REPUBLIC OF PARAGUAY

CONSTRUCTION PROJECT OF MICROWAVE NETWORK

Vol. II

DETAILED DESIGN

This report is one of the following three volumes:

Volume	I	Planning Report
Volume	**II**	**Detailed Design**
Volume	III	Tender Document and Technical Specification
Part	I	General Instructions for Tender
Part	II	Contructual Terms and Conditions
Part	III	Technical Specifications for Supply and Installations of Communication Equipment
Part	IV	Annex

LETTER OF SUBMITTAL

June, 1972

To His Excellency Mr. Takeo Fukuda
Minister of Foreign Affairs
Government of Japan

Excellency,

I have the honour to submit to your Excellency the "Detailed Design Report on Microwave Circuit Network Project in the Republic of Paraguay" together with the Technical Specifications and the necessary Tender Documents, the preparation of which have been entrusted to us, the Overseas Technical Cooperation Agency, by the Government of Japan.

Prior to the completion of this report, the Agency submitted, in January 1971, the planning report on the master plan of this project.

The construction project for the telecommunication facilities in Paraguay is being promoted by Ministerio de Obras Públicas Y Communicaciones and its subordinate agency, Administración Nacional de Telecommunicaciones -ANTELCO-. The said facilities are to form a part of the Pan-American telecommunication network and, in future, will constitute a basic communication circuit to be connected with the long-distance international circuit by means of microwave.

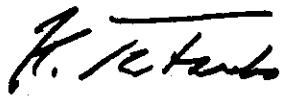
In reponse to the request of the Government of Paraguay for the technical cooperation in making a detailed investigation and construction designing for the above purpose, the Government of Japan decided to cooperate in the preparation of the detailed design and technical specifications.

In order to perform the assighment entrusted, the Agency dispatched a survey team to undertake the necessary investigations for 70 days from August 1971, under the cooperation of the Ministry of Posts and Telecommunications -MOPT-, Nippon Telegraph and Telephone Public corporation -NTT- and Kokusai Denshin Denwa Co., Ltd -KDD-. The team, after its return to Japan, studied the designing works, to prepare for this report.

We would be very happy if this report will be helpful for the expansion of telecommunication service and contribute to the economic and social development in Paraguay. It is also the desire of the Agency that the strong bonds of mutual friendship between two countries will be furthered through the materialization of the present project.

In submitting this report, we wish to express our sincere gratitude to the Government authorities of Paraguay and Japan, the Japanese Embassy in Paraguay, and all staffs concerned in MOPT, NTT and KDD for the support and cooperation they have so generously extended to us to make this investigation a success.

Yours respectfully,



Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

FOREWORD

The Republic of Paraguay and ANTELCO (The National Telecommunication Administration) which operates the telecommunication services in the Republic are earnestly engaging in the betterment of international and domestic telecommunications of the Republic.

Japanese Government, complying with the strong request of the Republic of Paraguay, dispatched a technical mission to the Republic with the object of field survey from August 20 to October 28, 1971 as the technical assistance toward the construction of microwave network and earth station for satellite communication in that Republic.

This report explains the fundamental design of the microwave network worked out on the basis of the results of field survey obtained by the technical mission.

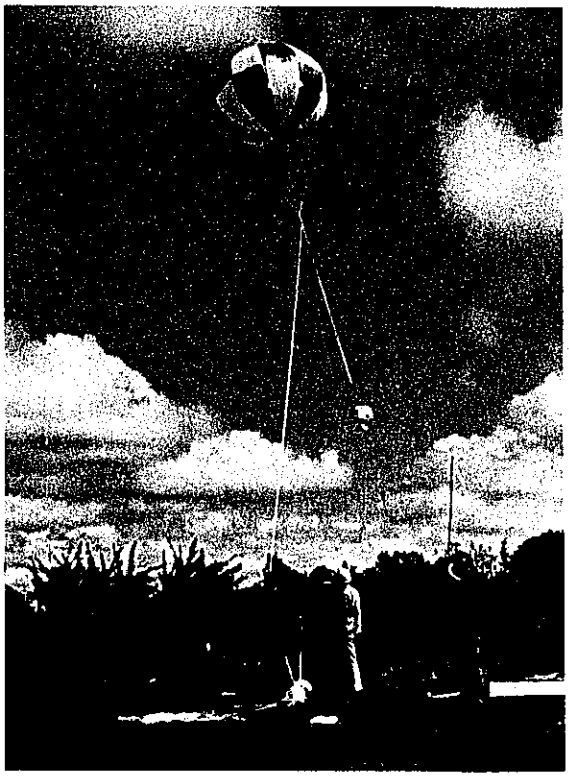
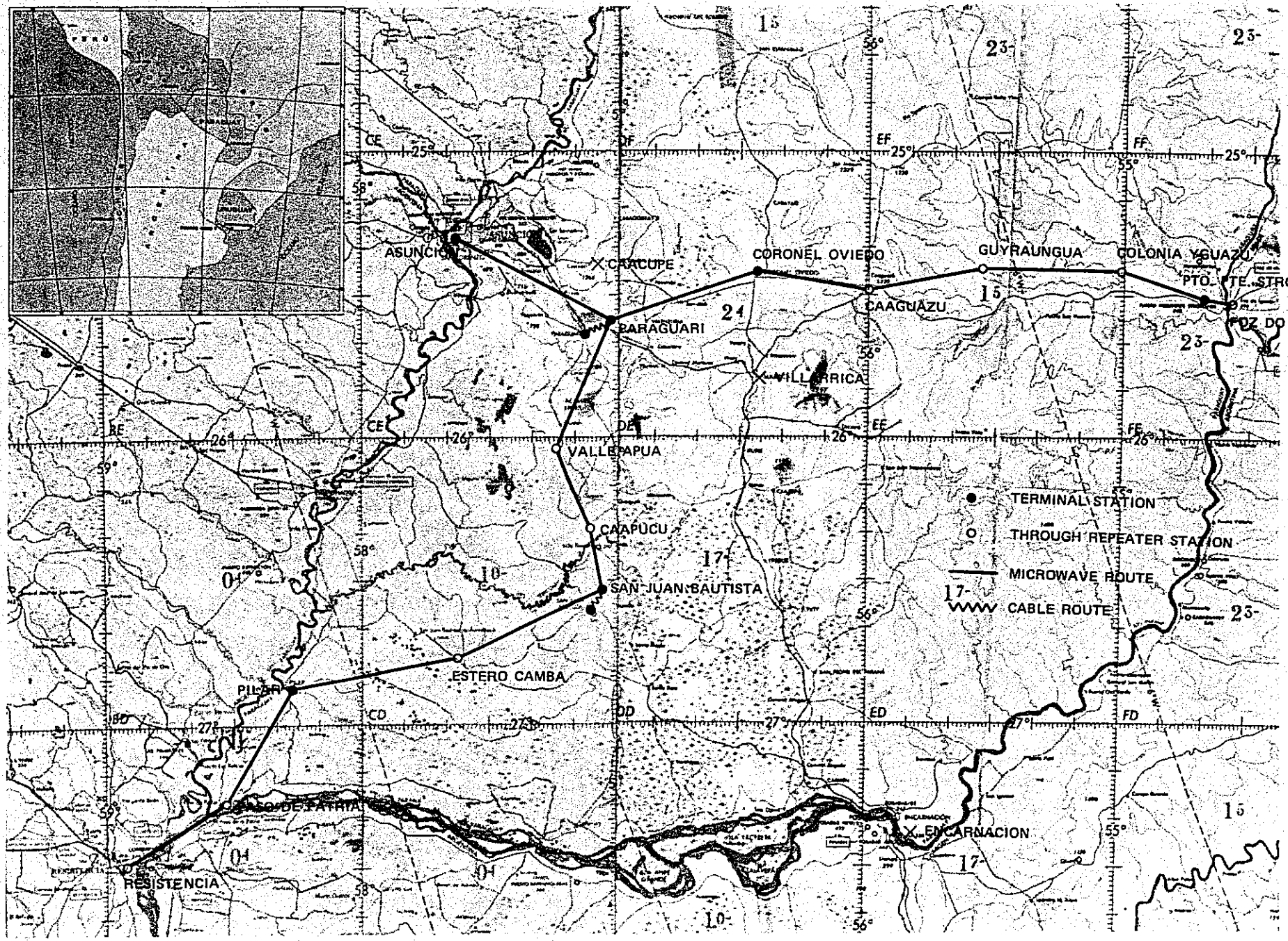


Photo 1. Members of Survey Team flying a balloon with a ball type mirror suspended from it for direction finding at Estero Camba.

Photo 2. A balloon with a ball type mirror sent up in the air at Estero Camba.

Photo 3. Members of Survey Team confirming the line-of-sight at Caaguazu using a ball type mirror attached to a balloon flown from Coronel Oviedo.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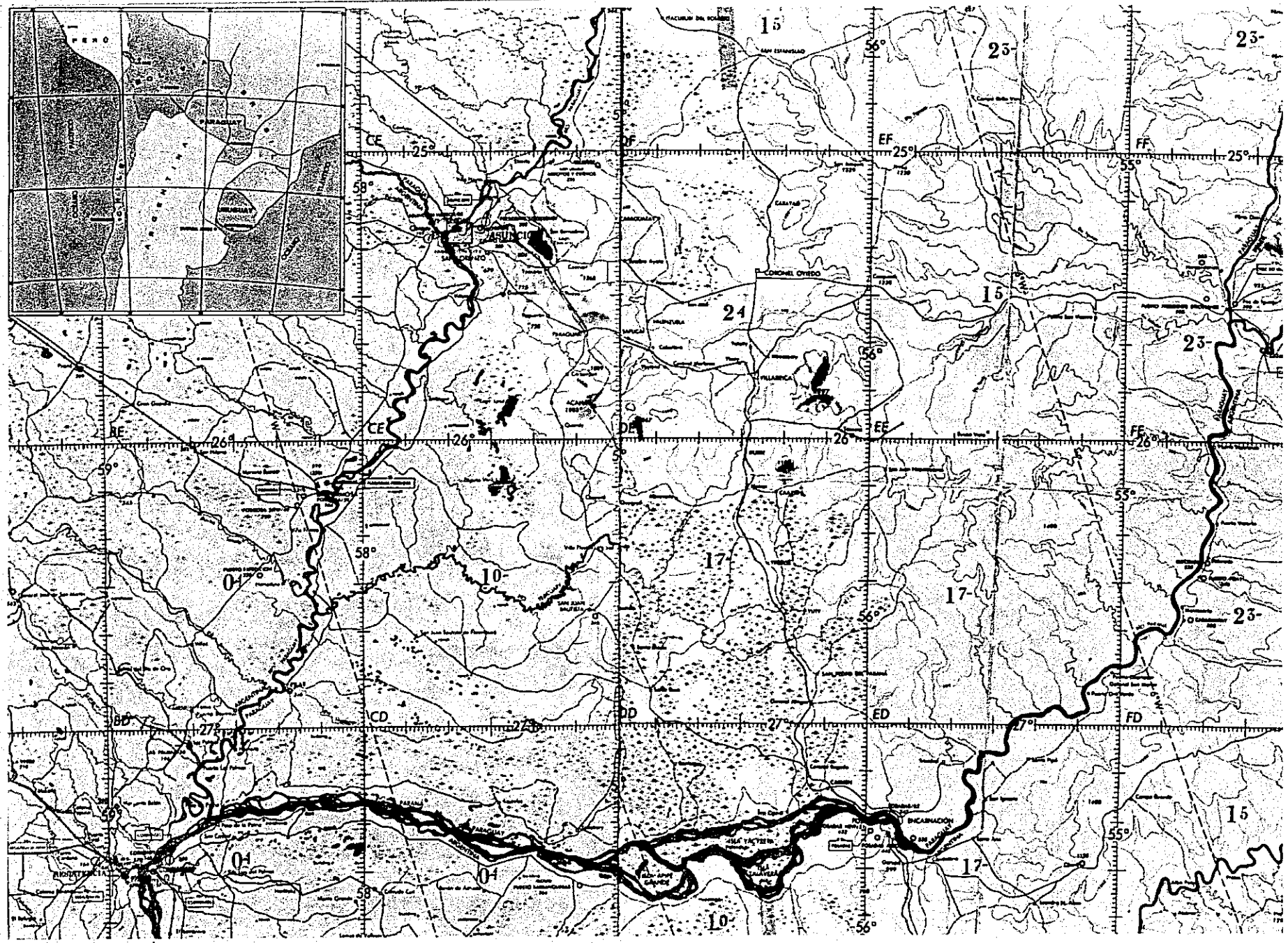
CAACUPE
CORONEL OVIEDO
GUYRAUNGUA
COLONIA YGUAZU
PTO. PTE. STROESSNER
CAAGUAZU
PARAGUARI
FOZ DO IGUAZU
VILLARRICA
VALLEMI
CAAPUCU
SAN JUAN BAUTISTA
ESTERO CAMBA
PILAR
RESISTENCIA
ENCARNACION
TERMINAL STATION
THROUGH REPEATER STATION
MICROWAVE ROUTE
CABLE ROUTE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LIST OF ABBREVIATIONS

This list enumerates abbreviations used in the report.

Abbreviation	Explanation
ANTELCO	The National Telecommunication Administration (Administracion Nacional de Telecomunicaciones)
ANDE	The National Electric Power Administration
CITEL	Commission of Inter-American Telecommunications
CCITT	International Telegraph and Telephone Consultive Committee
CCIR	International Radio Consultive Committee
EMBRATEL	Empresa Brasileira de Telecomunicaciones
ITU	International Telecommunication Union
AC	Alternating Current
CBC	Programme Transmission Circuit
CH	Channel
CTV	Color Television
DC	Direct Current
DP	Dial Pulse Signaling
FDM-FM	Frequency Division Multiplex Telephony – Frequency Modulation
HF	High Frequency
R/D	Ring Down Signaling
RF	Radio Frequency
SP	Stand-by System
TP	Telephone
VHF	Very High Frequency
MDF	Main Distributing Frame
PEF-P	Formed Polyethylene Insulated – Polyethylene Sheath Cable
VDF	Voice Distributing Frame
MN	Magnetic North
TN	Due North
dB	decibel
GHz	Giga Hertz
kVA	kilo Volt Ampere
MHz	Mega Hertz
ns	nano (10^{-9}) second
pW	pico Watt

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I. PURPOSE OF THE CONSTRUCTION OF MICROWAVE NETWORK

The actual situation of the telecommunication services in Paraguay is considerably backward in the propagation of domestic telephone service excepting Asuncion, the capital, and other one or two local cities where the telephone service is propagated.

Open wires are employed as the trunk lines between cities. The number of circuits is small, and the circuit quality is also inferior, so that the service is extremely insufficient.

Turning to international circuits, only several short wave circuits are operated with Middle and South American countries, and U.S.A. as well as several countries in Europe. Moreover, considerable backward situations are observed compared with other Middle and South American countries. However, the economic progress of the Republic of Paraguay in recent years is conspicuous. Accordingly, the traffics of telephone, telex etc. are showing very remarkable progress, and ANTELCO is now promoting the automatization of telephones exchange and the increase of subscribers.

On the other hand, countries in Middle and South America where conspicuous progress is taking place, are promoting the construction of microwave circuits according to the Inter-American Telecommunication Network Plan established by the Commission of Inter American Telecommunications (CITEL).

As a link of this plan, the Republic of Paraguay has established a plan and promoting the realization of constructing international microwave circuits connecting her with Argentine and Brazil which will be at the same time available as the domestic trunk line.

By the construction of these microwave circuits, not only the international circuits between the Republic of Paraguay and Argentine, Brazil, and other neighboring countries as well as her domestic trunk lines will be conspicuously ameliorated in number and quality of their circuits, but also there arises an expectation of propagating effects on political, economical, diplomatic, cultural, and other various aspects of the Republic of Paraguay due to the increasing international as well as domestic information activities.

II. INTERNATIONAL CIRCUIT PLAN

1. Present Situation

The number of international telecommunication circuits operated by ANTELCO is shown in Table II-1. In addition to those mentioned in the Table, there are frontier telecommunication circuits which directly connect cities located on both sides of the frontier of Paraguay and Argentine as well as Brazil. (Table II-2)

High frequency (HF) system is employed for international telecommunication circuits, while Very high frequency (VHF) or cable system is employed for the frontier telecommunication circuits.

2. Circuit Plan

The Republic of Paraguay is planning the construction of earth station for satellite communication in parallel with the construction of above mentioned microwave circuits. Generally, it is considered to be economically advantageous to adopt satellite communication for long range communication and microwave for communication with adjacent countries. Therefore, the international circuits with Argentine, Uruguay (via Buenos Aires), and Brazil are planned to depend on microwave circuits, while other circuits are planned to depend on satellite circuits. However, as the traffic with Argentine is extremely great as will be explained afterwards, it is planned that 25% of telephone and telex circuits will be transmitted via satellite circuits and remaining 75% will be transmitted via microwave with the purpose of making available to communicate even if either system fails down.

(1) Demand Forecast

As the methods of forecasting the traffic of international communications, there are following methods.

(a) Calculate the correlation of the communication traffic and the foreign trade from past results and forecast the communication traffic on the basis of the forecast amount of foreign trade in the future,

(applying some) adjustment based on the variation of other factors.

(b) Obtain the average annual growth rate of the communication traffic in the future assumed on the basis of the result of average annual growth rate in the past, (while applying) some adjustment, if necessary.

The former method is generally applied to short range forecasting, while the latter method is generally applied to long range forecasting. Considering the trend of international communication traffics in the Republic of Paraguay in which a considerable amount of factors other than the amount of foreign trade is supposed to be related, we decided to forecast the traffics by the latter method.

The annual average rates of growth of three major services in the future are assumed as follows on the basis of their results in the past. And the forecast of their traffic amount was obtained by operating a few adjustment for each country of destination upon the above average rates.

By the way, as to the traffic of international telephone, as the result of the amelioration of speech quality at the time of the commencement of the operation by means of microwave and satellite circuits (assumed to be in the year of 1975) the demand will be increased in big leap. So, it is assumed that the traffic of Paraguay with Argentine, Brazil, and Uruguay will be increased by 50%.

The forecast traffic amount is shown in Table II-3.

(2) Required Number of Circuits

The required number of circuits for the forecast amount of traffic is calculated by the following method.

Telegraph: One channel for each 440 messages/day (132,000 messages/year)

TELEX : According to the CCITT Recommendation F. 64, the values assumed for the calculation are as follows:

	1975	1980
Operation Method	Semi-automatic	Full-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 : According to the CCITT Recommendation E. 520, the values assumed for the calculation are as follows:

	1975
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 circuits
Leased telephone circuits
} Assumed on the basis of the demand of ICAO, IATA, and WMO.

By the way, as the demand forecast of other services (audio broadcast relay, phototelegraphy etc.) is small, they are omitted by the fundamental planning. However, they are taken into consideration by the practical system design.

The required number of circuits is shown in Table II-3.

In addition, it is considered that a part of the traffic between Argentine-Brazil (at present transmitted via satellite or short wave circuits) will be transmitted via these microwave circuits. The present situation and the future prospect of the circuits connection the both countries are as shown in Table II-4.

In the case of the traffic between Argentine-Brazil, it is assumed that the charge for leased circuit via Paraguayan microwave circuit is higher than that via satellite circuit. Therefore, it is assumed that only

25% of the number of circuits indicated in Table II-4 will be via microwave circuits.

As to the circuits for frontier communications, it is supposed that the communications transmitted in the area mentioned in Table II-5 will be operated via these microwave circuits. The annual growth rate of the traffic is assumed to be 5% and the number of circuits is calculated according to the method adopted by the international circuits.

The number of circuits to be accommodated in these microwave circuits, calculated according to the above forecast, are shown in Table II-6.

(3) TV Transmission

TV transmission line is planned between Paraguay and Argentine as well as Brazil according to the Inter-American Telecommunication Plan. Today, only one broadcasting TV station at Asuncion is operated in Paraguay. Considering the fact that for the time being, there is no plan for establishing new TV broadcasting station, while there is a plan for establishing TV transmission line via satellite circuits, one system of TV transmission line via microwave is planned for each of Paraguay-Argentine and Paraguay-Brazil circuits. By the way, taking the world-wide tendency in consideration, the circuits are designed for the purpose of color TV transmission.

III. TOLL CIRCUIT PLAN

1. Present Situation

The total number of telephone subscribers in the country is approximately 18,000 in 1970, approximately 16,000 of which are the subscribers residing in the capital, Asuncion, and the remaining some 2,000 subscribers are residing in other areas. (Table III-1) The number of telephone offices is approximately 100, of which those located at Asuncion, Encarnacion and Villarica are operated by automatic exchange system, while all the other offices are operated by magnetic exchange system.

According to the composition of the toll lines, the whole country excepting the central section of Asuncion is divided into 10 regions and each region comprises a telephone office which composes its center (Primary Center) and approximately 9 or so End Offices. As to the number of subscribers of Primary Centers, the beggest is that of Encarnacion with approximately 560 subscribers, and other Primary Centers have about 30-260 subscribers. The number of subscribers of end offices is very small with average 9 subscribers or so for one office.

Consolidation of toll lines is in backward situation with very small number of lines and inferior quality of transmission. The connection between end offices and Primary Center is provided almost by open wires, and the connection between Primary Center and Secondary Center (Asuncion) is provided either by open wires or open-wire carrier system (one system of 3 ch or 12 ch for one section). No wire transmission channel is provided between Asuncion and Pilar. And HF circuits are provided for the transmission between them. Manual Morse telegraph is employed. Also, telex has approximately 100 subscribers all over the country, all of them are residing in Asuncion excepting 8 subscribers located in local districts. The exchange of telex is carried out exclusively in Asuncion.

The toll leased service is not available.

2. Toll Telephone Circuit Plan

The forecasting method of toll telephone circuits is normally based upon the trend of traffic data between each destination in the past years and the forecast of the number of subscribers in the future. However, as sufficient traffic data were not obtained for Paraguay, the demand forecast for toll telephone circuits was carried out according to number of telephone subscribers and the forecast of the toll telephone calling rate in the future.

(1) Forecast of the Number of Telephone Subscribers

The number of telephone subscribers has increased 2.24 times during the decade 1960-1970. (increase of approximately 10,000 subscribers) Most of the increase is due to the increase of subscribers in Asuncion. As the result, the number of telephone subscribers per 100 residents is 3.9 subscribers in Asuncion and average 0.1 subscriber in other districts. The plan of ANTELCO for coping with the increase of subscribers in the future is not clear. However, as most of Primary Centers located in local districts are now constructing their new office buildings for the purpose of opening automatic exchange system and also their local networks are now being replaced by cables, it is supposed that the increase of subscribers in local districts will be also promoted in the future. The above-mentioned situations as well as the investigation report of ITU concerning the telecommunications in Paraguay (1967) are referred to for the forecast of the number of telephone subscribers in the future, and the result of forecast is shown in Table III-1.

(2) Required Number of Circuits

Although the toll telephone calling rate in Paraguay is 1/3 or less compared with that in Japan, it is anticipated that the calling rate will increase rapidly when the number of toll circuits will be increased by means of microwave circuits, by the effect of practically eliminating the waiting time and ameliorating the circuit quality. It is difficult to anticipate the increase of calls for a long period. However, for the purpose of estimating the increase up to 1990, it will be sufficient to suppose that the toll telephone calling rate will increase to the same level as that

obtained by Japan at present, and to make the toll telephone circuit plan consistent with the hereby anticipated calling rate.

By the way, as the number of calls between Primary Centers to each other is considerably small compared with that between Primary Center and Asuncion, it is planned to establish the circuits between Primary Centers and Asuncion, and the calls between Primary Centers to each other are exchanged at Asuncion. Therefore, it is assumed that all the outgoing calls from Primary Center are destined to Asuncion, and the calls originated from the subscribers of Asuncion are assumed to be destined to each Primary Center in the number divided proportionally to the number of subscribers in each Primary Area.

The calculation results of required number of toll telephone circuits on the section concerning these microwave circuits are shown in Table III-2.

3 Telegraph and TELEX Circuit Plan

There have been practically no variation of public telegraph traffic for these years, and one circuit between Asuncion and each Primary Center is sufficient for its service.

It is difficult to forecast the increase of the number of telex subscribers in local districts for long range. However, the calculation results of the number of telex circuits based upon the above-mentioned investigation report of ITU etc. are shown in Table III-2.

4. TV Transmission Plan

There is only one TV broadcasting station operating at Asuncion. For the time being, there is no plan for establishing new TV broadcasting station in local district. Therefore, it is decided to pay no attention for the domestic TV relaying circuit for the time being.

IV. DESIGN OF RADIO CIRCUITS

1. Transmission Line Plan

This microwave network constitutes a part of the international circuits connecting Paraguay (Asuncion) with Argentine and Brazil, and the following decision was established at the conference of CITEL (Commission of Inter-American Telecommunications) and between the countries concerned.

(a) The connecting positions at the boundary shall be as follows:

Argentine side: Between Paso de Patria and Resistencia

Brazil side : Between Pto. Pte. Stroessner and Foz do Iguacu

(b) The microwave system shall be capable of transmission for 960 telephone channels as well as one television signal.

On the other hand, as explained before, the domestic communication network in Paraguay is in extremely insufficient condition. Therefore, this microwave network is required to be available for the amelioration of domestic network, while, at the same time, serving as international circuits. Such being the case, the toll circuits connecting following Primary Centers situated next to the microwave routes with Asuncion, as well as those connecting these Primary Centers to each other are designed under the prospect that they will be accommodated into these microwave circuits.

(Names of Primary Centers)

Paraguari, Caacupe, Cnel. Oviedo, Villarrica,

Pto. Pte. Stroessner, San Juan Bautista, Pilar, Encarnacion

The number of circuits to be required in 1990 calculated on the basis of the demand forecast of international and domestic communications is as follows:

	International Circuits	Domestic Circuits	Total
Argentine side	138 CH	440 CH	578 CH
Brazil side	77 CH	241 CH	318 CH

Here, the telegraph and telex circuits are converted into telephone channels.

The circuits to Paraguari and Caacupe are included in the calculation of "Argentine side."

Therefore, when the traffic up to 1990 is considered, each one system of 960 Channel will be sufficient for the transmission of telephone, telegraph, and telex traffics directed to Argentine and Brazil.

As to TV transmission, there is no plan for domestic relay, and only international relay is to be operated for the time being. Therefore, the occupying time of transmission route is considered to be not so large. So, on the basis of economy, it is decided to provide the stand-by RF channel for the common use of TV transmission without constructing independent RF channel for TV transmission. The plan is decided to provide the possibility of adding a RF channel for independent use of TV in the case when TV transmission is increased in the future.

2. Designing Conditions of Radio Circuits

(1) Conditions of Design

On the basis of above-mentioned transmission line plan, the circuits are designed considering the quality, to be maintained as international circuits. economical design, and the convenience of maintenance.

(a) The circuit standard satisfies the recommendations of CCIR concerning telephone and television.

(b) Existing telephone offices as well as the buildings, towers and power facilities planned for the 2 GHz microwave system between Asuncion and Concepcion are utilized as far as possible for the purpose of economy.

(c) Considering the reduction of construction cost and the convenience of maintenance, the sites for radio stations is selected along all-weather roads or near the major roads as far as possible.

(d) These circuits are constructed considering the future of the communication plan of the Republic of Paraguay.

(2) Frequencies and System

In case that the above-mentioned item (c) is considered, apart of the Eastern and the Southern routes have the risk of mutual interference between satellite communication system. So, the frequency band 6440-

7080 MHz is employed avoiding the frequencies commonly used with the satellite communications. As to the alignment of frequencies, it is preferable to adopt the alignment shown in Table IV-1 from the view point of the improvement of the interruption time.

By the way, above alignment may be changed according to the conditions for international connection.

FDM-FM method is adopted, and 960 channel of telephone or CTV can be transmitted. The performance of the equipment is assumed to be as shown in Table IV-2.

3. Results of the Selection of the Route and Site

The results of the selection of the route and the site are shown in Fig. IV-1, that is:

By the Eastern route, 307.8 km between Asuncion and Pto. Pte. Stroessner is connected by 7 radio stations. By the Southern route, 347.9 km between Asuncion and Paso de Patria is connected by 8 radio stations. And both routes are branched at Paraguari station.

The proposed site for Asuncion is the Central-2 Telephone Office and the section between Asuncion and Cnel. Oviedo of the Eastern route is installed in parallel with the 2 GHz microwave route between Asuncion and Concepcion which is planned independently. In case that the route is selected other than the above route, the number of radio stations is increased and necessitates uneconomical expenditure.

The route between Cnel. Oviedo and Pto. Pte. Stroessner is selected along the all weather road. The topography of this section is formed Caaguazu as the highest point and gradually lowering to both Eastern and Western directions in the form of terrace. Therefore, Caaguazu is selected as the site of radio station in consideration of the height of the tower. As for Pto. Pte. Stroessner, a hill 2 km distant from the telephone office is selected because the height of the location of the telephone office is not sufficient so that very high tower would be required. As to other radio stations, locations as high as possible and distributed with good distances are

selected.

As to the Southern route, it is branched from the Eastern route at Paraguari station. The stations on the section from Paraguari to S.J. Bautista are located along the all-weather road. As the site of S.J. Bautista station, the Ita-Yull Hill, about 10 km distant North of the city of S.J. Bautista was selected because the city lies on a low land.

Also, the section between Valle Apua and S.J. Bautista can be linked by one hop according to the distribution of distance. However, as there is a ridge between them, a station was selected at Caapucu.

The section between S.J. Bautista and Paso de Patria is a large pampas area dotted with woods. However, it is difficult to locate stations apart from a road because there are swamps, together with big lakes all over the area. Therefore, the stations were selected along the road with adequate balance of the distance.

The propagation characteristics and profiles of these routes and the guide maps of each proposed site are shown in Table IV-3, Figs. IV-2 and IV-3.

4. Circuit Quality

Not only international circuits, but domestic toll circuits are installed on both Southern and Eastern routes, the structures of both routes comprise many of base-band sections as follows.

Easter route:	Asuncion – Cnel. Viedo
	Cnel. Oviedo – Pto. Pte. Stroessner
Southern route:	Asuncion – Paraguari
	Paraguari – S.J. Bautista
	S.J. Bautista – Pilar

However, overall noise power and interruption time of the circuits satisfy the standard recommended by CCIR as shown in Tables IV-4 and IV-5 because of the introduction of 4 mø parabolic antenna and low loss circular wave guide (employed only on the vertical portion) at some section consider-

ing the antenna height and sectional distance etc.

As explained in the above item, the transmission route between S.J. Bautista and Paso de Patria passes through swamp area. In addition, it is transmitted by low layer propagation. Therefore, the transmission is apt to be effected by meteorological change. Although the calculation results of interruption time satisfy the standard, the propagation will be investigated after the completion of construction, because the meteorological conditions on the field are not clear. And it is designed so that space-diversity equipment can be added in the future, if necessity requires.

V. RADIO SYSTEM DESIGN

1. System Configuration

The radio system configuration is shown in Figs. V-1 and V-2.

The fundamental principle of system configuration is as follows.

As to the number of RF channel, it is decided to be 1 telephone RF channel + 1 stand-by RF channel at initial stage, and TV is transmitted through the stand-by RF channel. It is considered that an independent TV RF channel will be added in the future. By the way, the section between Asuncion and Paraguari transmits both Eastern route and Southern route. So, it is decided that the above section will be constructed with 2 telephone RF channel + 1 stand-by RF channel from the initial stage.

Although the connecting conditions of the international connecting section are not clear, the equipments located in the Republic of Paraguay are designed according to the same conditions as the domestic section. By the way, of the above-mentioned sections, the section between Pto. Pte. Stroessner and Foz do Iguacu is not clear whether microwave system or coaxial cable system will be adopted. However, the design is carried out by the assumption of microwave system.

As to TV transmission, only international transmission is carried out for the time being. Therefore, it is sufficient to install equipments necessary for TV operation only at Asuncion. However, considering the test at the time of construction and the international branching test for maintenance and operation, equipments for TV operation are installed also at Pto. Pte. Stroessner and Pilar. By the way, it is considered that at the point when domestic TV relay is commenced, each station can operate the branching and insertion of TV program from/to Asuncion.

The transmission capacity is decided in consideration of TV transmission through the stand-by RF channel so that it may transmit telephone 960 channels or 1 channel of color television including 1 voice channel per radio channel.

2. Maintenance System

According to the personnel conditions, it is designed that the Asuncion station is the only attended station and all the other stations are unattended ones.

As the maintenance conditions, the supervision of the system is continuously operated at Asuncion. All the maintenance and test are performed by patrolling. One or more personnel are continuously supervising the system, and the maintenance and test are carried out by a group of two personnels. Number of groups required for the patroll is two or more because of the conditions of the route. The above-mentioned personnels carry out all the inspection, test, and maintenance of radio equipment as well as all the other equipments including carrier multiplex and power equipments. In the future, it may be considered that some simpler works among above-mentioned works will be performed by the personnel of the nearest telephone office. However, such design as leading the supervisory and control system into telephone offices is not considered by the designing.

The time required for arriving to the unattended station in an emergency from Asuncion is as follows:

Paraguari	1 hour 40 minutes	in all weathers
Cnel. Oviedo	2 hours	"
Caaguazu	3 hours	"
Guyraungua	4 hours	"
Cnia. Yguazu	5 hours	"
Pto. Pte. Stroessner	6 hours	"
Valle Apua	2 hours 30 minutes	"
Caapucu	3 hours	"
S. Juan Bautista	3 hours 30 minutes	"
Estero Camba	6 hours 20 minutes	in Fine weather only
Pilar	8 hours 20 minutes	"
Paso de Patria	11 hours	"

By the way, four wheel driving cars with the capacity of carrying two or more personnel as well as measuring equipments are employed for the patroll, two or more of which are to be positioned at Asuncion.

3. Supervisory and Control System

The following systems are necessary for the supervison and control of maintenance of microwave system.

(1) Switching system

(2) Supervisory and control system

(3) Omnibus order wire

(4) Express order wire

The service channel transmitting these signals are normally provided on the lower band of the telephone RF channel, and when the telephone RF channel is in failure, the service channel is changed over to the stand-by RF channel.

The formation of switching sections is shown in Fig. V-3.

The international connecting section is separated as an independent switching section because its design conditions are not clear. It is designed, for the time being, according to the system adopted in domestic section. Consideration is provided to the capacity of the control system so that the addition of TV RF channel in the future will be performed without difficulty. The automatic switching system controlled by receiving end detecting pilot and noise level is adopted. The manual operation for the switching system is available at receiving end station as well as from Asuncion station through the supervisory and control system. Also, the indication is not only available at local station, but also it may be indicated at Asuncion through the supervisory and control system. In this case, the indications of all the switching sections are not operated at the same time.

All the stations are supervised and controlled from Asuncion station through the supervisory and control system. Therefore, the Asuncion station is designed as the supervising and controlling station, while all the other stations are designed as supervised and controlled stations. The diagram is shown in Fig. V-3. Asuncion is provided with not only its proper supervising and controlling function, but also the function of selecting station for the purpose of remote supervision and control of supervised and controlled stations. The supervision and control of all the stations at the same time is not available.

Stations other than that of Asuncion are provided with the function of indicating the supervision of their respective stations.

The omnibus order wire connects all the stations and the conversation by means of calling through loudspeaker as well as four wire telephone set are available. The express order wire connects terminal stations to each other and the conversation by means of calling through loudspeaker as well as the four-wire telephone set are available. The design conditions of international connecting section are not clear. However, it is designed in the same way as the domestic section. The connection diagram is shown in Fig. V-3.

Examples of service channel diagrams are shown in Figs. V-4 and V-5 for the purpose of reference.

4. Equipment Design

All the equipments are designed according to the recommendation of CCIR excepting items specially provided.

Heterodyne system is adopted for the radio repeating system and FM system is adopted for the modulation system.

For the purpose of effecting the economy of maintenance and the improvement of reliability, completely solid state equipments are adopted for the repeaters, the modemos and the sound vision combiner and separator. In addition, the solid state devices are employed as the active elements of auxiliary equipments as far as possible. Therefore, direct current is employed for the power source and the voltage is determined to be DC-24V. Each equipment in the station is front operation type which enables the back-to-back arrangement.

As the antenna system, the single polarized antenna used for transmitting and receiving in common is adopted for the purpose of economy. Parabolic antenna is adopted, and wave guide is adopted for the feeder. The outdoor section of the wave guide is of air tight construction and dried air is continuously injected. The branching filter is designed so that the addition of television RF channel in the future will be available without difficulty.

As to switching system, both telephone and television RF channels at Asuncion are provided with video switching system, while other stations are provided with video and IF switching system for telephone and TV RF channel, respectively, in principle. As to the priority by automatic switching system, the RF channel of the preceeding fault has the priority of change over, while the RF channel of the following fault is held. In case two systems fail at the same time, the order of priority is as follows: Telephone-A, Telephone-B, Television RF channel. In case failure is generated on the working RF channel while the stand-by RF channel is under operation, the operation of stand-by RF channel is released automatically and the working system is relieved. By the way, each working RF channel is provided with turning off function of automatic switching.

The stand-by channel and the TV RF channel established in the future directed from Asuncion to Paraguari are normally branched at Paraguari to the direction from Paraguari to Cnel. Oviedo and the direction from Paraguari to S. Juan Bautista, without any control. As the transmission toward the reverse direction of above-mentioned systems, either the connection of above-mentioned systems, either the connection from Cnel. Oviedo to Asuncion or the connection from S. Juan Bautista to Asuncion is selected at Paraguari by local or remote control.

Furthermore, after the television RF channel will be added in the future, transmission and reception of each two television programs will be available at the same time in Asuncion by employing the television RF channels and the stand-by RF channels. In this case, above-mentioned television programs will be transmitted at Paraguari in the following order:

```
          TV            TV
Asuncion --> Paraguari --> S. Juan Bautista

          stand-by          TV
Asuncion ------> Paraguari --> Cnel. Oviedo

                TV          TV
S. Juan Bautista --> Paraguari --> Asuncion

              TV          Stand-by
Cnel. Oviedo --> Paraguari ------> Asuncion
```

At Pto. Pte. Stroessner and Pilar, the circuits of the stand-by RF

channel and the television RF channel in future are set to "off" in ordinary conditions, and extended and connected when necessity requires such as for international TV transmission. In this case, during stand by hours, pilot signal is transmitted between adjacent countries to each other for the purpose of system supervision.

The indication of the switching equipment includes the following items.

(1) Failure of working RF channel (by each channel and direction)
(2) Stand-by RF channel is switched over and under operation
(3) The working RF channel is restored
(4) Stand-by RF channel is under operation for TV transmission
(5) Failure of service channel
(6) The situation of RF channel connection at Paraguari
(7) The situation of RF channel connection at international section
(8) Miscellaneous (spare)

The remote supervisory and control system is designed in consideration of the switching over, branching and insertion of modemos at each station in the future.

As to the priority of the indication of automatic supervision, the indication of station of proceeding failure has the priority, and that of following failure is held. In case two or more station failed at the same time, the indication of the station nearest to Asuncion has the priority. In any of the above cases, the action of indicating the station of following failure is started automatically by the reset operation at Asuncion.

The indication of the remote supervisory and control equipment includes the following items:

(1) Station alarm (by each station)
(2) Failure of radio equipment
(3) Failure of carrier multiplex equipment
(4) Information of power equipment (Includes abnormality of commercial power, engine-generator is under operation etc.)
(5) Alarm of door opening
(6) Fire alarm

(7) Non-urgent alarm

(8) Failure of service channel

(9) Indication under maintenance

(10) Answer for control

(11) Miscellaneous (spare)

The control function of the supervisory and control equipment includes the following items:

(1) Engine-generator start

(2) Engine-generator stop

(3) Switching over of engine-generator

(4) Switching over of television demodulator (to be added in the future)

(5) Switching over of television modulator (to be added in the future)

(6) Insertion of television program (by each system) (to be added in the future)

(7) Remote operation of switching equipment (by each item).

By the design of installation of antenna, pipings of wave guide, and distribution of equipments in the rooms of four stations at S. Juan Bautista, Estero Camba, Pilar, and Paso de Patria, full consideration is paid to the additional installation of equipments for space diversity system in the future.

Also, by the design of the station at S. Juan Bautista, full consideration is paid to the introduction of independent microwave system to the direction of Encarnacion in the future. In this case, the structure of above-mentioned independent microwave system is assumed to be the same as this project.

For reference sake, an example of communication system diagrams by each station is shown in Figs. V-6 – V-13.

VI. DESIGN OF CARRIER MULTIPLEX AND VOICE FREQUENCY TELEGRAPH SYSTEM

In this chapter, the design of international and domestic carrier multiplex circuits, broadcast relay circuits, and voice frequency telegraph circuits is explained.

1. Circuit Quality and System

(1) International and domestic circuits satisfy the recommendation of CCITT.

(2) FDM-FM system is adopted as the transmission system, and the frequency arrangement in the base band is according to the standard of CCITT.

2. Circuit Accommodation

The circuit accommodation plan is as shown in Table VI-1 and Fig. VI-1. This is decided in consideration of the following items.

(1) The circuit accommodation serves as the basis of equipment design, therefore, the required numbers of channel for each year is indicated.

(2) For the purpose of maintenance of circuit quality as well as for the sake of economy, Asuncion is connected with each terminal station by independent super-group. Therefore, the super-group passing through each terminal station is connected by super-group through filter.

(3) For the purpose of changing over in case of circuit test or failure, one system of super-group operable by each terminal station in common is composed for each of the Southern route and the Eastern route.

(4) For the purpose of changing over in case of circuit test or failure, one system of spare group is composed between Asuncion and each terminal station.

(5) Telegraph circuits are composed in the same way as the telephone circuits. Asuncion is connected with each terminal station. The numbers of accommodation are shown in Table VI-1.

(6) One broadcast relay circuit is composed as an international circuit for each of the Southern route and the Eastern route from Asuncion. By the way, as to accommodation plan of international circuits, the number of circuits to be accommodated and the alignment of super-groups at the section of international connection may be changed according to the arrangement with countries concerned.

3. Signaling System

For the time being, toll telephone circuits are operated by the Semi-automatic exchange system (Operator dialing method). The Dial pulse signaling (DP) system and Ring down signaling (R/D) system, i.e. outband signaling method with 3825 Hz relative frequency are adopted.

The two signaling systems above mentioned are used to connect each subscribers as follows;

(1) International toll telephone connection: R/D system

(2) Connection between Asuncion and local areas: DP system

(3) Inter-connection between local areas

(All these connections are operated at the manual board of Asuncion office)

Local area ⟶ Asuncion : R/D system

Asuncion ⟶ Local area : DP system

More-over, ANTELCO considers the Automatic toll telephone switching system in the future. Therefore the signaling system shall be employed the R2 signaling system appointed by CCITT Recommendations Q350 – Q380 in Volume VI.

4. Equipment Design

(1) Standard

The equipment shall be in accordance with the standard of CCITT unless otherwise indicated.

(2) Number of Establishments

The establishment shall be in accordance with the required number for the year 1980 as shown in Table VI-1 and Fig. VI-1. By the way, it shall be so designed that additional installation will be provided for the demand of the year 1990, putting the equipment already installed into good use.

This work does not include the construction of the transmission routes between S. J. Bautista and Encarnacion, Paraguari and Caacupe, and Cnel. Oviedo and Villarrica. However, as extension of the transmission routes is expected in near future, super-group equipment (including super-group through filter) is installed at S. J. Bautista station, and super-group equipment and group equipment (including group through filter) are installed at Paraguari station and Cnel. Oviedo station. Furthermore, equipments up to the channel equipment of above-mentioned transmission routes are installed at Asuncion station.

As to the telegraph circuits toward Encarnacion, Caacupe, and Villarrica, voice frequency telegraph equipment are installed at Asuncion station in the same way as the telephone circuits.

(3) Block Diagram of the Carrier Multiplex System

A typical block diagram of the carrier multiplex system is shown in Fig. VI-2.

(4) Items Remarked with Special Attention to Equipment Design

(a) Carrier Multiplex Equipment

As all the stations are the unattented station except Asuncion station, the design of equipment needs to pay consideration to the maintenance.

That is to say, full solid state type is adopted for the equipments. Failures in unattended stations are indicated locally, and at the same time the alarm may be transmitted to Asuncion. Also, important sections which require instantaneous change over in case of failure are installed in duplicate.

Equipment are, in principle, provided with the possibility of back to back arrangement.

As the power source, DC-24 V is employed, like the radio equipment.

The signals in the carrier section, Out-band signal 3825 Hz relative frequency is employed. These signals are converted to dial impulse signal and R/D signal (25 Hz) by means of signal equipment, respectively.

In case when Automatic toll telephone switching system shall be employed in the future, it is scheduled to employ the R2 signal system. Therefor, the multiplex equipment used in this system shall be designed that the signaling system can be converted DP system and R/D system into R2 signal system economically.

(b) Voice Frequency Telegraph Equipment

The code transmission speed is 50 band and 24 telegraph channels is accommodated in one telephone circuit.

Equipments of composite type are considered for the purpose of economy.

As to the power source of the equipments, existing DC-60V is employed.

The equipments for international telegraph circuits may be changed according to the arrangement between countries concerned.

(c) Broadcast Relay Circuit Equipment

The 84 - 96 KHz band (equivalent to 3 telephone channels) of the base group of the carrier multiplex equipment is employed for this equipment, and the broadcast signal 50 Hz - 10 KHz band is transmitted.

5. Miscellaneous

(1) Construction

The carrier multiplex equipment and the broadcast relay equipment are installed in a same building as microwave equipment, while the voice frequency telegraph equipment is installed in telephone office.

Radio terminal station and telephone office are connected by means of the toll cable system mentioned in Chapter VII. The entrance-cable of the telephone office is used the underground type. However, at Asuncion and Pilar where both buildings are in a same site, they are connected by directly buried armoured cable. The necessitated number is 1,400 pairs or more at Asuncion and 100 pairs or more at Pilar.

(2) Scope of Project

As to the carrier multiplex system, and the broadcast relay and voice frequency telegraph system, the scope of project is up to the input terminal of distribution frame at telephone office (including the construction of the distribution frame).

By the way, telegraph perforators, transmitters, printers, and other telegraph terminal equipments are not included in this project. So, they are to be planned independently by ANTELCO.

VII. DESIGN OF TOLL CABLE

1. Sections and System

Radio terminal stations are installed distant from telephone offices at Paraguari, San Juan Bautista, Cnel. Oviedo, and Pto. Pte. Stroessner. For the purpose of installing carrier multiplex equipment for microwave systems in these telephone offices, it is necessary to compose entrance circuits by means of coaxial cable or microwave. However, as the number of toll circuits to be led in is small, it is not economical. Therefore, the carrier multiplex equipment are installed in radio terminal stations and entrance circuits are composed by installing toll cable between radio terminal station and telephone office. Considering the transmission loss, value of DC resistance and other electrical characteristics as well as construction cost etc., the conductor diameter of toll cables, and the difference of loaded and non-loaded cables etc. are investigated. The results are shown in Table VIII-1.

By the way, as to toll cable, PEF-P cable (Formed Polyethylene Insulated – Polyethylene Sheath Cable) which has superior electric characteristics and advantage of maintenance is employed. And the cable will be constructed in the principle along a road for the convenience of the construction and the maintenance.

2. Number of Cable Pairs

The number of cable pairs is small because the number of circuits is small. Therefore, the consideration of constructing additional cables in an intermediate period is excluded. And it is decided to construct cables with sufficient capacity for satisfying the demand for circuits anticipated in 1990 at the beginning.

The number of cable pairs is selected so that it will satisfy the demand in 1990 by using the side and the phantom circuits.

The number of cable pairs by each section are shown in Table VIII-1.

3. Transmission Loss

The telecommunication system in Paraguay comprises the following three stages:

Subscriber --- TE (Terminal Exchange)
TE --- PC (Primary Center)
PC --- SC (Secondary Center)

Only one SC is existing, that is, Asuncion, which serves also as the international exchange office.

The plan of distributing the transmission loss between above three stages is not yet established.

As this microwave circuits composes the trunk line for toll communication, it is required to satisfy the standard of transmission loss between PC – SC including the toll cable sections. However, under existing circumstances, as most part of the circuits between PC and TE and subscriber is composed of open wire, the electrical characteristics are largely changed according to weather conditions etc. so that there exists the possibility of unstabilizing the circuits by inserting amplifiers in toll cables. Therefore, the reduction of transmission loss by means of amplifier is not adopted for the time being. And the amelioration of the transmission loss will be scheduled when the circuits PC – TE – Subscriber will be arranged in the future.

The minimum transmission loss of each section when PC and SC are operated by 2-wire exchange system is shown in Table VII-1. (The switching-office loss is assumed to be as shown in Fig. VII-1).

4. Scope of the Project

The scope of works carried out according to this project is as follows:

(1) Toll Cable Line

All the poles are newly constructed. But at Paraguari, the existing poles will be used after reinforced.

At Paraguari and San Juan Bautista, all the pairs of the cables in-

cluding phantom circuits are loaded.

(2) Inter-office Equipment

As to radio terminal stations, the VDF constructed for the carrier multiplex system is commonly used by toll cable system.

At telephone offices, distribution frames for toll cable are newly installed.

Many repeating coils and lightening facilities to correspond to the required number of circuits in 1980 are inserted actually.

The construction work of signal equipments, switching equipments, and wiring etc. on the side of telephone offices are not included in this project. These works shall be independently planned by ANTELCO.

VIII. DESIGN OF POWER SUPPLY

1. Designing Conditions of Power Equipments

The basic principle of the designing of power equipments is as follows:

The power source for communication equipment is DC type. However, AC type power source is applied to the power source of measurement air dehydrator.

AC power source is applied to the aeronautical light beacons, room illumination and other miscellaneous devices.

Therefore, as to power source, the system by which AC is rectified and batteries are charged by floating is adopted.

As AC power source, commercial power is utilized as far as possible by such stations where commercial power is available. By such stations, the system "commercial power + stand-by engine-generator" is adopted. By other stations, the system of alternately operating one of two engine generators according to timer is adopted.

The designing conditions of power equipment is as follows:

As to commercial power receiving equipment and engine generator as well as their accessories, those provided with the capacity required for the year 1990 are installed. As to battery chargers and batteries, those provided with the capacity required for the year 1980 and paid necessary considerations for the addition or replacement in the future, are installed.

The names of the stations where commercial power is available are as shown in Table VIII-1.

As the countermeasure for power suspension for a long time, as well as failure and overhauling of engine generator for a long time etc., two pairs of engine-generator mounted on vehicle for emergency use are stationed at Asuncion. In addition, because of the bad road conditions, one more engine-generator is provided for each of the following three stations: Estero Camba, Pilar, and Paso de Patria.

As to the designing of the capacity of batteries, it is decided that the

holding time is 2 hours or more at Asuncion and 8 hours or more at other stations.

The period of alternate operation of engine-generator is decided to be 2 days.

The capacity of fuel tank is decided to be one month or more by the continuous operation, with rated load.

By the way, the possibility of common employment of the power equipments or existing 2 GHz system at Paraguari and Cnel. Oviedo stations was investigated and it was found to be unpractical. So, it is designed to install independent power equipment.

By the designing of capacity of each equipment, the following four stations are designed considering the addition of space diversity system in the future: S. Juan Bautista, Estero Camba, Pilar, and Paso de Patria.

Furthermore, the capacities of the commercial power receiving equipment and the engine-generator as well as their accessories at S. J. Bautista station were decided considering the introduction of independent microwave system to the direction of Encarnacion in the future. However, as to the capacities of battery charger and batteries, above consideration was not applied. In this case, it is assumed that the composition of above-mentioned independent microwave system is the same as that of this project.

2. Systems

The receiving system of commercial power and the engine-generator system are 380 V 3 phase 4-wire system satisfying the standard of ANDE.

The power source for measuring equipment and lamp, etc. is single phase 220 V.

The output voltage of battery charger and batteries is DC-24 V complying with the communication equipments.

The engine generator are provided with automatic start and stop function. They are started by the abnormality of commercial power, the remote control, or the timer, and stopped by the restoration of commercial

power, remote control, or the timer. However, the action of stoppage is operated by the lapse of delay time of 10 minutes or less after the time of the recovery of commercial power, to confirm the recovery.

The change over of the load is operated automatically according to the above operation.

The air cooling method is adopted for the engine because of the easiness of the maintenance. In addition, daily service fuel tank is installed within the power room which is supplied automatically from outdoor fuel tank. By the way, the outdoor fuel tank is designed and constructed by the building construction work.

For reference sake, examples of power system diagrams are shown in Figs. VIII-1 – VIII-3.

3. Commercial Power Receiving Line

The commercial power receiving line is designed according to Table VIII-1 and conforms to the standards of ANDE. The receiving line includes arresting equipment, circuit breaker, and other accessories, and is designed and constructed by separate procedure of construction other than the construction work of the main power equipments.

4. Miscellaneous

Power source of DC-60V is used in each telephone office as the power source for voice frequency telegraph equipment.

IX. DESIGN OF TOWERS

1. Designing Conditions of Towers

The type of the towers for supporting antennas to be constructed by this project is determined to be of self standing type with the capacity to be required in 1990.

The designing conditions of towers are as follows.

According to the values of meteorological statistics in the Republic of Paraguay, the anti-wind strength is decided to stand the wind force of 120 km/h. or more. As to the anti-earthquake strength, it is not considered as there is utterly no phenomenon of earthquake in that land.

The towers are colored white and red alternately for each vertical length of 3 – 5 m with their tops red-painted as day-time aeronautical beacons. In addition, two red lamps of 100 W or more are installed on the tops as the night aeronautical beacons. Furthermore, the lamps are installed at middles of towers where the tower height is more than 45 m. By the way, these light beacons are automatically turned on and off by means of photocell etc.

The tower foundations are designed with full consideration of the load of various installations including antennas and the tower bodies as well as of the soil pressure. By the way, the tower foundations are designed and constructed according to the procedure of the construction of the buildings.

At Asuncion, the existing tower for 2 GHz system is used in common with this microwave system.

At Paraguari and Cnel. Oviedo, the common employment of the existing towers for 2 GHz system was investigated. However, it is decided that the common employment is not available. Therefore, the design is carried out as an independent installation.

At S. Juan Bautista, capacity of the tower is designed considering the installation of additional antenna for an independent microwave system toward Encarnacion which will be constructed in the future.

Also, the capacity of towers at four stations at S. Juan Bautista, Estero Camba, Pilar and Paso de Patria is decided considering the additional mounting of auxiliary receiving antennas for the space diversity system which may be added to those stations in the future.

2. Height of Antennas and Capacity of Towers

The height of antennas and capacity of towers by each station are shown in Figs. IX-1 – IX-2. As to the determination of the height of antennas, refer to Chapter IV.

X. SITES, BUILDINGS AND ROADS

1. Conditions for the Sites

Major facilities to be built on the site is as follows.
And the area required for these facilities is shown in Table X-1.

(1) Building

(2) Tower

(3) Fuel Tank for Engine-generator

(4) Fence

By the way, when tower is to be erected, it is desirable to have a working space including the site around the tower indicated in Table X-1 while the construction work is carried on. When above mentioned working space is not available because the working site is within a city area, it is necessary to secure the working space mentioned in the Note of Table X-1.

Felling and levelling are necessary in the site. However, banking shall be avoided where tower or building is to be constructed, as the soil pressure is reduced at the banked section.

Fence shall be installed around the site.

Also, in case the site is surrounded by woods, fire protective belt is established for the purpose of protecting the burning of radio station by fire expanding from woods. The width of the fire protective belt is more than 15 m along the building and fuel tank, and all the trees within the fire protective belt shall be cut down.

2. Designing Conditions of Building

The building of each radio station is newly built. But, at Asuncion station, it is now under consideration to use CENTRL-II station or not by ANTELCO.

(1) Area and Height

Building accommodates radio equipments, carrier multiplex equip-

ments (except voice frequency telegraph equipment), power equipments and their accessories.

Further, equipments for the connecting circuits between the earth station of satellite communications and central office are accommodated in Asuncion station. It is anticipated that at Paraguari and Cnel. Oviedo, the equipments for entrance circuits will be installed in the future directed toward Caacupe and Villarrica respectively. Also, it is anticipated that at San Juan Bautista, the equipment for microwave circuits directed to Encarnacion will be installed in the future. Therefore, the buildings of above-mentioned offices are provided with space for accommodating the equipments. The additional installation of the equipments for space diversity system is also considered according to the data which will be obtained after opening of these microwave circuits at San Juan Bautista, Estero Camba, Pilar and Paso de Patria. Therefore, those stations are provided with the space for their installation.

In principle, radio equipments and carrier multiplex equipments are aligned back to back, and the usable space between frame alignments are 1.5 m or more because of the convenience of maintenance works.

Also, room for maintenance personnel is installed at Asuncion and spaces for the convenience of simple repair works are provided at other radio stations.

The building space required for each radio station is shown in Table X-2.

The effective height (the height from the upper surface of the floor to the ceiling or the lower surface of the beam) of building is approximately 3.5 m.

(2) Floor Pressure

More than 1 ton/m^2 is necessary for the floor pressure of the building.

(3) Temperature and Moisture

It is required that the temperature and the moisture in the building are within the following ranges.

Room temperature : 5 to 40 degree C

Relati /e humidity of the room: Less than 95 %

By the way, in case air conditioning apparatus is employed, it is necessary to enlarge the capacity of power equipments as it consumes relatively large quantity of power compared with the communication equipments. Therefore, each radio station is designed in such way that it satisfies above-mentioned conditions of temperature and moisture without employing air conditioning apparatus.

(4) Electric Facilities

Lamps for room illumination and outlets for measuring equipments etc. are installed in the building.

The capacity of the outlet is approximately 1 KVA per one outlet.

(5) Fuel Tank

Fuel tank for engine generator is installed in the site (outdoor). The fuel tank is connected to fuel pump as well as daily service tank by means of piping.

The capacity of fuel tank is decided to be larger than the value mentioned in Table X-2 considering the periodic of the supply.

3. Example of the Block Plans of Buildings

An example of block plans of buildings prepared according to above conditions is shown in Figs. X-1 – X-8. As the Figs. are only examples, block plans other than these Figs. may also be adopted.

4. Cautions Concerning the Building Designs

It is required that the designs of buildings are adapted to the equipments to be accommodated. And sometimes the conditions of building design

may differ according to the equipments to be accommodated. Therefore, it is necessary to confirm the above-mentioned conditions of building design by arrangement between the designer of the building and the constructor of the equipments at the period when the constructor of the equipment is determined.

It is also required that the detailed designs of building satisfy the conditions for the installation of equipments (for example, supporters of frames, position where wave guide is constructed, etc.). Therefore, it is necessary to determine the detailed designs of building after satisfactory arrangement with the constructor of the equipments.

In swamp area, it is necessary to consider the height of the building floor so that flood does not rise above the floor.

As to the location and dimensions of fuel tank, it is also necessary to determine after arrangement with the constructor of the equipments.

5. Earthing

Earthing shown in Table X-3 are installed in the site of each radio station.

6. Conditions for Design of Roads

The radio stations requiring construction of new roads are shown in Table X-4.

The roads from Asuncion to each radio station are required to be passable under any weather conditions. However, the national road to the stations at Estero Camba, Pilar and Paso de Patria sometimes becomes unpassable in rainy day. Therefore, above fact was taken into consideration by the design of equipments.

The designing conditions of roads to be newly constructed are as follows:

(1) 3 m or more width, and 4 m or more width at curve. The radius of curved is 10 m or more.

(2) Slope is less than 1/10. (Partially, less than 1/7 is the permissible value).

(3) The road surface is either paved or gravelled and passable under any weather.

(4) Side-ditchs shall be located at one side (both sides according to the topography).

(5) In case that the road distance is long, shunt areas for vehicles shall be located with proper interval.

XI. MEASURING EQUIPMENTS, TOOLS, AND SPARES

1. Measuring Equipments and Tools

Measuring equipments and tools are limited to those required for maintenance. Those employed only for construction works are not included.

The power source of measuring equipments is AC single phase 220 V excepting those power source built-in types and pen-recorder.

Measuring equipments are constructed as easily transportable structures for the benefit of patrolling maintenance excepting those structured on fixed frames.

The species of measuring equipments are as follows including those mentioned in Table XI-1.

(1) Common Measuring Equipments.

(2) Measuring Equipments for Radio System.

(3) Measuring Equipments for Carrier Multiplex System.

(4) Measuring Equipments for Voice Frequency Telegraph System.

(5) Measuring Equipments for Power System.

The allocation of measuring equipments is, as the principle, as follows.

Common measuring equipments are allocated to all the stations excepting those employed only for terminal station. And the measuring equipments for terminal station are allocated to all terminal station. Measuring equipments for radio system excepting those for TV equipments are allocated to all the terminal stations. As the measuring equipments necessary for repeater stations are small in number, they are transported from terminal stations when patrolling.

Among the measuring equipments for radio-system, those employed for television equipments are allocated to Asuncion, Pto. Pte. Stroessner and Pilar considering the dividing test at the time of international relay.

Measuring equipments for carrier multiplex system are allocated to all the terminal stations.

As the measuring equipments for voice frequency telegraph system are

generally small in size and easily transportable, two sets of them are allocated at Asuncion, one of which is carried and employed by patrol. However, as Pilar is situated at a place where the road conditions are not satisfactory, one set of them is allocated there.

Measuring equipments for power system are allocated to all the stations.

One set of tools is allocated to every office. However, as the tools for engine generator, two sets of them are allocated only to Asuncion station.

2. Spares

One set of spare panels of radio and voice frequency telegraph equipments including power source panel (one panel for one species) is allocated to each terminal station.

As the spare panels necessary for repeater stations are small in number, they are carried from terminal station in case of failure.

As the spare panel for carrier multiplex equipments, one set of channel translating equipments necessary for one group as well as one set of power source panel are allocated to all the terminal stations.

For the purpose of treatment for toll cable failure, 250 m for each of the cables conforming to Table VII-1 is cllocated at necessary stations.

As the countermeasure for loss and breaking, 30% or more of connecting cords, connectors, U links, handsets etc. provided to each office equipment including measuring equipment are allocated at Asuncion.

As the countermeasure for inter-station cable failure 10% or more of total length of installation of communication cables etc. in all stations, excluding power cables and earth wires is allocated at Asuncion. The minimum length of these cables is 10 m.

The consumable goods, such as lamps and fuses are provided to each equipments with quantities required for two years' operation including the period of technical supervision for maintenance.

The consumable parts necessary for the operation of engine-generators are provided to each station with quantities required for two years' operation including the period of technical supervision for maintenance (including the parts for overhaul, if necessary).

XII. TRAINING, ACCEPTANCE TESTS AND SUPERVISION FOR MAINTENANCE

1. Training

At present, ANTELCO, has no personnel capable of maintaining these microwave systems. Therefore, this project has the plan for their training.

(1) Training During The Construction Work

(a) Training at the factory manufacturing the equipments.
The training is planned for 4 personnels during 3 months.

(b) Training during the construction work on the site.
The training is carried out by occupying the construction work.

(2) Training After Operation is Started

As to the training system after operation is started, ANTELCO is responsible for the planning as well as the execution. However, the following equipments necessary for the training are installed by this project. The location of installation is appointed by ANTELCO.

Radio transmitting and receiving equipment	:	one set each
Telephone FM modulator	:	one set
Telephone FM demodulator	:	one set
Remote supervisory and control equipment (for supervising station)	:	one set
Remote supervisory and control equipment (for supervised station)	:	one set
Switching equipment	:	one set
Power equipment (battery charger, batteries)	:	one set
Measuring equipments	:	one set

2. Acceptance Test and Technical Supervision for Maintenance

Acceptance test is carried out at the time of the completion of the installation work (as to a part of equipments, during the process of the installation work). The operation of the system is started when the test is successfully ended.

As it is effective to continue the guidance of maintenance practice and supervision for maintenance by the constructor after the operation is started, this project plans these actions for one year.

The content of the supervision for maintenance is limited to the dispatch of three personels responsible for the guidance of maintenance and the cost of operation and maintenance during this period is excluded.

XIII. SCOPE OF THIS PROJECT

The scope of this project is the part of transmission lines necessary for international as well as domestic toll communication circuits.

The following works are not included in this project. Therefore, they shall be planned independently from this project.

(1) Inter-office work of telephone offices

(a) Of the entrance facilities, the work from MDF of telephone office to the switch board side.

(b) Work of switch board and signalling equipments.

(c) Work of terminal equipments of telegraph and TELEX.

(d) Work of accessory equipments to above items.

(2) Construction of transmission line from radio station to broadcasting TV station.

(3) Entrance work between radio station and Caacupe, Villarrica, as well as Encarnacion.

(4) Purchase of sites of radio stations.

XIV. PREPARATION OF SPECIFICATIONS

1. Specifications for the Section Concerning International Connection

The specifications are unable to be prepared at the time when this detailed design is prepared because arrangement between countries concerned is not yet concluded. Therefore, the following section is not included in the specifications prepared at this time. They will be prepared by ANTELCO independently at the time when the arrangement between countries concerned will be concluded.

(1) Radio equipments at Paso de Patria to the direction of Resistencia.

(2) Radio equipments at Pto. Pte. Stroessner to the direction of Foz do Iguacu.

(3) Carrier multiplex equipments at Pilar to the direction of Resistencia (Super group translating equipment and its accessories.)

(4) Carrier multiplex equipment at Pto. Pte. Stroessner to the direction of Foz do Iguacu. (ibid.)

(5) Carrier multiplex equipments for international circuits at Asuncion (group translating equipment, channel translating equipment, and signaling equipment), broadcasting relay circuit equipment, voice frequency telegraph equipments and their accessories.

By the way, the determination of the alignment of base-band frequencies of order wires between terminal stations at Pilar and Resistencia is required to be in conformity with the base-band frequency alignment of the remote supervisory and control signal, switching signal, and order wires in this microwave system.

2. Specifications of Space Diversity System

As to the sections San Juan Bautista, Estero Camba, Pilar, Paso de Patria and Resistencia, it is necessary to investigate whether the adoption of space diversity system is required or not on the basis of data obtained after this microwave system is operated. When it is determined that the adoption of space diversity system is necessary, the specifications will be prepared by

ANTELCO as an additional work for this project. In this case, the "individual control space diversity system due to inphase linear adder" is preferable.

3. Specifications of Civil Engineering, Building, Commercial Power Receiving Lines and Vehicle for Maintenance

The specifications necessary for this project are prepared by the technical mission. However, as to the scope mentioned in above items 1 and 2 as well as the following scope, the specification shall be prepared by ANTELCO.

(1) Felling, levelling and encircling fences of radio station.

(2) Construction of building (including fuel tank, illumination in the building and outlets).

(3) Earthing.

(4) Foundation of tower.

(5) Receiving lines of commercial power.

(6) Wiring for power source of the voice frequency telegraph equipments.

(7) Construction of new roads.

(8) Fire protective belt.

(9) Vehicle for maintenance.

When specifications for items (1), (2), (3), (7) and (8) are prepared, Chapter X "Site, office building, and road" shall be referred to.

As to item (4) foundation of tower, specifications shall be prepared on the basis of the design drawings of tower foundation to be presented from the constructor of the equipments.

As to item (5) and (6), specifications conforming to the standards of ANDE shall be prepared on the basis of required capacity of power to be presented from the constructor of the equipments. The arrestor on the commercial power receiving lines and the circuit breakers at radio stations are included in these specifications.

XV. SCHEDULE OF THE CONSTRUCTION WORK

The schedule of the construction work is shown in Fig. XV-1.

CONCLUSION

In order to construct this microwave system, a great deal of cooperation and arrangement between various sections are required in the future. Also, in order to operate effectively these microwave system as the international circuits and domestic trunk lines, it is necessary to promote the determination of the concrete method of international connection. Also, it is required to promote work of reinvestigating the construction plan of switching equipments for the purpose of preparing and executing a plan in conformity with this project of microwave circuits and other concerning works.

We are expecting that the above requirements are promoted smoothly and these microwave circuits will render an important contribution toward the improvement of the economy and the culture of the Republic of Paraguay.

We express our hearty thanks to the Government of Paraguay, President and personnel of ANTELCO as well as Japanese Embassy and those concerned ho have cooperated with our survey on the field.

ANNEX

Table II-1 Number of International Circuits (1970)

	Telegraph	TELEX	Telephone
Buenos Aires	1	8	3
Lapaz	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

Table II-2 Number of Frontier Circuits (1970)

	Telephone
Asuncion – Clorinda	3
Asuncion – Formosa	1
Asuncion – Resistencia	1
Encarnacion – Posadas	2
Pto. Pte. Stroessner – Foz do Iguacu	2
Alberdi – Formosa	1
Pilar – Bermejo	1
Total	11

Table II-3 Estimated Traffic and Number of Circuits for International Communication

	Service	1975		1980		1990	
		Traffic	Circuits	Traffic	Circuits	Traffic	Circuits
Argentina	Tg	102.2	1	112.8	1	138	2
	Tx	42.8	8	79.0	9	305	25
	Tp	762.2	19	1,532.8	34	6,200	119
	L. Tg		7		8		12
	L. Tp		2		3		4
Uruguay	Tg	12.3	1	13.6	1	17	1
	Tx			7.0	2	29	5
	Tp	50.9	3	102.4	5	414	12
	L. Tg		1		2		4
	L. Tp						
Brazil	Tg	16.7	1	18.4	1	23	1
	Tx	7.2	3	14.5	4	59	8
	Tp	68.4	4	137.6	6	556	15
	L. Tg		4		5		7
	L. Tp		3		3		4

Note: Tg: International Telegraph, Traffic Unit: 1,000 messages
Tx: International TELEX, Traffic Unit: 1,000 times
Tp: International Telephone, Traffic Unit: 1,000 minutes
L. Tg: Leased International Telegraph
L. Tp: Leased International Telephone

Table II-4 Estimated Number of Circuits Between Argentina and Brazil

	1970	1975	1980	1990
Number of Circuits (Converted into Telephone Channel)	7	15	30	100

Table II-5 Estimated Traffic and Number of Circuits for Frontier Communication via Microwave System (Telephone)

	1975		1980		1990	
	Traffic	Circuits	Traffic	Circuits	Traffic	Circuits
Asuncion-Resistencia	88.2	4	112.5	4	183	5
Asuncion-Foz do Iguacu	25.4	2	32.4	2	53	3

Note: Traffic Unit 1,000 minutes

Table II-6 Estimated Number of International Circuits via Microwave System

		Telephone			Telegraph		TELEX	
		1975	1980	1990	1980	1990	1980	1990
Direction of Argentina	International (Argentina)	16	28	93	9	14	6	19
	International (Uruguay)	3	5	12	3	5	2	5
	Through (Argentina - Brazil)	4	8	25				
	Frontier (Asuncion - Resistencia)	4	4	5				
	Total	27	45	135	12	19	8	24
Direction of Brazil	International (Brazil)	36	38	48	6	8	4	8
	Through (Argentina - Brazil)	4	8	25				
	Frontier (Asuncion - Foz do Iguacu)	2	2	3				
	Total	42	48	76	6	8	4	8

Note: Number of circuits is modified in accordance with the agreement between ANTELCO and ENBRATEL.

Table III-1 Present and Estimated Number of Telephone Subscribers

District	1970	1975	1980	1990
Asuncion (City Area)	16,136	41,800	45,000	51,800
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	280	480	980
Pto. Pte. Stroessner		420	460	535
Concepcion	275	460	650	1,020
Paraguari	107	330	460	710
San Juan Bautista	75	350	470	720
Puerto Rosario	22	340	440	640
Pilar	103	340	440	630
P. J. Caballero	–	430	640	1,060
Ype Jhu	–	25	40	70
Total	18,299	47,555	52,740	63,665

Table III-2 Estimated Number of Toll Circuits

Section	Telephone			Telegraph		TELEX	
	1975	1980	1990	1980	1990	1980	1990
Asuncion - Paraguari	37	43	54	1	1	0	2
Asuncion - Caacupe	75	81	104	1	1	1	3
Asuncion - S. J. Bautista	36	40	47	1	1	1	3
Asuncion - Encarnacion	149	160	183	1	1	3	6
Asuncion - Pilar	37	40	47	1	1	0	6
Subtotal	334	364	435	5	5	5	20
Asuncion - Cnel. Oviedo	37	43	74	1	1	1	2
Asuncion - Villarrica	90	99	114	1	1	2	6
Asuncion - P. P. Stroessner	40	43	50	1	1	1	2
Subtotal	167	185	238	3	3	4	10

Table IV-1 (1) Radio-Channel Frequency Arrangement

Frequency (MHz)		Channel No.	Asuncion		Paraguari		Valle Apua		Caapucu		S. J. Bautista		Estero Camba		Pilar		Paso de Patria
H or V	V or H																
6440		1	TP-A														
	6460	2															
6480		3															
	6500	4															
6520		5	TV														
	6540	6															
6560		7															
	6580	8															
6600		9	TP-B														
	6620	10															
6640		11															
	6660	12															
6680		13	SP														
	6700	14															
6720		15															
	6740	16															
6780		1'	TP-A														
	6800	2'															
6820		3'															
	6840	4'															
6860		5'	TV														
	6880	6'															
6900		7'															
	6920	8'															
6940		9'	TP-B														
	6960	10'															
6980		11'															
	7000	12'															
7020		13'	SP														
	7040	14'															
7060		15'															
	7080	16'															

Note: H or V (V or H) stands for Horizontal polarized wave or Vertical polarized wave, respectively.

Table IV-1 (2) Radio-Channel Frequency Arrangement

Frequency (MHz)		Channel No.	Asuncion	Paraguari	Cnel Oviedo	Caaguazu	Guyraungua	Coloner Yguazu	Pto. Pte. Stroessner
H or V	V or H								
6440		1	TP-A						
	6460	2							
6480		3							
	6500	4							
6520		5	TV						
	6540	6							
6560		7							
	6580	8							
6600		9	TP-B						
	6620	10							
6640		11							
	6660	12							
6680		13	SP						
	6700	14							
6720		15							
	6740	16							
6780		1'	TP-A						
	6800	2'							
6820		3'							
	6840	4'							
6860		5'	TV						
	6880	6'							
6900		7'							
	6920	8'							
6940		9'	TP-B						
	6960	10'							
6980		11'							
	7000	12'							
7020		13'	SP						
	7040	14'							
7060		15'							
	7080	16'							

Note: H or V (V or H) stands for Horizontal polarized wave or Vertical polarized wave, respectively.

Table IV-2 Boundary Condition for Calculation

Equipment	Item	Characteristic
Repeater	Noise Figure	7 dB
	Transmitting Power	26.5 dB (450 mW)
	Distortion Noise	60 pW (1TR)
Modulator and Demodulator	Thermal Noise	40 pW (1MOD. DEM)
	Distortion Noise	60 pW (1MOD. DEM)
Palabolic Antenna		
diameter 4mø	Gain	45.6 dB
diameter 3mø	Gain	44.0 dB
Feeder		
Circular W/G	Loss	0.011 dB/m
Rectangular W/G	Loss	0.06 dB/m
	Echo Noise	20 pW (1 Feeder)
Branching Circuit	Loss	3.7 dB (1TR)

Note: Feeder length is estimated as following;

Vertical Part; Antenna Height

Horizontal Part; 20m

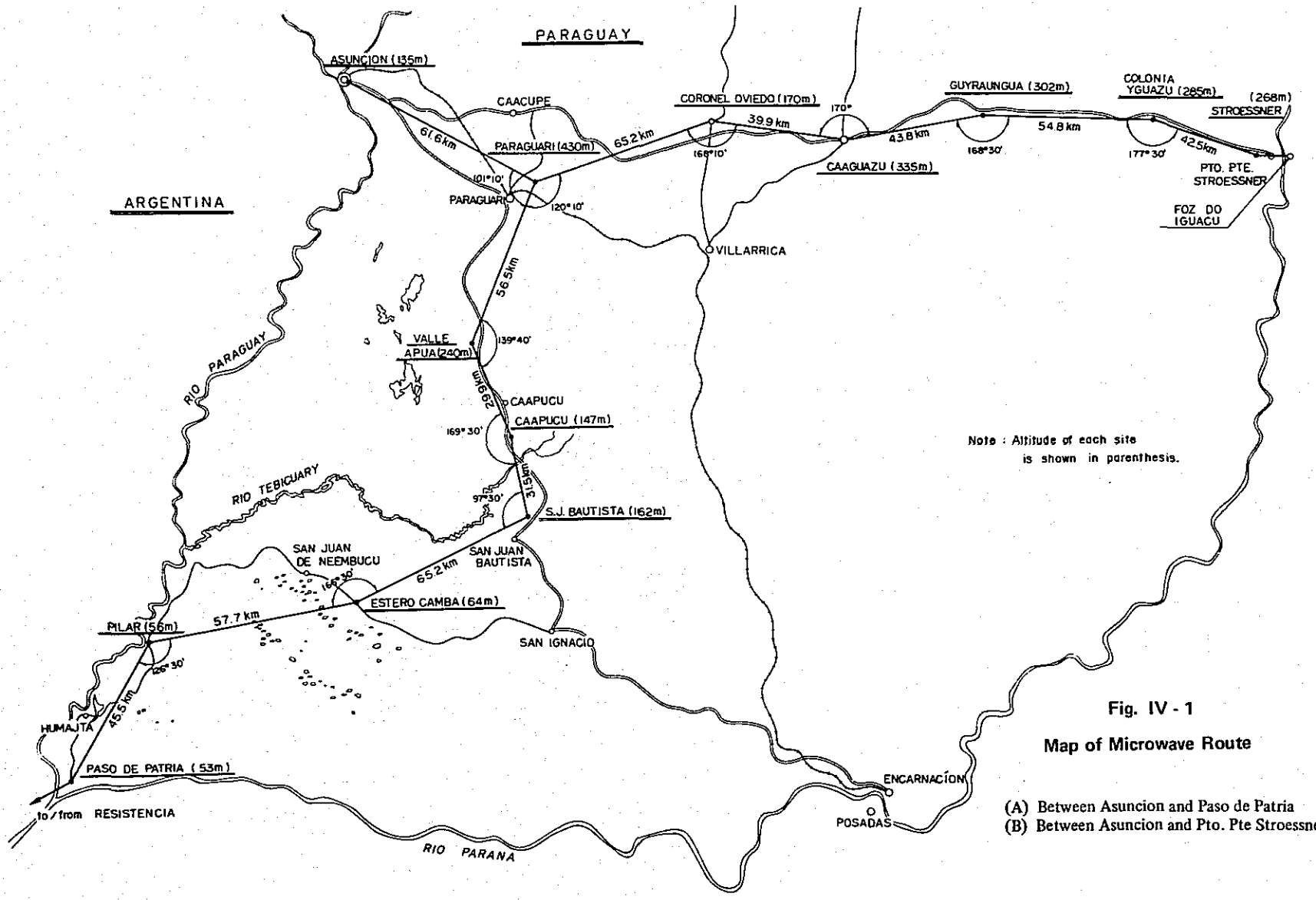


Fig. IV - 1

Map of Microwave Route

(A) Between Asuncion and Paso de Patria
(B) Between Asuncion and Pto. Pte Stroessner

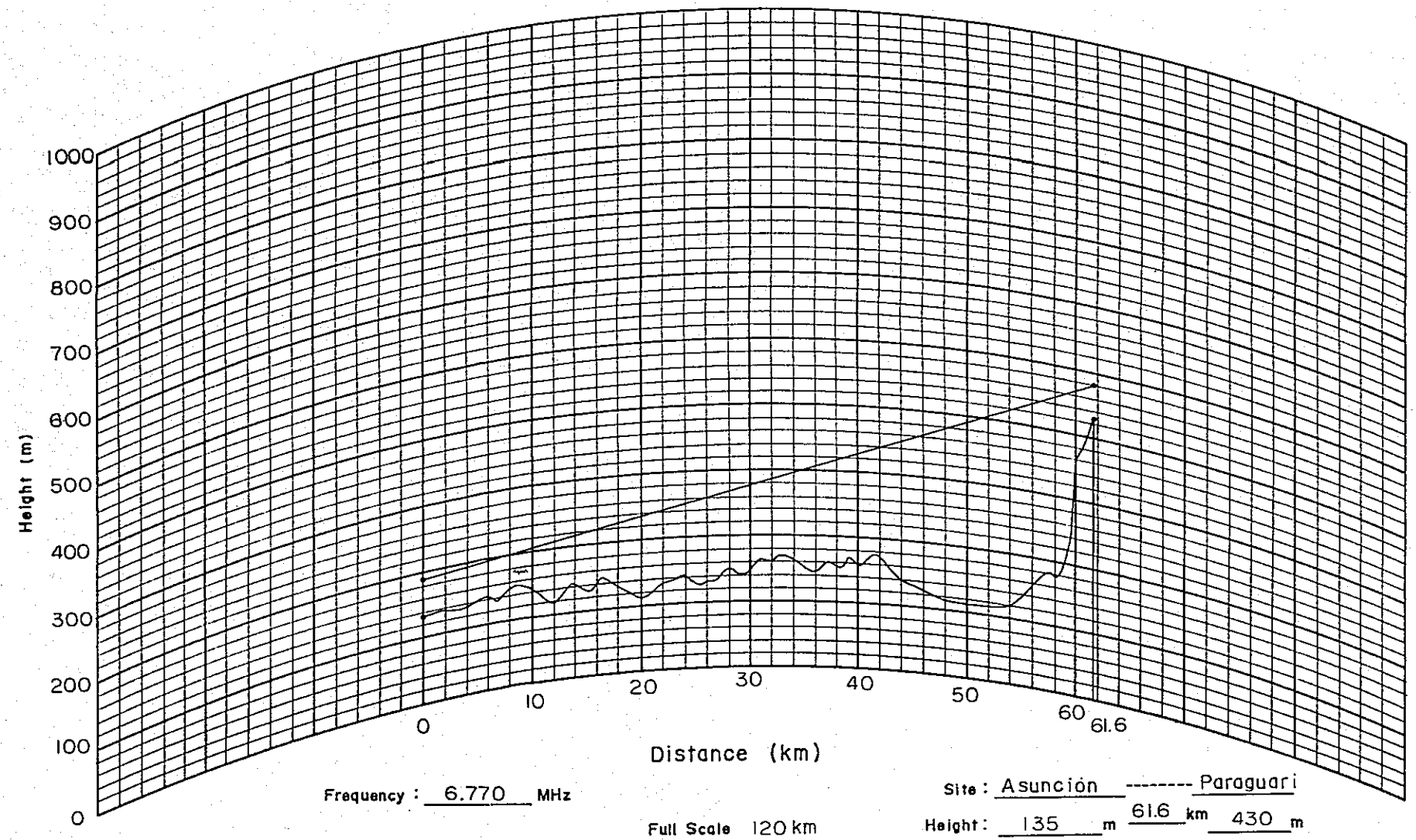
Table IV-3 (1) List of Propagation Characteristics (Southward Route)

Item		Site	Asuncion	Paraguari	Valle Apua	Caapucu	S. J. Bautista	Estero Camba	Pilar	Paso de Patria
Antenna Altitude above the Sea Lebel		m	190 480	465 275	275 157	157 182	142 174	179 171	156 133	
Propagation Path Length		km	61.6	56.5	29.9	31.5	65.2	57.7	45.5	
Ridge Condition	Distance from Site	km	9.0	2.5	12.0	25.0	32.6	28.8	22.7	
	Altitude above the Sea Level	m	177.0	432.0	186.0	140.0	84.0	84.0	76.0	
	Clearance at K = 4/3	m	27.6	16.7	29.0	27.3	61.6	42.1	38.1	
	1st Flesnel's Radius	m	18.4	10.3	17.8	15.1	26.8	25.2	22.4	
Clearance Margin at K = 4/3		m	9.2	6.4	11.2	12.2	34.8	16.9	15.7	
Reflection Point	Distance from Site	km	Reflected Wave is Negligible				30.0	29.6	26.2	
	Altitude above the Sea	m					64.0	64.0	56.0	
	Classification of Condition						Plain (including Forests and Swamps)			
	Reflection Loss	dB					10	10	10	
Total Loss of Reflected Wave		dB					10	10	10	
Path Difference		m					0.19	0.1	0.2	
Delay Time		nS					0.63	0.4	0.6	
Propagation Distortion Noise		pW					Less than 1	Less than 1	Less than 1	

Table IV-3 (2) List of Propagation Characteristics (Eastward Route)

Item		Site		Asuncion		Paraguari		Cnel Oviedo		Caaguazu		Guyra-ungua		Colonia-Yguazu		P. P. Storessner	
Antenna Altitude above the Sea Level			m	190	480	455	190	240	415	400	372	382	395	395	320		
Propagation Path Length			km	61.6		65.2		39.9		43.8		54.8		42.5			
Ridge Condition	Distance from Site		km	9.0		61.0		13.5		7.5		26.0		29.0			
	Altitude above the Sea Level		m	177.0		170.0		251.0		353.0		305.0		288.0			
	Clearance at K = 4/3		m	27.6		22.0		27.2		26.2		38.7		32.8			
	1st Flesnel's Radius		m	18.4		13.2		19.9		16.6		24.6		20.2			
Clearance Margin at K = 4/3			m	9.2		8.8		7.3		9.6		14.1		12.6			
Reflection Point	Distance from Site		km														
	Altitude above the Sea		m														
	Classification of Condition																
	Reflection Loss		dB	Reflected Wave is Negligible													
Total Loss of Reflected Wave			dB														
Path Difference			m														
Delay Time			nS														
Propagation Distortion Noise			pW														

Fig. IV - 2 - (1) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

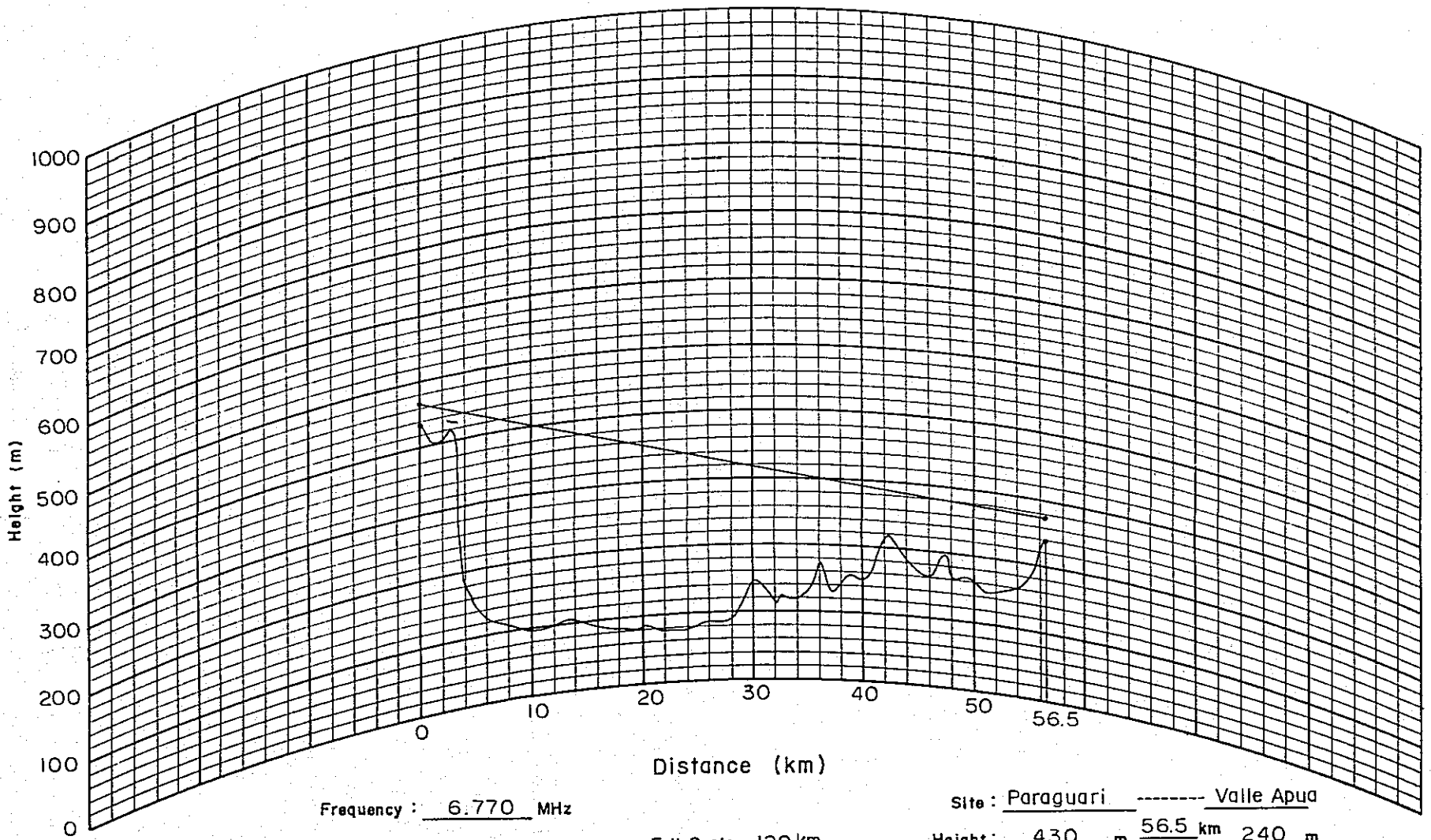
Full Scale 120 km

Site : Asunción -------- Paraguari

Height : 135 m 61.6 km 430 m

Antenna Height : 55 m 50 m

Fig. IV - 2 - (2) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

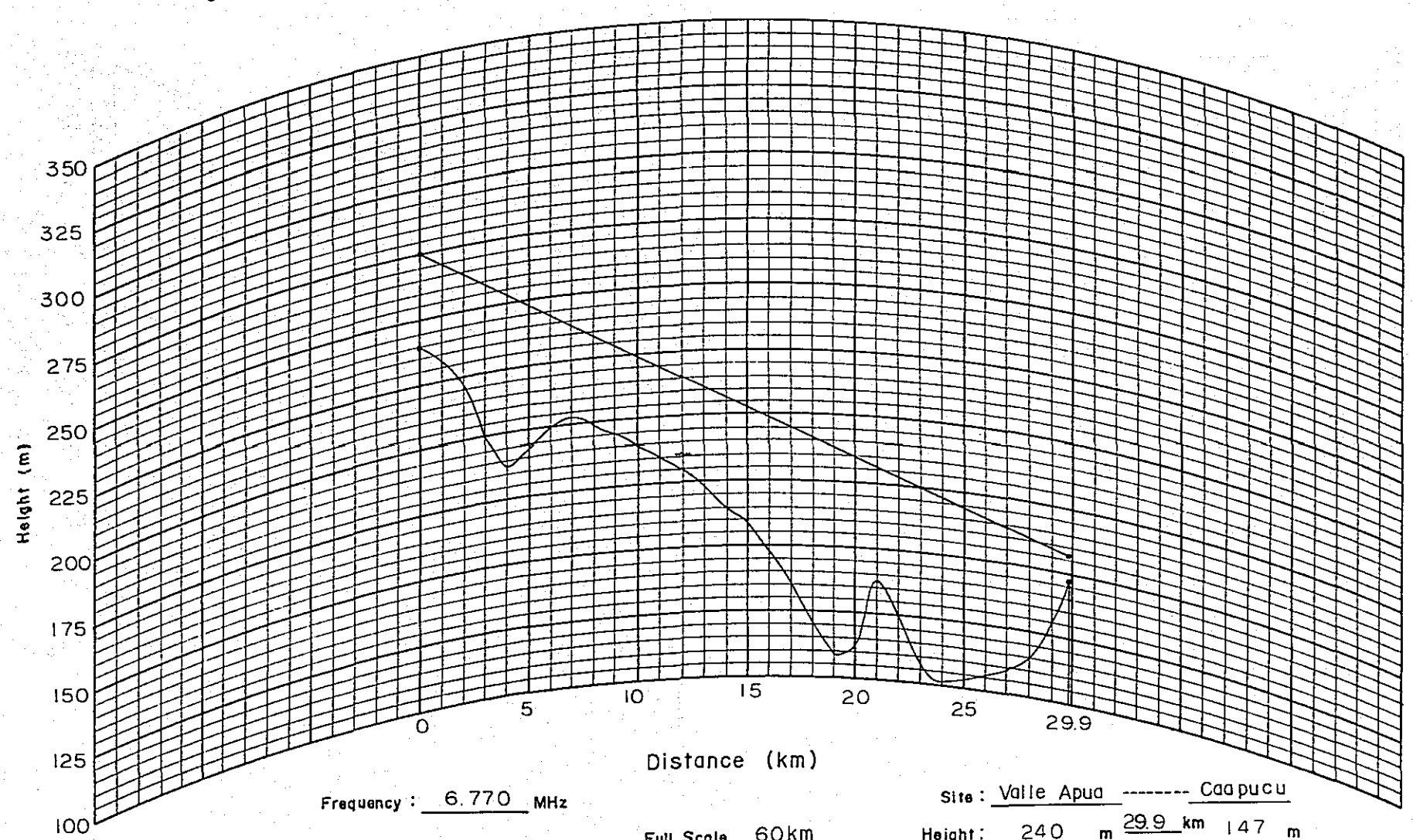
Full Scale 120 km

Site : Paraguari -------- Valle Apua

Height : 430 m 56.5 km 240 m

Antenna Height : 35 m 35 m

Fig. IV - 2 - (3) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

Full Scale 60km

Site : Valle Apua -------- Caapucu

Height : 240 m 29.9 km 147 m

Antenna Height : 35 m 10 m

Fig. IV - 2 - (4) PATH PROFILE (K=4/3)

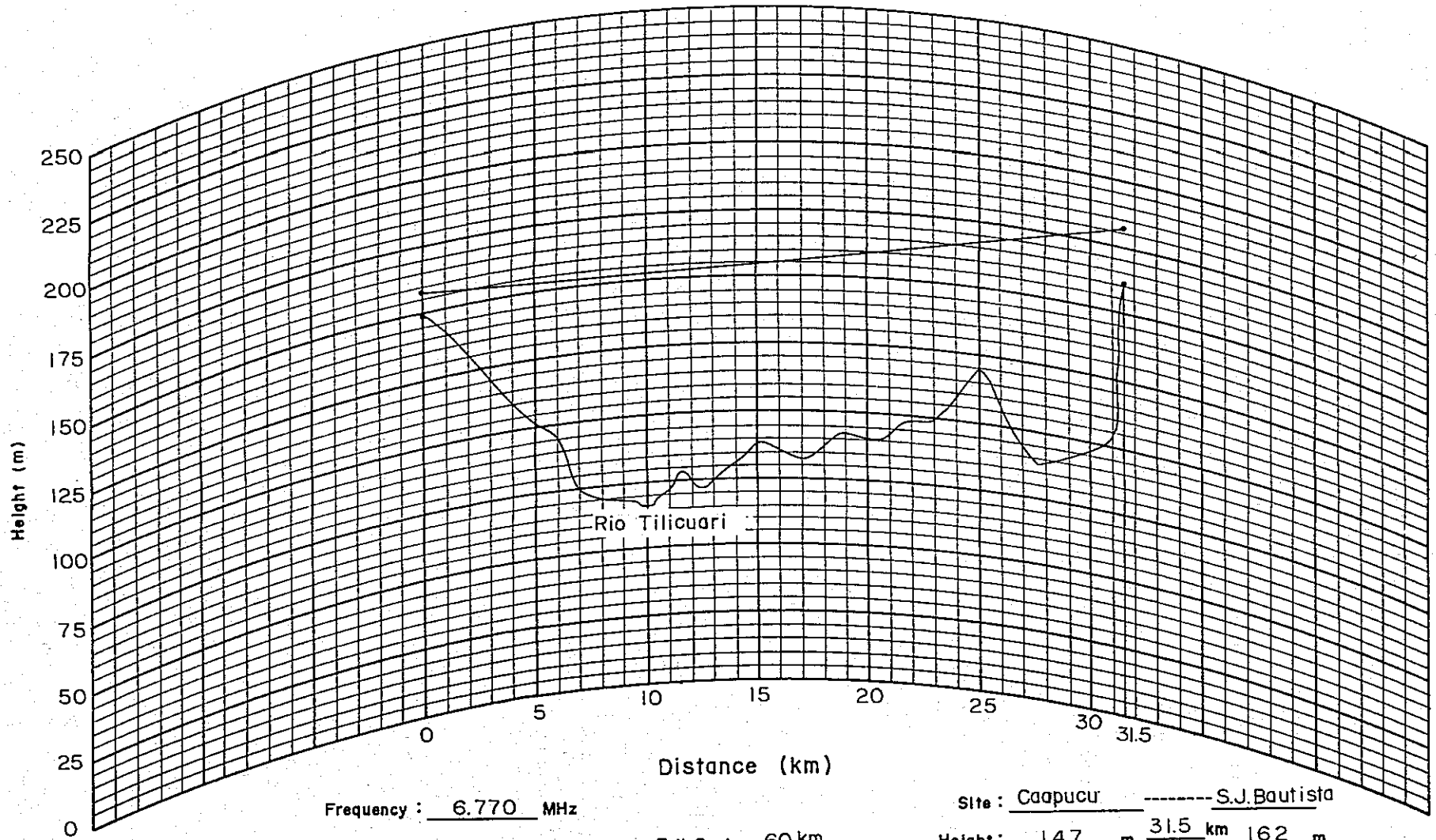
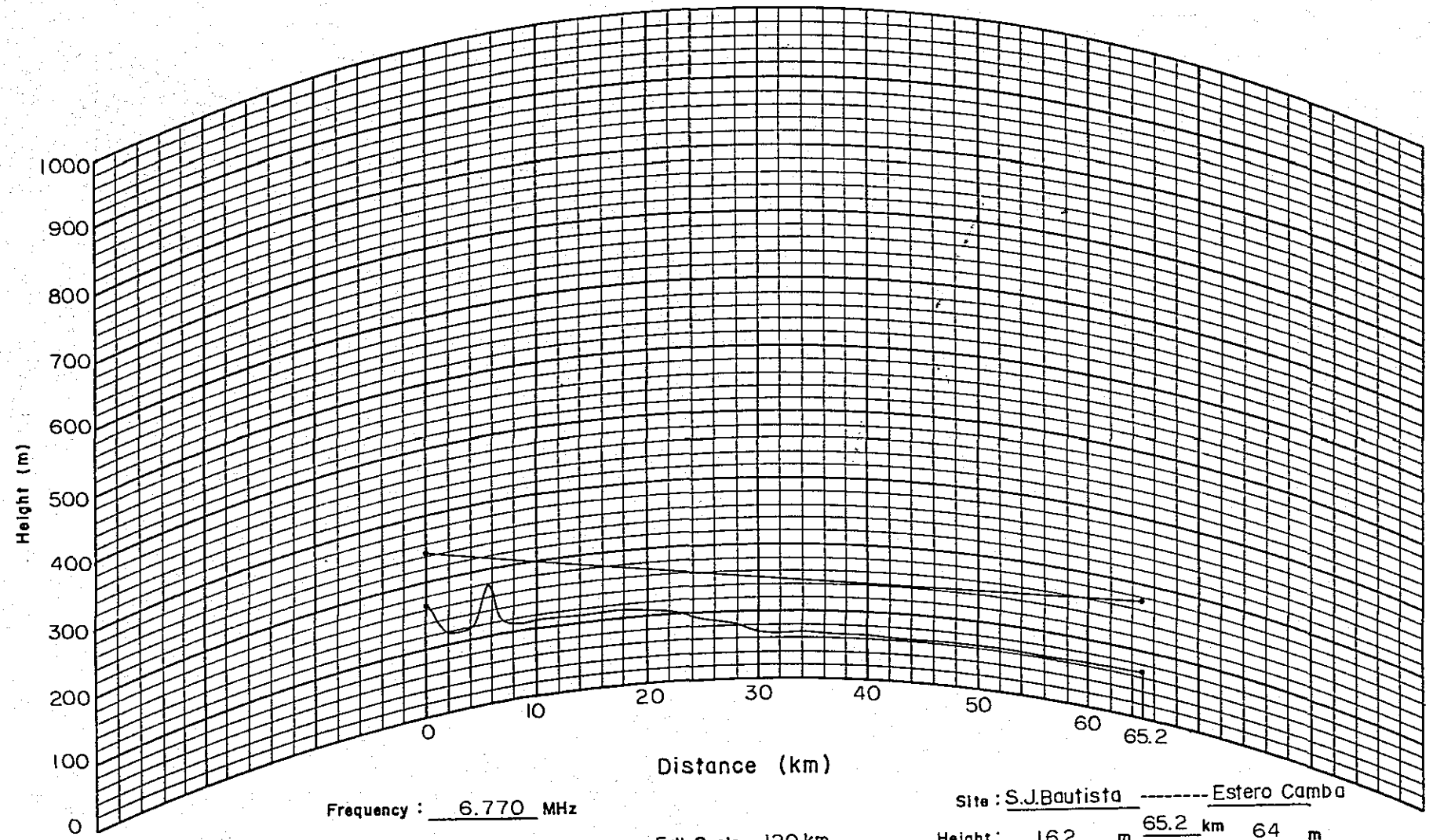


Fig. IV - 2 - (5) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

Full Scale 120 km

Site : S.J.Bautista -------- Estero Camba

Height : 162 m 65.2 km 64 m

Antenna Height : 80 m 110 m

Fig. IV - 2 - (6) PATH PROFILE (K=4/3)

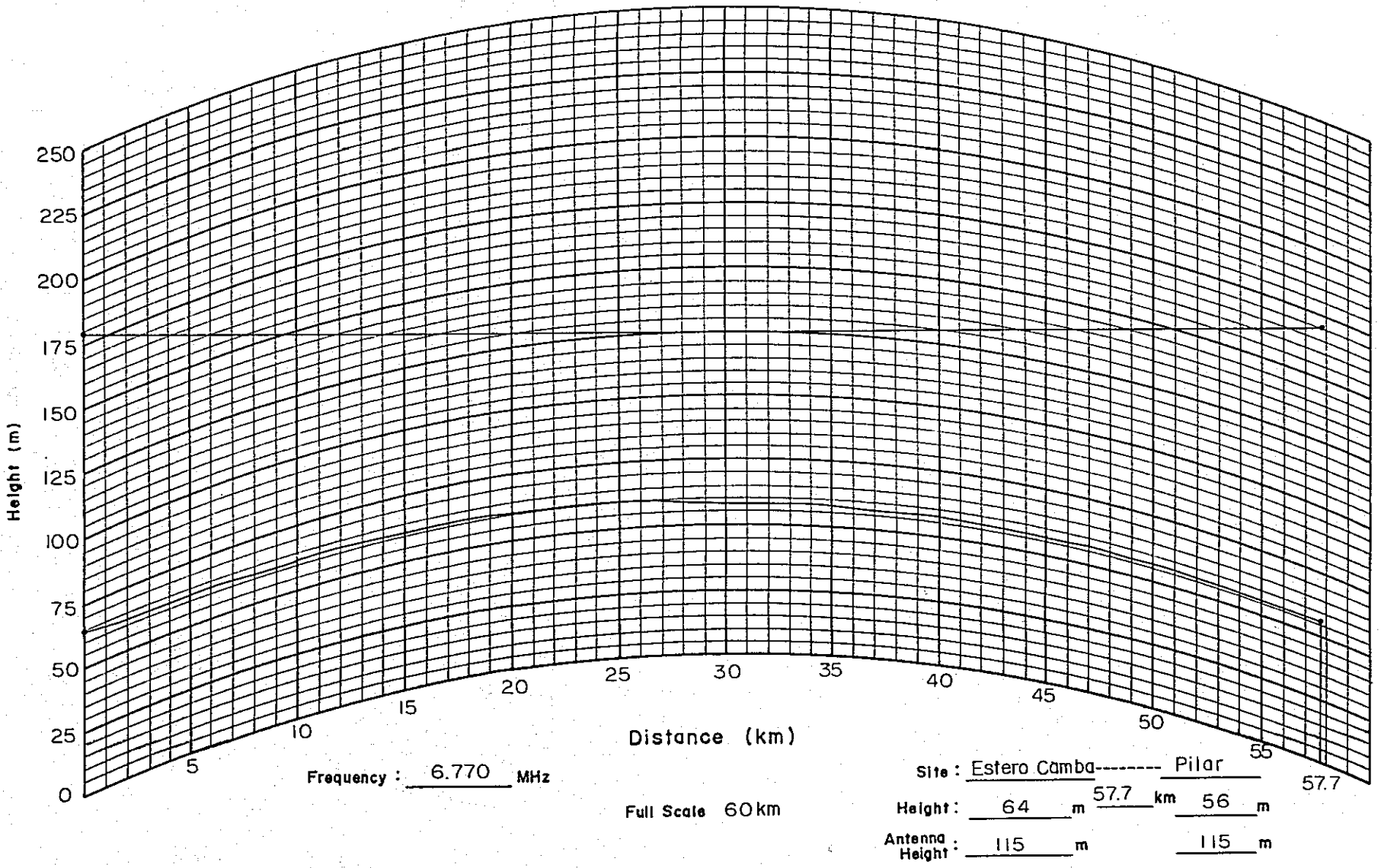


Fig. IV - 2 - (7) PATH PROFILE (K=4/3)

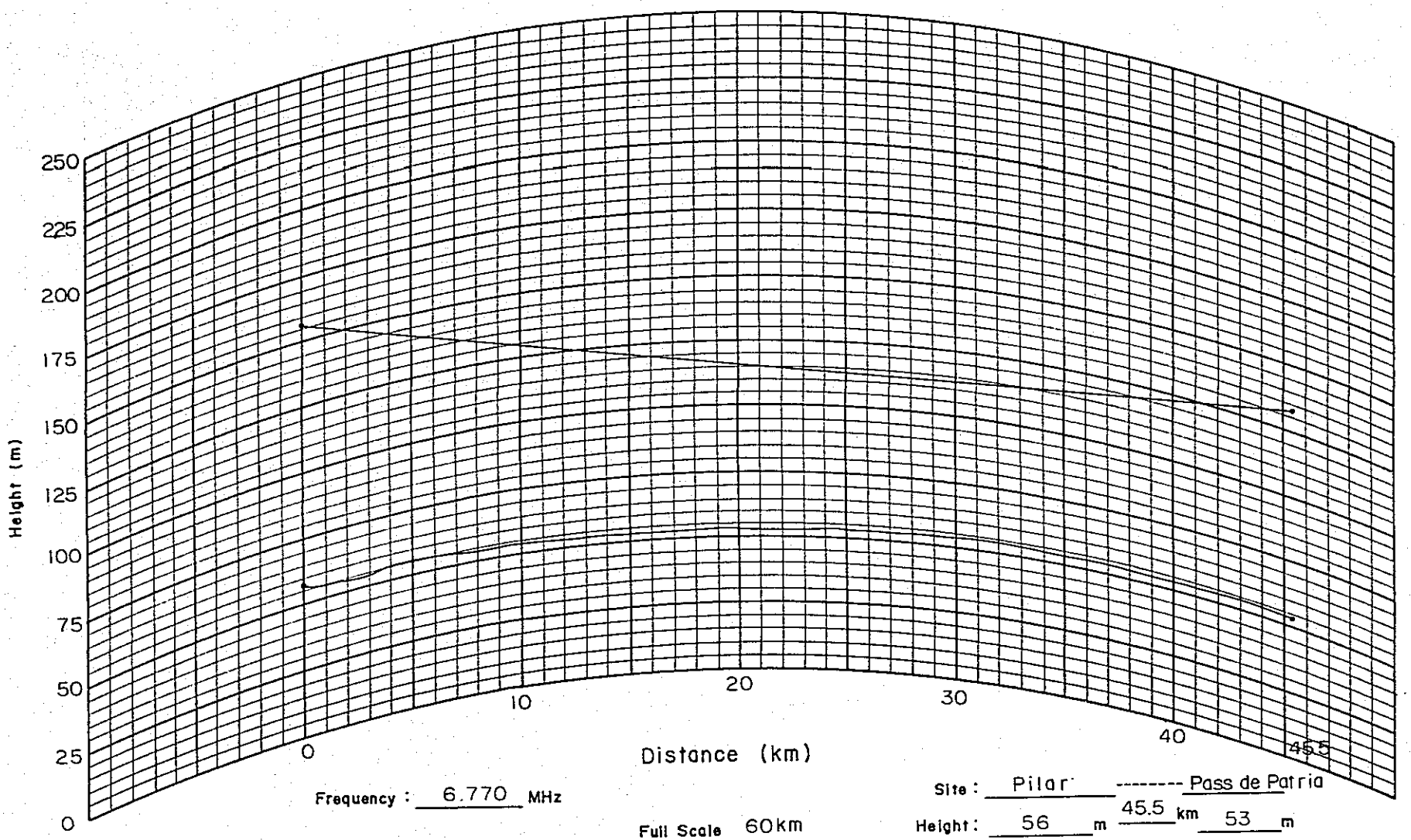
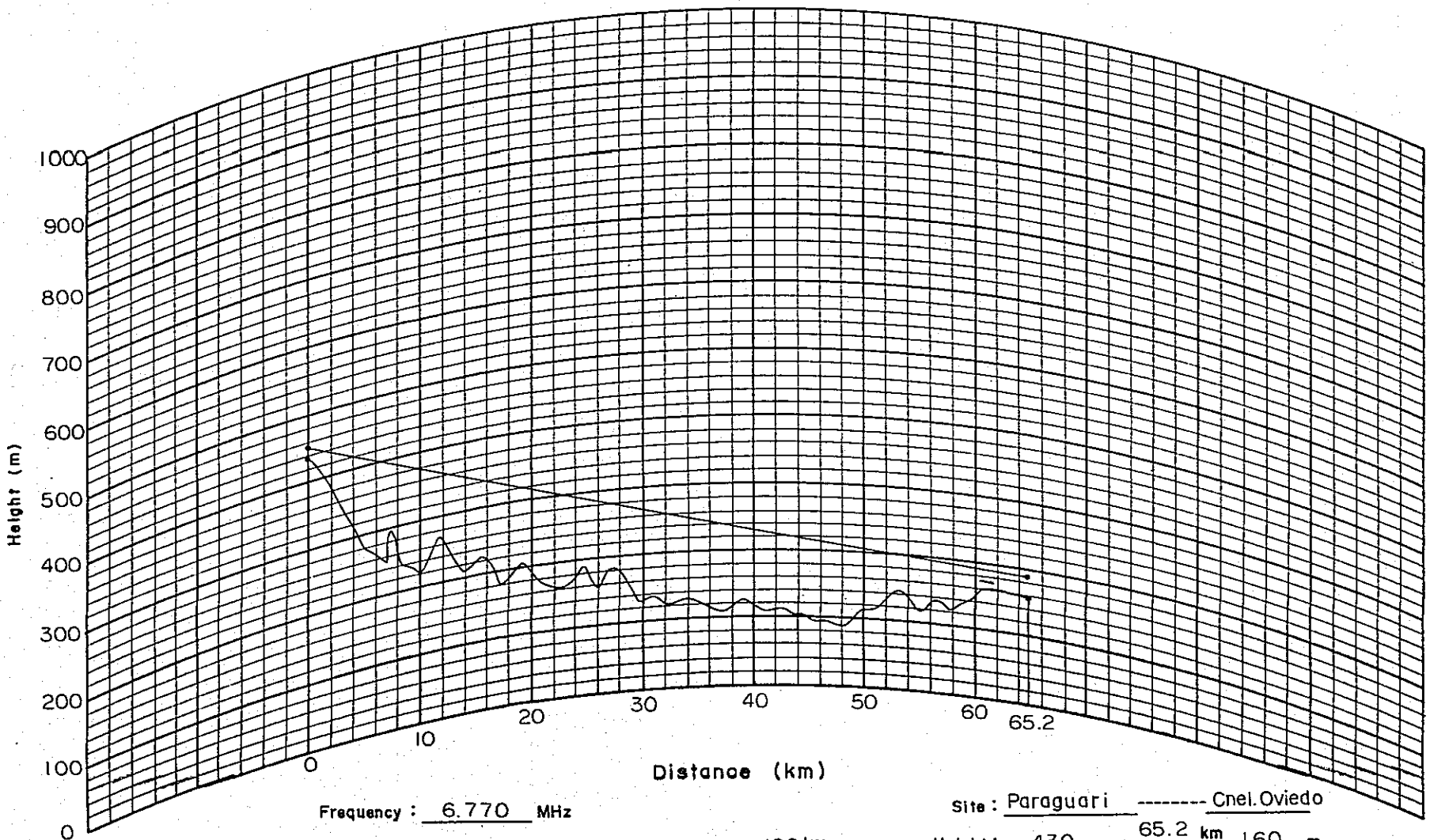


Fig. IV - 2 - (8) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

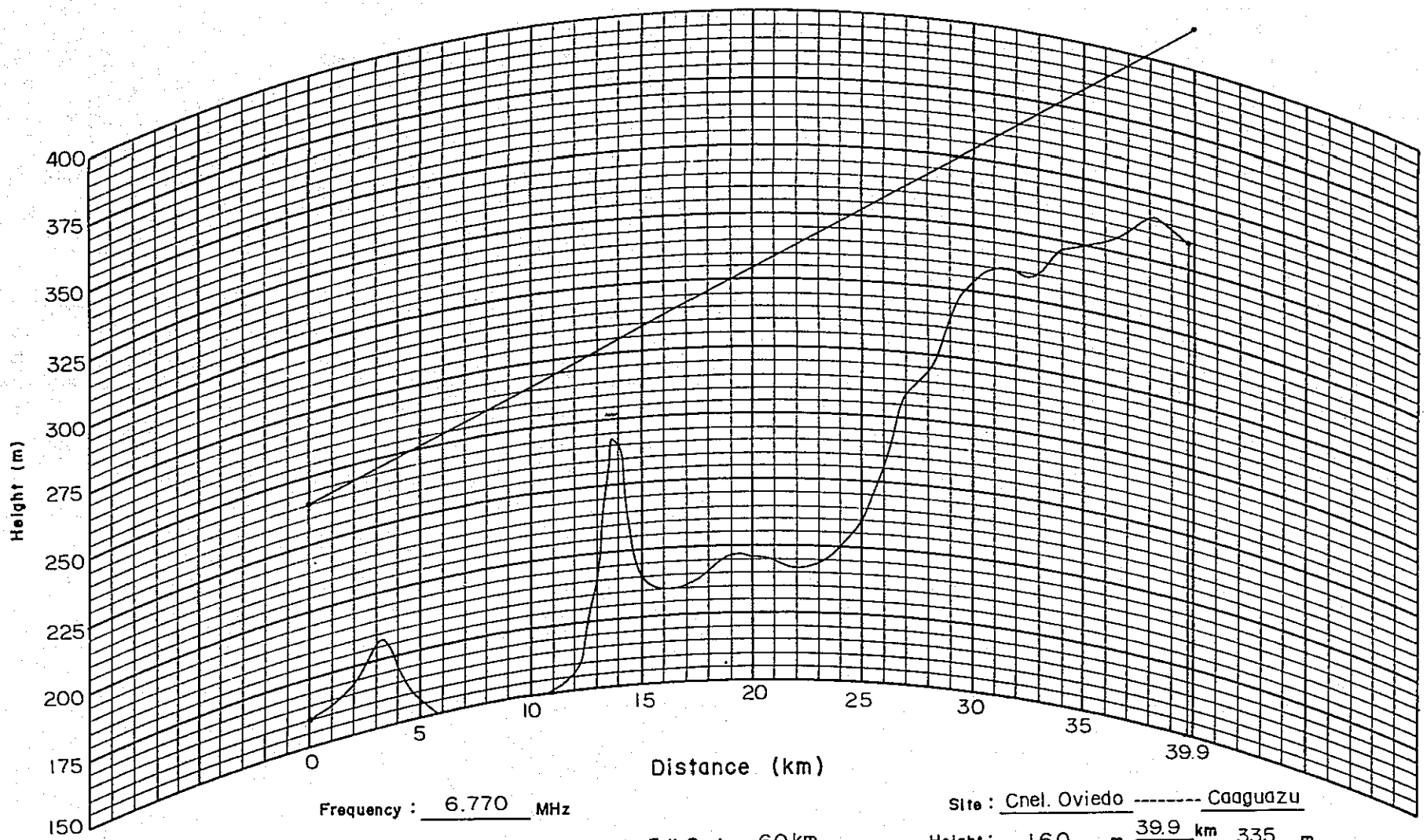
Full Scale 120 km

Site : Paraguari -------- Cnel. Oviedo

Height : 430 m 65.2 km 160 m

Antenna Height : 25 m 30 m

Fig. IV - 2 - (9) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

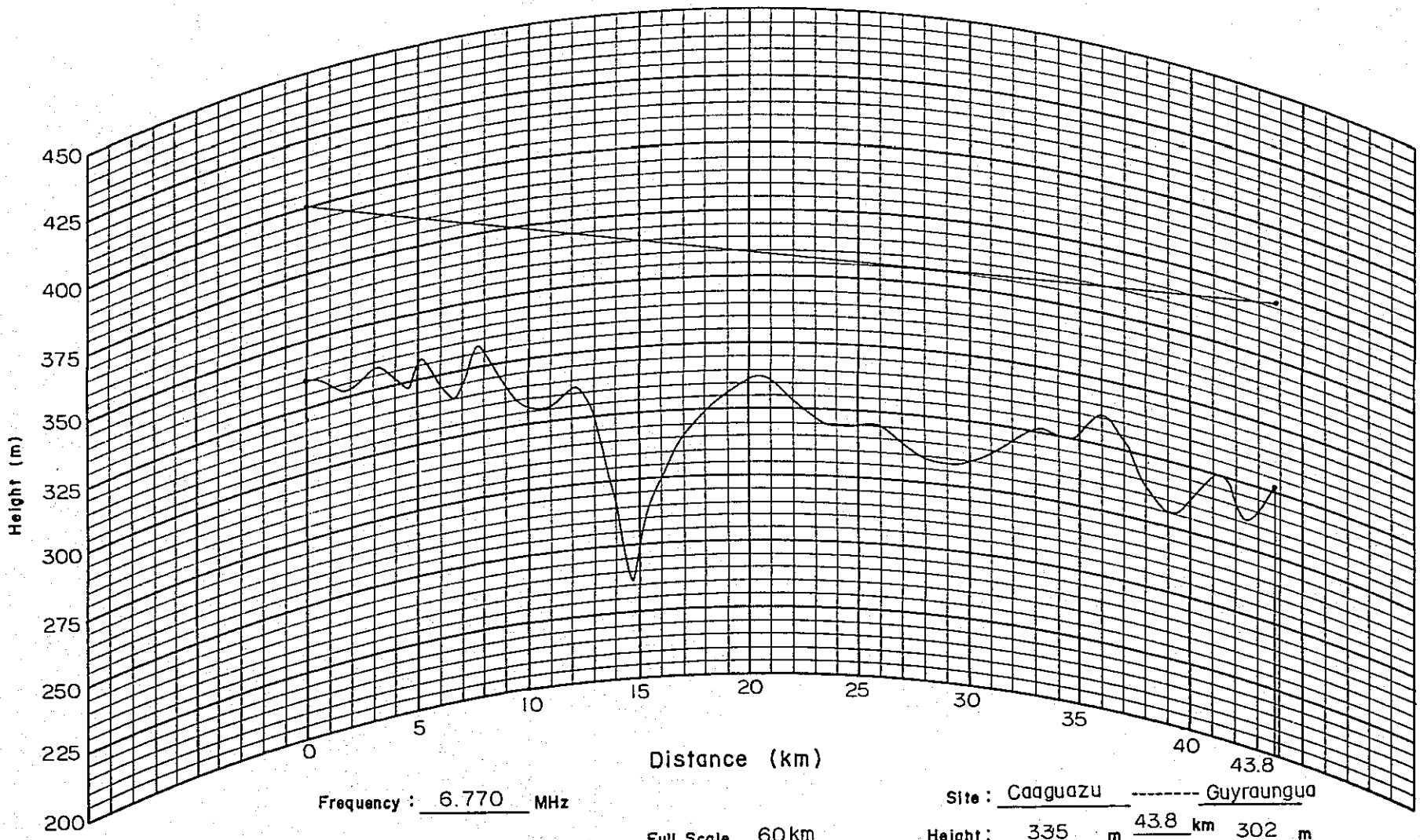
Full Scale 60 km

Site : Cnel. Oviedo -------- Caaguazu

Height : 160 m 39.9 km 335 m

Antenna Height : 80 m 80 m

Fig. IV-2-(10) PATH PROFILE (K=4/3)



Frequency : 6.770 MHz

Full Scale 60km

Site : Caaguazu -------- Guyraungua

Height : 335 m 43.8 km 302 m

Antenna Height : 65 m 70 m

Fig. IV-2-(11) PATH PROFILE (K=4/3)

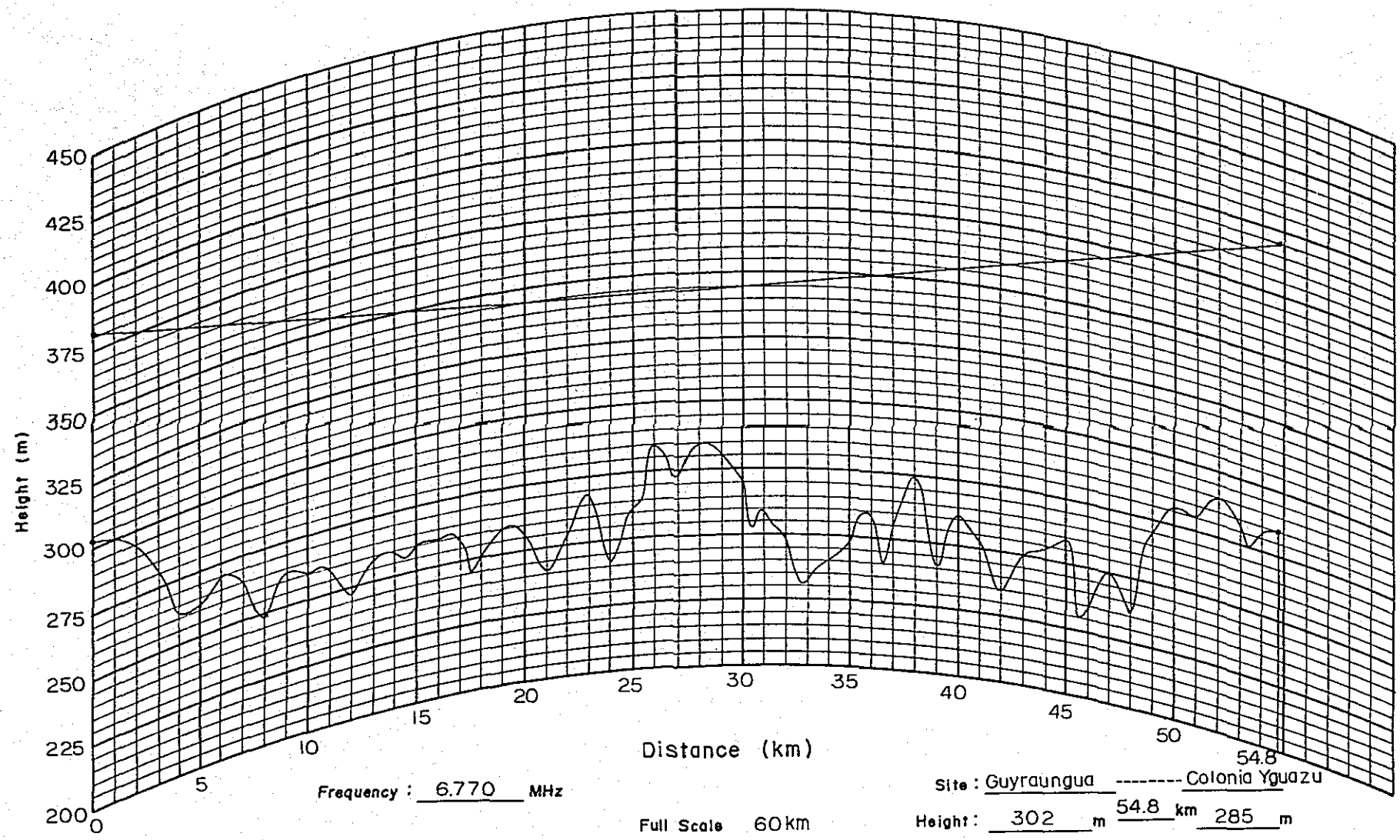
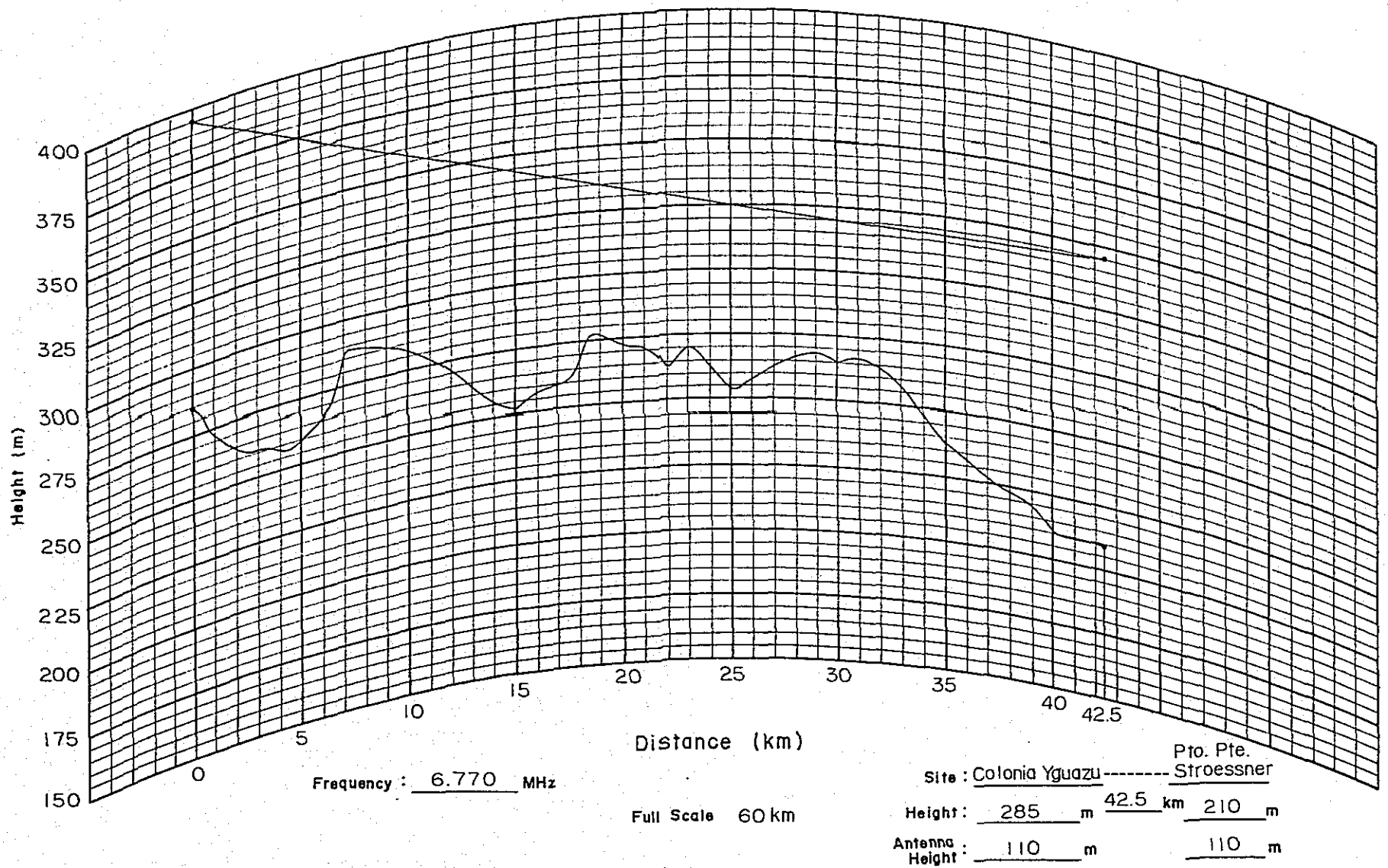


Fig. IV - 2 - (12) PATH PROFILE (K=4/3)



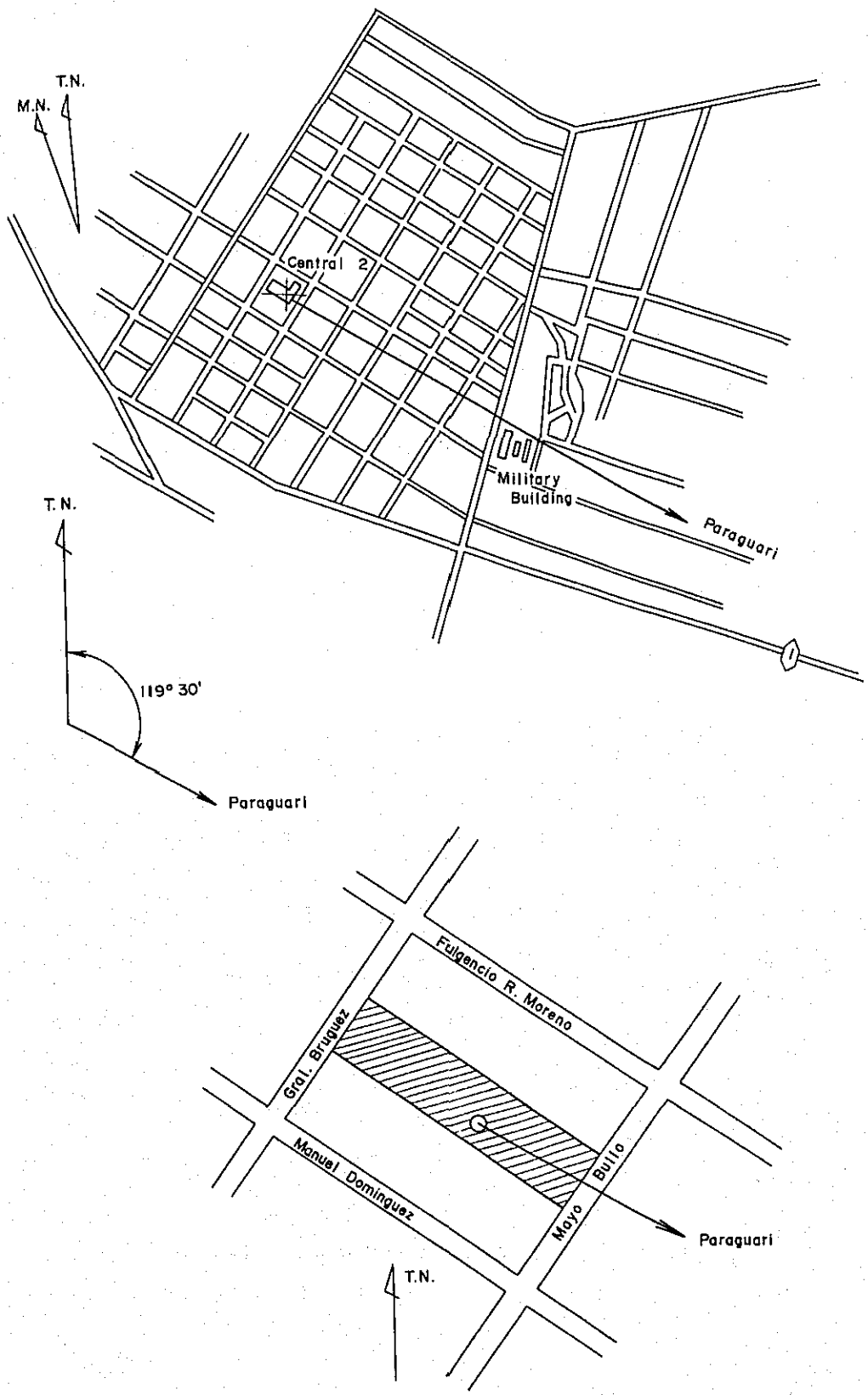


Fig. IV - 3 - (1) Guide Map of the Site Asuncion (Central 2.)

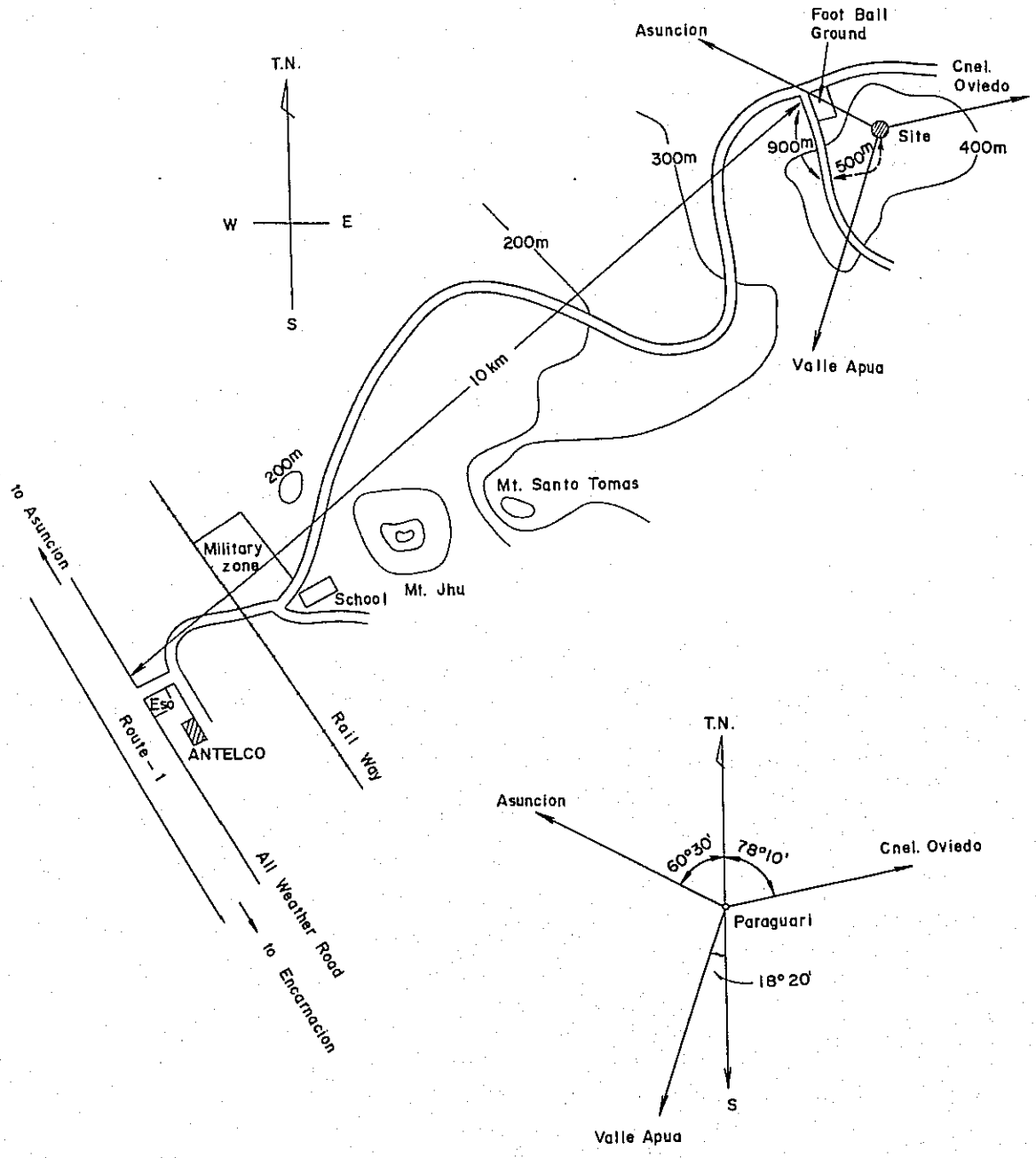


Fig. IV - 3 - (2) Guide Map of the Site Paraguari

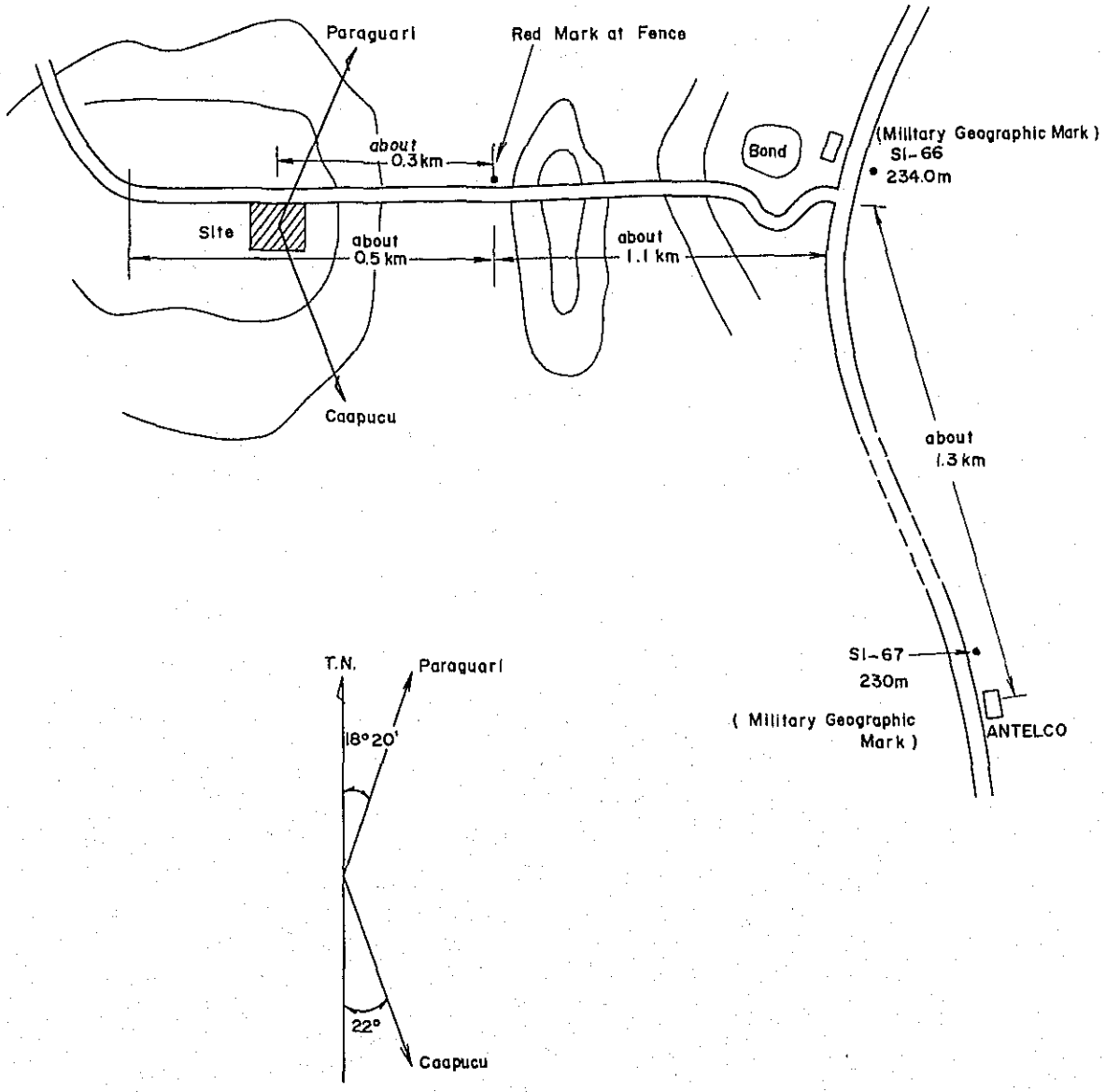
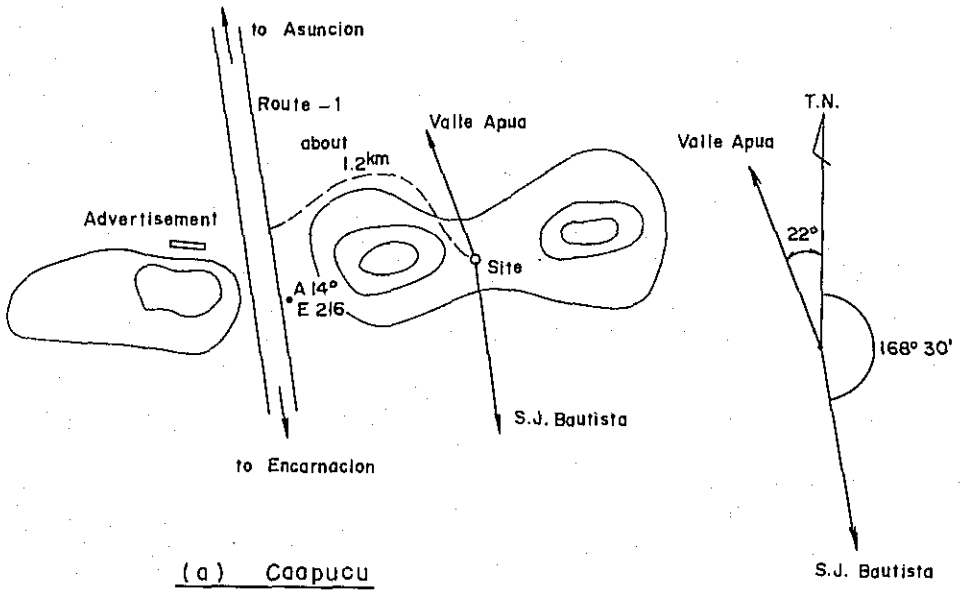
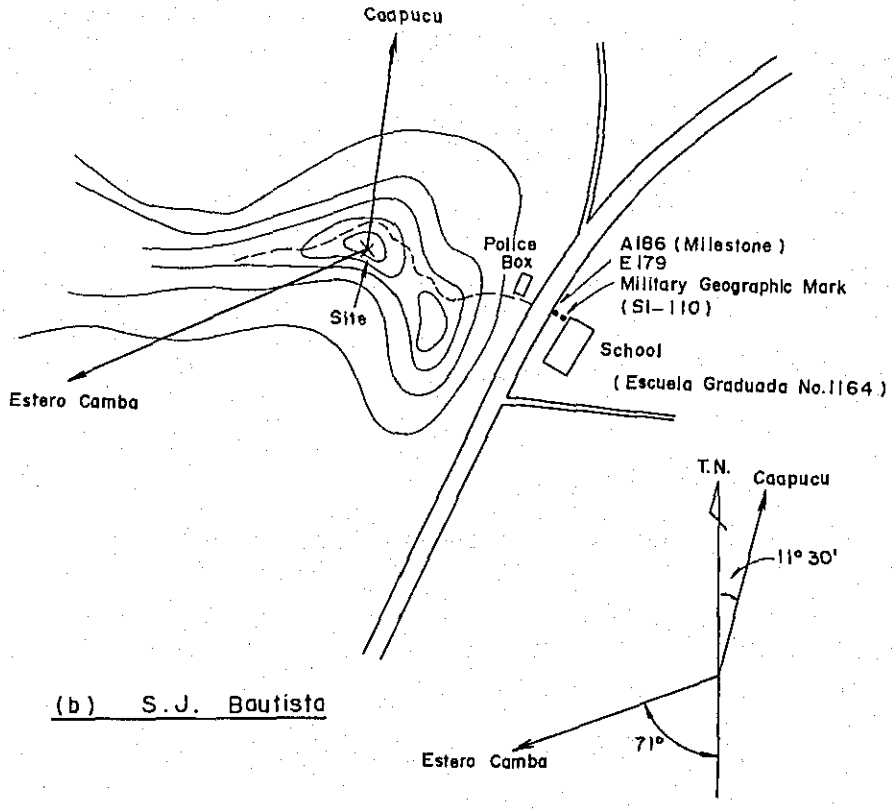


Fig IV - 3 - (3) Guide Map of the Site Valle Apua



(a) Caapucu



(b) S.J. Bautista

Fig. IV-3-(4) Guide Maps of the Sites, Caapucu and S.J. Bautista

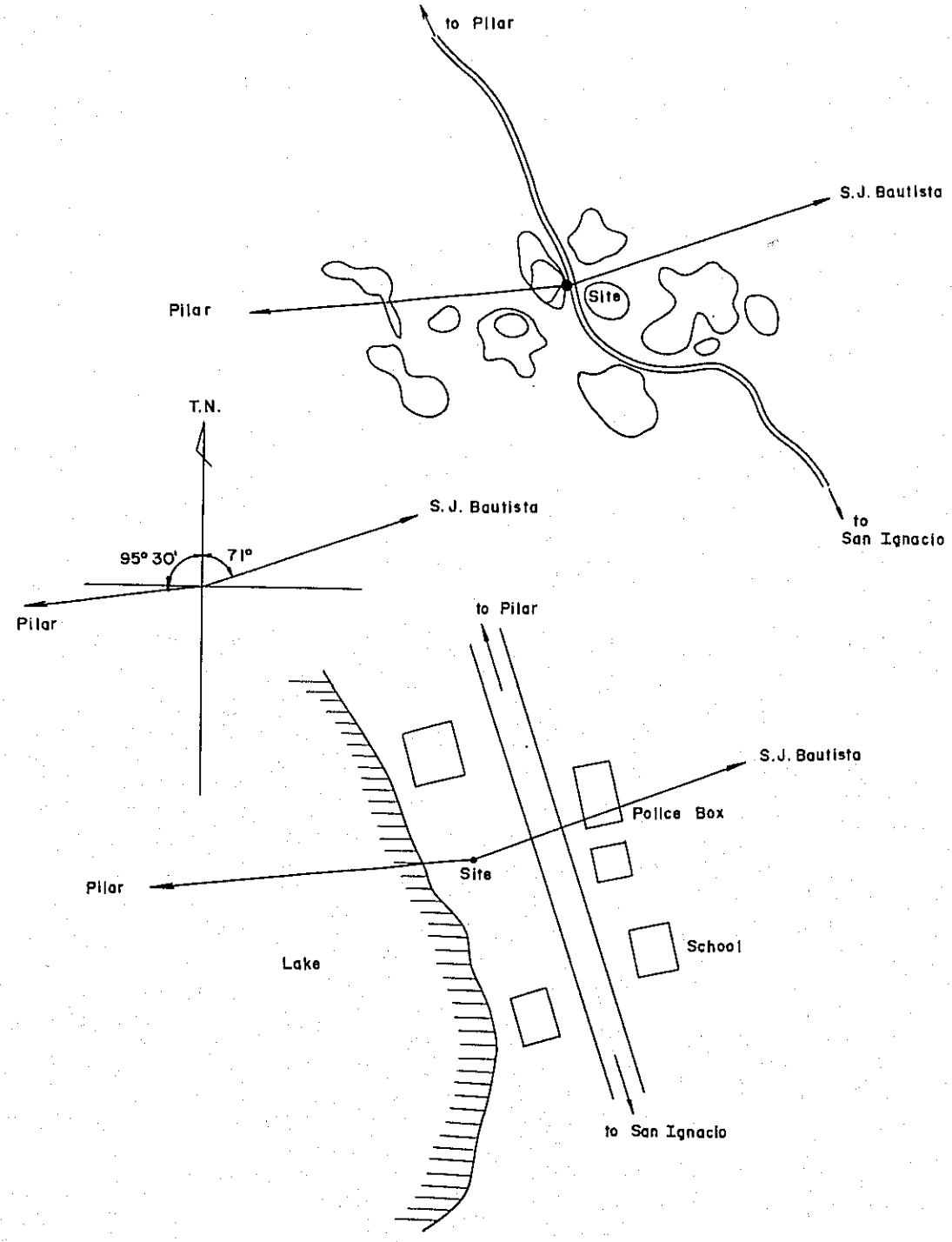
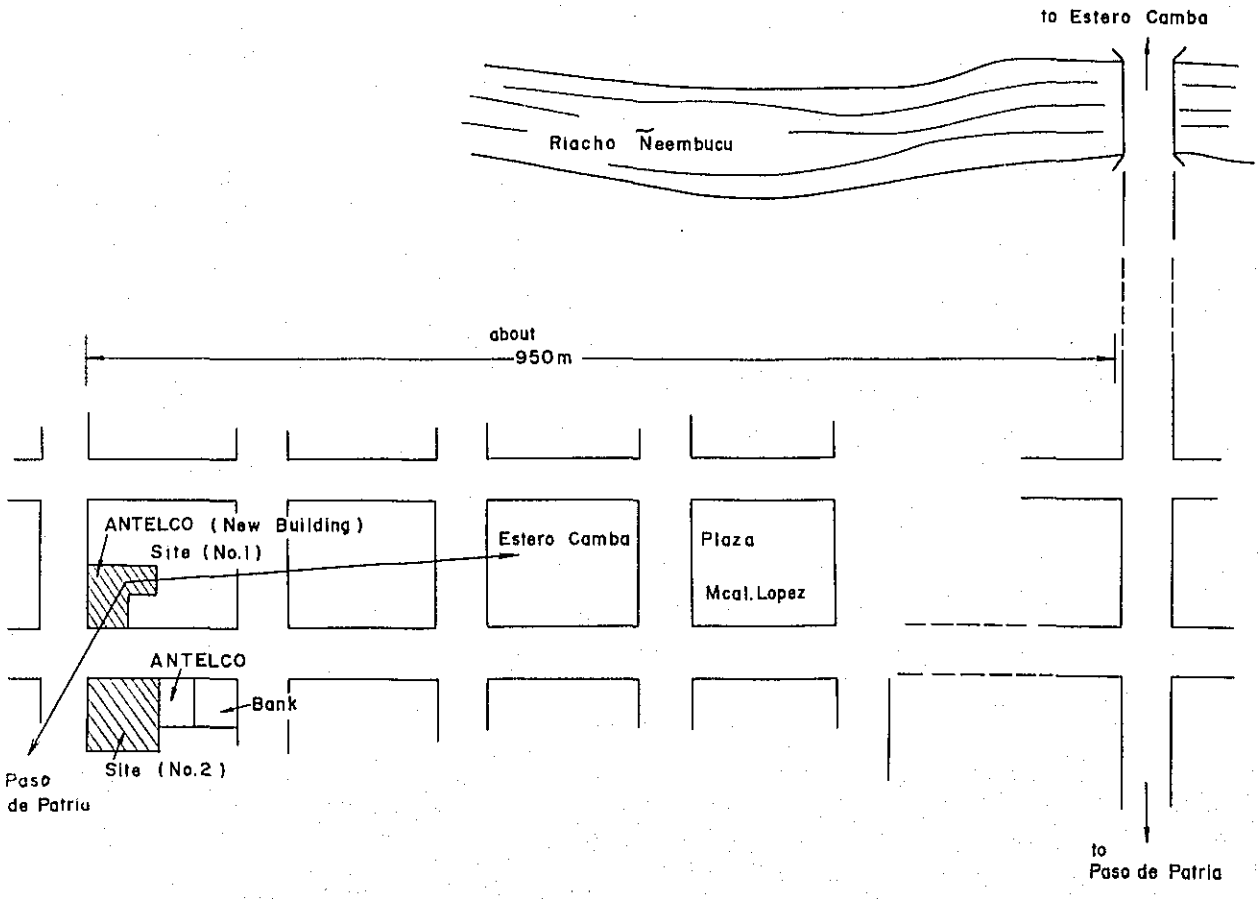


Fig. IV - 3 - (5) Guide Map of the Site Estero Camba



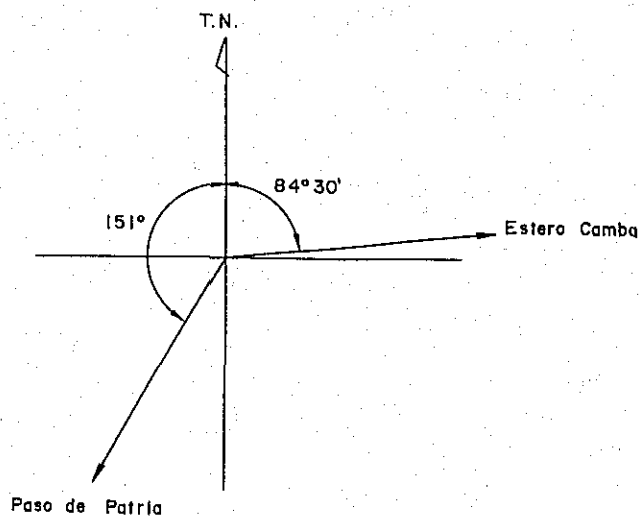


Fig. IV - 3 - (6) Guide Map of the Site Pilar

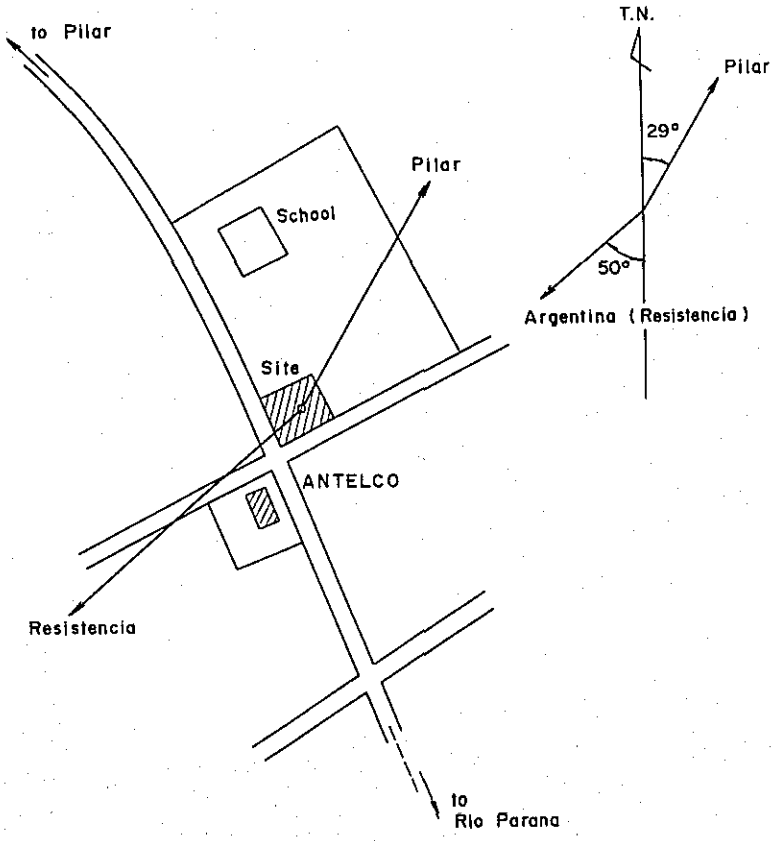


Fig. IV - 3 - (7) Guide Map of the Site Paso de Patria

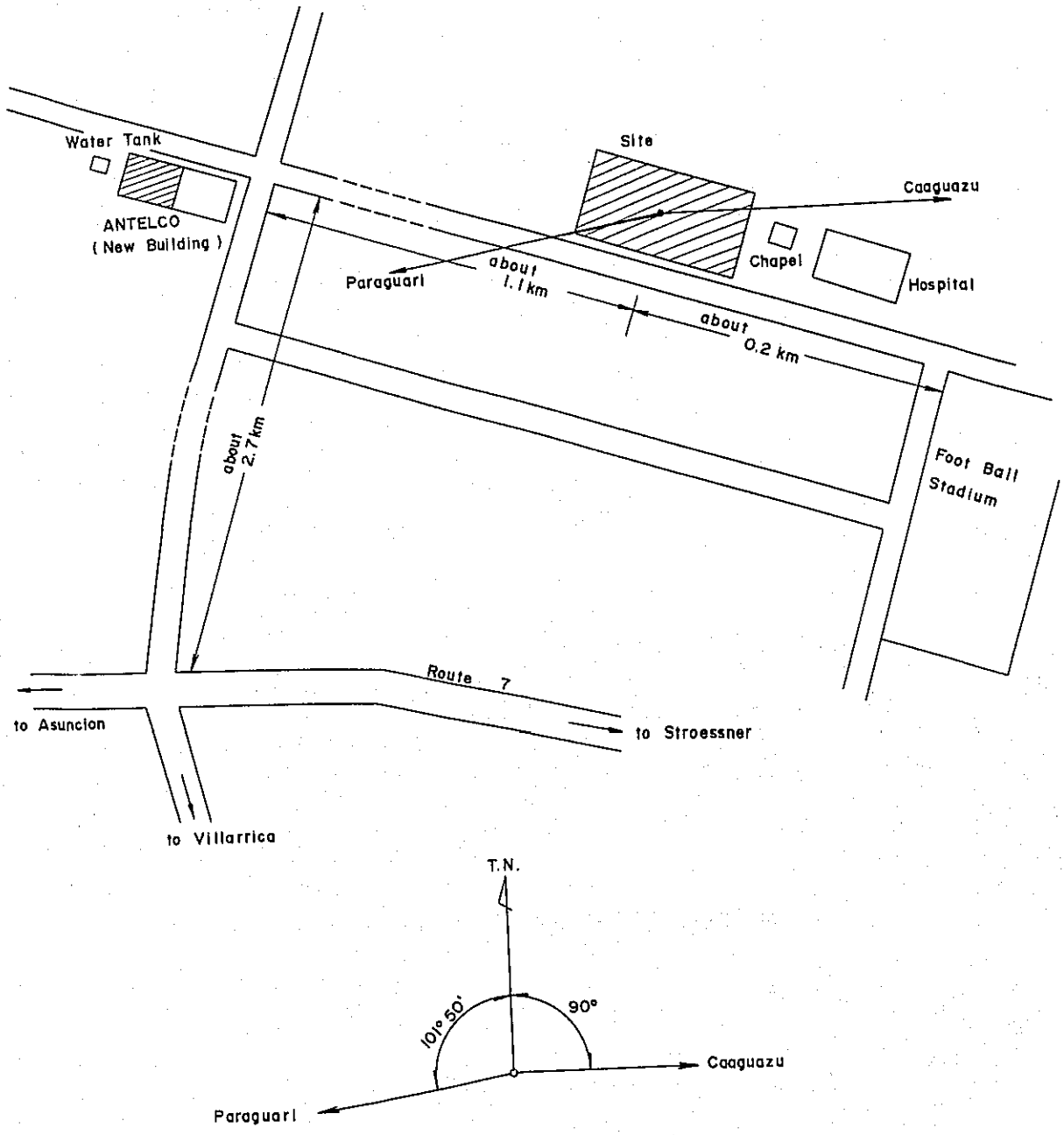
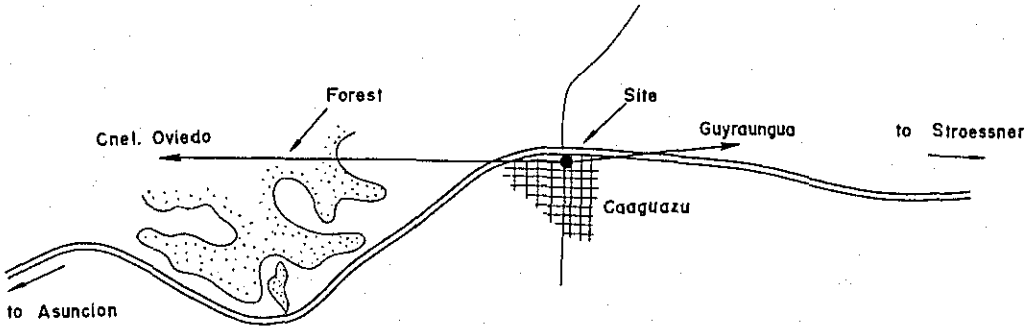


Fig. IV - 3 - (8) Guide Map of the Site Coronel Oviedo



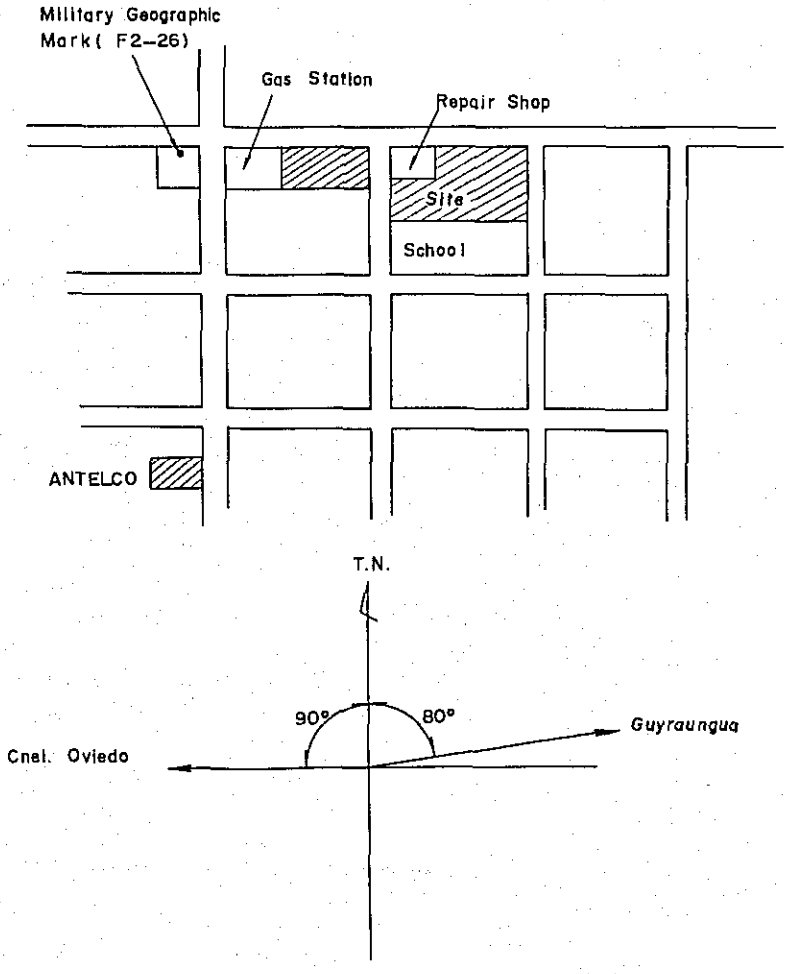


Fig. IV - 3 - (9) Guide Map of the Site Caaguazu

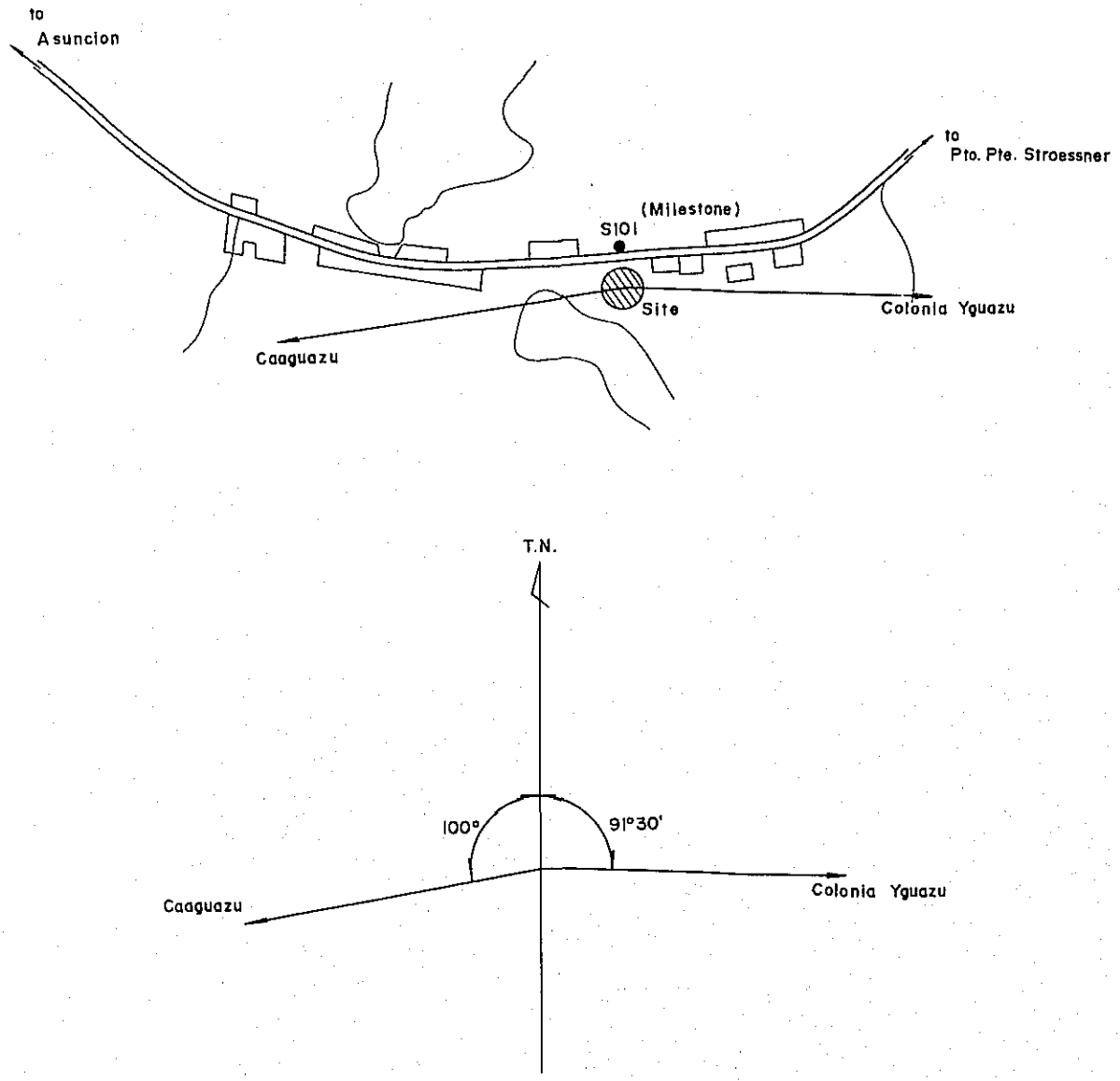
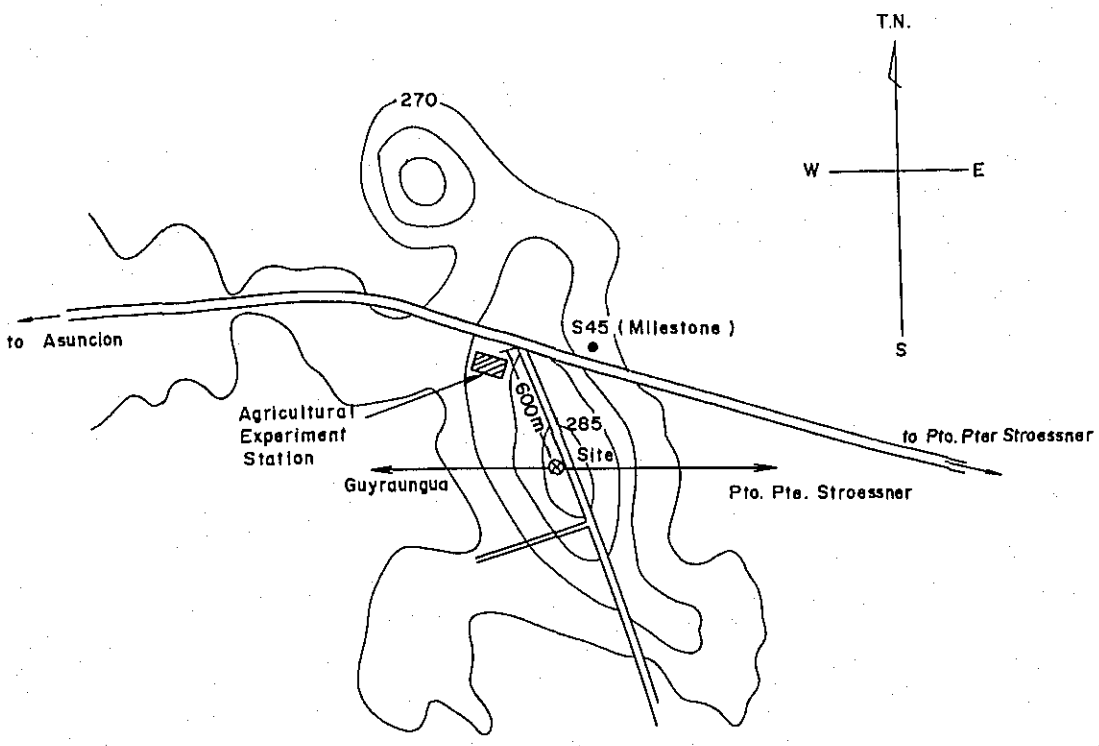


Fig. IV - 3 - (10) Guide Map of the Site Guyraungua



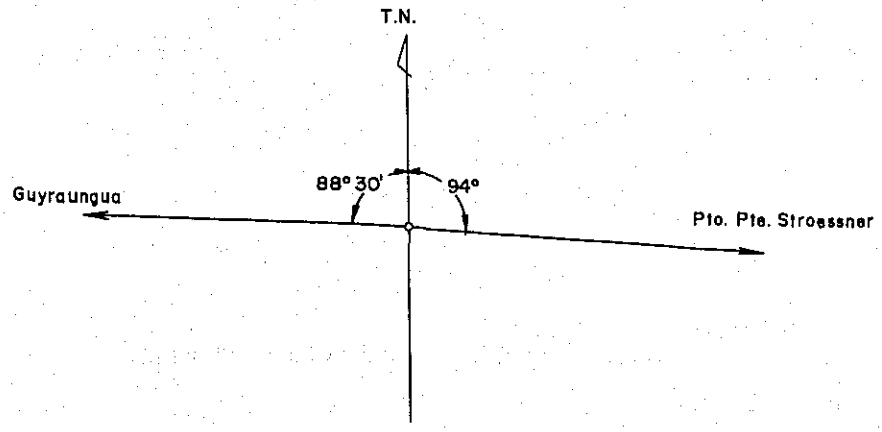


Fig. IV-3-(11) Guide Map of the Site Colonia Yguazu

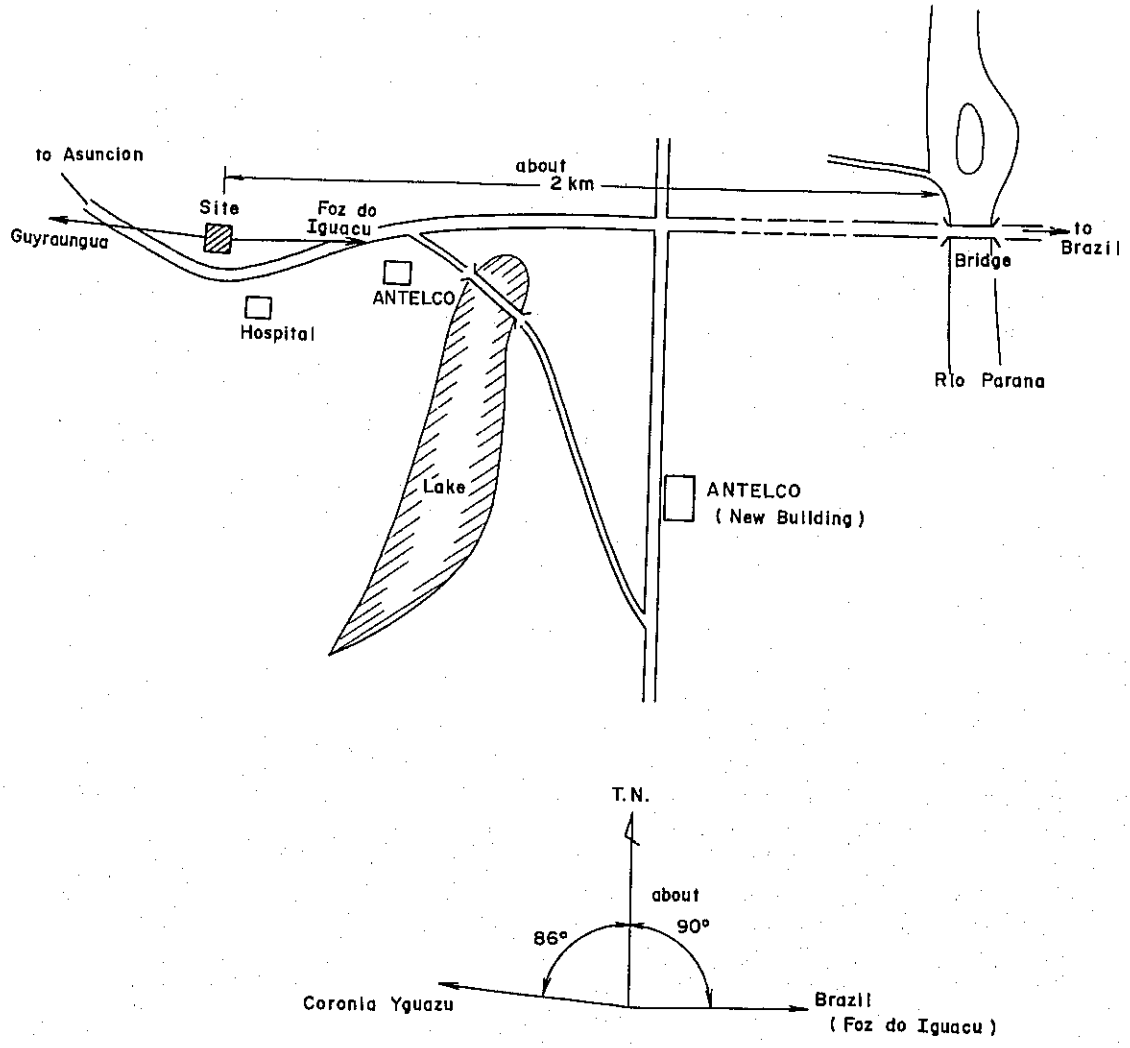


Fig. IV-3-(12) Guide Map of the Site Pto.Pte.Stroessner

Table IV-4-(1) Total Noise (Southward Route)

Item	Site	Asuncion	Paraguari	Subtotal	Paraguari	Valle Apua	Caapucu	S. J. Bautista	Subtotal	S. J. Bautista	Estero Camba	Pilar	Subtotal	Pilar	Paso de Patria	Subtotal	Total
Thermal Noise	Repeater	152		152	132	51	45		228	105	91		196	49		49	625
	Modulator and Demodulator	40		40		40			40		40		40	20		20	140
	Auxiliary Equipment	40		40		40			40		40		40	20		20	140
Distortion Noise	Repeater	60		60	60	60	60		180	60	60		120	60		60	420
	Modulator and Demodulator	60		60		60			60		60		60	30		30	210
	Auxiliary Equipment	60		60		60			60		60		60	30		30	210
Interference Noise	Echo	40		40	40	40	40		120	40	40		80	40		40	280
	Front/Back	Asuncion to P. Patria 27.4		27.4	24.6	13.7	7.4		45.7	11.5	10.1		21.6	2.4		2.4	97.1
	Over Reach	P. Patria to Asuncion 16.9		16.9	9.6	11.2	14.9		35.7	33.0	2.7		35.7	9.5		9.5	97.8
Total Noise	Unweighted Value			479.4					773.7				631.7			258.5	2,122.8
	Weighted Value			269.3					434.7				354.9			145.2	1,192.5
	Limit of Weighted Value			384.8					653.7				668.7			336.5	1,243.7

Note; The value shows noise power in pW.

Table IV-4-(2) Total Noise (Eastward Route)

Item	Site	Asuncion	Paraguari	Cnel Oviedo	Sub-total	Cnel Oviedo	Caaguazu	Guyraungua	Colonia-Yguazu	P. P. stroessner	Sub-total	Total
Thermal Noise	Repeater	152	136		288	215	183	72	47.5		517.5	805.5
	Modulator and Demodulator	40			40	40					40	80
	Auxiliary Equipment	40			40	40					40	80
Distortion Noise	Repeater	60	60		120	60	60	60	60		240	360
	Modulator and Demodulator	60			60	60					60	120
	Auxiliary Equipment	60			60	60					60	120
Interference Noise	Echo	40	40		80	40	40	40	40		160	240
	Front/Back	Asuncion to P.P. Stroessner 27.4	15.0		42.4	8.8	5.9	13.5	2.6		30.8	73.2
	Over Reach	P.P. Stroessner to Asuncion 16.9	22.0		38.9	9.2	13.6	8.0	5.3		36.1	75.0
Total Noise	Unweighted Value				730.4						1,153.6	1,880.5
	Weighted Value				410.3						648.1	1,056.5
	Limit of Weighted Value				580.4						743.0	1,123.4

Note; The value shows noise power in pW.

Table IV-5-(1) Interruption Time (Southward Route)

Item \ Switching Section / Site		Asuncion - Paraguari	Paraguari - S. J. Bautista			S. J. Bautista - Pilar		Pilar - P. Patria	Total
		Asuncion	Paraguari	Valle Apua	Caapucu	S. J. Bautista	Estero Camba	Pilar	P. Patria	
Propagation Path Condition		Plain	Plain	Plain	Plain	Plain	Plain	Plain		
Hop Distance	km	61.6	56.5	29.9	31.5	65.2	57.7	45.5		
Distance of Baseband Section	km	61.6	117.9			122.9		45.5	347.9	
Thermal Noise	pW	152.0	132.0	51.0	44.6	105.0	91.0	49.0		
Occurrence Probability of Rayleigh Fading (P)	10^{-4}	153.1	113.1	12.3	14.6	186.8	121.8	53.0		
Ditto (Pe) in case of Reflection Coefficient more than about 0.3	10^{-2}					(13)	(8.2)	(3.6)		
Probability of Noise Burst exceeding 1,000,000 pW (Pi)	10^{-8}	465.4	298.5	12.5	13.0	392.3 (1,365.0)	221.7 (746.2)	52.0 (176.4)		
Total of Pi in One Section	10^{-8}	465.4	324.0			614.0 (2,247.7)		52.0 (176.4)	1,455.4 (3,213.5)	
Ditto (including the Noise-Switching Effect)	10^{-8}	155.1	108.0			205 (749.2)		17.3 (58.8)	485.1 (1,071.1)	
Limited Value	10^{-8}	246.4	471.6			491.6		182.0	1,391.6	

Note; The value calculated by Pe is shown in parenthesis.

Table IV-5-(2) Interruption Time (Eastward Route)

Item \ Switching Section / Site		Asuncion - Cnel Oviedo		Cnel Oviedo - Pto. Pte. Stroessner				Total	
		Asuncion	Paraguari	Cnel Oviedo	Caaguazu	Guyra-ungua	Colonia Yguazu	P. P. Stroessner	Route Total
Propagation Path Condition		Plain	Plain	Plain	Plain	Plain	Plain		
Hop Distance	km	61.6	65.2	39.9	43.8	54.8	42.5		
Distance of Baseband Section	km	126.8		181.0				307.8	
Thermal Noise	pW	152	136	215	183	72	47.5		
Occurrence Probability of Rayleigh Fading (P)	10^{-4}	153.1	186.8	33.5	46.4	101.7	28.2		
Ditto (Pe) in case of Reflection Coefficient more than about 0.3	10^{-2}								
Probability of Noise Burst exceeding 1,000,000 pW (Pi)	10^{-8}	465.4	508	116.6	169.8	146.4	26.8		
Total of Pi in One Section	10^{-8}	973.4		459.6				1,433.0	
Ditto (including the Noise-Switching Effect)	10^{-8}	324.4		153.2				477.6	
Limited Value	10^{-8}	507.2		724.0				1,231.2	

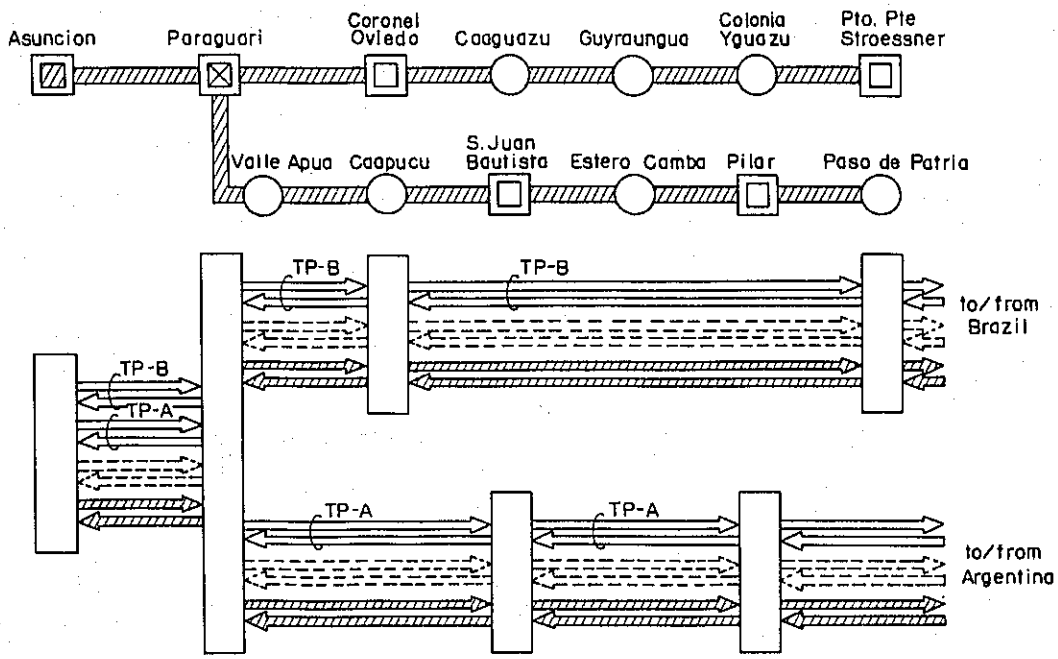


Fig. V-1 Microwave System Configuration

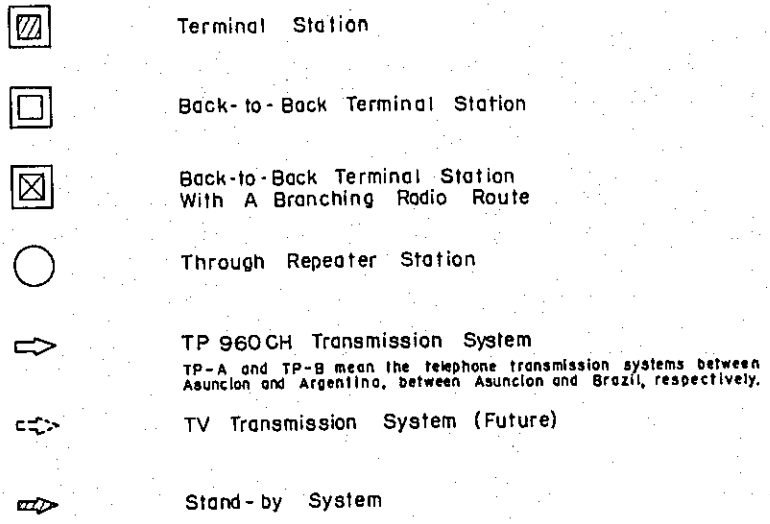


Fig. V-2 Abbreviation

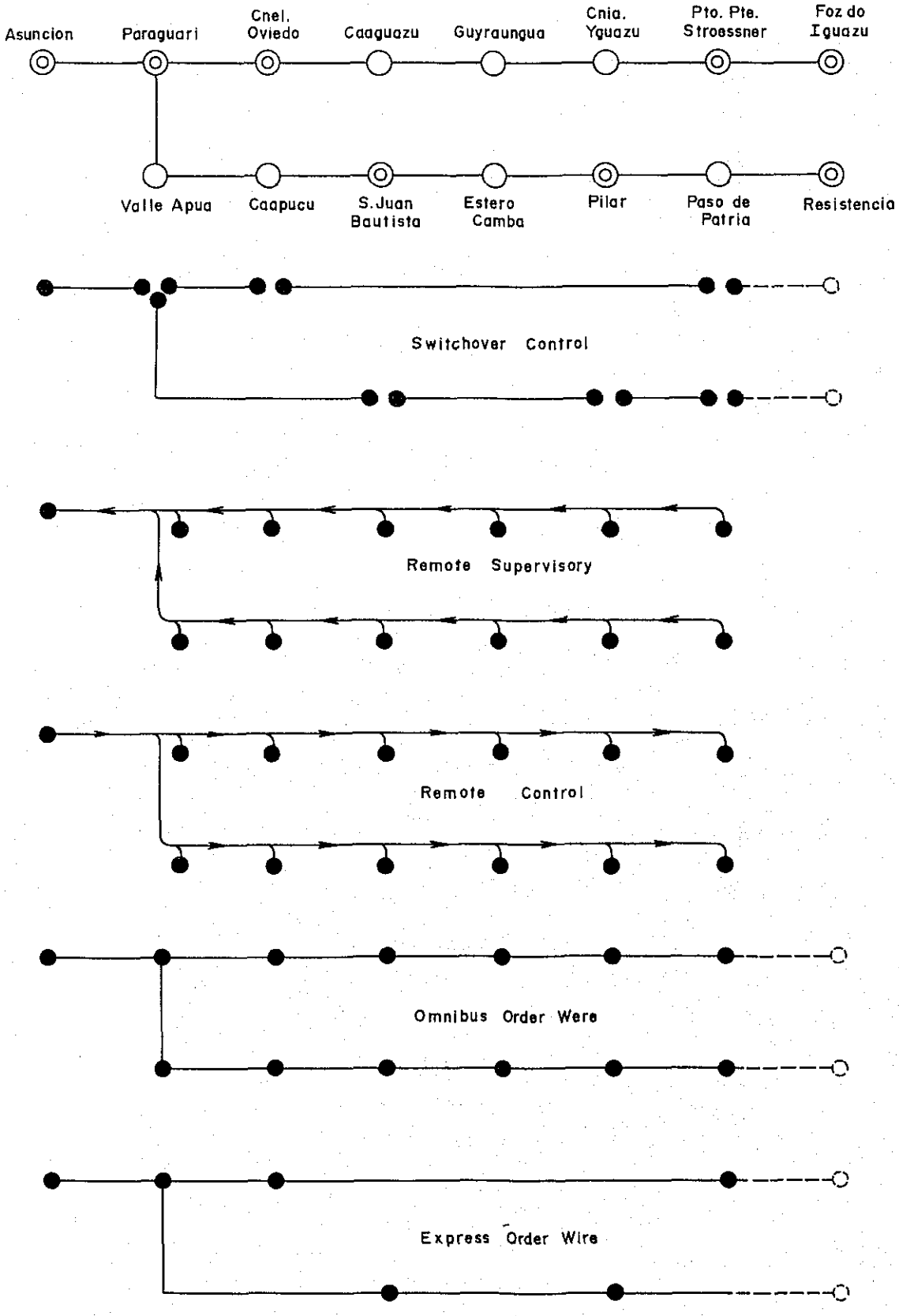


Fig. V - 3 Supervisory and Control System

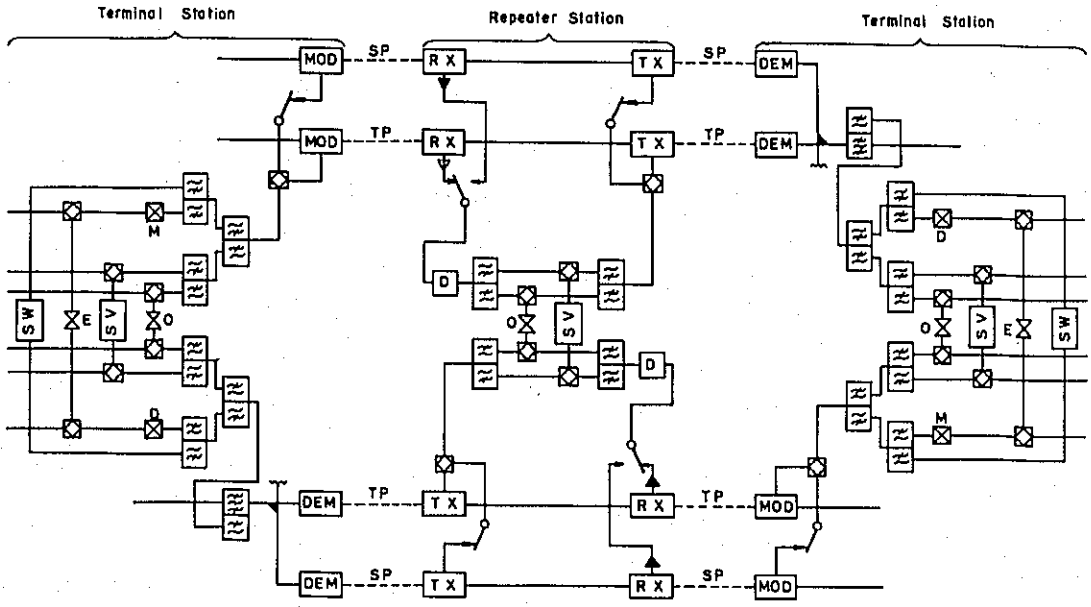


Fig. V - 4 Schematic Diagram of Service Channel

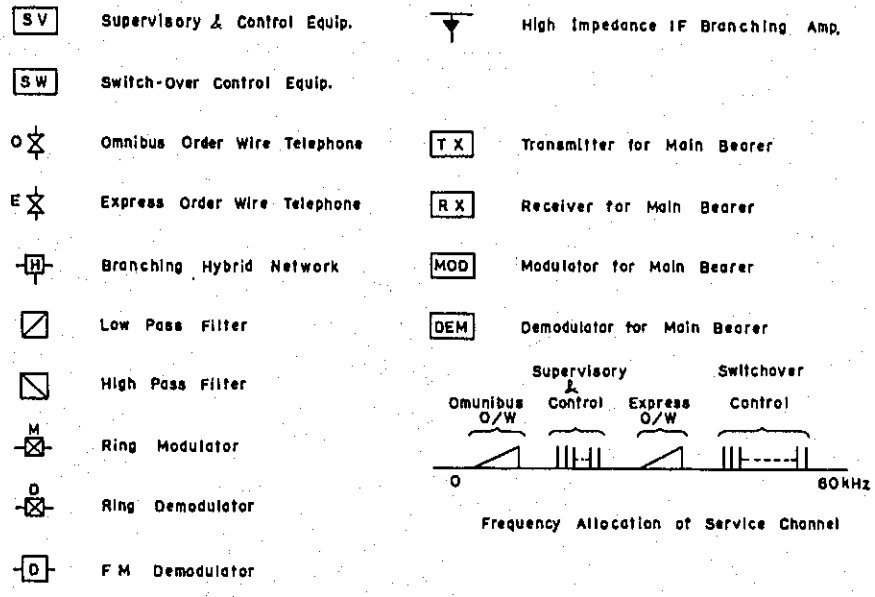


Fig. V - 5 Abbreviation

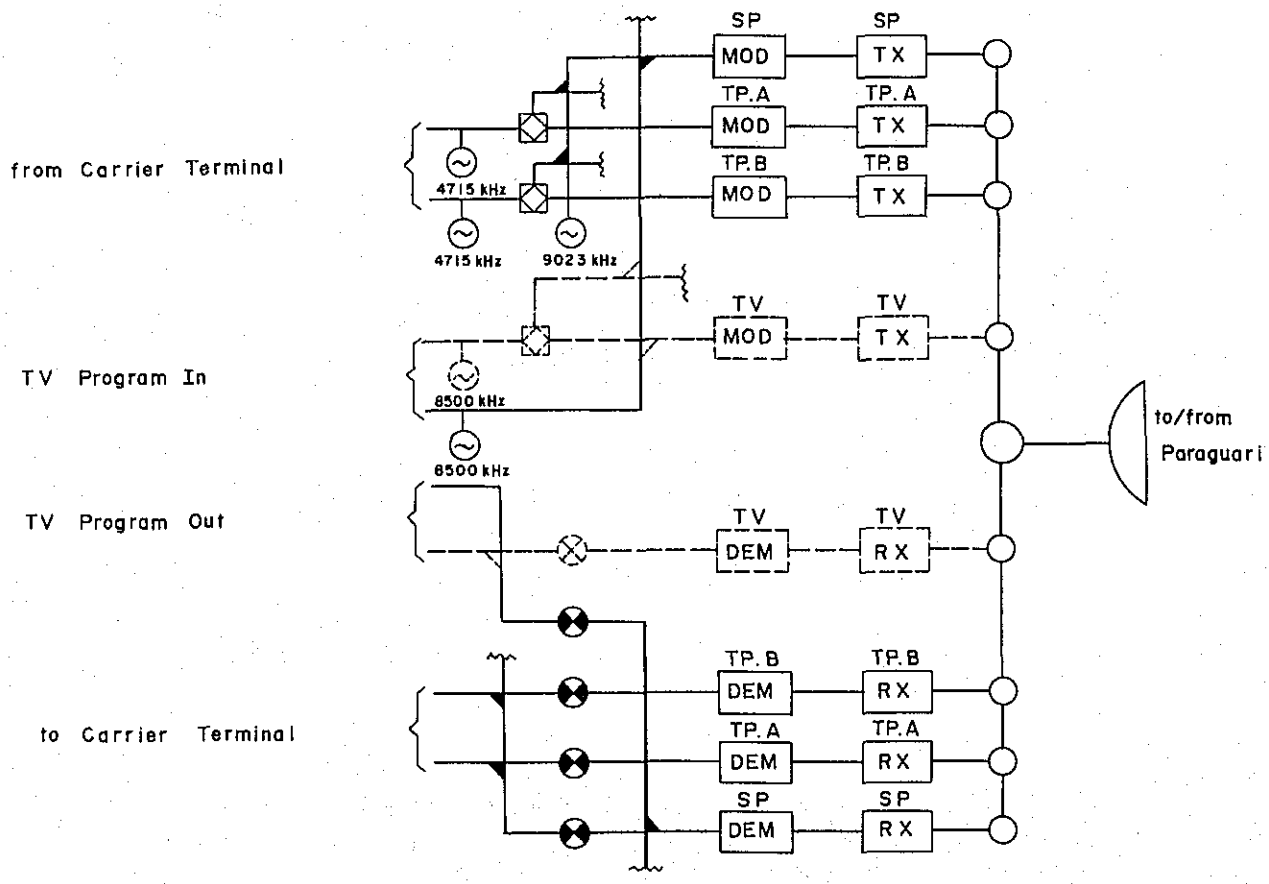


Fig. V - 6 Schematic Diagram of Terminal Station (Asuncion)

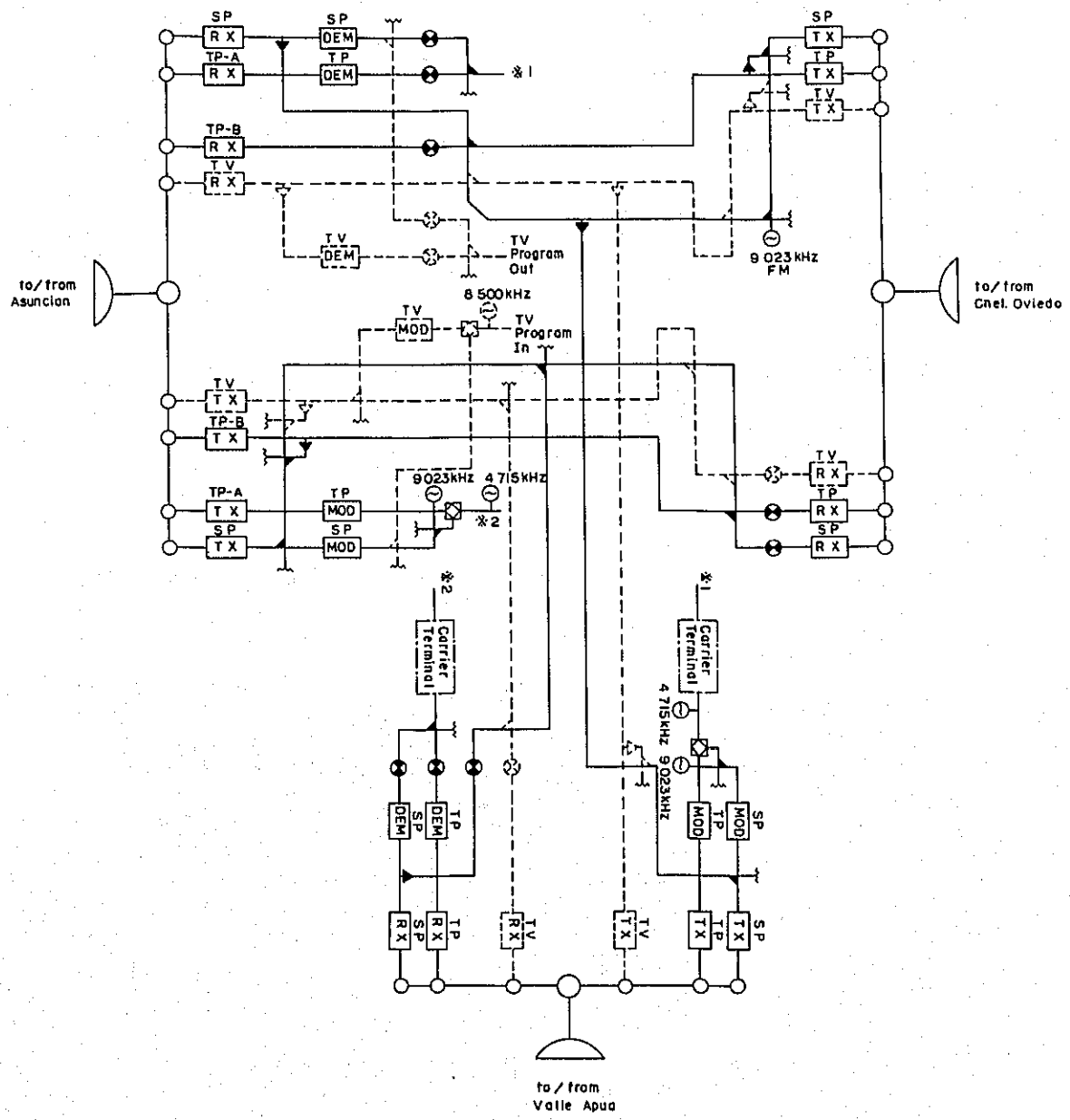


Fig V - 7 Schematic Diagram of Terminal Station (Paraguari)

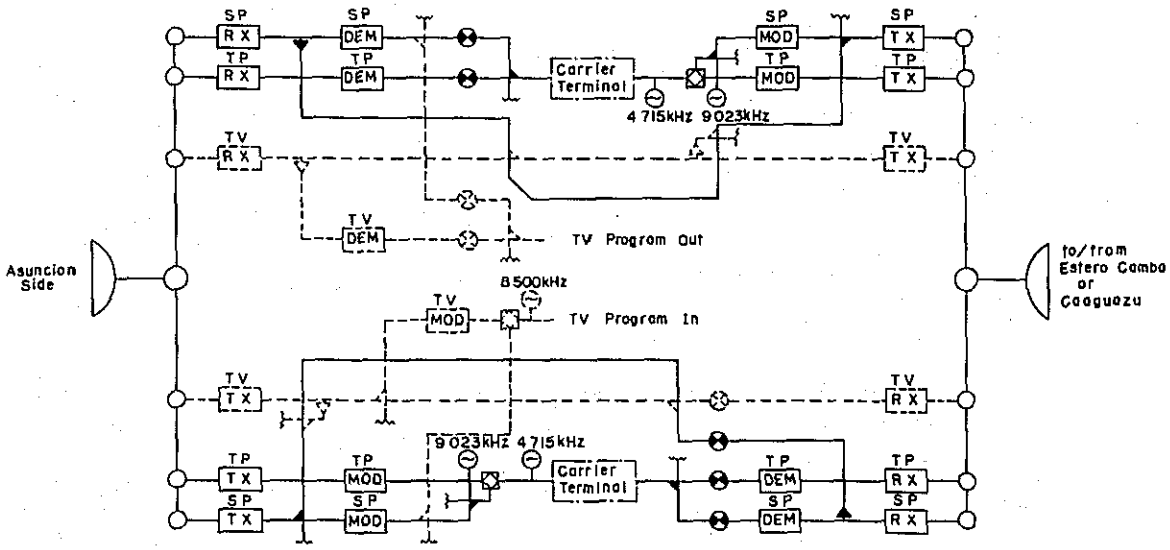


Fig. V - 8 Schematic Diagram of Terminal Station (Cnel, Oviedo, S.Juan Bautista)

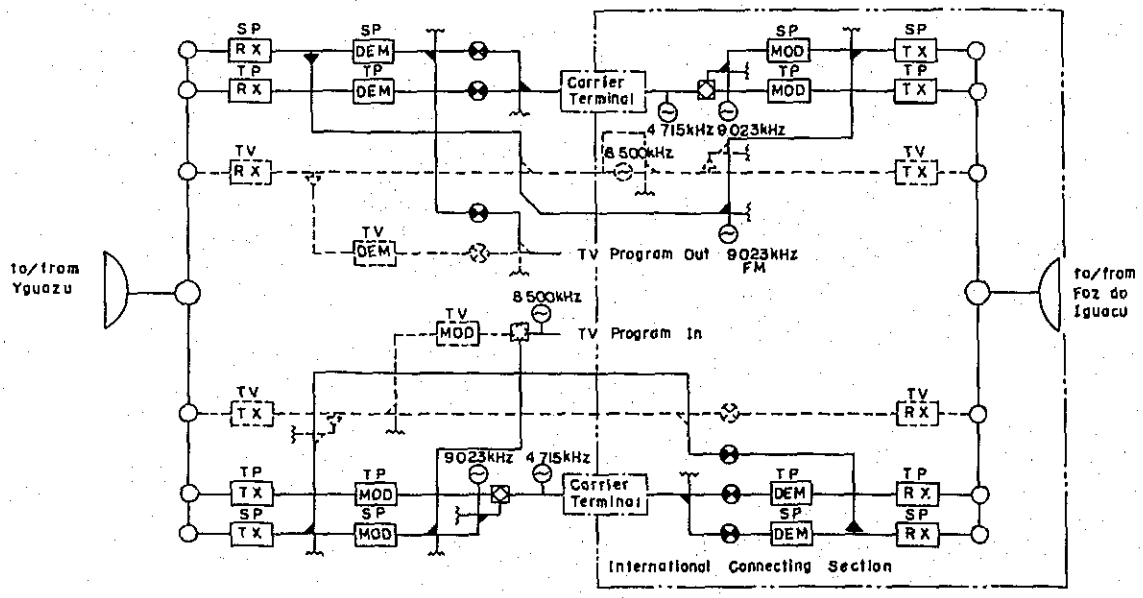


Fig. V - 9 Schematic Diagram of Terminal Station (Pto. Pte. Stroessner)

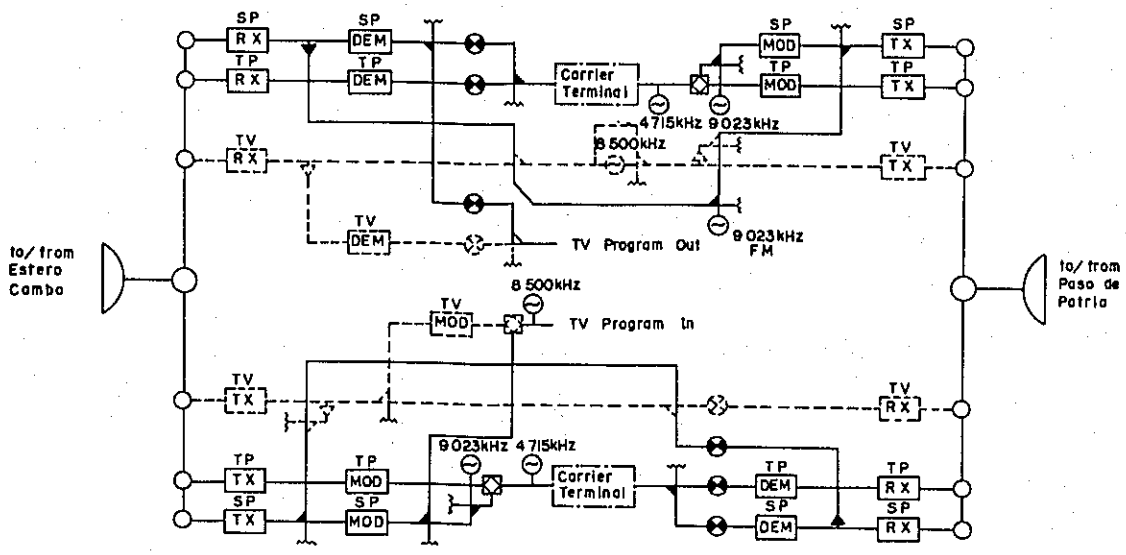


Fig. V - 10 Schematic Diagram of Terminal Station (Pilar)

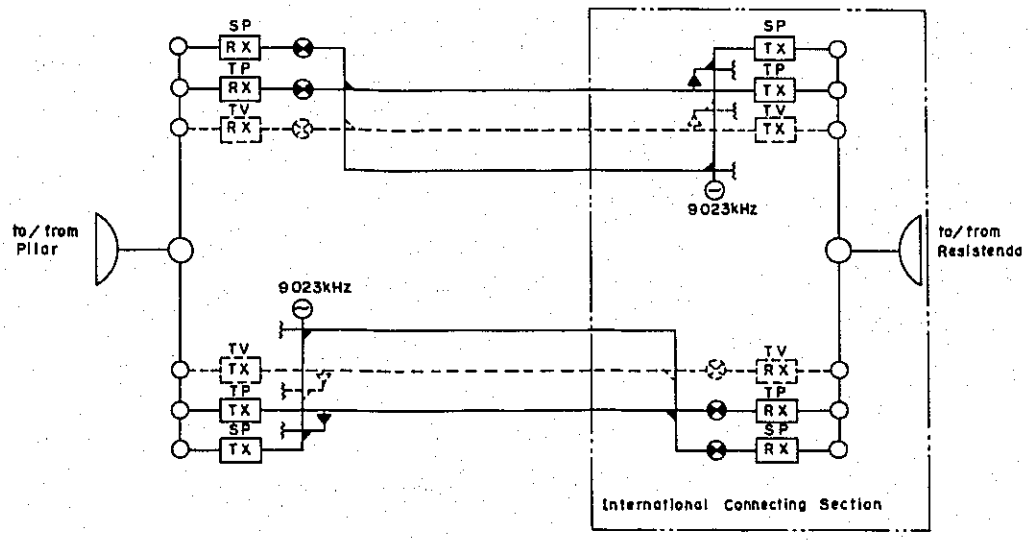


Fig. V - 11 Schematic Diagram of Repeater Station (Paso de Potria)

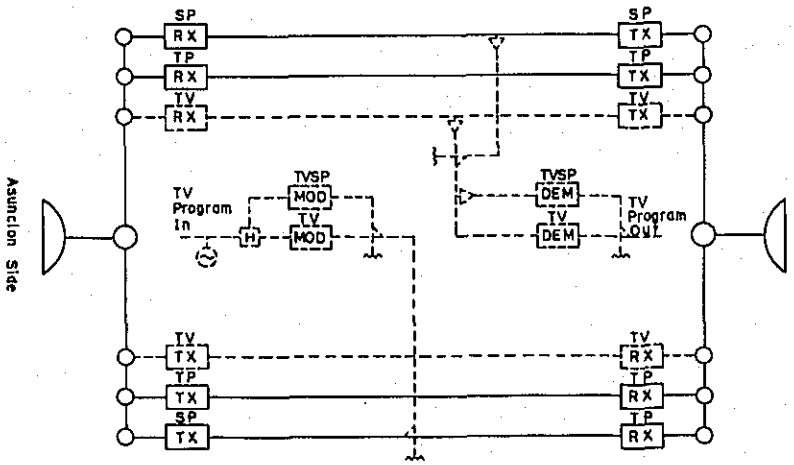


Fig. V - 12 Schematic Diagram of Repeater Station (Except Paso de Patria)

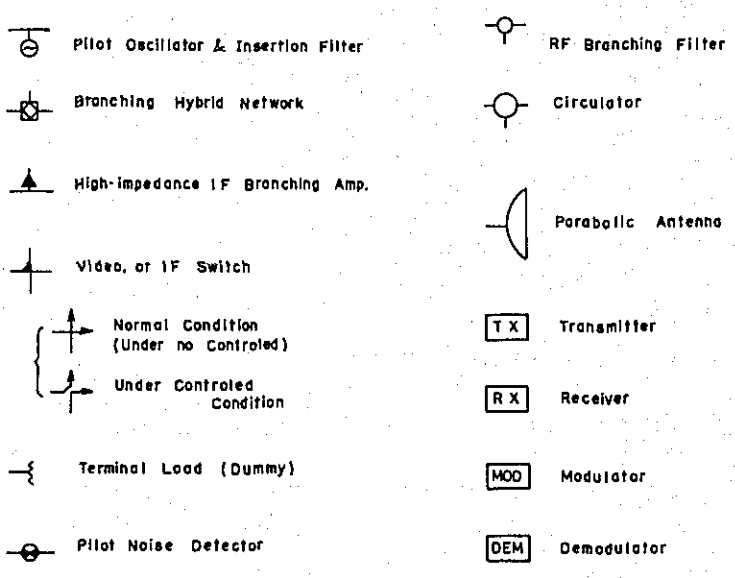


Fig. V - 13 Abbreviation

Table VI - 1 Number of Circuits

	1980						1990			
	Telephone			Telegraph	CBC	Total	Telephone	Telegraph	CBC	Total
	R/D	Dialing	Total							
Argentina - Brazil	8		8			8	25			25
Asuncion - Argentina	28		28	15 (1)	1 (3)	32	93	33 (2)	1 (3)	98
Asuncion - Uruguay	5		5	5 (1)		6	12	10 (1)		13
Asuncion - Resistencia	4		4			4	5			5
Asuncion - Paraguari	2	41	43	1 (1)		44	54	3 (1)		55
Asuncion - Caacupe	3	78	81	2 (1)		82	104	4 (1)		105
Asuncion - S. J. Bautista	2	38	40	2 (1)		41	47	4 (1)		48
Asuncion - Encarnacion	5	155	160	4 (1)		161	183	7 (1)		184
Asuncion - Pilar	2	38	40	1 (1)		41	47	7 (1)		48
Total	59	350	409	30 (7)	1 (3)	419	570	68 (8)	1 (3)	581
Argentina - Brazil	8		8			8	25			25
Asuncion - Rio de Janeiro	13		13	10 (1)	1 (3)	17	16	16 (1)	1 (3)	20
Asuncion - Curitiba	25		25			25	32			32
Asuncion - Foz do Iguacu	2		2			2	3			3
Asuncion - Coronel Oviedo	2	41	43	2 (1)		44	74	3 (1)		75
Asuncion - Villarrica	3	96	99	3 (1)		100	114	7 (1)		115
Asuncion - P. P. Stroessner	2	41	43	2 (1)		44	50	3 (1)		51
Total	55	178	233	17 (4)	1 (3)	240	314	29 (4)	1 (3)	321

Note; This table does not include Spare Channel.
The values in parenthesis are converted into Telephone-Channels

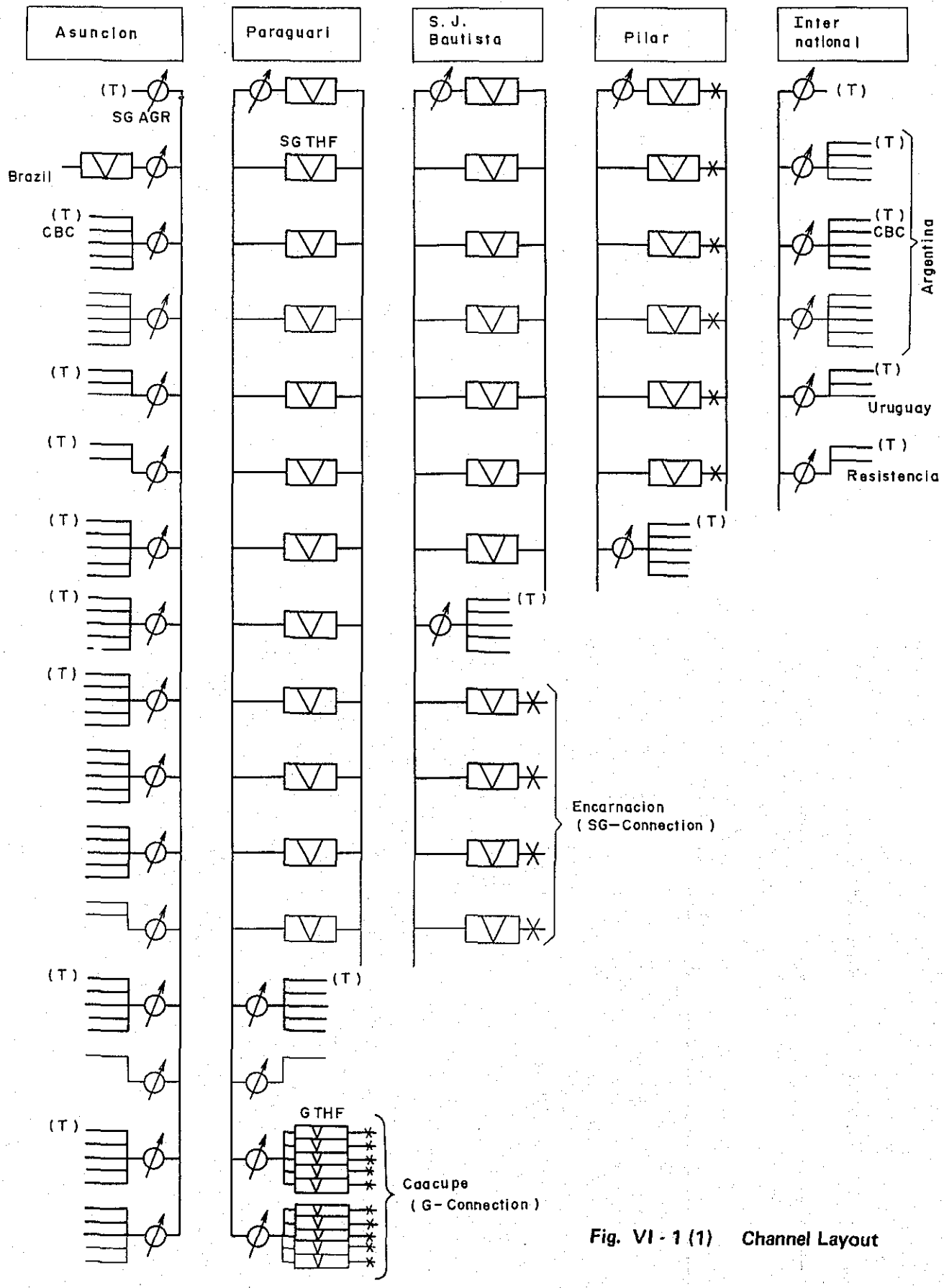
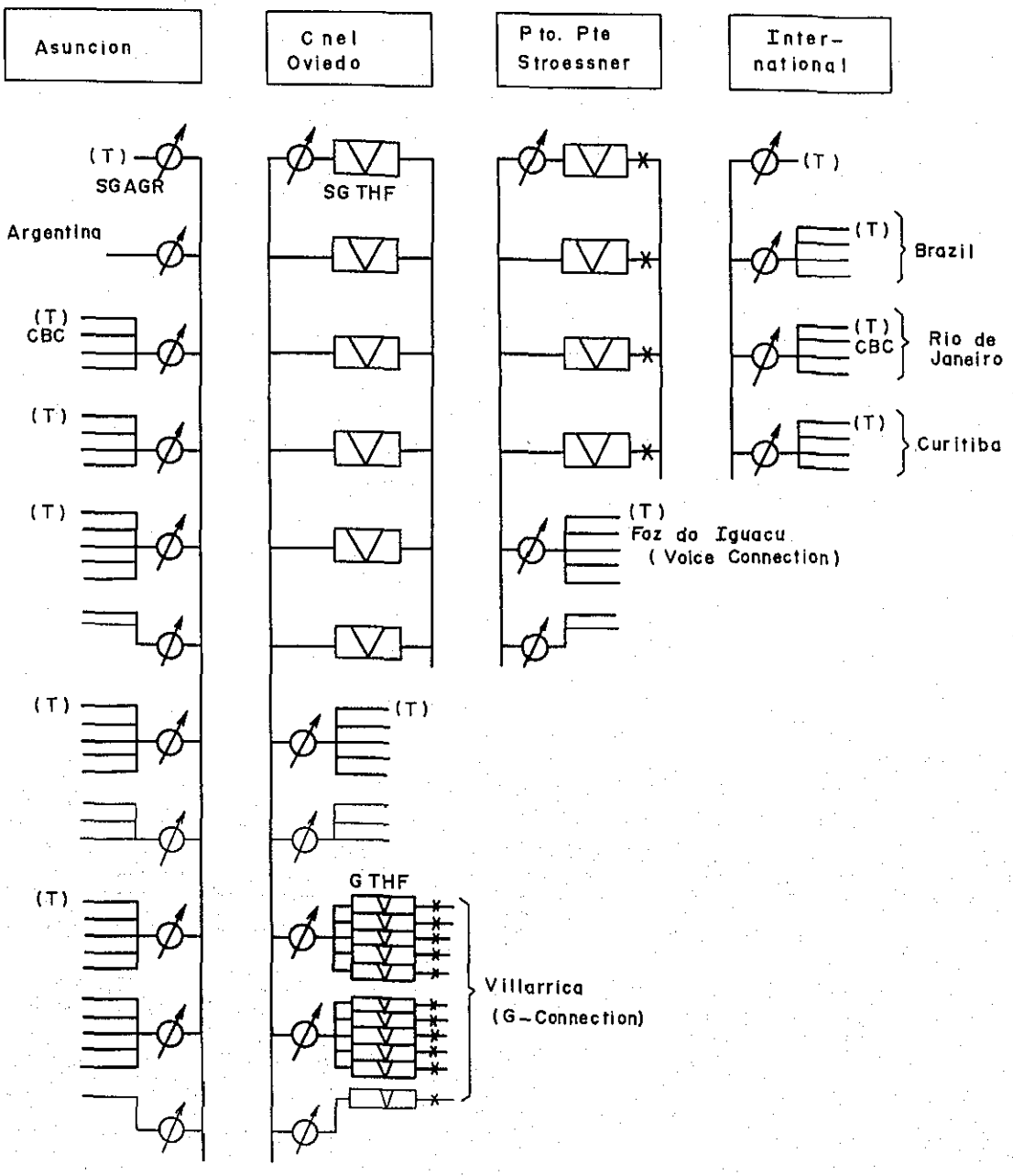


Fig. VI - 1 (1) **Channel Layout**



Note ;

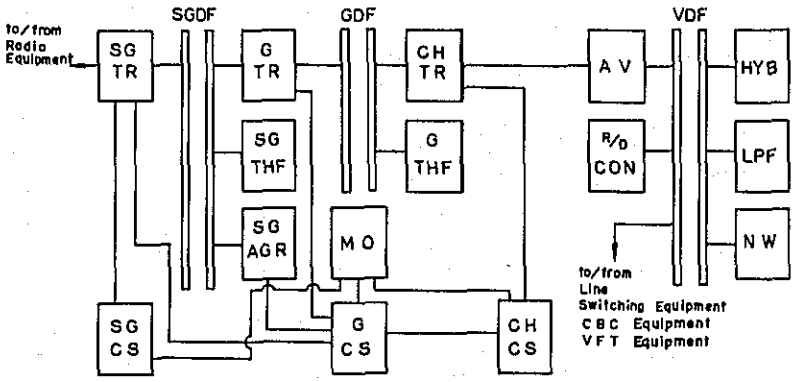
1. Thick line means circuits in 1980
   Thick line means circuits in 1990
2. SG ; Super-Group Translating Equipment
   SG THF ; Super-Group Through Filter Equipment
   SG AGR ; Super-Group Automatic Gain Regulator Equipment (at Receiving Side)
   G ; Group Translating Equipment

GTHF ; Group Through Filter Equipment

3. (T) ; SG or G for Spare and Test

4. -X- ; This mark shows the boundary of this project.

Fig. VI - 1 (2) Channel Layout



Legend;

1. SG. TR ; Super-Group Translating Equipment
2. SG. CS ; SG. Carrier Supply Equipment
3. SG. AGR; SG. Automatic Gain Regulating Equ.
4. SG. THF; SG. Through Filter
5. SG. DF ; SG. Distribution Frame
6. G TR ; Group Translating Equipment
7. G CS ; Group Carrier Supply Equipment
8. G THF; Group Through Filter
9. GDF ; Group Distribution Frame
10. CH.TR; Channel Translating Equipment
11. CH.CS; Channel Carrier Supply Equipment
12. HYB ; 2W/4W Translating Equipment
13. R/D REP; R/D Converter Equipment
14. LPF ; Low Pass Filter
15. A V ; Variable Attennator
16. N W ; Network
17. VDF ; Voice Distribution Frame
18. M O ; Master Oscillator

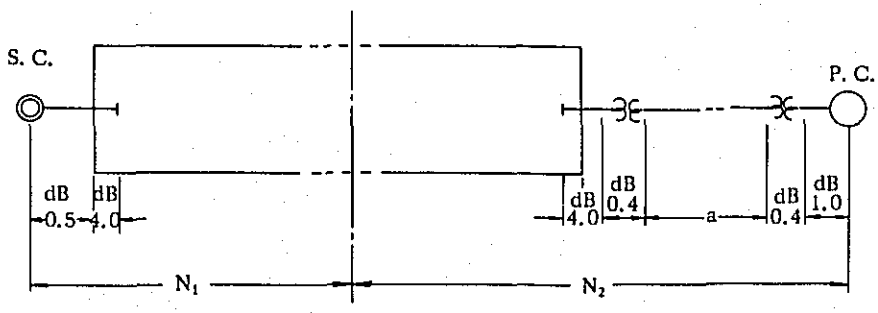
Fig. VI - 2 Typical Carrier Multiplex System Block Diagram

Table VII - 1 Loaded and Non-Loaded Cable System

Section	Paraguari - Paraguari P. C.	S. J. Bautista S. J. Bautista P. C.	Cnel. Oviedo - Cnel. Oviedo P. C.	P. P. Storoessner - P. P. Stroessner P. C.
Approx. Distance	11 km	11 km	1.5 km	2.0 km
Type of Cable	PEF-P Cable 0.9mm Loaded	PEF-P Cable 0.9mm Loaded	PEF-P Cable 0.65mm Non-loaded	PEF-P Cable 0.65mm Non-loaded
Min. Transmission Loss (between Asuncion - P. C.)	(phantom) 5 dB	(phantom) 5 dB	(phantom) 5 dB	(phantom) 5dB
D. C. Roop Resistance (Nominal)	792Ω	792Ω	170Ω	226Ω
Number of Pairs	150p	100p	150p	150p
Type of Circuits	S + P	S + P	S + P	S + P
Type of Construction	Airial	Airial	Airial	Airial

Note: 1. Measuring Frequency for Min. Transmission Loss
Loaded Cable 0.8 kHz, Non-Loaded Cable 1.5 kHz

2. Type of Circuits S + P; Using Side Circuits and Phantom Circuits.



Note. a: Transmission Loss of Cable

N_1+N_2 : Min. Transmission Loss between S. C. and P. C.
($N_1 \fallingdotseq 2.0$ dB)

Fig. VII - 1 Min. Transmission Loss

Table VIII-1 List of the Station where Commercial Power is Avairable

Station Name	Date of Commercial Power Avairable	Approx. Distance of Receiving Commercial Power Line
Asuncion	Already	———
Paraguari	May 1972	10 km
Cnel. Oviedo	September 1972	0 km
Caaguazu	September 1972	0 km
Pto. Pte. Stroessner	Already	0. 5 km
Caapucu	October 1972	10 km
S. Juan Bautista	October 1972	9 km

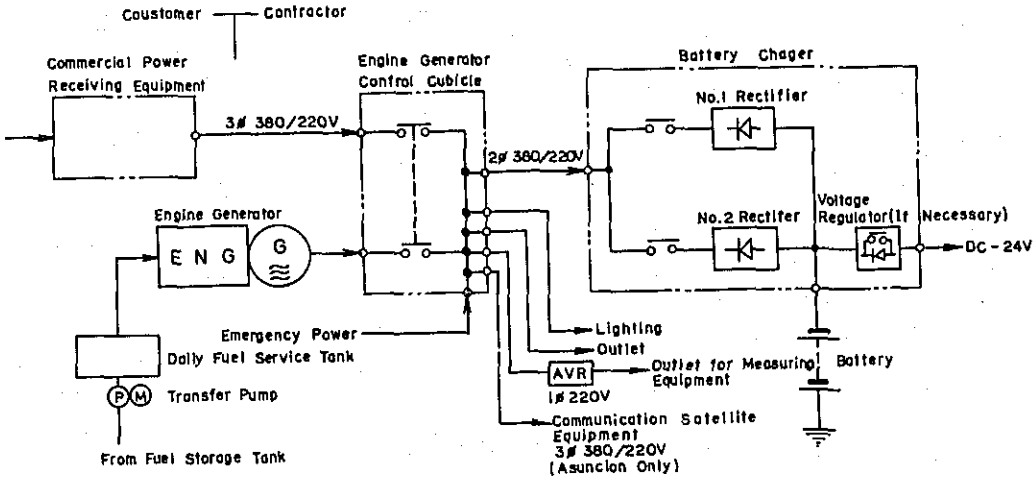


Fig. VIII - 1 Power Supply System - I (Commercial Power is Available)

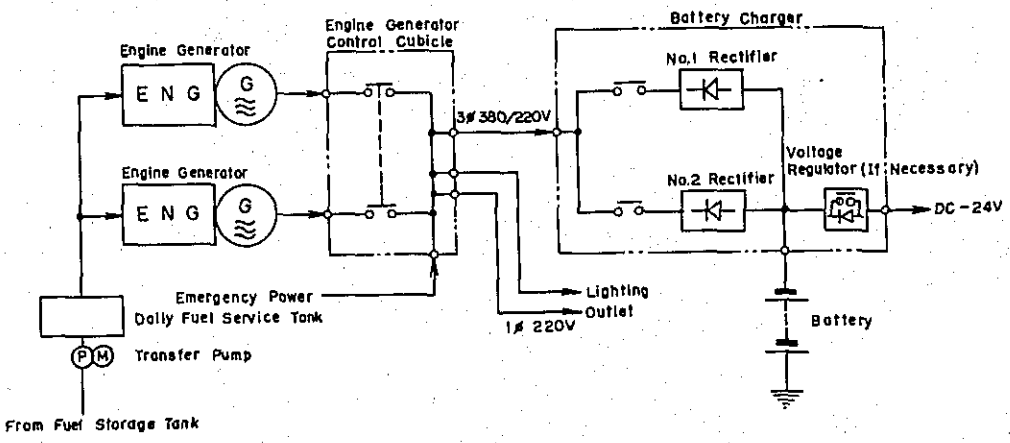


Fig. VIII-2 Power Supply System - II (Commercial Power is Unavailable)

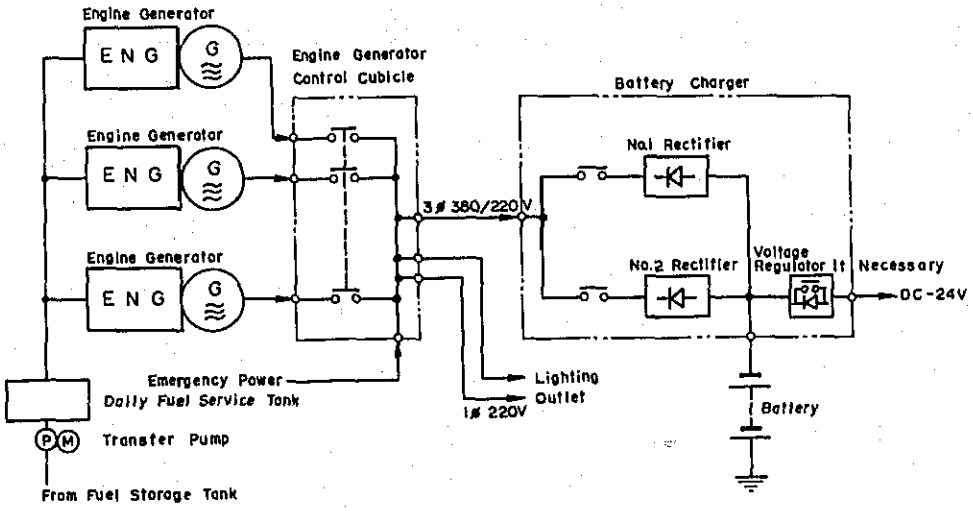


Fig. VIII-3 Power Supply System - III (Commercial Power is Unavailable)

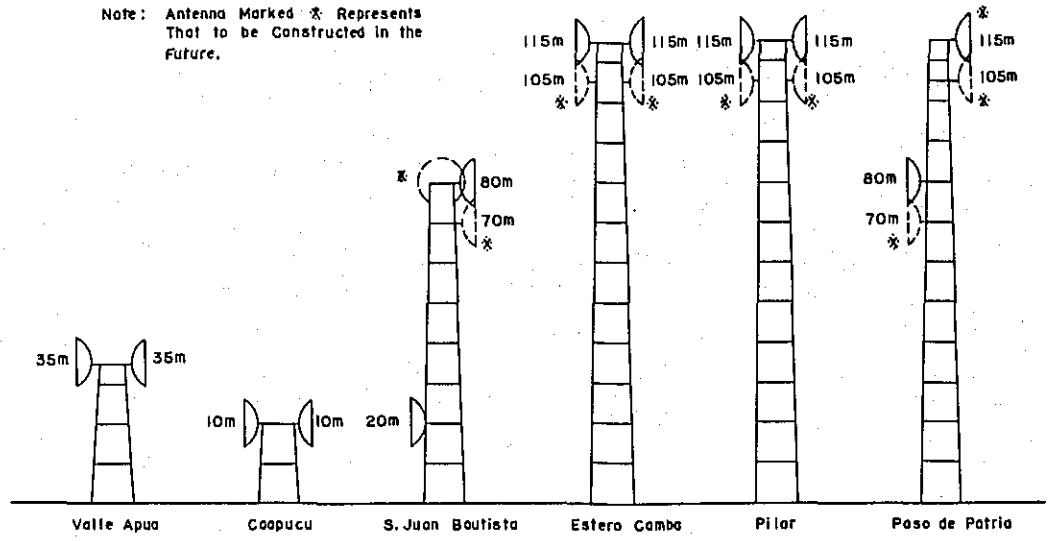


Fig. IX - 1 Conceptional Figure of the Tower with Antenna

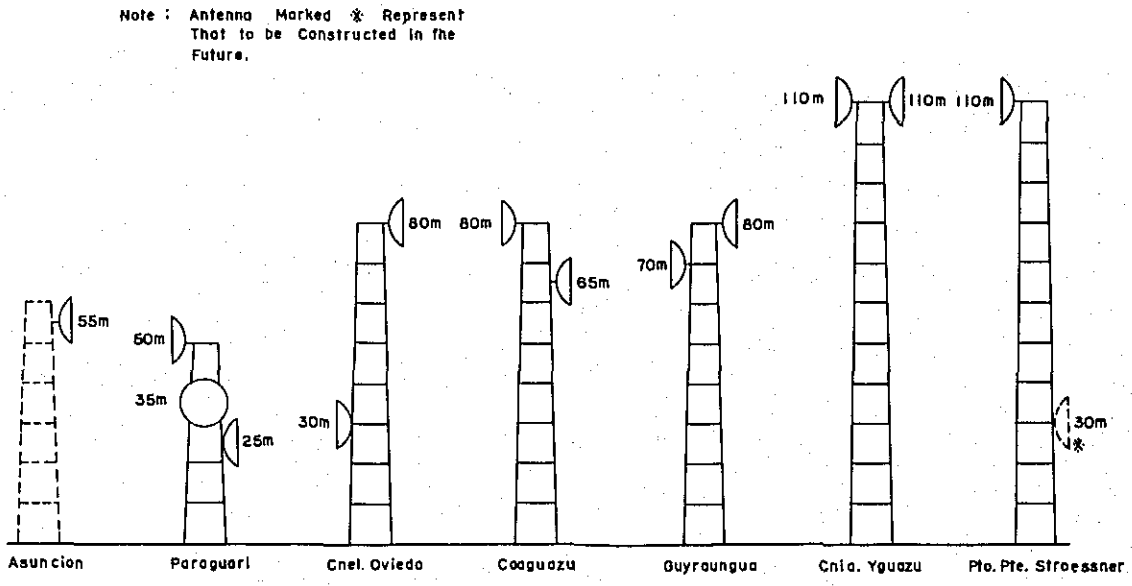


Fig. IX - 2 Conceptional Figure of the Tower with Antenna

Table X - 1 Dimensions of Site and Working Space for Tower Installation

	Min. Dimension of Site	Working Space for Tower Installation	Note
Asuncion			Tower is already constructed by 2 GHz System Project.
Paraguari	30m x 35m	60m x 60m	
Valle Apua	25m x 30m	45m x 45m	
Caapucu	25m x 30m	15m x 15m	
S. J. Bautista	30m x 35m	80m x 80m	
Estero Camba	35m x 45m	100m x 100m	
Pilar	30m x 40m	100m x 100m	min. Working Space 35m x 35m
Paso de Patria	25m x 35m	100m x 100m	
Cnel. Oviedo	30m x 35m	80m x 80m	min. Working Space 30m x 30m
Caaguazu	25m x 35m	80m x 80m	min. Working Space 30m x 30m
Guyraungua	25m x 35m	100m x 100m	
Cnia. Yguazu	35m x 45m	100m x 100m	
Pto. Pte. Stroessner	35m x 45m	100m x 100m	

Table X - 2 Building and Fuel Tank

Name of Radio Station	Dimension of Building	Capacity of Fuel Tank
Asuncion	8m x 16m	4,000ℓ
Paraguari	8m x 12m	4,000ℓ
Valle Apua	8m x 8m	2,500ℓ
Caapucu	8m x 8m	2,500ℓ
S. J. Bautista	8m x 12m	4,000ℓ
Estero Camba	8m x 8m	2,500ℓ
Pilar	8m x 12m	2,500ℓ
Paso de Patria	8m x 8m	2,500ℓ
Cnel. Oviedo	8m x 12m	2,500ℓ
Caaguazu	8m x 8m	2,500ℓ
Guyraungua	8m x 8m	2,500ℓ
Cnia. Yguazu	8m x 8m	2,500ℓ
Pto. Pte. Stroessner	8m x 12m	2,500ℓ

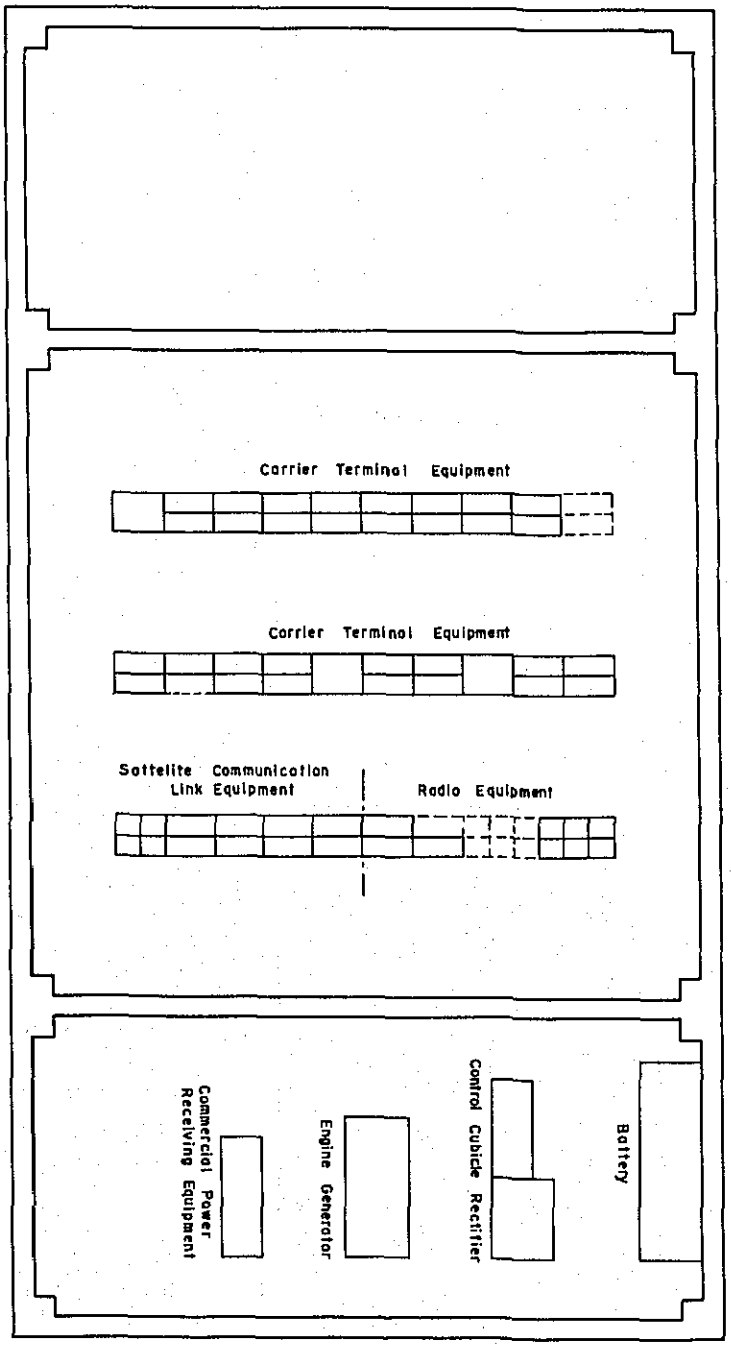


Fig. X - 1 *Station Layout for Asuncion*

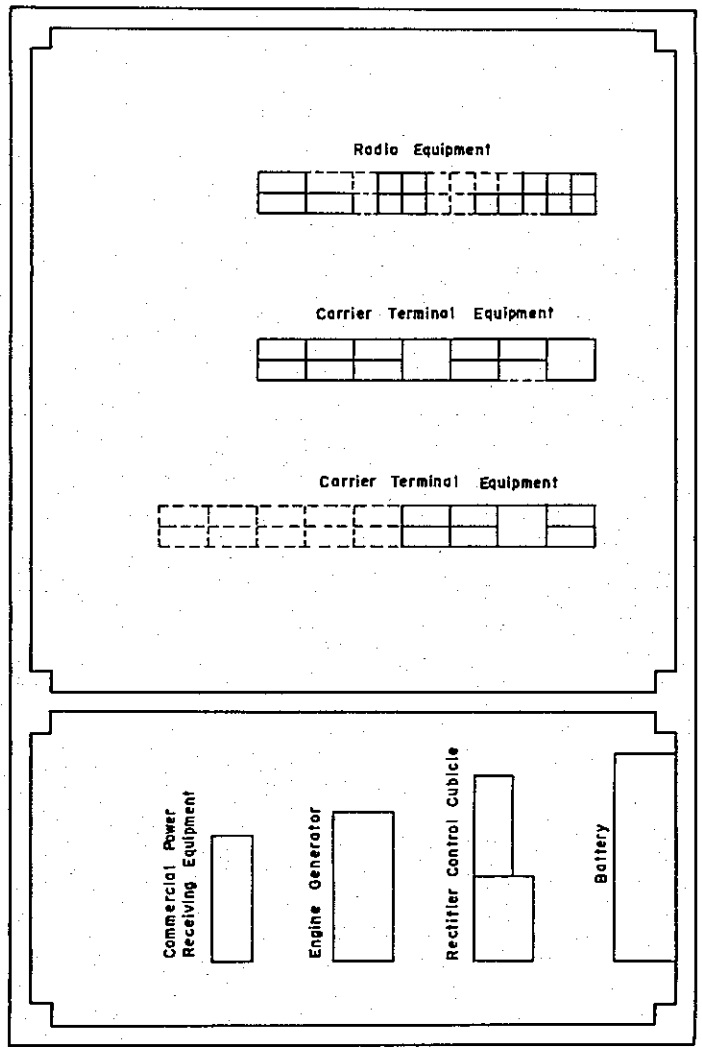


Fig X - 2 Station Layout for Paraguari

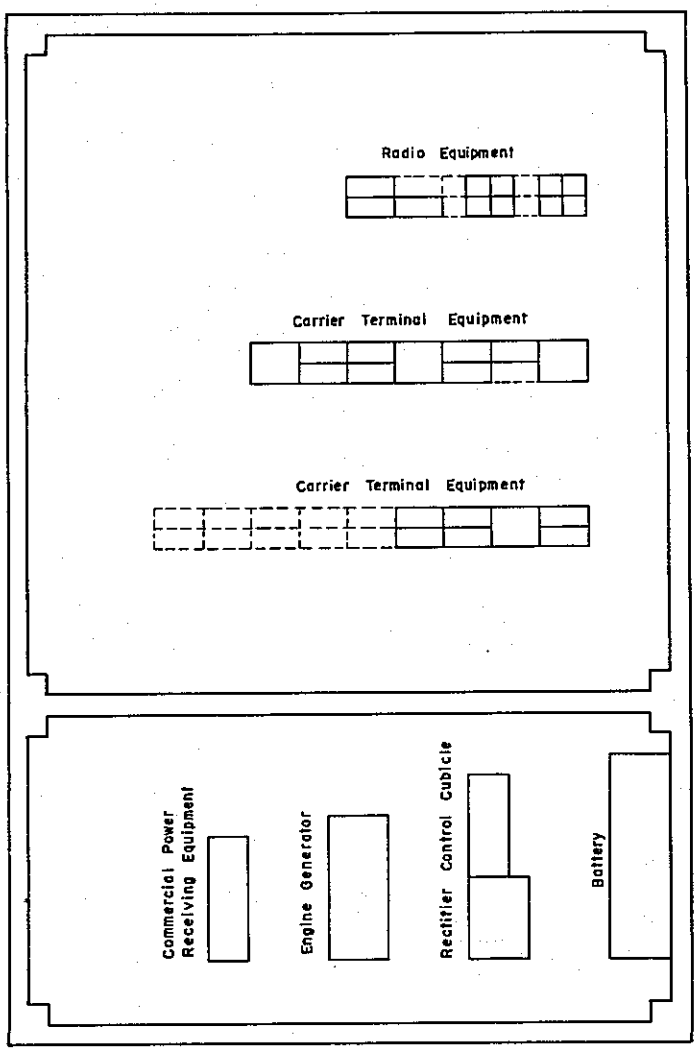


Fig. X - 3 Station Layout for Cnel. Oviedo

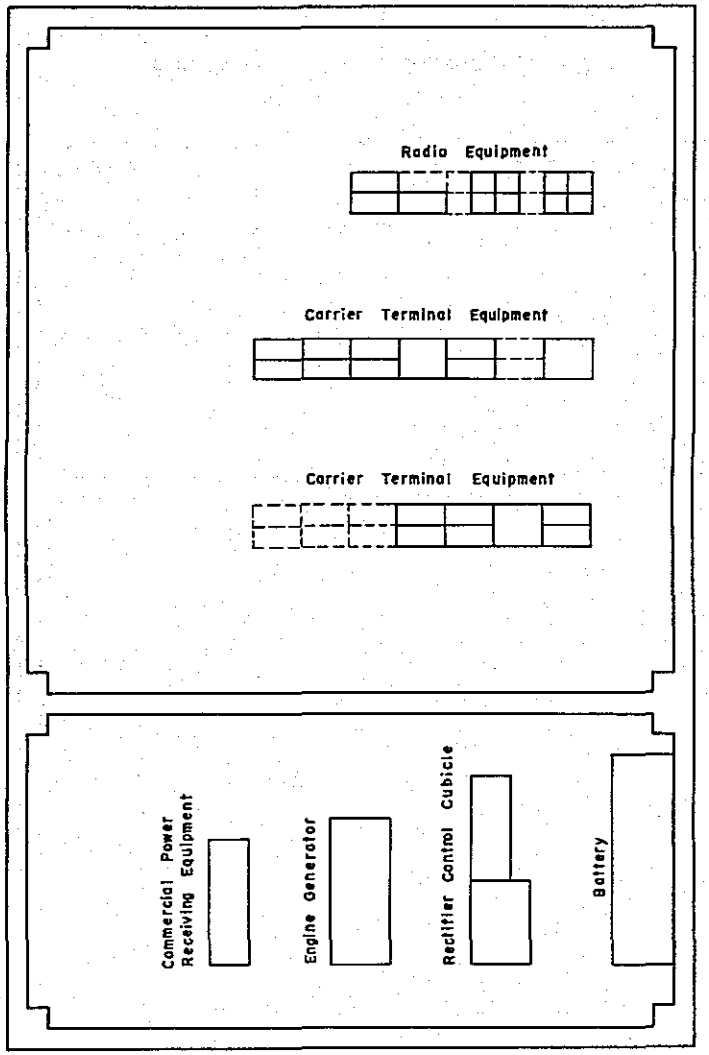


Fig. X - 4 Station Layout for Pto. Pte. Stroessner

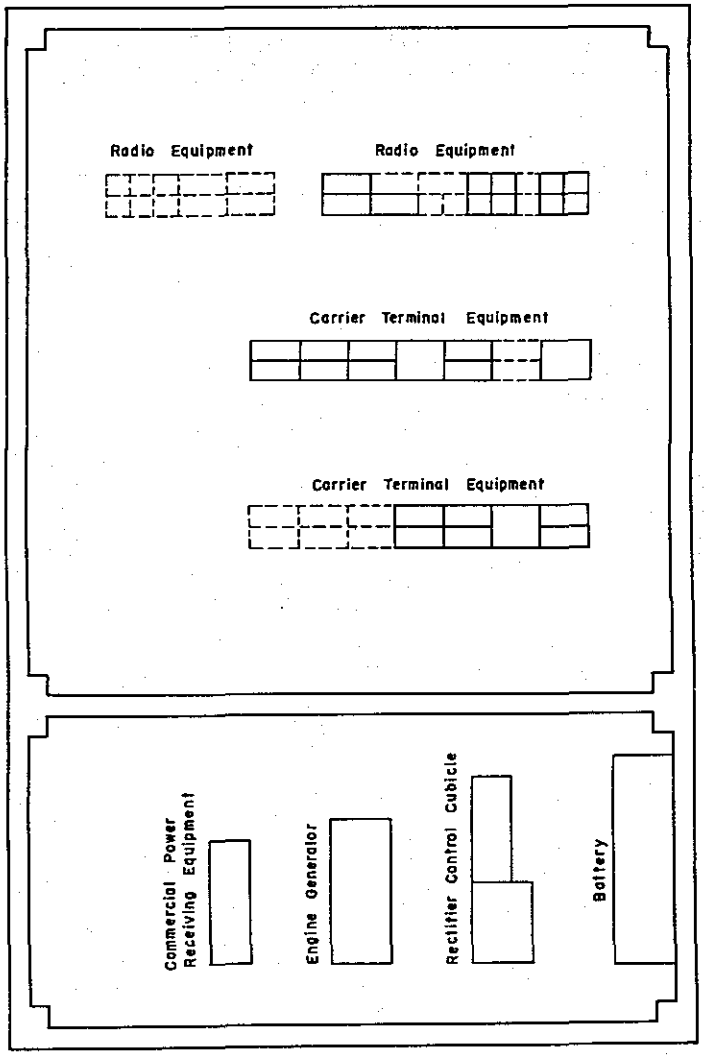


Fig. X - 5 Station Layout for S. Juan Bautista

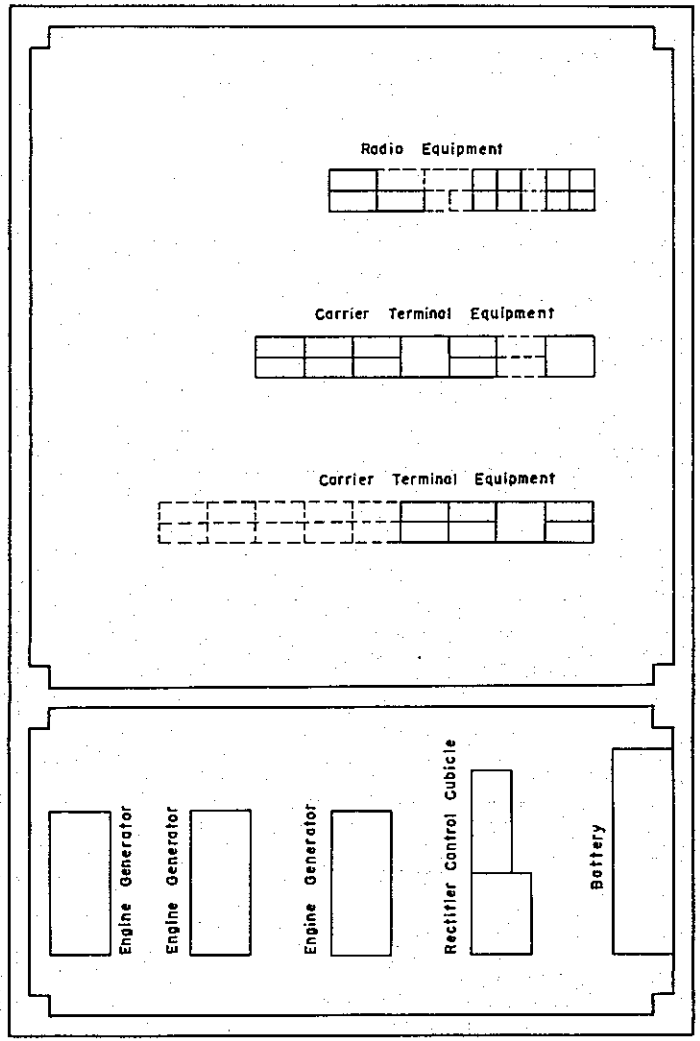


Fig. X - 6 Station Layout for Pilar

Note : Caaguazu ※
Guyraungua ※※
Cnia. Yguazu ※※
Valle Apua ※※
Caapucu ※

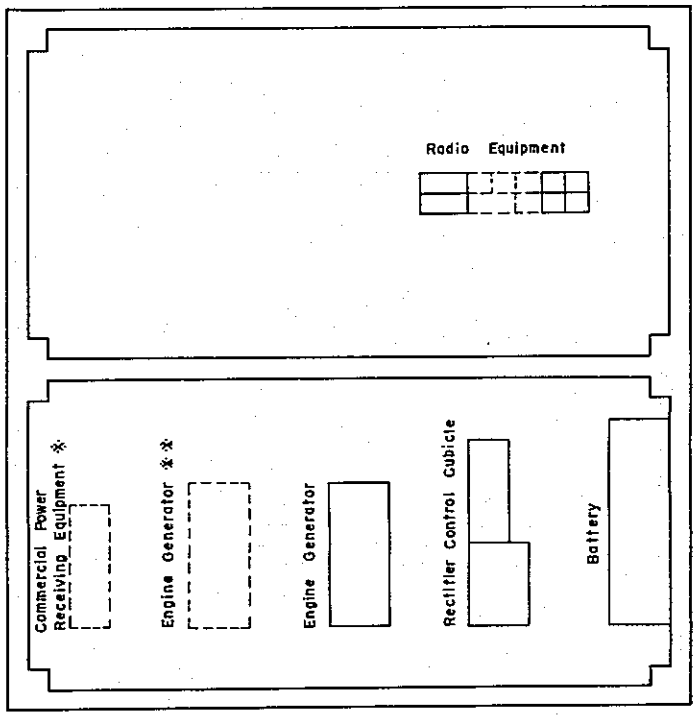


Fig. X-7 Station Layout for Caaguazu, Guyraungua, Cnia. Yguazu, Valle Apua, Caapucu

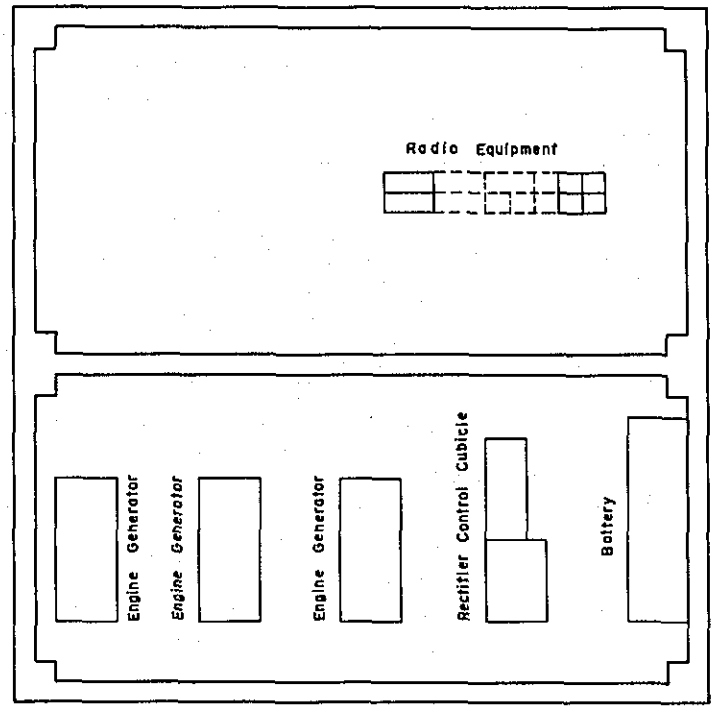


Fig. X - 8 Station Layout for Estero Camba, Paso de Patria

Table X - 3 Type of Earth

Purpose	Earth Resistance
Communication Equipment	10 Ω or less
Power Supply Equipment	10 Ω or less
Lightning	10 Ω or less

Table X - 4 Road to be Newly Constructed

Name of Radio Station	Approx. Distance	Note
Caapucu	1. 2 km	Road, between national road and radio station site, shall be newly constructed.
S. J. Bautista	0. 6 km	
Guyraungua	50 m	
Pto. Pte. Stroessner	50 m	

Table XI - 1 List of Measuring Equipment for Maintenace

Common Measuring Equipment

(1) Using at All Around Station

MULT-M	Multi-range Volt-ammeter
TESTER	Circuit Tester
MEG	Megger

(2) Using at Terminal Station only

HV	High-impedance Voltmeter
OSILLO	Oscilloscope
REC	Pen Recorder

Measuring Equipment for Microwave System

(1) Using commonly, Both of Telephone and Television

BSG	Baseband Signal Generater
BLM	Baseband Level-meter
NM	Noise Measuring Equipment
LIN	Linearity Measuring Equipment
DELAY	Delay Measuring Equipment
AMP	Amplitude Characteristics Measuring Equipment
DEV	Deviation Measuring Equipment
RFM	Radio Frequency-meter
RFPM	Radio Frequency Power-meter
IFSG	IF Test Signal Generator
IFLM	IF Level-meter
REP	Measuring Equipment for Repeater
SC	Measuring Equipment for Service Channel

(2) Using for Television only

TVSG	Television Test Signal Generator
TVM	Television Circuit Performance Measuring Equipment
MM	Master Monitor

Measuring Equipment for Multiplex System

CSG	Signal Generator for Carrier System
ASG	Signal Generator for Audio System
CLM	Level-meter for Carrier System
ALM	Level-meter for Audio System
SLM	Selective Level-meter
PSO	Psophometer
IS	Impulse Sender (Including Impulse Distortion-meter)

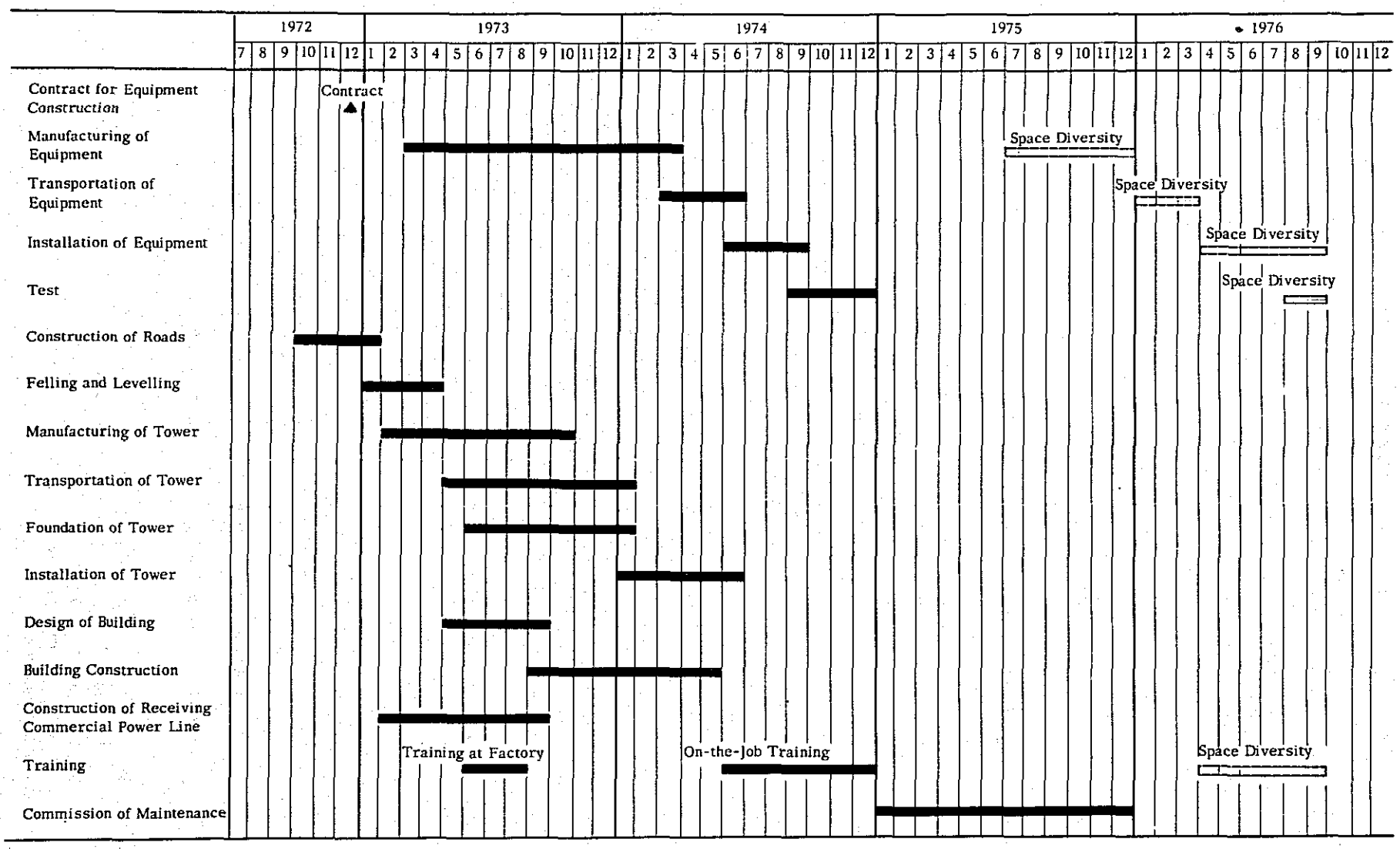
Measuring Equipment for VFT System

VTM	VFT Transmission Measuring Set
TDM	Telegraph Distortion Measuring Set

Measuring Equipment for Power System

Portable 3V Volt-meter for Battery Checking
Syringe Hydrometer
Battery Thermometer
Tachometer

Fig. XV - 1 Construction Schedule



Note: This schedule will be applied, if the contract for equipment construction including international connection sections should be concluded before December, 1972.