REPUBLIC OF PARAGUAY

CONSTRUCTION PROJECTS OF MICROWAVE NETWORK AND EARTH STATION FOR SATELLITE COMMUNICATIONS

VOLUME I
PLANNING REPORT

FEBRUARY 1972

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

This report consists of the following three volumes:

Volume I	Planning Report
Volume II	Detailed Design
Volume III	Technical Specification of Tender Document

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Chapter I Background and Purpose of Survey

Acceding to the urgent request made by the Paraguayan Government, a survey team was dispatched to Paraguay which lasted from August 20 to October 28, 1971, by the Japanese Government as Japan's technical cooperation in the construction of a microwave network and an earth station for satellite communication system.

The survey team was assigned to perform the following task for both the microwave construction project and the earth construction station project.

(1) Technical and economic analysis of the two projects

(2) Site selection and preparation of construction design of the microwave stations and the earth station

(3) Preparation of tender specifications

Since the preparation of the construction design and tender specifications is still in progress, this report covers Item (1) and gives a brief account of Item (2).

In addition a preliminary survey for the earth station construction was already carried out by two experts sent by the Japanese Government during a one month period from February to March, 1970.

Formation of the survey team is as shown below.

			(Period of Survey)
Leader	Kazuo KATO	Radio Regulatory Bureau, Ministry of Post and Telecommunications	Aug. 20 - Oct. 28
Member (Chief of Microwave Party)	Masashi SHOJI	Micorwave Division, Nippon Telegraph & Telephone Public Corporation	"
Member	Shinichi TAKANO	"	"
"	Tadashi WATANABE	"	"
"	Ichiro TAKEMURA	Maintenance Bureau, Nippon Telegraph & Telephone Public Corporation	"
"	Shozo ISHIJIMA	Tokyo Radio Communications Division, Nippon Telegraph & Telephone Public Corporation	"
"	Fumio NIREI	Microwave Division, Nippon Telegraph & Telephone Public Corporation	"

Member	Shoichi MATSUHASHI	Engineering Bureau, Nippon Telegraph & Telephone Public Corporation	Aug. 20 - Oct. 28
"	Hidesaburo KOMURO	Radio Regulatory Bureau, Ministry of Post and Telecommunications	"
"	Masayoshi TANI	President's Secretariat, Kokusai Denshin Denwa Co., Ltd.	"
Member (Chief of Earth Station Party)	Shigeru MIYAKE	International Cooperation Office, Kokusai Denshin Denwa Co., Ltd.	Aug. 20 - Sep. 23
"	Toshio TSUBOI	"	"
"	Yozo KONO	Transmission System Department, Kokusai Denshin Denwa Co., Ltd.	
Member (Economic Party)	Masakazu HAYASHI	President's Secretariat, Kokusai Denshin Denwa Co., Ltd.	"
(Coordinator)	Yoshio NAKAHIRA	Overseas Technical Cooperation Agency	Aug. 20 - Oct. 28

Chapter II Need for Project Implementation

Except in Asuncion and a few other cities where telephones are popularized and installation of automatic telephone exchanges is in progress, the domestic telecommunication of Paraguay is in a rather retarded state. This can be seen from the poor popularization of telephones, availability of a limited number of open wire toll circuits (approx. 3 circuits) for inter-urban communication, and dependence of HF circuits alone in some cities.

Paraguay is also backward in international telecommunication service. Except for HF circuits established to connect Asuncion, the capital, with the Central and South American countries, the United States and a few European countries, the country resorts to either cables or VHF circuits for frontier communication with the adjoining countries like Argentina and Brazil.

The backwardness of telecommunications, which is conspicuous in toll telephone service and international communication, is chiefly due to the fact that Paraguay is an inland country with a small population and its economy is rendered inactive by its dependence on primary industries such as agriculture, forestry and livestock farming.

However, the political stability maintained over the past ten years has greatly accelerated the pace of the country's economic development, contributing to the traffic growth of telephones and telex. To cope with this rising traffic, improvement and introduction of automatic exchange in the domestic telephone and telex network is now being steadily pushed forward under the West German aid.

In the developing Central and South American countries, construction of micro-wave circuits is being implemented according to the inter-American telecommunication network plan formulated by the Inter-American Telecommunications Commission (CITEL). Taking its own part in this plan, Paraguay is planning to construct as international micro-wave circuit running through the country for connection with Argentina and Brazil and to use it as a trunk line for domestic toll circuits.

The telecommunication service in Paraguay is managed by ANTELCO (The National Telecommunication Administration), an independent management organ belonging to the Ministry of Public Works. ANTELCO is exerting strenuous efforts for the construction and improvement of the Paraguay telecommunication network which is on a lower level than in other Latin American countries.

The survey was conducted in line with such need for improvement and produced findings given in the following pages which the team considers will amply justify the implementation of the project.

Chapter III Estimate of Traffic Demand and Number of Circuits for International Telecommunications

1. Present Status

Table 1 shows the traffic volume, number of circuits and balance sheet condition in ANTELCO's international telecommunication services. In the entire income of ANTELCO including the income from domestic communication services, international telecommunication services account for as much as 32%. As compared to Japan where the receipts from international telecommunication services occupie only about 0.1% in the total income of both Nippon Telegraph and Telephone Public Corporation and International Telegraph & Telephone Co., Ltd., this high ratio is characteristic of Paraguayan telecommunication services.

2. Estimate of Traffic Demand

The following two methods are generally employed at present in estimating the demand for international telecommunication services:

(1) Method in which the demand is estimated by applying the predicted future trade volume to the equation of correlation between the volumes of international telecommunications and foreign trade, with some adjustments made to the obtained value to counterbalance the variations due to other elements. In this case, the equation is obtained from the past volumes of both international telecommunications and foreign trade since the former is generally closely affected by the latter.

(2) Method in which the average demand growth rate in future is estimated from the past record of annual demand growth rate, with some adjustments made if necessary. This method is based on the fact that the volume of international telecommunications shows a growth in exponential function when viewed in time series.

The former method is employed mostly for short-range estimate and the latter for long-range estimate. In this report, the latter method is employed since factors other than foreign trade are believed to closely bear upon the volume of international telecommunications in Paraguay.

The future annual growth rates of the three major services of international telecommunications are estimated as follows, with some allowance provided for each of the forty major party countries.

International telegramme service	2%
International telex service	15%
International telephone service	15%

As regards international telephone service, the inauguration of the satellite and microwave communication systems in 1975 is expected to yield a sharp demand increase as described below as a result of the striking improvement of transmission quality.

International telephone service with the United States, Canada and European countries	10%
International telephone service with other parts of the world	50%

3. Number of Circuits Required

(1) Countries with which direct connections are expected

It is assumed that direct connections will be had with those countries with which direct circuits have already been established and which are expected to show a demand increase exceeding the following criterion values, and that traffic with all the other countries will be carried through the same routes via third countries as at present.

Criterion Demand for Establishment of Direct Circuit:

Telegramme	130/day (39 thousand/year)
Telex	15/day (1.5 thousand/year)
Telephone	40/day (12 thousand/year)

(2) Calculation of Number of Circuits Required

Future traffic demand summed up for each country to be directly connected with Paraguay is shown in Table 2. Number of circuits required to satisfy the said demand is calculated on the basis of the following conditions.

Telegramme: One circuit for each 440 messages/day (132 thousand/year)

Telex: Calculated as per CCITT Recommendation F. 64
Values assumed for the calculation are as shown below.

	1975	1980, 85
Operation method	Semi-automatic	Fully automatic
Chargeable minutes	4.7 min/call	4.7 min/call
Operation minutes	4.2 min/call	2.2 min/call
Concentration ratio in the busiest hour	15%	15%
Loss Probability	1/30	1/50

Telephone: Calculated as per CCITT Recommendation E. 520
Values assumed for the calculation are as shown below.

	1975, 1980 and 1985
Operation method	Semi-automatic
Chargeable minutes	4.7 min/call
Operation minutes	5.0 min/call
Concentration ratio in the busiest hour	15%
Loss Probability	3%

Leased telegraph circuit } Estimated from demand data of
Leased telephone circuit } ICAO, IATA and WMO

In the above calculation, other services (such as Programme Transmission Service, Phototelegramme, Television Transmission Service and so on) are disregarded because of their small demand.

Number of required circuits obtained by the above calculation method is shown in Table 2.

(3) Circuit Allocation between the Satellite and Microwave Communication System

It is generally considered advantageous, both economically and technically, to resort to a satellite system for long-distance communication and to a microwave communication system for short-distance communication. Consequently, for international telecommunications with Argentina, Urguay (direct connection via Buenos Aires) and with Brazil, it is envisaged that the microwave system will be utilized, and for communications with all other countries to be directly connected with Paraguay, satellite communication is considered.

However, since the volume of communication between Paraguay and Argentina is very large, it is assumed that 25% of telex and telephone circuits are planned to be established through the satellite system to provide against the possible failure of the microwave system.

As for the communication with Bolivia, the existing HF circuit will be maintained since the country has not yet mapped out any concrete plan for construction of an earth station, and for utilization of the microwave route in Paraguay.

(4) Traffic Volume and Number of Circuits Required through the Satellite System

As per Table 3.

(5) Traffic Volume and Number of Circuits Required through the Microwave System

a. International Telecommunications

Traffic volume and number of circuits required for international telecommunications through the microwave system are as shown in Table 4-(1). Besides, it is conceivable that the communication between Argentina and Brazil, which is currently made through their own satellite systems or HF circuits, will be partially conducted through the planned microwave system. The present and estimated future numbers of voice grade circuits between these two countries are as tabulated below.

	Telephone	Telegramme	Telex	Leased Telegraph Circuit	Total
Number of Existing Circuits between Argentina and Brazil (1970)	6 ch	2	15	5	7 ch (VG)
			1 ch (VG)		

	1970	1975	1980	1985
Estimated Number of Voice Grade Circuits	7 ch	15 ch	30	60

It is assumed that 25% of these estimated number of circuits required will be established through the planned microwave system, which is considered to incur a higher rental charge than the satellite system, and therefore, the number of additional international circuits are as shown below. (See Table 4-(2))

	1975	1980	1985
Number of circuits utilized between Artentina and Brazil	4 ch	8	15

b. Frontier Communications

As of the end of 1970, 11 telephone cirucits are established to cope with the substantial traffic volume between cities located close to the border line. Since the planned microwave route is considered to be used for telephone communication in the following sections, demand and number of circuits in the said sections are taken into account (See Table 4-(3)).

Asuncion - Resistencia (Argentina)

Asuncion - Foz de Yguazu (Brazil; communication with districts farther than Foz de Yguazu inclusive)

The annual growth rate of demand is set at 5% for these sections and the number of required circuits calculated, in principle, on the same basis as adopted for the aforementioned international communications.

Table 1 - Present Status of ANTELCO's International Telecommunication Services

(1966 - 1970)

Type of Service	Year	Traffic Volume		No. of Circuits	Income	Expenditure	Profit
International Telegramme	1966	153 thousand messages	3,396 thousand words	(unknown)	₲54 million	31	23
	67	151	3,460		58	32	26
	68	152	3,447		53	35	18
	69	161	3,663	8	58	41	17
	70	167	3,687	8	61	43	18
International Telex	1966	24 thousand calls	107 thousand minutes	(unknown)	28	9	19
	67	26	117		31	13	18
		29	128		34	15	19
		36	161	10	43	31	12
	70	41	191	14	50	38	12
International Telephone	1966	49 thousand calls	211 thousand minutes	(unknown)	27	12	15
	67	50	213		32	16	16
	68	79	361		44	18	26
	69	105	464	9	63	37	26
	70	112	526	9	62	40	22
				Total for 1970	173	121	52

Number of ANTELECO's International Telecommunication Circuits (1970)

	Telegramme	Telex	Telephone
Buenos Aires	1 ch	8	3
La Paz	1		
Lima	1	1	
Montevideo	1		1
Rio de Janeiro	1	1	1
Santiago			1
New York	2	3	2
Madrid			1
Hamburg	1	1	
Total	8	14	9

ANTELECO's Total Income and Expenditure (Unit: Million ₲)

Year	Total Income	Total Expenditure	Profit
1966	305	269	36
1967	351	294	57
1968	420	336	84
1969	496	404	92
1970	544	451	93

Table 2 - Estimated Traffic Demand and Number of Circuits Required for International Telecommunication Services

(Calculated for each country to be directly connected with Paraguay)

Country	Type of Service	1975 Demand	1975 Ch	1980 Demand	1980 Ch	1985 Demand	1985 Ch	Utilized System
Argentina	Tg	102.2 thousand messages	1	112.8	1	124.6	1	Microwave; however, 25% of Tx and Tp traffic are to be carried via Satellite
	Tx	42.8 thousand calls	8	79.0	9	151.7	15	
	Tp	762.2 thousand minutes	19	1,532.8	34	3,083.1	62	
	L. Tg		7		8		10	
	L. Tp		2		3		3	
Bolivia	Tg	2.5	1	2.8	1	3.0	1	HF
	Tx							
	Tp							
	L. Tg							
	L. Tp							
Brazil	Tg	16.7	1	18.4	1	20.4	1	Microwave
	Tx	7.2	3	14.5	4	29.1	5	
	Tp	68.4	4	137.6	6	276.7	9	
	L. Tg		4		5		6	
	L. Tp		3		3		3	
Chile	Tg							Satellite
	Tx					7.3	2	
	Tp	19.7	2	39.6	3	79.7	4	
	L. Tg		1		1		1	
	L. Tp							
Peru	Tg	2.4	1	2.7	1	3.0	1	Satellite
	Tx	1.8	1	3.5	2	7.1	2	
	Tp							
	L. Tg		1		1		1	
	L. Tp							
Uruguay	Tg	12.3	1	13.6	1	15.0	1	Microwave
	Tx			7.0	2	14.2	3	
	Tp	50.9	3	102.4	5	205.9	7	
	L. Tg		1		2		3	
	L. Tp							
U.S.A.	Tg	30.7	1	33.8	1	37.3	1	Satellite
	Tx	15.1	4	30.2	5	61.0	8	
	Tp	213.6	8	429.5	12	864.0	21	
	L. Tg		2		3		4	
	L. Tp							

Country	Type of Service	1975 Demand	1975 Ch	1980 Demand	1980 Ch	1985 Demand	1985 Ch	Utilized System
France	Tg							
	Tx					7.3	2	
	Tp							Satellite
	L. Tg							
	L. Tp							
Great Britain	Tg							
	Tx					6.9	22	
	Tp							Satellite
	L. Tg							
	L. Tp							
Germany	Tg	20.2	1	22.3	1	24.7	1	
	Tx	18.0	4	29.1	5	32.7	5	
	Tp							Satellite
	L. Tg		2		2		3	
	L. Tp							
Italy	Tg							
	Tx			7.0	2	14.2	3	
	Tp							Satellite
	L. Tg							
	L. Tp							
Spain	Tg							
	Tx					5.3	2	
	Tp	3.4	1	6.8	1	13.8	2	Satellite
	L. Tg							
	L. Tp							
Switzerland	Tg							
	Tx					6.5	2	
	Tp							Satellite
	L. Tg							
	L. Tp							
Total	Tg	187.0	7	206.4	7	228.0	7	
	Tx	84.9	20	170.3	29	343.3	51	
	Tp	1,118.2	37	2,248.7	61	4,523.2	105	
	L. Tg		18		22		28	
	L. Tp		5		6		6	

Notes: (1) Tg - International telegramme
Tx - International telex
Tp - International telephone
L. Tg - Leased telegraph circuit
L. Tp - Leased telephone circuit

(2) Traffic Demand for telephone service is expressed in minutes due to the absence of statistical data for number of calls by country.

Table 3 - Estimated Traffic Demand and Number of Circuits Required via Satellite System

Country	Type of service	1975		1980		1985	
		Demand	Ch	Demand	Ch	Demand	Ch
Argentina (25% for Tp and Tx traffic)	Tp	190.6 thousand minutes	5	383.2	9	770.8	16
	L. Tp						
	Tg						
	Tx	110.7 thousand calls	2	19.8	3	17.9	4
	L. Tg						
Chile	Tp	19.7	2	39.6	3	79.7	4
	L. Tp						
	Tg						
	Tx					7.3	2
	L. Tg		1				1
Peru	Tp						
	L. Tp						
	Tg	2.4 thousand	1	2.7	1	3.0	1
	Tx	1.8 messages	1	3.5	2	7.1	2
	L. Tg		1		1		1
U.S.A.	Tp	213.6	8	429.5	12	864.0	21
	L. Tp						
	Tg	30.7	1	33.8	1	37.3	1
	Tx	15.1	4	30.2	5	61.0	8
	L. Tg		2		3		4
France	Tp						
	L. Tp						
	Tg						
	Tx					7.3	2
	L. Tg						
Great Britain	Tp						
	L. Tp						
	Tg						
	Tx					6.9	2
	L. Tg						
Germany	Tp						
	L. Tp						
	Tg	20.2	1	22.3	1	24.7	1
	Tx	18.0	4	29.1	5	32.7	5
	L. Tg		2		2		3

Country	Type of Service	1975		1980		1985	
		Demand	Ch	Demand	Ch	Demand	Ch
Italy	Tp						
	L. Tp						
	Tg						
	Tx			7.0	2	14.2	3
	L. Tg						
Spain	Tp	3.4	1	6.8	1	13.8	1
	L. Tp						
	Tg						
	Tx					5.3	2
	L. Tg						
Switzerland	Tp						
	L. Tp						
	Tg						
	Tx					6.5	2
	L. Tg						
Total	Tp	427.3	16	859.1	25	1,728.3	43
	L. Tp						
	Tg	53.3	3	58.8	3	65.0	3
	Tx	45.6	11	89.6	17	186.2	32
	L. Tg		6		7		9
Conversion into Voice Grade Circuit		17 ch		27		45	

The configuration of telephone circuits is subject to minor changes by the introduction of SPADE system. For balance sheet estimate, however, the values shown in this table are used.

Table 4 - Estimated Traffic Demand and Number of Circuit Required via Microwave System

(1) International Telecommunications

Country	Type of Service	1975		1980		1985	
		Demand	Ch	Demand	Ch	Demand	Ch
Argentina (75% for Tp & Tx traffic)	Tp	571.6 thousand minutes	14	1,149.6	25	2,312.3	46
	L. Tp		2		3		3
	Tg	102.2 thousand messages	1	112.8	1	124.6	1
	Tx	32.1 thousand calls	6	59.2	6	113.8	11
	L. Tg		7		8		10
Uruguay	Tp	50.9	3	102.4	5	205.9	7
	L. Tp						
	Tg	12.3	1	13.6	1	15.0	1
	Tx			7.0	2	14.2	3
	L. Tg		1		2		3
Brazil	Tp	68.4	4	137.6	6	276.7	9
	L. Tp		3		3		3
	Tg	16.7	1	18.4	1	20.4	1
	Tx	7.2	3	14.5	4	29.1	5
	L. Tg		4		5		6
Total	Tp	690.9	21	1,389.6	36	2,794.9	62
	L. Tp		5		6		6
	Tg	131.2	3	144.8	3	160.0	3
	Tx	39.3	9	80.7	12	157.1	19
	L. Tg		12		15		19

(2) Number of Circuits Utilized between Argentina and Brazil

	1975	1980	1985
Number of Circuits	4 ch	8	15

(3) Frontier Communications (Telephone)

Section	1975		1980		1985	
	Demand	Ch	Demand	Ch	Demand	Ch
Asuncion - Resistencia	88.2 thousand minutes	4	112.5	4	143.6	5
Asuncion - Foz de Yguazu	25.4	2	32.4	2	41.4	2
Total	113.6	6	144.9	6	185.0	7

(4) Toll Telephone Service (Ref. Chapter IV)

Section	1975		1980		1985	
	Demand	Ch	Demand	Ch	Demand	Ch
Asuncion - Paraguari	65 hrs/day	20	81	26	96	31
Asuncion - Cnel. Oviedo	99	32	123	40	147	47
Asuncion - Stroessner	22	8	27	11	31	12
Asuncion - S.J. Bautista	69	24	83	26	96	31
Asuncion - Pilar	54	16	65	22	76	26
Total	309	100	379	125	446	147

Notes: 1) As for toll telephone demand, those sections in which toll telephone traffic is expected to be carried soon are selected from Table 1 given in Chapter IV and the volume of toll calls per subscriber is calculated on the assumption that it will be half the value recorded in Japan.

2) Demands for city-to-city telegramme and telex services are disregarded since their income and expenditure are considered negligible.

Chapter IV Estimate of Demand and Number of Circuits of Toll Communications

1. Existing State

The country's telephone subscribers totalled about 18 thousand in 1970, of whom approximately 16 thousand are in Asuncion and the remaining 2 thousand in local districts (See Table 1). About 100 telephone exchanges in the country employ the magnetic switchboard except in Asuncion and Encarnacion where the automatic exchange system has been introduced. For the purpose of toll circuit composition, the entire country excluding the city area of Asuncion is divided into ten districts each having a primary center and an average of about nine end offices. Of these primary centers, the one in Encarnacion has the largest number of subscribers (about 560), while others have 30 to 260 subscribers. Subscribers to end offices are very small in number, averaging about nine per end office.

Toll circuits are not only needful of improvement but also limited in number. Besides this, their transmission performance is rather poor. Open wires are mostly used to connect end offices and their primary center, and either open wires or open wire carrier system (3 ch or 12 ch system) are employed for connection between primary centers and the secondary center (Asuncion). There is no wire transmission line between Asuncion and Pilar and as a consequence, telephone communication between the two places resorts to HF radio circuits.

The manual Morse type is used for telegraphy. Of a total of about 100 telex subscribers, only eight are local subscribers and all the rest are in Asuncion. Telex exchange is carried out only in Asuncion.

There is no leased toll communication circuit established at present.

2. Estimate of Demand and Number of Circuits

During the ten year period from 1960 to 1970, the country's total of telephone subscribers increased by 2.24 times, showing an increment of about ten thousand. Since the greater part of this increment was created by additional subscription in Asuncion, the number of subscribers per 100 persons averaged 3.9 in Asuncion and 0.1 is other parts of the country in 1970. Though ANTELCO's plan for increasing subscribers was not made clear, the team considers that local subscribers will increase smoothly because most of local primary centers are constructing new buildings for introduction of automatic exchange system and also pushing forward the installation

of intra-urban telephone cables. Table 1 shows the number of telephone subscribers in the future as estimated on the basis of such progress and the ITU's report on Paraguayan telecommunications published in 1967.

At present, the volume of toll telephone calls is less than one-third the value recorded in Japan. It is expected, however, that in the future when the completion of the microwave network provides a larger number of toll circuits, reduces the waiting time to virtual zero and also improves the transmission performance, the volume of toll telephone calls will show a spiralling increase. Though the estimate of call increase over a long period entails difficulties, it is reasonable to estimate that the volume of calls per subscriber in 1990 will increase to the existing level in Japan and is advisable to plan the installation of toll telephone circuits accordingly.

Table 2 shows the numbers of toll telephone circuits calculated to be required in the future between Asuncion and various districts of the country.

As for public telegrammes, one circuit between Asuncion and respective primary centers will suffice since the traffic has shown no noticeable ups or downs over the past several years.

Long-range estimate of the increase in local telex subscribers is difficult. Numbers of telex circuits to be required in future were calculated on the basis of the above-mentioned report of ITU, and are shown in Table 2.

Paraguay has only one TV station located in Asuncion, and has no plan, at present, to establish additional TV stations in local districts. Domestic relaying of TV signals is therefore disregarded in this report.

Table 1 - Present and Estimated Number of Telephone Subscribers

Districts	1970	1975	1980	1990
Asuncion (city area)	16, 136	18, 600	21, 800	28, 600
Asuncion (suburban area)	245			
Encarnacion	654	1, 340	1, 730	2, 510
Caacupe	145	670	890	1, 420
Villarrica	303	770	1, 040	1, 570
Cnel. Oviedo	234	500	700	1, 100
Pto. Pte. Stroessner		110	150	230
Concepcion	275	460	650	1, 020
Paraguari	107	330	460	710
San Juan Bautista	75	350	470	720
Puerto Rosario	22	195	295	500
Pilar	103	275	370	560
P. J. Caballero	-	430	640	1, 060
Ype Jhu	-	25	40	70
Total	18, 299	24, 055	29, 235	40, 070

Table 2 - Estimated Number of Toll Circuits

Section	Telephone			Telegraph		Telex	
	1975	1980	1990	1975	1990	1975	1990
Asuncion ~ Paraguari	20	26	36	1	1	0	2
" ~ Caacupe	40	47	69	1	1	0	3
" ~ S.J. Bautista	24	26	36	1	1	1	3
" ~ Encarnacion	80	94	121	1	1	3	6
" ~ Pilar	16	22	30	1	1	0	6
Subtotal	180	215	292	5	5	4	20
Asuncion ~ Cnel. Oviedo	32	40	53	1	1	0	2
" ~ Viliarrica	48	58	76	1	1	2	6
" ~ P.P. Stroessner	8	11	14	1	1	1	2
Subtotal	88	109	143	3	3	3	10

Note: As the communication between primary centers is extremely small relative to that between Asuncion and primary centers, the circuits are to be established between Asuncion and primary centers so that the communication between primary centers will be made via Asuncion.

Chapter V Earth Station Construction Project

In view of the findings of our recent survey in Paraguay, we basically support the report of the preliminary survey carried out during February to March 1970 by two specialists dispatched by the Japanese Government.

However, the lapse of one and a half year since the preliminary survey has been changed in general situations and brought about advancement in satellite communications techniques.

In this connection, we find it necessary, in the light of our experience gained from the recent survey, to make some additions and revisions to the previous report.

The present report has been prepared on the basis of the previous report, with these newly developed situations in view.

1. Establishment of Satellite Communications Circuits

In establishing the satellite communications circuits, attention must be directed to a number of factors such as the number of outgoing circuits from Paraguay, the number of incoming cirucits from other countries, communications with adjacent countries over the projected CITEL network, temporary circuits for emergence use, and future circuit planning.

It is most advisable from the technical and economical points of view that 24-channel FDM-FM system, the minimum transmission unit, be employed in combination with SPADE system to satisfy the demand for the traffic via satellite circuits. (For details of SPADE system, refer to the explanation given in page 43.

SPADE system promises advantages particularly for countries like Paraguay which has many destinations with a relatively small number of circuits for each of them. Though this system has not yet been put in practical use, there is no doubt that it will be put to actual application before long, since more than 30 countries of the world are hoping to make use of it and ten of them are ready to install SPADE equipment by the end of 1972.

For telegraph and telex transmission, it is advisable to adopt the so-called VFT system in which 24 telegraph channels can be multiplied in a single voice frequency channel.

TV circuit should be so designed as to have the performance characteristics for transmission of colour TV programmes. For the present, however, it should be so installed as will be capable of relaying monochrome TV programmes only.

Details of the satellite communications circuits plan will be as described below.

(1) Destinations covered by the First Phase Plan (up to 1975) 7 countries - Argentine, Chile, Peru, U.S.A., Brazil, Spain and Germany.

(2) Distinations covered by the Second Phase Plan (1976 - 1980) 9 countries Italy and Uruguay to be added to the first phase plan.

(3) Number of Circuits

Table 1 - Planned Number of Satellite Communications Circuits

Circuit / Country	Telephone Circuit		Telegraph Circuit	
	~ 1975	~ 1980	~ 1975	~ 1980
Argentina	5	7	2	3
Chile	2	3	1	1
Peru	1	SPADE	3	4
U.S.A.	8	11	7	7
Brazil	1	1	-	-
Spain	1	SPADE	-	-
Germany	-	SPADE	7	8
Italy	-	SPADE	-	2
Uruguay	-	SPADE	-	2
Total	18 (SPADE)	22 SPADE	20	27

(4) Number of Carriers

Table 2 - Planned Number of Carriers for Satellite Communications

Carrier / Item	Transmit Carrier		Receive Carrier	
	1975	1980	1975	1980
Telephone and telegraph(including order wire circuits)	1 (SPADE)	1 SPADE	7 (SPADE)	9 SPADE
TV-Video	1	1	1	1
TV-Cue and Sound	2	2	2	2
Total	4 (SPADE)	4 SPADE	10 (SPADE)	12 SPADE

(5) Required Radio Frequency Bandwidth

FDM-FM system	- 2.5 MHz
SPADE system	- Bandwidth for 3 channels
TV-Video	- 30 MHz

2. Site Selection of Earth Station

In addition to the three sites recommended by the preliminary survey, two more sites are proposed for the following reasons.

(1) The top priority site recommended by the previous survey is located under the take-off and landing courses of the international airport and military airbase of Paraguay.

(2) The said site is only about 13 km from Asuncion and therefore, the construction of the earth station at this site will exert a repressive effect on the rapid outward development of the capital city observed recently.

(3) It is desirable to select a site provided with better surrounding conditions.

For these reasons, the two new sites located about 10 km farther from the previously recommended sites were surveyed and added as shown in Fig. 1. The features of all the five sites including the two additional sites are shown in Table 3 together with their ranking. The team considers it advisable that the construction site be selected from among these five sites.

3. Antenna and Building of Earth Station

The previously recommended antenna is of the conventional type designed to install the high power amplifier, low noise amplifier with a helium gas cooling device on its moving part. The one recommended this time is of the wheel-on-track mount type designed to install all these communications equipment on its pedestal and not on its moving part. Compared with the conventional type antennas, the wheel-on-track mount type antenna is more economical because it has a lighter moving part and can be designed and constructed with greater ease. Further, it provides increased convenience for additional installation of communications equipment, maintenance, operation and many other merits. The station building, to be built adjacent to this antenna, should accommodate all the other communications equipment, monitor and control equipment, power supply equipment, and air-conditioning (cooling) equipment, and should also have a control room, office rooms, warehouses, reception room, dining room, etc. Table 4 shows floor space of the required rooms.

4. Outline of Plan for Satellite Communications System

Fig. 2 shows the blockdiagram of the entire system of planned satellite communications of the earth station, central office and microwave connecting link.

Fig. 3 shows the blockdiagram of the antenna equipment, transmitting and receiving equipment and modulator/demodulator equipment to be installed at the earth station.

Fig. 4 shows the blockdiagram of the terminal equipment and 7 GHz microwave radio equipment for connection with the central office which are to be installed in the earth station.

Fig. 5 shows the blockdiagram of the terminal equipment, switchboard for international telephone exchange and 7 GHz microwave radio equipment for connection with the earth station which are all to be installed in the central office building.

Fig. 6 is the blockdiagram of power supply system planned for the earth station and Fig. 7 is likewise the blockdiagram of power supply system planned for the central office.

5. Recommended System

(1) Access Satellite

Atlantic Ocean INTELSTAT-IV series Satellites

(2) Service Circuits

Telephone, telegraph and telex;

Monochrome television

SPADE

(3) Countries for Direct Communications

Argentina, Chile, Peru, U.S.A., Brazil, Spain and Germany planned for direct communications up to 1975, with Italy and Uruguay to be added as from 1976 for a total of nine countries.

(4) Service Hours

24 hours a day

(5) Site of Earth Station

Aregua Bl is recommended for construction place of the earth station which is to occupy a compound of about 7 ha or more.

(6) Antenna

To assure the performance characteristics of a standard earth station specified by INTELSAT Document (ICSC-45-13E), the antenna is recommended to be of the modified cassegrain antenna having more than 28 m main reflector with the wheel-on-track mount type. It should also be capable of covering the entire bandwith specified both for transmission and reception, and also operated by auto-tracking mode as well as manual tracking mode.

(7) Transmitting Equipment

Transmitter saturated output power:

800 W (Klystron) for telephony (incl. order wire circuits) and telegraphy circuits

800 W (Klystron) for SPADE circuits

2.5 kW (Klystron) for stand-by purpose of above circuits and TV circuit

The transmitter should be able to be tuned within the entire bandwidth of 500 MHz (5,925 - 6,425 MHz) and also equipped with up-converters and FM modulators.

(8) Receiving Equipment

For top stage amplification, two units of helium gas cooled parametric low noise amplifiers are to be installed. One of the two units is for stand-by purpose.

In view of the characteristics of the antenna, the G/T should exceed 40.7 dB and cover the entire bandwidth of 3,700 - 4,200 MHz for reception.

The FM demodulators should be installed for nine telephone circuits, with telegraph and orderwire circuits (incl. stand-by circuits) and TV circuit. Further, down-converters should also be provided to make connection with FM demodulators and SPADE equipment possible.

(9) Terminal Equipment

The terminal equipment should be capable of rearranging the baseband signals between satellite circuits and microwave connecting link circuits, (incl. order wire circuits). Further engineering service circuits equipment and TV terminal equipment should also be installed. Installation of TV standards converter is not recommended.

(10) Test Equipment

Test equipment needed for line-up test via satellite and station loop test are to be provided.

(11) Microwave Connecting Link

As the connecting link between the earth station and central office, two routes of 7 GHz band single hop microwave links are to be installed. One of the two routes is for telephone channels and the other is intended for stand-by purpose, or TV programmes transmission.

60 telephone channels and one TV circuit are initially to be installed. The breakdown of the 60 telephone channels is as shown below.

For telephony circuits via satellite	24 ch
For order wire circuits between the earth earth station and central office	12 ch
For TV audio	12 ch
For SPADE circuits	3 ch
For spare	9 ch

(12) Power Supply Equipment

The earth station should be equipped with power facilities capable of supplying 350 kVA power consumption. A non-break power source should be used to supply electric power to the transmitting equipment, receiving equipment, terminal equipment and any other important communications equipment. The central office equipment is also to be supplied with electric power from a 15 kVA non-break power source.

(13) Equipment of Central Office

For telephone and telegraph communications, the central office should be provided with echo suppressor, VFT terminal equipment and a ring-down international switchboard for communications via satellite. The monochorome TV monitoring and testing equipment should also be installed at the central office.

6. Construction Schedule and Construction Administration

Table 5 shows the construction schedule of the earth station to be implemented after the contractor is selected.

In order to ensure smooth progress of the construction work, the services of consultants will be required.

7. Training

Training of the engineers and operators of the earth station and central office should be carried out prior to the operation of the station. Table 6 shows the

curriculum prepared for such training.

8. Construction Cost

Cost and expenses required for the construction of the earth station are shown in Table 7.

9. Others

The implementation of the project demands that Paraguay has to join INTELSAT and make a coordination with the adjacent countries about microwave mutual interference at an early date.

SPADE SYSTEM

The SPADE System, which stands for the Single Channel per carrier PCM Multiple Access Demand Assignment Equipment, is a kind of demand assignment multiple access communication system developed to attain a higher efficient utilization of the satellite transponders.

Under the existing multiple access communication system, both the frequencies and the number of channels are prefixed. If such a system is employed at an earth station which must communicate with many countries and yet has a limited number of circuits with such countries, it inevitably invites an extreme decline of the circuits utilization efficiency.

To bring a solution for this problem, the SPADE system was developed in which the establishment of the circuits is made possible irrespective of which carrier is employed for which destinations whenever a call occurs.

In this system, the radio frequency bandwidth of the satellite is assigned 36 MHz and is divided at intervals of 45 kHz and each of the bands thus divided is allotted with one voice channel. All the channels are pooled as a whole, and respective earth stations are enabled to utilize any of them whenever a call occurs.

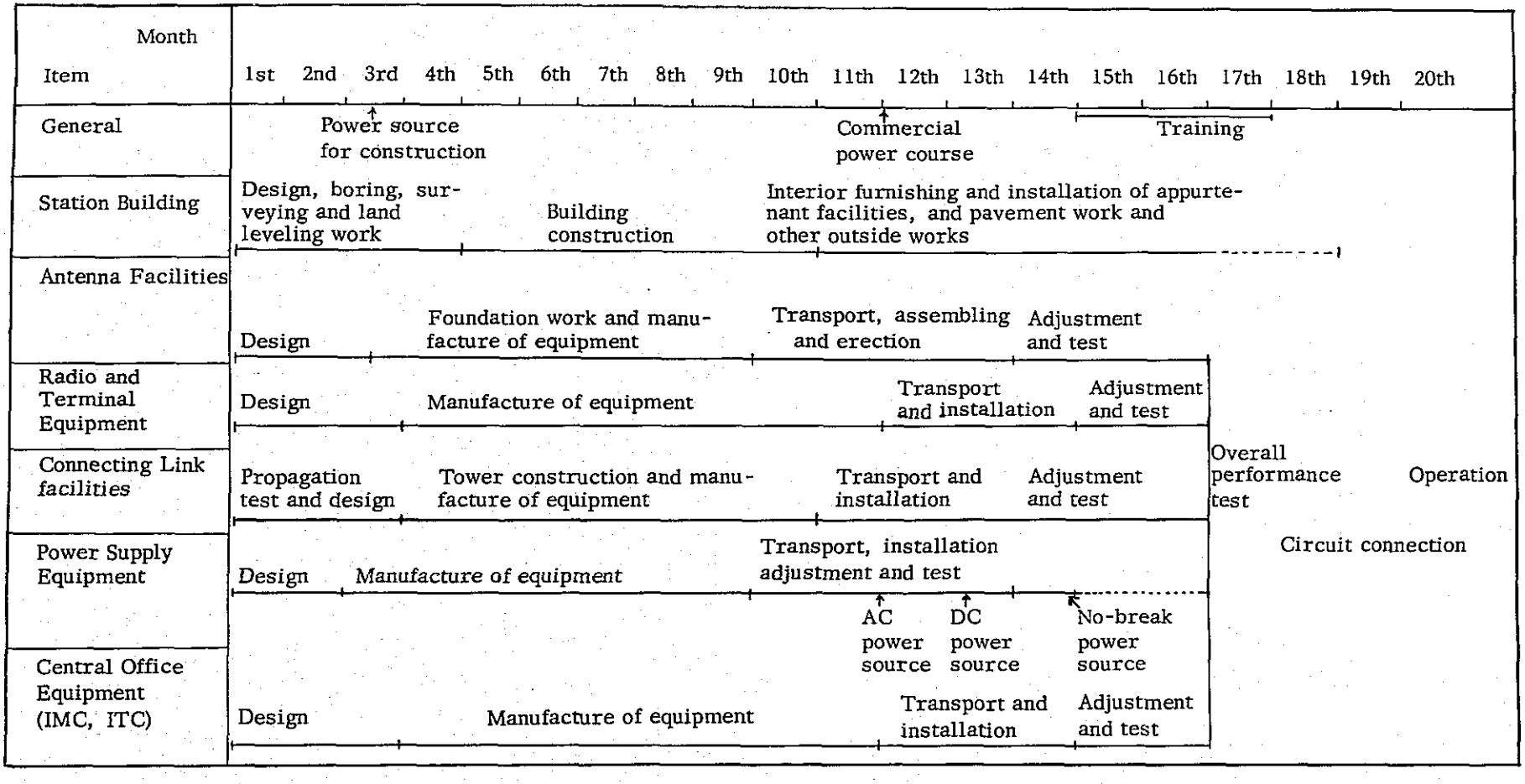
Table 3 - Comparison of Proposed Construction Sites of Paraguay Earth Station

Items	San Rafael A1	San Rafael A2	Ybyraty	Aregua B1	Aregua B2
Distance from Central II	13.2 km	12.5 km	30.5 km	23.5 km	25.5 km
Area	enough, flat	enough, flat	enough, flat	enough, flat	enough, flat
Land arrangement	almost not one antenna must be moved	necessary threes must be cut.	necessary trees must be cut.	necessary threes must be cut.	necessary trees must be cut.
Road accessibility	repair 1 km near Luque-San Lorenzo road	repair 0.5 km near Luque-San Lorenzo road	construction 1 km near high-way No. 2	construction 1 km near Capiate-Aregua road	construction 2 km near Capiata-Aregua road
Power Supply	3 km from transformer station	3 km from transformer station	4 km-long new line must be constructed from Ypacarai	6 km-long new line must be constructed from Capiata	7 km-long new line must be constructed from Capiata
Water availability	yes	yes	unknown	yes	yes
Dwelling condition	good	good	fair, 4 km from Ypacarai	good, 1.5 km from Aregua	good, 3 km from Aregua
Meteorology	good	good	good	good	good
Airfield disturbance	yes	yes	no problem	no problem	no problem
City enlargement	problem	problem	no problem	no problem	no problem
Surroundings	good	good	bad	very good	very good
Land	exist	necessary	necessary	necessary	necessary
Visibility to Satellite	excellent	excellent	excellent	excellent	excellent
Propagation condition of connecting link	good	good	poor	good	good
Interference	no problem	no problem	no problem	no problem	no problem
External noise	slight airway	slight airway	no problem	no problem	no problem
Ranking	3	4	5	1	2

Table 4 - Floor Space, Equipment and Rooms of Earth Station

1.	Antenna Pedestal	250 m^2	Transmitting and receiving equipment, antenna drive control equipment, etc.
2.	Communications Equipment Room	250 m^2	Modulator and demodulator, terminal equipment, microwave radio equipment for connection with the central office, etc.
3.	Control Room	80 m^2	Monitor and control equipment for antenna, transmitting, receiving, TV, and power supply equipment.
4.	Power Supply Equipment Room	450 m^2	Power reception and distributing equipment no-break power source equipment, rectifier, battery, diesel engine generator, air-conditioning equipment, etc.
5.	Office Rooms and Others	270 m^2	Station Master's room, office rooms, engineers' office rooms, guards' room, conference room, reception room, dining room, bedroom, warehouse, workshop, etc.
	Total floor space:	1,300 m^2	

Table 5 - Construction Schedule of Paraguay Earth Station
(For the period after selection of the contractor)



Notes: 1) *Manufacture of equipment includes factory test.*
2) This schedule does not allow for any time allowance.

Table 6 - Training Curriculum for Staffs of Earth Station and Central Office

Job classification and training hours / Course	Technical Dept. persons of Earth Station		Operating Dept. Persons of Earth Station		Persons of Central Office	
	Chief engineers	Engineers	Chief operators	Operators	Int'l telephone exchange operators	Maintenance engineers
International Telecommunications and Organization of INTELSAT	7	3	7	3	-	-
Communication Satellite and Satellite Communication System	5	5	5	5	-	-
System Design	10	10	5	5	-	-
Basic Study in Microwave Engineerings	10	10	5	5	-	5
Basic Study in Television Engineerings	5	5	3	3	-	5
Basic Study in Multiplex Carrier Transmission Techniques	3	3	3	3	-	3
Outline of Earth Station Facilities	30	15	20	10	-	10
Outline of Microwave Connecting Link	5	3	3	3	-	3
Outline of Central Office Facilities	5	3	3	3	5	5
Measuring Instrument and Measuring Methods	15	15	5	5	-	5
Operation training of Earth Station Equipment	5	3	30	20	-	-
Operation training of International Telephone Exchange	-	-	-	-	15	-
Total (unit hours)	100	75	89	65	20	36

Table 7 - Construction Cost of Earth Station

Cost / Item	(Unit: million yen)			(Unit: US$1,000)		
	Foreign currency	Local currency	Total	Foreign currency	Local currency	Total
Installation of Earth Station Equipment and Facilities	1,232	29	1,261	4,000	94	4,094
Construction of Station Building	100	9	109	325	28	353
Installation of Microwave Connecting Link	54	2	56	175	6	181
Installation of Central Office Equipment and Facilities	132	3	135	429	11	440
Commissioning of Maintenance Work	18	0	18	58	0	58
Consulting Fee	60	0	60	195	0	195
Subtotal	1,596	43	1,639	5,182	139	5,321
Reserve Fund	30	120	150	97	390	487
Total			1,789			5,808

Note: 1. Values in U.S. Dollars are calculated at a conversion rate of US$1 - 308 yen.

2. Access road and entrance power cable to the earth station are not included.

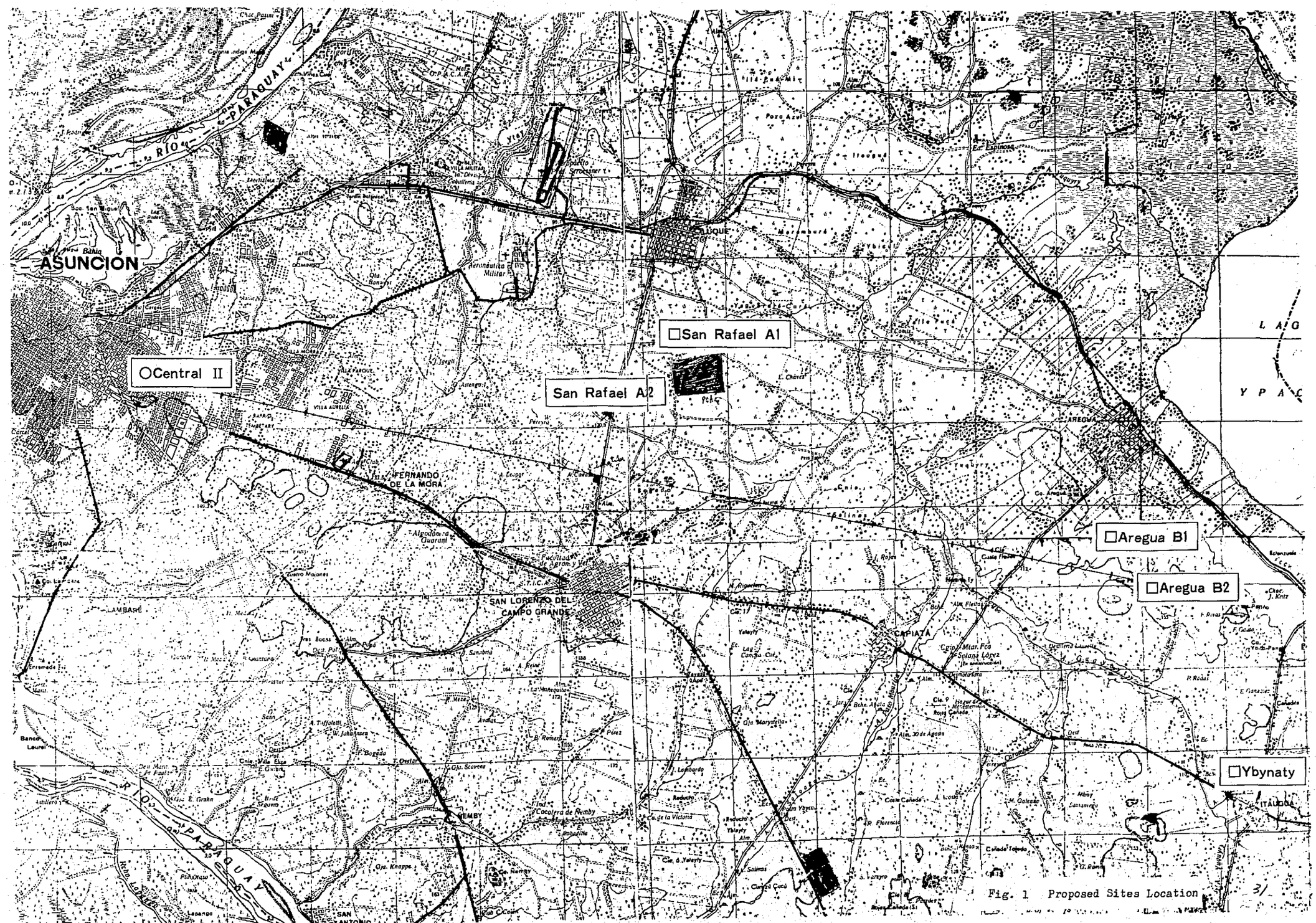


Fig. 1 Proposed Sites Location

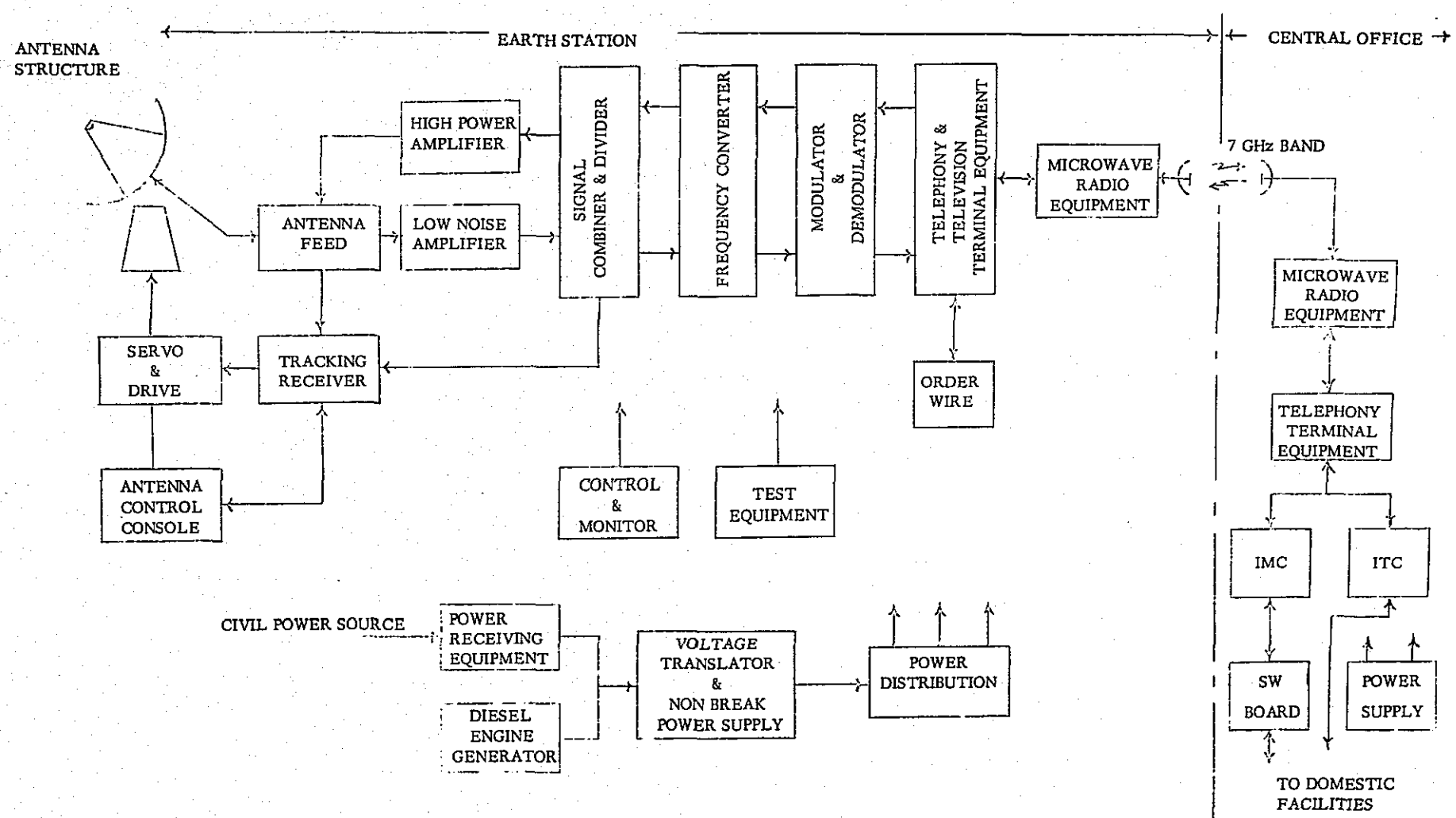


Figure 2. Overall Blockdiagram of Paraguay Earth Station

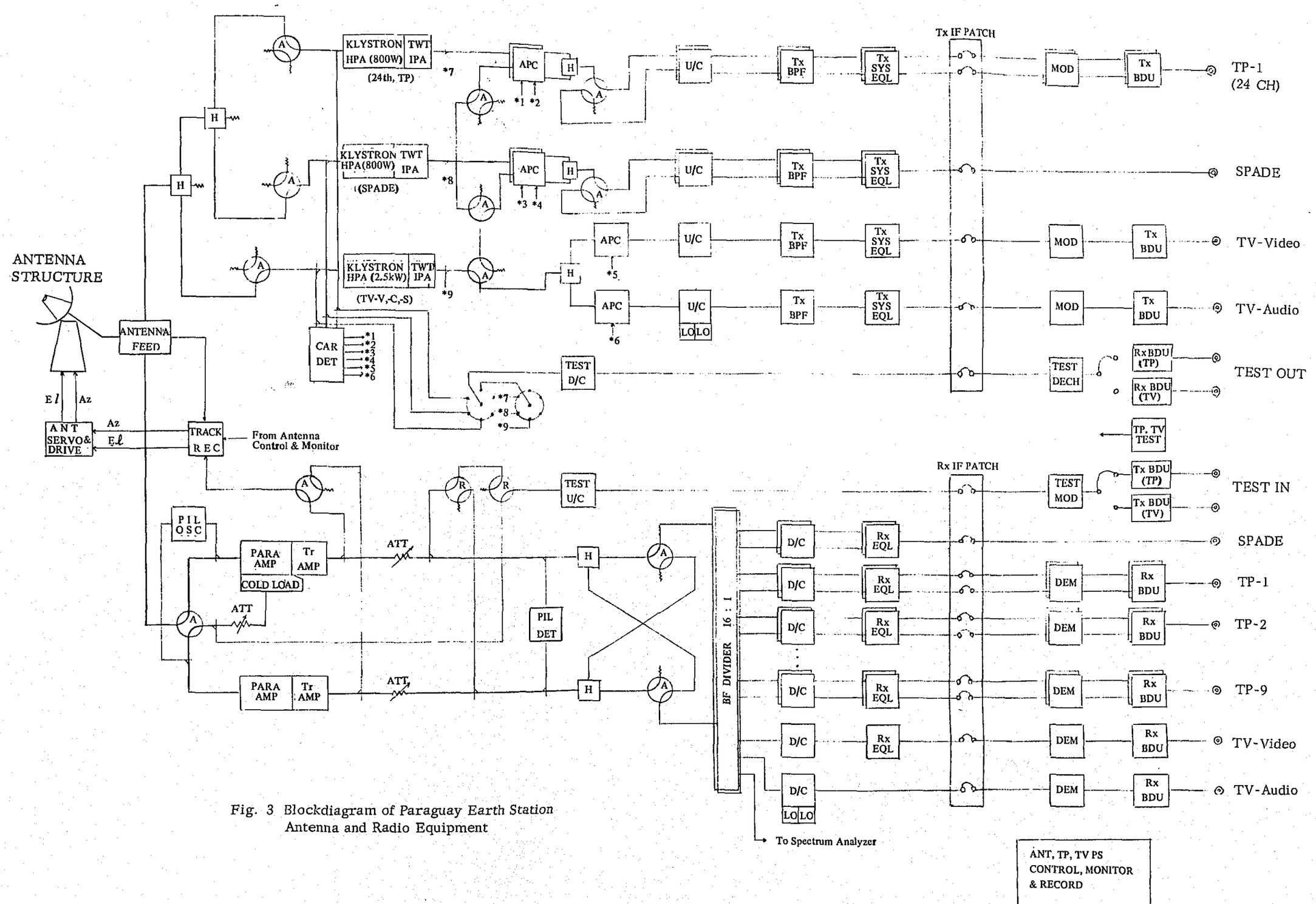


Fig. 3 Blockdiagram of Paraguay Earth Station Antenna and Radio Equipment

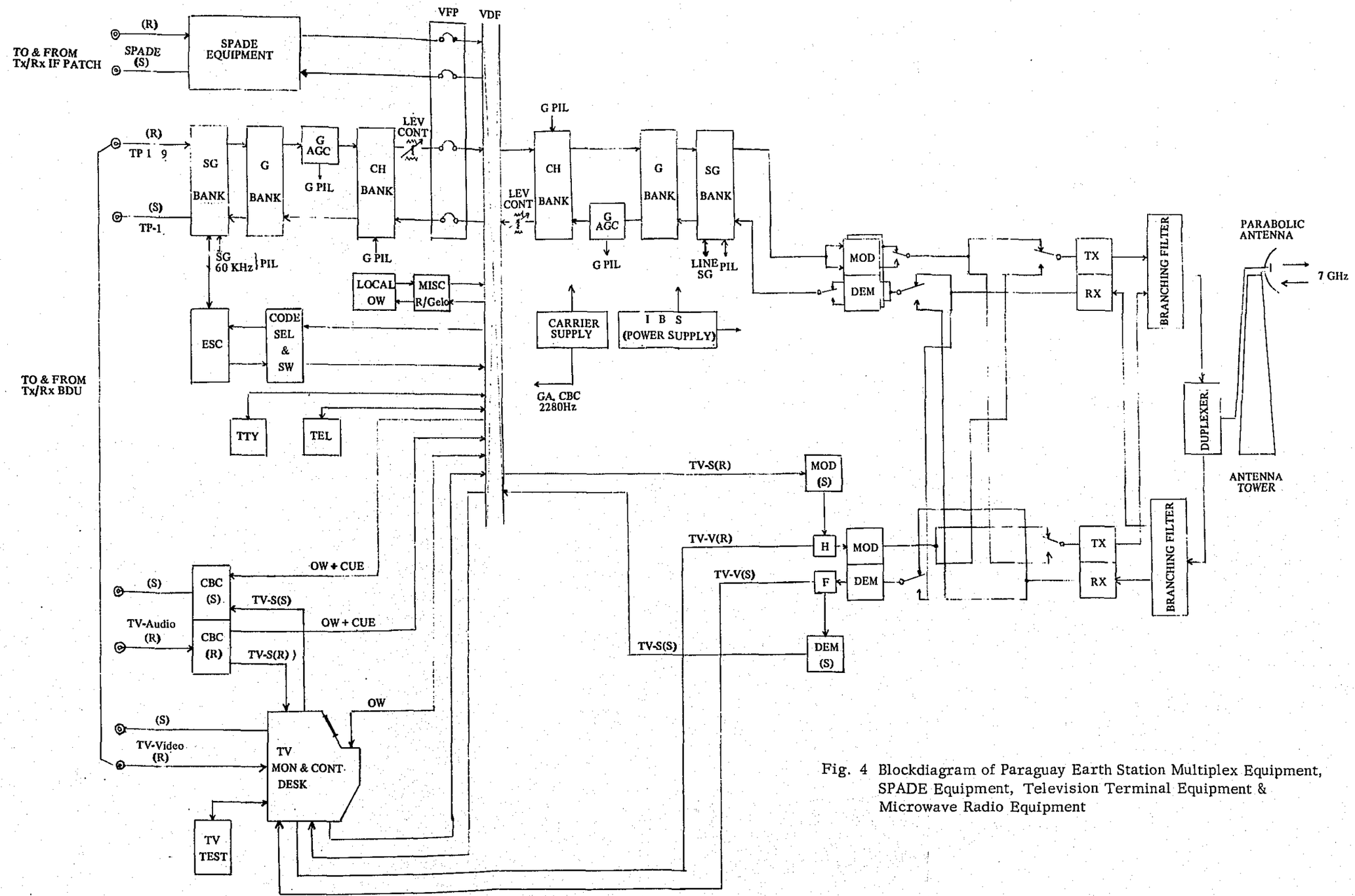


Fig. 4 Blockdiagram of Paraguay Earth Station Multiplex Equipment, SPADE Equipment, Television Terminal Equipment & Microwave Radio Equipment

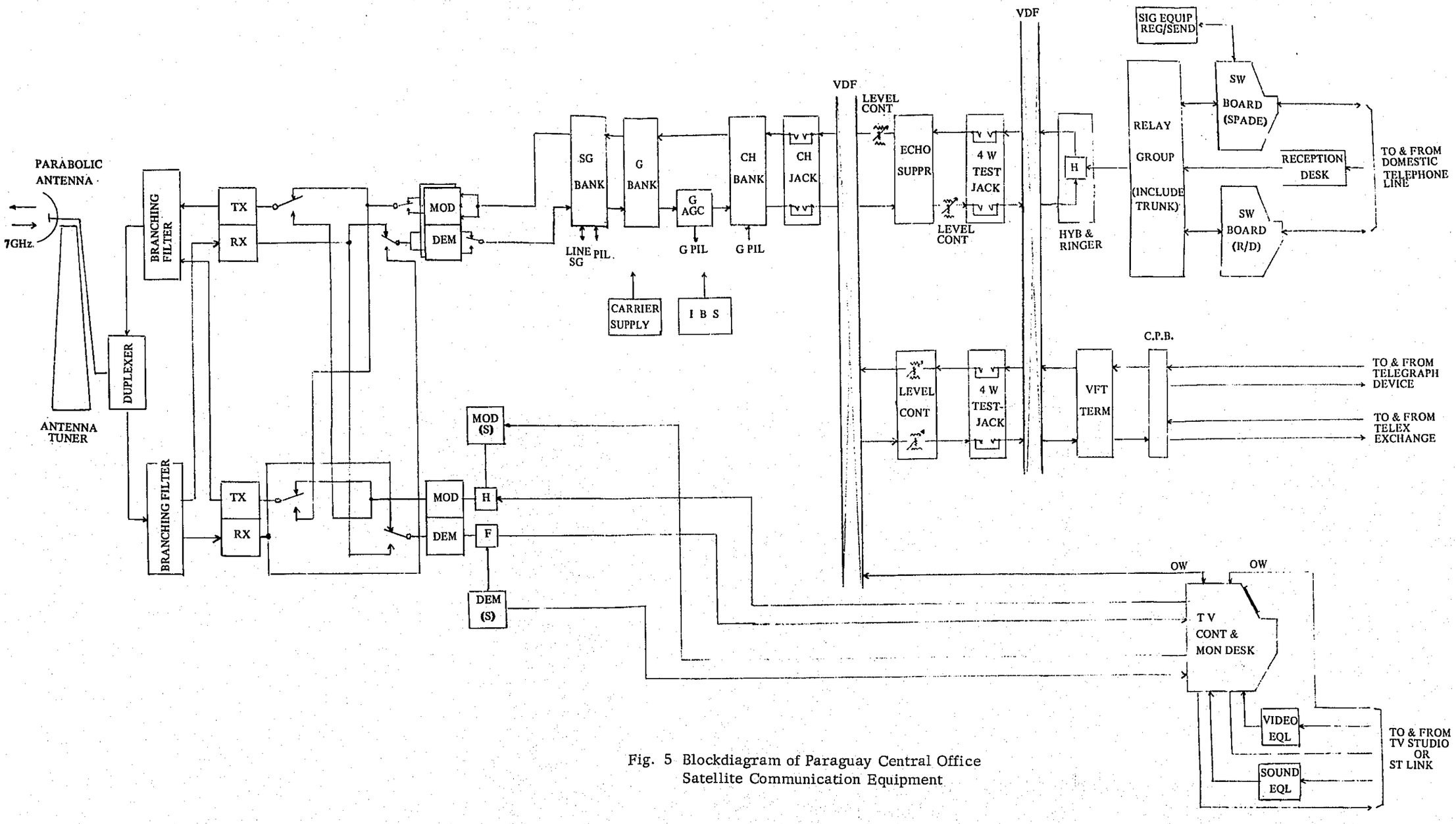


Fig. 5 Blockdiagram of Paraguay Central Office Satellite Communication Equipment

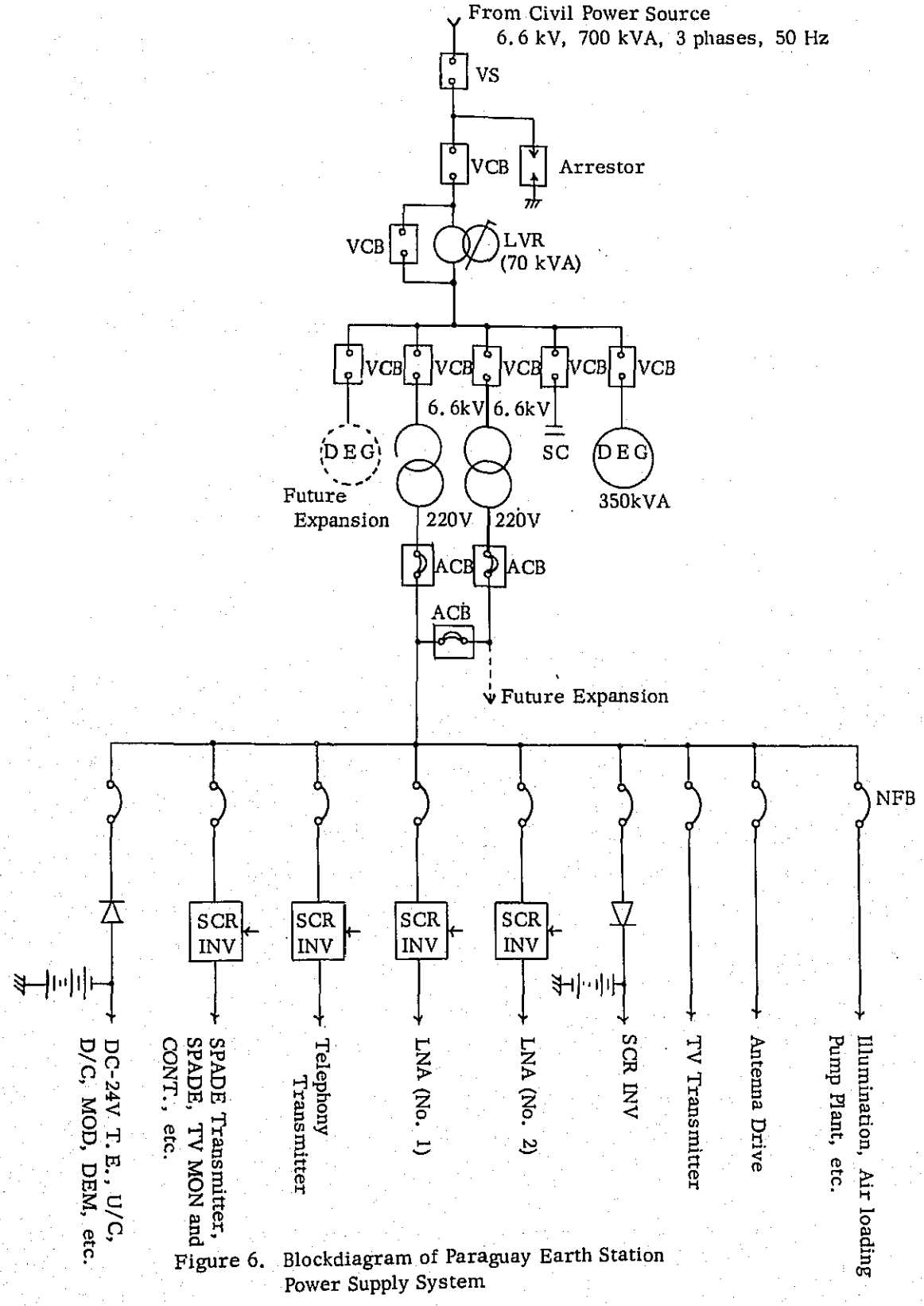


Figure 6. Blockdiagram of Paraguay Earth Station Power Supply System

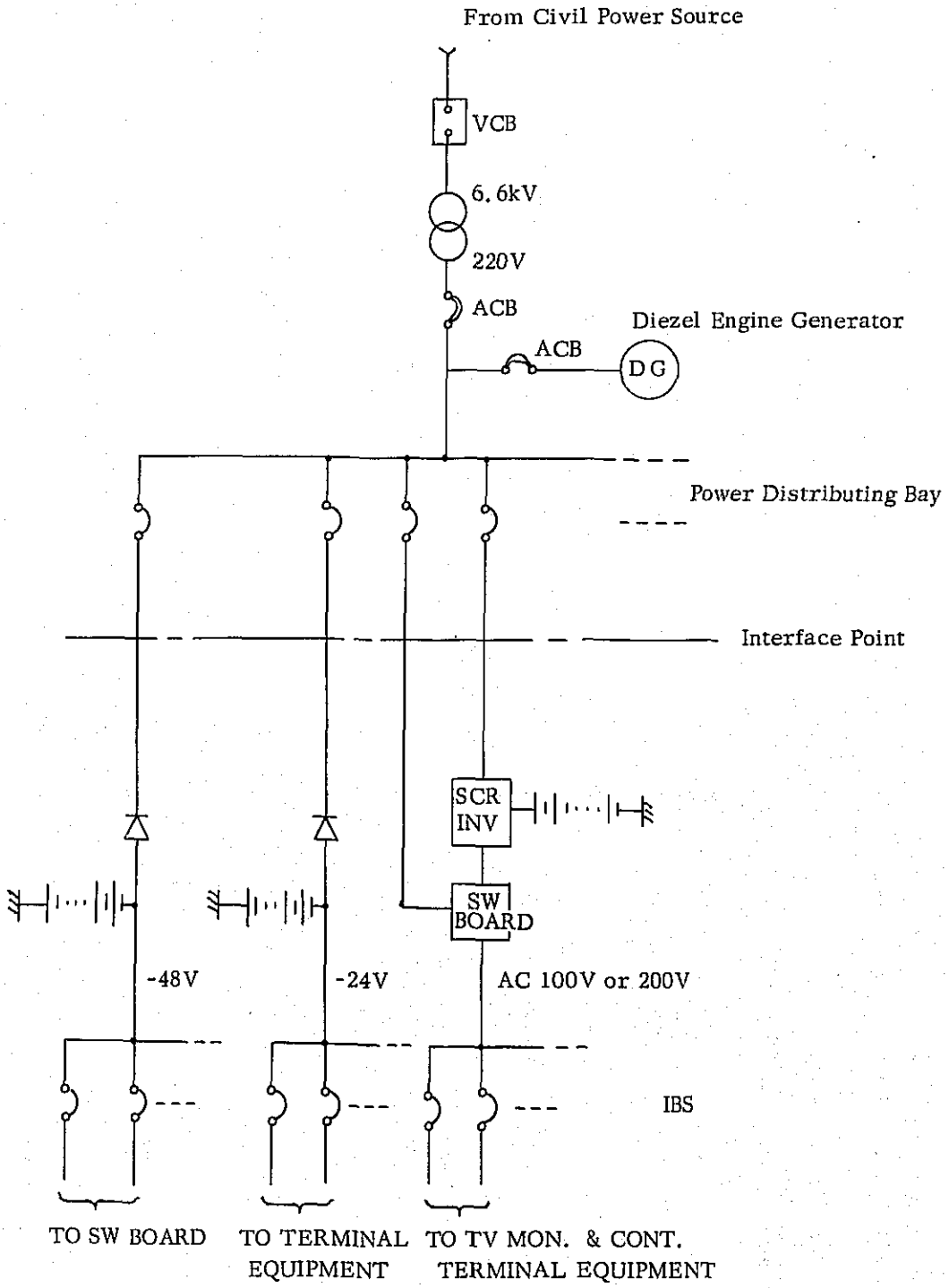


Figure 7. Blockdiagram of Paraguay Central Office Power Supply System

Chapter VI Microwave Network Construction Project

1. Transmission Network Plan

The planned microwave network constitutes part of the international circuit (Inter-American Telecommunication Network) which connects Paraguay (Asuncion) with Brazil and Argentina. Regarding its construction, the following agreement has already been reached at the meeting of CITEL (Inter-American Telecommunications Commission) and at the meetings of Paraguay and the adjoining two countries.

(1) The network will be connected with the adjoining two countries across the the border in the following sections.

In the section between Pto. Pte. Stroessner and Foz do Iguacu for connection with Brazil, and in the section between Paso de Patria and Resistencia for connection with Argentina.

(2) The network will consist of 960 telephone channels and TV programme transmission.

Since the domestic telecommunication network of Paraguay is in an extremely unsatisfactory state as described already, the microwave network should serve the dual purpose of functioning as an international circuit and accelerating the improvement of domestic telecommunication network. For this reason, the transmission network was so planned that all the toll circuits between Asuncion and primary centers closest to the microwave route in Asuncion - Pto. Pte. Stroessner and Asuncion - Paso de Patria section as well as all the toll circuits between these primary centers will be connected to the planned microwave network.

Names of such primary centers are shown below.

Paraguari, Caacupe, Cnel. Oviedo, Villarrica, Pto. Pte. Stroessner, San Juan Bautista, Pilar and Encarnacion.

Number of telephone circuits required in 1990, as calculated on the basis of the demand estimate of international and domestic telecommunications, is as given below.

Between Asuncion and Pto. Pte. Stroessner:

International - 48 ch, domestic - 146 ch, totalling 194 ch.

Between Asuncion and Paso de Patria:

International - 138 ch, domestic - 297 ch, totalling 435 ch.

In the above calculation, telegraph and telex circuits were converted to telephone channels.

For the period up to 1990, therefore, one system of 960 ch will suffice for each of the above sections insofar as telephone, telegraph and telex alone are considered. It is believed that transmission lines will not be used for many hours for TV programme transmission because there are no plans at present for domestic TV relaying service and international TV programme relaying alone is considered for some time in the future. It is accordingly planned, for economical reasons, that the stand-by system will be utilized for TV transmission without constructing an exclusive TV transmission system and that a TV system will be newly constructed if necessitated by the future increase of TV transmission hours.

As the network is part of the international telecommunication network, the transmission network construction will be based on the CCIR's standard for its radio transmission sections and on the CCITT's standard for its carrier transmission sections.

2. Route and Site Selection

A field survey was conducted for route and site selection on the basis of the transmission network plan described in the preceding section. As a result of studies made on the propagation characteristics and problems involved in the construction and maintenance work, the team effected a minor change to ANTELCO's plan for the route and sites as illustrated in Fig. 1. The new plan was so prepared that the towers, buildings and power supply facilities, planned by the project of 2 GHz route between Asuncion and Conception, will be commonly used in Asuncion, Paraguari and Cnel. Oviedo.

Number of repeater stations	13
{ Radio terminal stations	6 }
{ Through repeater stations	7 }
Distance of the Route	
Asuncion - Pto. Pte. Stroessner	307.8 km
Asuncion - Paso de Patria	347.9 km

Due to topographical restrictions, the east-west propagation cannot be avoided in the planning of the microwave route. To avert the interference of a communication satellite system with terrestrial microwave system, a frequency hand of 6.77 ± 340 MHz is planned to be used.

Figure 2 shows the configuration of microwave system.

3. Outline of Construction Work

(1) Scope of Construction Work

The scope of construction work covers the transmission parts requested for the international telecommunication system and domestic toll communication system, and includes neither the exchange equipment, terminal equipment and their appurtenant facilities, nor the transmission route between the TV studio and repeater station. Nor does it cover the entrance circuits to the telephone exchange in Caacupe, Villarrica and Encarnacion. Installation of all these must be planned separately from the transmission network project.

Table 1 shows the scope of work for each repeater station.

(2) Construction Period

As shown in the construction schedule (Fig. 3), the transmission system is planned to be commissioned 24 months after the contract for its construction is concluded.

4. Training, Maintenance and Construction Administration

The microwave system is designed to have only unattended stations except in Asuncion where they will be monitored and controlled. Staff dispatched from Asuncion will patrol for the maintenance of these unattended stations. Since ANTELCO has no staff capable of such maintenance service, the following training will be required before the commissioning of the system.

Training at the manufacturing factory of equipment and instrument.

Training during the construction period.

For site guidance and training of maintenance staffs, it is advisable that the maintenance be entrusted to the contractor for a period of about one year.

It may be added that ANTELCO earnestly supports the above-mentioned training and commissioned maintenance service plan.

To ensure smooth implementation of this plan, it is necessary to establish a construction administration system intended for the qualification test of tenderers, inspection of equipment and instrument upon delivery, control and supervision of construction work, and acceptance test of the system. Considering the situation in Paraguay, the team believes it essential that such administrative activities be left to a consultants.

5. Construction Cost

With account taken of the fore going conditions, a rough design of the microwave system was prepared to estimate the construction cost required. Table 2 shows the estimated construction cost.

6. Matters to be Taken into Consideration

(1) The need for the space diversity system should be studied for the propagation path in the San Juan Bautista - Estero Camba - Pilar - Paso de Patria section. It is possible that need will arise for additional construction work for incorporating the space diversity system, though such need naturally depends on the actual operation data and theoretical studies produced a result to the contrary. Cost for additional construction work is included in the overall cost shown in Table 2. If such additional work becomes necessary, the construction period will have to be extended as shown in Fig. 3.

(2) No decision has yet been reached as to the method of international connection of this microwave network. The scope, cost and period of construction described in this report are therefore subject to change that may be necessitated by the decision reached.

(3) It is possible that the 2 GHz system construction and new construction of automatic exchanges planned by ANTELCO will cause partial change in the scope of construction work shown in Table 1 for the four stations (Asuncion, Paraguari, Cnel. Oviedo and Pilar).

Table 1 - Scope of Construction Work of Microwave Network

	Asuncion	Paraguari	Valle Apua	Caapucu	San Juan Bautista	Estero Camba	Pilar	Paso de Patria	Cnel. Oviedo	Caaguazu	Guyra-ungua	Colonia Yguazu	Pto. Pte. Stroessner	Remarks
Ratio Equipment	○	○	○	○	○	○	○	○	○	○	○	○	○	
Carrier Equipment for Microwave System	○	○	-	-	○	-	○	-	○	-	-	-	○	
Power Engine generator	○	*○	○	○	○	○	*○	○	*○	○	○	○	○	
Equip- ment Rectifier, Battery, etc.	○	○	○	○	○	○	○	○	○	○	○	○	○	
Tower	*60m	*30m	35m	10m	75m	110m	110m	80m	*80m	75m	80m	110m	110m	Figures show appropriate height above ground.
Road	-	-	-	1.2km	0.6km	-	-	-	-	-	0.05km	-	0.05km	Figures show approximate length of newly constructed roads.
Felling of Trees	-	-	900m^2	-	900m^2	-	-	-	-	-	900m^2	900m^2	900m^2	
Levelling Work	-	-	-	900m^2	900m^2	-	-	-	-	-	900m^2	900m^2	900m^2	
Station Building	○	*○	○	○	○	○	○	○	*○	○	○	○	○	
Power Receiving Line from Commercial Power Source	0km	*10km	-	10km	9km	-	-	-	0km	0km	-	-	0.5km	0 km indicates that the cable length can be disregarded.
Entrance Cable	-	11km	-	-	11km	-	-	-	*1.5km	-	-	-	2km	
Car-loaded Engine-generator	1	-	-	-	-	-	-	-	-	-	-	-	-	
Portable Engine-generator	1	-	-	-	-	-	-	-	-	-	-	-	-	
Car for Maintenance Patrol	2	-	-	-	-	-	-	-	-	-	-	-	-	
Training Equipment	1	-	-	-	-	-	-	-	-	-	-	-	-	

Notes: 1) It is possible that the asterisked works will be excluded from the scope of work by the 2 GHz system construction and new construction of telephone exchanges planned by ANTELCO.

2) Connecting route to Villarrica, Caacupe and Encarnacion is not included in the scope of work.

Table 2 - Construction Cost for Microwave System

	(Unit: Million Yen)			(Unit: US$1,000)		
	Foreign currency	Local currency	Total	Foreign currency	Local currency	Total
Construction of Communication Equipments	1,346	501	1,847	4,370	1,626	5,996
Construction of Station Buildings and Roads		26	26		84	84
Expenses of Commissioned Maintenance Service and Maintenance Cars	26	0	26	84	0	84
Consulting Fees	64		64	208		208
Subtotal	1,436	527	1,963	4,662	1,710	6,372
Contingencies		108			351	
Total		2,071			6,723	

Note: Calculation was worked out at a conversion rate of 308 yen = US$1.

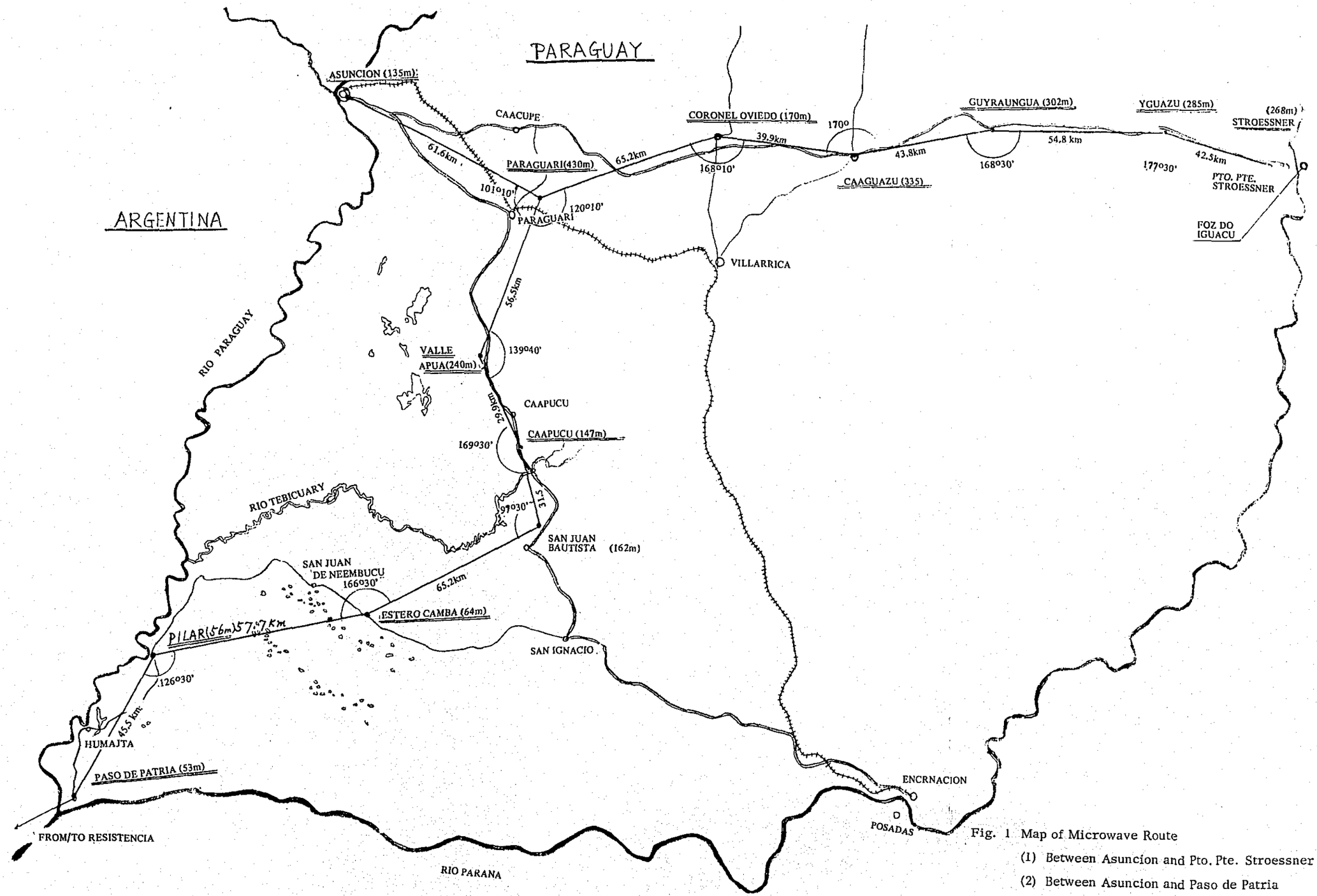


Fig. 1 Map of Microwave Route

(1) Between Asuncion and Pto. Pte. Stroessner

(2) Between Asuncion and Paso de Patria

Fig. 2 Configuration of Microwave System

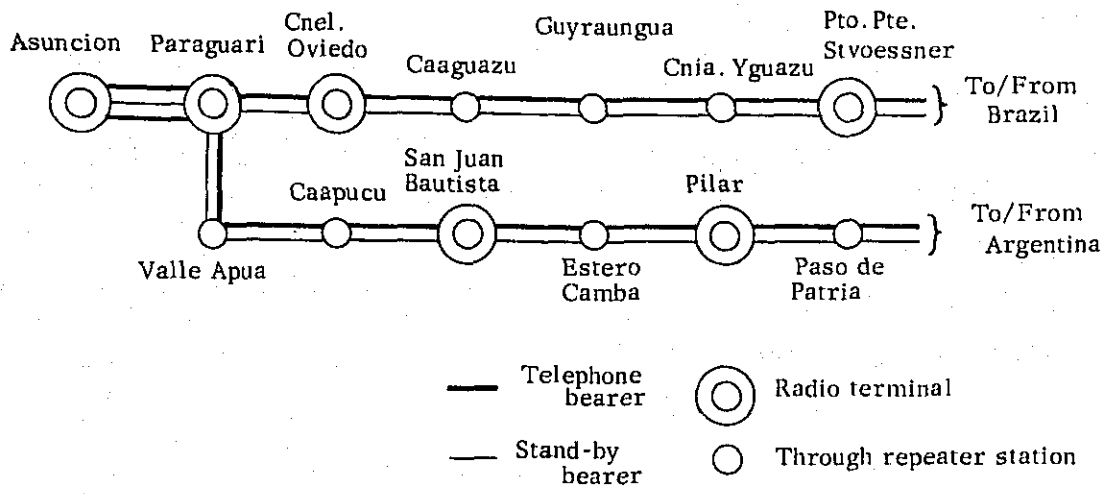
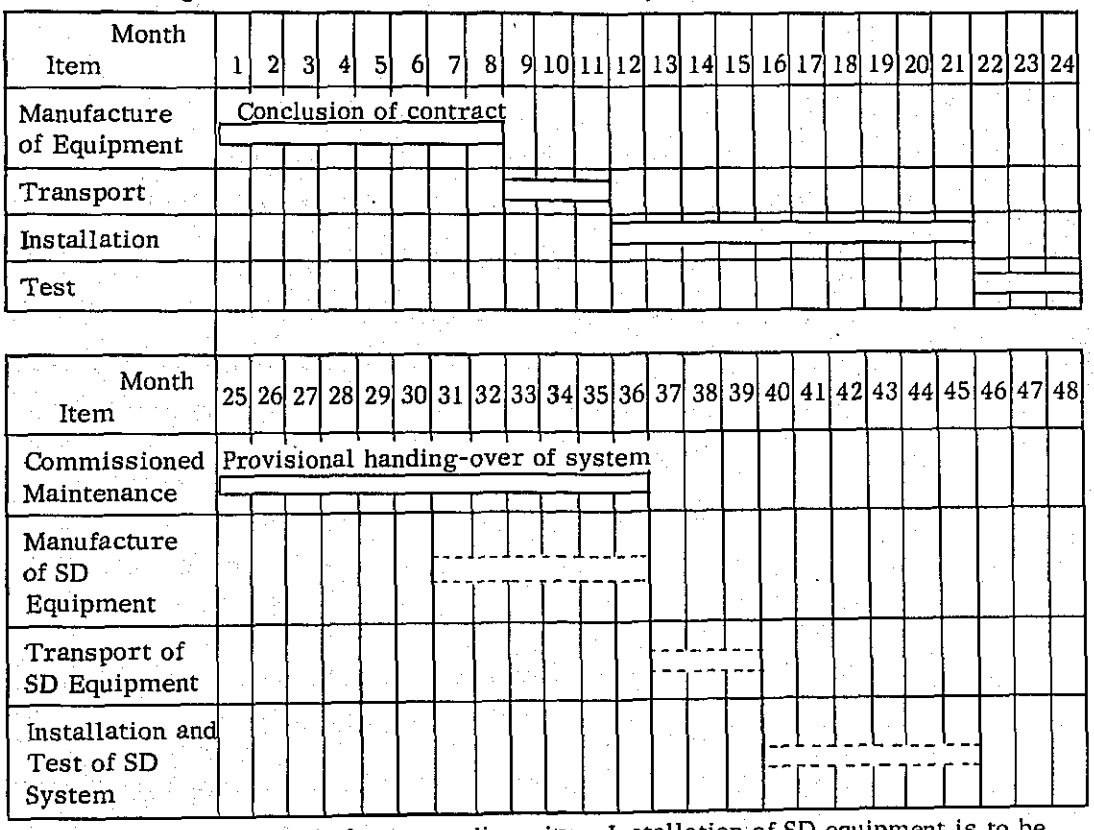


Fig. 3 - Work Schedule for Microwave System Construction



Note: SD stands for space diversity. Installation of SD equipment is to be carried out if the actual operation data calls for it.

Chapter VII Economic Evaluation of Project

1. *Balance Sheet Estimates*

(1) Income

The future income is estimated from the traffic volumes multiplied by respective unit incomes (income per minute, word or channel) of international communications, frontier communications and toll telephone calls. Unit income from these communication services is assumed to be as follows on the basis of the current income level. In assuming the following values, however, account is taken of some revision of the current tariff system at the time of inauguration of the satellite and microwave systems.

a. International telegramme	to Argentina, Brazil, Uruguay		$0.09/word
	Other countries		$0.13/word
b. International telex	to Argentina, Brazil		$1.50/min
	Uruguay		$1.00/min
	Other countries		$1.30/min
c. International telephone	to Argentina		$1.00/min
	Other countries		$1.20/min

d. Leased telephone circuit

In the absence of any leased telephone circuit in Paraguay, the rate is assumed as follows on the basis of the rate currently charged in various countries of the world and its recent downward trend.

Intra-continental circuit	$4,000/ch/month
Inter-continental circuit	$6,000/ch/month

e. Leased telegraph circuit

The rate is set at 40% of the amount charged for the leased telephone circuit in conformity to CCITT Recommendation D2.

Intra-continental circuit	$1,600/ch/month
Intra-continental circuit	$2,400/ch/month

f. Circuit offered for communications between Argentina and Brazil (Voice grade circuit)

The monthly rate is set at $2,500/ch since about 30% of the rate on a commercial basis is charged on a communication enterprise to whom a circuit is offered.

g. Frontier communications (Telephone) $0.50/min

h. Toll telephone service $0.15/min

(2) Expenditure

The future expenditure is calculated with account taken of the cost analysis of the satellite and microwave communication systems in Japan, data for financial comparison between Paraguay and Japan, ANTELCO's past expenditure record, and inherent conditions of Paraguay.

a. Expenses for maintenance and operation of the earth station and connecting line

Considering the fact that both the number of maintenance staffs and the personnel cost per capita are approximately half of those in Japan, the maintenance and operation expenses are set at about half of the value recorded in Japan, with an allowance for 2% annual growth of wages and commodity prices in Paraguay. (The maintenance and operation cost occupies 4.1% in the total construction cost at time of inauguration.

b. Maintenance and operation expenses of the microwave system

It is assumed that the maintenance and operation cost of the microwave system occupies 4% of total construction cost on the basis of data available in Japan. Further, an annual growth rate of 2% is estimated.

c. Depreciation expense of earth station and connecting line

Amortization in equal amounts with an average durable years assumed to be ten years.

d. Depreciation expense of microwave system

Amortization in equal amounts with an average durable years assumed to be ten years.

e. Satellite utilization charge

With INTELSAT's rate reduction schedule taken into consideration, the following rates are assumed.

Actual record	- 1970 (per telephone channel)	$20,000/year
"	- 1971	$15,000/year
Planned rate	- 1975	$7,000/year
Estimated rate	- 1980	$5,000/year
"	- 1985	$3,000/year

f. General operational expenses

These cover the personnel cost, depreciation expense and all other expenses at the central office, local offices and the headquarters, and are assumed as follows from the comparison of costs recorded in Japan and by ANTELCO.

i.	International telegramme	$0.083/word
ii.	International telex	$17 thousand/ch
iii.	International telephone	$22 thousand/ch
iv.	Leased telephone circuit	$7 thousand/ch
v.	Leased telegraph circuit	$2 thousand/ch
vi.	Circuit offered for communications between Argentina and Brazil	$7 thousand/ch
vii.	Frontier communications (Telephone)	$22 thousand/ch
viii.	Toll telephone service	$9 thousand/ch

g. Interest on Loan

Two financing conditions are assumed, one being the World Bank's loan condition (interest rate - 7.25% per annum; repayment period - 20 years including five years of deferment) and the other a fairly lenient loan condition (interest rate - 3%; repayment period - 25 years including seven years of deferment). Table 1 shows the repayment schedule for the two cases.

It is further assumed that the deferment period will commence in March 1972 when the loan agreement will be concluded.

(3) Balance sheet estimates by system and year are shown in Table 2.

2. Cash Flow

As per Table 3.

3. Conclusion

As will be clear from Table 2, the operation of the two systems combined is expected to record red figures for four to five years after they are put in operation. The satellite communication system, in particular, will need considerably longer period than the microwave system before its operation starts recording black figures because of the small traffic expected.

However, the balance sheet condition of the two systems combined is expected to show black figure in 1979/1980 and subsequent years by rapid traffic increase, yielding a sufficient profit to counterbalance the cumulative deficit in four to five years thereafter.

As regards cash flow, fund shortage will be encountered from the initial stage of operation as shown in Table 3 if the loan condition is very strict, and in this case, the repayment of loan will become difficult. If the loan condition lenient, on the other hand, the operation of the systems will be fairly stabilized financially, entailing no difficulty in repayment.

The operation of these systems will doubtlessly improve the Paraguayan telecommunication network. Besides note must be taken of such immense indirect benefits derivable from the operation of the systems as the possibility to communicate directly with any country of the world at any desired time via the satellites and the resulting assurance of firmer independence of communication, realization of a toll telephone automatic dialling network, and rapid inflow of overseas news which will bring about about closer tie and exchange with other parts of the world in various aspects of human activities including politics, economy, culture and so forth.

Table 1-1 Loan Repayment Schedule (1)

Interest rate : 7.25%
Repayment term: 20 years incl. 5 years deferment period

(Unit: US$1,000)

Year and Month	Amortization Amount	Remainder of Loan after each Amortization	Interest Repayable
Mar 1972	0 (Loan agreement concluded and deferment term commenced)		
Sep "	0		
Mar 1973	0 (Construction started in January 1973; construction period - 2 years)		(Interest during construction)
Sep "	0		
Mar 1974	0		
Sep "	0		
Mar 1975	0 (Inauguration of the two systems in January 1975)	12,531	454 } 908 { Satellite 420
Sep "	0	12,531	454 } 908 { Microwave 488
Mar 1976	0	12,531	454 } 908 { 420
Sep "	0	12,531	454 } 908 { 488
Mar 1977	418 } 836	12,113	454 } 893 { 413
Sep "	418 } 836	11,695	439 } 893 { 480
Mar 1978	418 } 836	11,277	424 } 833 { 386
Sep "	418 } 836	10,859	409 } 833 { 447
Mar 1979	418 } 836	10,441	394 } 772 { 357
Sep "	418 } 836	10,023	378 } 772 { 415
Mar 1980	418 } 836	9,605	363 } 711 { 329
Sep "	418 } 836	9,187	348 } 711 { 382
Mar 1981	418 } 836	8,769	333 } 651 { 301
Sep "	418 } 836	8,351	318 } 651 { 350
Mar 1982	418 } 836	7,933	303 } 591 { 274
Sep "	418 } 836	7,515	288 } 591 { 317
Mar 1983	418 } 836	7,097	272 } 529 { 245
Sep "	418 } 836	6,679	257 } 529 { 284
Mar 1984	418 } 836	6,261	242 } 469 { 217
Sep "	418 } 836	5,843	227 } 469 { 252
Mar 1985	418 } 836	5,425	212 } 409 { 189
Sep "	418 } 836	5,007	197 } 409 { 220
Mar 1986	418 } 836	4,589	182 } 348 { 161
Sep "	418 } 836	4,171	166 } 348 { 187
Mar 1987	418 } 836	3,753	151 } 287 { 133
Sep "	418 } 836	3,335	136 } 287 { 154
Mar 1988	418 } 836	2,917	121 } 227 { 105
Sep "	418 } 836	2,499	106 } 227 { 122
Mar 1989	418 } 836	2,081	91 } 166 { 77
Sep "	418 } 836	1,663	75 } 166 { 89
Mar 1990	418 } 836	1,245	60 } 105 { 49
Sep "	418 } 836	827	45 } 105 { 56
Mar 1990	418 } 836	1,245	60 } 105 { 49
Sep "	418 } 836	827	45 } 105 { 56
Mar 1991	414 } 827	413	30 } 45 { 21
Sep "	413 } 827	0	15 } 45 { 24
Total	12,531	0	8,852

Table 1-2 Loan Repayment Schedule (2)

Interest rate: : 3%

Repayment term: 25 years incl. 7 years deferment period

(Unit: US$1,000)

Year and Month	Amortization Amount	Remaineder of Loan after each Amortization	Interest Repayable
Mar.1972	0		
Sep "	0		
Mar 1973	0		
Sep "	0		(Interest during construction)
Mar 1974	0		
Sep "	0		
Mar 1975	0	12,531	188 } 376 { Satellite 174
Sep "	0	12,531	188 } Microwave 202
Mar 1976	0	12,531	188 } 376 { 174
Sep "	0	12,531	188 } 202
Mar 1977	0	12,531	188 } 376 { 174
Sep "	0	12,531	188 } 202
Mar 1978	0	12,531	188 } 376 { 174
Sep "	0	12,531	188 } 202
Mar 1979	348 } 696	12,183	188 } 371 { 172
Sep "	348 }	11,835	183 } 199
Mar 1980	348 } 696	11,487	178 } 350 { 162
Sep "	348 }	11,139	172 } 188
Mar 1981	348 } 696	10,791	167 } 329 { 152
Sep "	348 }	10,443	162 } 177
Mar 1982	348 } 696	10,095	157 } 308 { 143
Sep "	348 }	9,747	151 } 165
Mar 1983	348 } 696	9,399	146 } 287 { 133
Sep "	348 }	9,051	141 } 154
Mar 1984	348 } 696	8,703	136 } 267 { 124
Sep "	348 }	8,355	131 } 143
Mar 1985	348 } 696	8,007	125 } 245 { 113
Sep "	348 }	7,659	120 } 132
Mar 1986	348 } 696	7,311	115 } 225 { 104
Sep "	348 }	6,963	110 } 121
Mar 1986	348 } 696	6,615	104 } 203 { 94
Sep "	348 }	6,267	99 } 109
Mar 1988	348 } 696	5,919	94 } 183 { 85
Sep "	348 }	5,571	89 } 98
Mar 1989	348 } 696	5,223	84 } 162 { 75
Sep "	348 }	4,875	78 } 87
Mar 1990	348 } 696	4,527	73 } 141 { 65
Sep "	348 }	4,179	68 } 76
Mar 1991	348 } 696	3,831	63 } 120 { 56
Sep "	348 }	3,483	57 } 64
Mar 1992	348 } 696	3,135	52 } 99 { 46
Sep "	348 }	2,787	47 } 53
Mar 1993	348 } 696	2,439	42 } 79 { 37
Sep "	348 }	2,091	37 } 42
Mar 1994	348 } 696	1,743	31 } 58 { 27
Sep "	348 }	1,395	26 } 31
Mar 1995	348 } 696	1,047	21 } 37 { 17
Sep "	348 }	699	16 } 20
Mar 1996	349 } 699	350	10 } 15 { 7
Sep "	350 }	0	5 } 8
Total	12,531	0	4,983

Table 2-1 Balance Sheet Estimates by Year and System (1975 - 1985)

Unit: US$1,000

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Satellite Communication System	Income from Communication Services	1,067	1,193	1,334	1,493	1,671	1,870	2,122	2,408	2,733	3,101	3,519
	Maintenance and Operation Expenses of Earth Station and Connecting Line	241	246	251	256	261	266	271	277	283	288	294
	Depreciation Expense of Earth Station and Connecting Line	581	581	581	581	581	581	581	581	581	581	581
	Satellite Utilization Charge	119	119	126	129	132	135	135	135	135	135	135
	General Operational Expenses	652	704	760	820	885	956	1,064	1,184	1,318	1,466	1,632
	Interest (rate: 7.25%)	420	420	413	386	357	329	301	274	245	217	189
	(rate: 3%)	174	174	174	174	172	162	152	143	133	124	113
	Total Expenditure	2,013	2,074	2,131	2,172	2,216	2,267	2,352	2,451	2,562	2,687	2,831
		1,767	1,828	1,892	1,960	2,031	2,100	2,203	2,320	2,450	2,594	2,755
	Balance	-946	-881	-797	-679	-545	-397	-230	-43	171	414	688
		-700	-635	-558	-467	-360	-230	-81	88	283	507	764

Table 2-2

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Microwave System Connection	Income from Communication Services	2,736	2,981	3,247	3,538	3,854	4,199	4,610	5,061	5,556	6,100	6,696
	Maintenance and Operation Expenses of Microwave System	270	275	281	287	293	299	305	311	317	323	329
	Depreciation Expense of Microwave System	448	448	448	448	448	448	448	448	448	448	448
	General Operational Expenses	1,983	2,102	2,228	2,362	2,504	2,656	2,831	3,017	3,216	3,428	3,653
	Interest (rate: 7.25%)	488	488	480	447	415	382	350	317	284	252	220
	Interest (rate: 3%)	202	202	202	202	199	188	177	165	154	143	132
	Total Expenditure	3,182	3,313	3,437	3,544	3,660	3,785	3,934	4,093	4,265	4,451	4,650
		2,903	3,027	3,159	3,299	3,444	3,591	3,761	3,941	4,135	4,342	4,562
	Balance	-453	-332	-190	-6	194	414	676	968	1,291	1,649	2,046
		-167	-46	88	239	410	608	849	1,120	1,421	1,758	2,134
Grand Total	Income	3,803	4,174	4,581	5,031	5,525	6.069	6,732	7,469	8,289	9,201	10,215
	Expenditure	5,202	5,387	5,568	5,716	5,876	6,052	6,286	6,544	6,827	7,138	7,481
		4,670	4,855	5,051	5,259	5,475	5,691	5,964	6,261	6,585	6,936	7,317
	Balance	-1,399	-1,213	-987	-685	-351	17	446	925	1,462	2,063	2,734
		-867	-681	-470	-228	50	378	768	1,208	1,704	2,265	2,898

Notes:

1) Upper figures indicate the case where loan is provided at an annual interest rate of 7.25%, repayable in 20 years including 5 year deferment term.

2) Lower figures indicate the case where loan is provided at an annual interest rate of 3%, repayable in 25 years including 7 year deferment term.

3) Figures for the intermediate years between 1975, 1980 and 1985 are supplemented by taking into account the average annual growth rate and other factors.

4) For the satellite communication system, assumption is made that the second system will be constructed and operated in 1985 when the service life of the first system expires. (Cost of construction is assumed to be the same as for the first system.)

Table 3 - Cash Flow

Unit: US$1,000

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
(1) Income-Expenditure Balance	-1,399 -867	-1,213 -681	-987 -470	-685 -228	-351 50	17 378	446 768	925 1,208	1,462 1,704	2,063 2,265	2,734 2,898
(2) Depreciation Expense	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029
(3) Total Funds (1) + (2)	-370 162	-184 348	42 559	344 801	678 1,079	1,046 1,407	1,475 1,797	1,954 2,237	2,491 2,733	3,092 3,294	3,763 3,927
(4) Amortinization Amount	0 0	0 0	836 0	836 0	836 696	836 696	836 696	836 696	836 696	836 696	836 696
(5) Remainder of Funds	-370 162	-184 348	-794 559	-492 801	-158 383	210 711	639 1,101	1,118 1,541	1,655 2,037	2,256 2,598	2,927 3,231
(6) Cumulative Total of Funds	-370 162	-554 510	-1,348 1,069	-1,840 1,870	-1,998 2,253	-1,788 2,964	-1,149 4,065	-31 5,606	1,624 7,643	-1,928 4,433	999 7,664

Notes: 1) Upper figures are for the loan provided at an annual interest rate of 7.25%, repayable in 20 20 years including 5 year deferment term.

2) 5,808 for the second system is subtracted from the cumulative total for 1984.