

Table 7-5 Telephone Tariff (1)

1. Domestic Telephone Tariff Rate System

(1) Installation Charge

1.	Large Scale Company and Bank	LE 165
2.	Small Scale Company and Small Shop	LE 110
3.	Residence, Doctor, Government Office, Engineer Office, Lawyer Office, etc.	LE 55

(2) Subscription Charge

All telephone subscribers	LE 20/year

(3) Local Call Charge (Excess Call Charge Type)

The number of free calls:

1.	Residence	1,500 calls
2.	Government Office	1,000 calls
3.	Business Office (large scale and small scale)	300 calls

LF 0.033/call in excess of the above number of calls.

No telephone speech time limitations to LE 0.033 of charge on local call.

(4) Deposit

LE 2.2/year for each categories of subscribers with excess calls over the number of free calls.

Telephone Tariff (2)

(5) Trunk Call Charge

Distance (Km)	Daytime 8:00-10:00	Night Time 19:00-8:00
0-25	LE 0.033	LE 0.033
26-50	0.055	0.033
51-75	0.11	0.055
76-100	0.11	0.055
101-125	0.165	0.11
126-150	0.165	0.11
151-175	0.22	0.165
176-200	0.22	0.165
201-250	0.275	0.22
251-300	0.275	0.22
301-500	0.385	0.33
501-	0.385	0.33

(6) For Telephone Subscribers in Manual Board Exchange Area

i) Installation Charge LE 55

ii) Subscription Charge 23-30/year

LE 30: Cairo & Alexandria
23: Other Cities
16.5: For the area where telephone operators working time is less than 14 hours/day

iii) Excess Calls Charge: N.A.

Telephone Tariff (3)

2. International Telephone Tariff Rate System

In case of connection to the international principal overseas cities from Cairo:

		First 3 minutes	Succeeding 1 minute
1.	London	LE 6.750	LE 2.250
2.	Kuwait	5.530	1.840
3.	New York	8.450	2.815
4.	Tokyo	13.795	4.510

Table 7-6 Operating Revenue (*)

(Unit: LE '000)

Period (Year)	Domestic	International	TV	Total
1	-	-	-	-
2	-	-	-	-
3	1,805	2,206	333	4,344
4	2,924	3,574	500	6,998
5	3,158	3,859	500	7,517
6	3,410	4,168	500	8,078
7	3,683	4,502	500	8,685
8	3,683	4,502	500	8,685
9	3,683	4,502	500	8,685
10	3,683	4,502	500	8,685
11	3,683	4,502	500	8,685
12	3,683	4,502	500	8,685
13	3,683	4,502	500	8,685
14	3,683	4,502	500	8,685
15	3,683	4,502	500	8,685
16	3,683	4,502	500	8,685
17	3,683	4,502	500	8,685

Note: Operating Revenues are composed of Trunk calls, Telegraph, Telex, International calls and Miscellaneous revenues excluding TV leased circuit charges.

Table 7-7 Loan Interest Payment & Loan Principal Repayment Schedule

(Unit: LE '000)

Period (Year)	Foreign Loan	Cumulative Foreign Loan	Repayment of Foreign Loan	Cumulative Instalment	Balance of Foreign Loan	Interest Payment
1	8,121	8,121	-	-	8,121	406
2	27,417	35,538	-	-	35,538	1,777
3	611	36,149	-	-	36,149	1,807
4	-	-	-	-	36,149	1,807
5	-	-	-	-	36,149	1,807
6	-	-	-	-	36,149	1,807
7	-	-	-	-	36,149	1,807
8	-	-	2,008	2,008	34,141	1,707
9	-	-	2,008	4,016	32,133	1,607
10	-	-	2,008	6,024	30,125	1,506
11	-	-	2,008	8,032	28,117	1,406
12	-	-	2,008	10,040	26,109	1,305
13	-	-	2,008	12,048	24.101	1,205
14	-	-	2,008	14,056	22,093	1,105
15	-	-	2,008	16,064	20,085	1,004
16	-	-	2,008	18,072	18,077	904
17	-	-	2,008	20,080	16,069	803
18	-	-	2,008	22,088	14,061	703
19	-	-	2,008	24,096	12,053	603
20	-	-	2,008	26,104	10,045	502
21	-	-	2,008	28,112	8,037	402
22	-	-	2,008	30,120	6,029	301
23	-	-	2,008	32,128	4,029	201
24	-	-	2,008	34,136	2,013	101
25	-	-	2,013	36,149	0	0

Table 7-8 Cash Flow Statement (1)
- Cash Inflow -

(Unit: LE '000)

Period (Year)	Overating Revenue	Foreign Loan	Total Cash Inflow
1	-	8,154	8,154
2	-	27,067	27,064
3	4,344	611	4,955
4	6,998	-	6,998
5	7,517	-	7,517
6	8,078	-	8,078
7	8,685	-	8,685
8	8,685	-	8,685
9	8,685	-	8,685
10	8,685	-	8,685
11	8,685	-	8,685
12	8,685	-	8,685
13	8,685	-	8,685
14	8,685	-	8,685
15	8,685	-	8,685
16	8,685	-	8,685
17	8,685	-	8,685

Cash Flow Statement (2)
- Cash Outflow -

(Unit: LE '000)

Period (Year)	Investment in Fixed Assets	Investment in Current Assets	Operating Expenses	Repayment of Foreign Loan	Interest on Foreign Loan	Total Cash Outflow
1	9,307	-	-	-	406	9,713
2	30,160	-	-	-	1,777	31,937
3	854	869	1,738	-	1,807	5,268
4	-	531	2,799	-	1,807	5,137
5	-	104	3,007	-	1,807	4,918
6	-	112	3,231	-	1,807	5,150
7	-	121	3,474	-	1,807	5,402
8	-	0	3,474	2,008	1,707	7,189
9	-	0	3,474	2,008	1,607	7,089
10	-	0	3,474	2,008	1,506	6,988
11	-	0	3,474	2,008	1,406	6,888
12	-	0	3,474	2,008	1,305	6,787
13	-	0	3,474	2,008	1,205	6,687
14	-	0	3,474	2,008	1,105	6,587
15	-	0	3,474	2,008	1,004	6,086
16	-	0	3,474	2,008	903	6,386
17	-2,897	-1,737	3,474	2,008	803	1,651

Residual Repayment of Foreign Loan: LE 16,069

Residual Interest on Foreign Loan : LE 2,813

Cash Flow Statement (3)
- Net Cash Flow -

(Unit: LE '000)

Period (Year)	Net Cash Flow
1	-1,559
2	-4,873
3	-313
4	1,861
5	2,599
6	2,928
7	3,283
8	1,496
9	1,596
10	1,697
11	1,797
12	1,898
13	1,998
14	2,098
15	2,199
16	2,299
17	7,034

Note: The deficits in the initial second and third years amounting to LE 1,559,000, LE 4,873,000 and LE 313,000 respectively, are to be covered by the ARENTO funds.

Table 7-9 Estimation of Profit Ratio of Total Liabilities and Net Worth

The financial internal rate of return of this investment can be estimated by the following method of analysis for the profit ratio of total liabilities and net worth:

$$I = \sum_{v} \frac{C_v}{(1+i)^v} - \text{(salvage value)}$$

$$D = \sum_{v} \frac{d_v}{(1+i)^v}$$

$$R = \sum_{v} \frac{r_v}{(1+i)^v}$$

$$I + D = R$$

where:

I: Present worth of initial construction cost and necessary working capital

D: Present worth of annual operating expense required for system management

R: Present worth of revenue obtainable from system operation

i: Discount rate

v: System year concerned

C_v: Annual capital expense including working capital

d_v: Annual operating expense required for system management

r_v: Annual revenue from system operation

ANNEX