REPUBLIC OF PARAGUAY

CONSTRUCTION PROJECT OF EARTH STATION FOR SATELLITE COMMUNICATIONS

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 Construction Project of Earth Station for Satellite Constructions 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 1972, the planning report on the master plan of this project.

The microwave circuit network project included in the construction project of telecommunication facilities in Paraguay is being promoted, forming the Pan-American telecommunication network -CITEL-, by Ministerior de Obras Públicas Y Communicaciones and its subordinate agency, Administración Nacional de Telecommunicacions –ANTELCO– of that country. While under this project the construction of an earth station is planned for the long-distance international telecommunication.

In response 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.

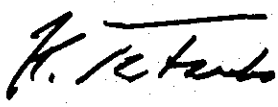
In order to perform the assignment entrusted by the Government of Japan, the Agency dispatched a survey team to undertake the necessary investigations for 35 days from August 1971, under the cooperation of the Ministry of Posts and Telecommunications

-MOPT-, Nippon Telegraph and Telephone Public Corporation -NTT- 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

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I. INTRODUCTION

In designing the implementation plan for the construction of satellite earth station in Paraguay, consideration has been given particularly to such requirements that the station will not only possess all necessary technical characteristics to have access to the INTELSAT communications satellites, but it will also be able to provide easy maintenance and operation.

It should further meet the requirements of economic viability. Above all, the station should be such the is most suitable in all respects to the specific situation of the Republic of Paraguay.

We firmly believe that the projected earth station will bring improved transmission quality and hence improvement in services to the international telecommunications in Paraguay, and resultantly contribute to a speedy development in economy of the country.

The feasibility survey of a prospective satellite earth station in Paraguay was conducted for the first time in February-March 1970 by two communications specialists dispatched by the Japanese Government. Their report has already been submitted to the Paraguay authorities.

The second survey was carried out by a Japanese Government's survey team in August-September, 1971, at the same time as the survey of the construction of a terrestrial microwave network.

The report of second survey was drawn up by making some additions and amendments to the recommendations set forth in the report of the first survey, taking into account the changes in general aspects and technical report of the first survey, taking into account the changes in general aspects and technical advancement brought about in one and half year period since the first survey, as well as the firsthand experience gained in Paraguay by the second survey team.

An implementation plan of earth station construction in Paraguay will be described in the succeeding paragraphs on the basis of the findings of surveys

as mentioned above.

The report of the second survey team is attached hereto as Annex-1 (Basic Considerations for the Establishment of Satellite Communication System in Paraguay).

II. IMPLEMENTATION PLAN AND EARTH STATION CONSTRUCTION PROJECT

1. Objective

This implementation plan deals with various technical characteristics of the earth station facilities, central station facilities, and terrestrial microwave connecting link in respect of the earth station complex that is going to be established in Paraguay for the purpose of participating in the INTELSAT-IV satellite communication service.

2. Scope of Project

The construction project envisaged in this plan will include the construction of earth station and associated facilities thereof as described in paragraph 1 above, as well as checking of performance characteristics of these facilities, training of technical operators and, if required, conducting of earth station maintenance work on the basis of consignment.

However, it is considered that the Paraguayan authorities will have to assume responsibility for the matters illustrated below, which are incidental to the implementation of this project.

i. Accession to the INTELSAT and necessary arrangment therefor.

ii. Arrangement for establishment of communications circuits with other countries.

iii. Coordination of radio-wave interference with adjacent countries.

iv. Procurement of land for earth station construction site.

v. Construction of access road to the earth station site, laying of power supply cable and installation of subscriber's telephone lines.

vi. Extension of Central II Office building, power receiving equipment (incl. Diesel-engine generator) and microwave antenna tower on the Central II building.

vii. Circuit shifting arrangment between high-frequency and satellite circuits.

3. Promotion of Project

It will be instrumental to the ANTELCO to have a temporary of organization such as "Earth Station Construction Promotion Committee" for smoother realization of the project. It is also advisable that the Paraguayan authorities employ, for efficient implementation of this project, and engineering consultant who has substantial ability and is able to offer necessary assistance in a wide range of technical aspects.

III. SYSTEM DESIGN APPROACH

1. Design Philosophies

In conducting satellite communications system designing, the following documents were employed as a reference for its standards and basic idea.

(1) Report on the survey with regard to earth station construction project.

(a) Annex-1: Basic Considerations for the Establishement of Satellite Communications System in Paraguay, September, 1971.

(b) Construction Projects of Microwave Network and Earth Station for Satellite Communications, Volume I, Planning Report.

(c) March, 1970, Specialist Team Japan, Basic Considerations for the Establishment of Satellite Communications System in Paraguay

Preliminary Report

(2) ITU Regulations

(3) CCIR and CCITT Recommendations

(4) ICSC Document 45-13E W/1/70, 14th January, 1970. Amendment and Revision thereof

(5) ICSC Document 37-38E/1/69 January, 1969

(6) Satellite System Operations Plans and Satellite System Operations Guide.

(7) Other ICSC documents

2. Technical Characteristics of Standard Earth Station in INTELSAT System

The interim Communications Satellite Committee (ICSC) has specified the technical characteristics of the standard earth station in respect of the INTELSAT-IV satellites in its Document 45-13E referred to above, and with respect to the INTELSAT-III satellites, specification was made in the ICSC Document 37-38E as mentioned above.

We indicated the characteristics of these two systems in the same table as shown in Annex-2 so that the differences between these two satellite

systems may be more clearly recognized.

The system designing of earth station complex should be made to satisfy these technical characteristics to the greatest extent and to enable an easier maintenance and operation of the facilities.

3. System Configuration

3.1 Communications Satellite

In the Atlantic region, both INTELSAT-III and-IV series satellites are now in orbit being used for international communications.

At the time of operational commissioning of the projected Paraguay earth station, however, it is anticipated that the traffic so far routed through the INTELSAT-III will all have been shifted to the INTELSAT-IV satellite. With this in view, the system of earth station will be designed for access to the INTELSAT-IV satellite.

At present, the INTELSAT-IV F-2 satellite is positioned over the west longitude 24.5^{o}. Fig. 1 represents the ground area where the satellite IV F-2 can be witnessed at the elevation angle of 5^{o}.

3.2 Access Mode and Service Classes

As shown in Annex-1, page 2, paragraph 2.2, the recommended access mode of telephone circuits (incl. telegraph and telex circuits) includes both of FDM-FM system (Frequency Division Multiplexing-Frequency Modulation System) that has pre-assigned multiplex access capability and SPADE system (Single Channel Per Carrier PCM Multiple Access Demand Assignment Equipment) that provides a demand assigned multiple access feature.

For telegram and telex circuits, the VFT multidestination system will be adopted, in which one voice channel carries 24 teleprinter channels.

Designing of television transmission system will be accomplished

so as to make it possible to transmit colored TV video. However, the television terminal will be equipped for monochrome only.

3.3 Establishment of Satellite Circuits

In establishing satellite communications circuits, consideration should be given to the following factors.

(1) Number of outbound circuits of Paraguay

(2) Number of inbound circuits

(3) Communication circuits with adjacent countries connected to CITEL's Pan-American Terrestrial Microwave Network

(4) Emergency measures

(5) Assessment of future traffic demand and arrangement for increase in traffic volume

(6) Existing international circuits operated in high-frequency system or via relay route

In view of the above factors, and from the technical and economic viewpoint as well, it will be appropriate to establish telephone circuits (incl. telegraph and telex circuits) that comprise a minimum size of 24 channels in FDM-FM system, 3 channels in SPADE system and one television transmission circuit.

Establishment of SPADE circuit not only permits capability of connecting to all of the SPADE-equipped earth stations that have access to the Atlantic INTELSAT-IV satellite, but it also enables to take over, for transmission, the traffic overflowed on the FDM-FM circuits.

3.3.1 Destinations for the Initial Project (- 1975)

Destinations: 7 countries
Argentine, Chile, Peru, the U. S. A.,
Brazil, Spain, West Germany

3.3.2 Destinations for the Future Project (1976 - 1980)

Destinations: 9 countries
Italy and Urguay in addition to the abovementioned 7 countries

3.3.3 Number of Cicruits

The satellite circuits will be established as listed in Table 1 according to the estimate of circuit requirements. The equipment will be so planned as to have flexibility against the increase or decrease in the number of satellite circuits.

Table 1 Satellite Circuits of Paraguay

Number of circuits / Destination	Telephone		Telegraph	
	- 1975	1976 - 1980	- 1975	1976 - 1980
Argentine	5	7	2	3
Chile	2	3	1	1
Peru	1	SPADE	3	4
U. S. A.	8	11	7	7
Brazil	1	1	-	-
Spain	1	SPADE	-	-
W. Germany	-	SPADE	7	8
Italy	-	SPADE	-	2
Urguay	-	SPADE	-	2
Total	18 (SPADE)	22 SPADE	20	27

3.3.4 Number of Radio Carrier-Waves

In order to accommodate the satellite circuits listed in Table 1, carriers will be allocated as shown in Table 2.

The carrier frequencies will be determined according to the

Atlantic Region Satellite System Operation Plan (SSOP) which will be in effect at the time of commissioning of the Paraguayan earth station.

Table 2 Number of Radio Carrier-Waves

Carriers / Item	Transmission		Reception	
	- 1975	1976 - 1980	- 1975	1976 - 1980
Telephone (incl. telex and service circuits)	1 (SPADE)	1 SPADE	7 (SPADE)	9
TV-Video	1	1	1	1
TV-Cue and Sound	2	2	2	2
Total	4 (SPADE)	4 SPADE	10 (SPADE)	12 SPADE

3.3.5 Transmit Carrier Bandwidth

FDM-FM carrier	2.4 MHz/carrier
SPADE carrier	45KHz/carrier in 36MHz
TV-video carrier	30MHz/carrier

3.3.6 Operation Hours

24 hours continuous

IV. SITE LOCATION

1. Earth Station Site

1.1 General

With regard to the selection of earth station site, the report of the first survey team, submitted in May, 1970, mentioned three areas of SAN RAFAEL A-1 and A-2 which are situated in the vicinity of a radio receiving station and YBYRATY. Among these site areas, SAN RAFAEL A-1 was proposed as a most promising site.

As the result of the second survey, however, it was revealed that the area covering SAN RAFAEL A-1 and A-2 is situated directly under a circular flight route of planes landing on or taking off the Asuncion airport. It was also noticed that these proposed sites are lying as near as only 13Km away from the center of the city of Asuncion and that urbanization program was in progress at a high rate in these suburban areas.

Thus we are afraid that the establishment of an earth station in such areas will possibly restrain the outward development of the city of Asuncion in future. Under the circumstances, we propose, in addition to the avove, AREGUA B-1 and B-2 for a station site.

1.2 Conditions for Selection

In making selection of a station construction site, the following conditions were considered.

(a) Meteorological requirements

(b) Harmful noise source and interference of terrestrial microwave network

(c) Clearance of the air above the elevation angle of 3^{o}

(d) Development program in the areas surrounding the projected station site

(e) No ill-effect of airport and flight routes

(f) Easy installation of a connecting link between earth station and central station

(g) Easy construction of access road to the site and availability of power and water supply

(h) Isolation from highways with excessively heavy traffic

(i) Absence of high tension power lines of 220KV or higher within 1Km around the site

(j) Land of 7ha or larger available for the site

(k) Bearing power of soil enough for the earth station antenna

(l) No possible spoiling of the natural beauty and satisfactory living environment

(m) Countermeasures against calamities

1.2.1 Meteorological Requirements

1.2.1.1 Wind Velocity and Direction

One of the factors that seriously affect the antenna performance is the wind. In the event that the strong wind forces the antenna to deviate more than 0.03^{o} from its due azimuth, the transmission quality will be badly affected.

Considering from the fact that AREGUA is at the distance of about 23Km from Asuncion, the weather conditions in AREGUA area may be inferred from that of the Asuncion area.

The annual average wind velocity in Asuncion is 10-12KPH (approx. 2.8-3.3MPS). A maximum instantaneous wind velocity of 122KPH (34MPS) was recorded in February, 1953, which is the greatest ever recorded during the period from 1933 to 1969. (Reference 1)
The average wind velocity at that time comes to be 81KPH (23MPS), taking the gust factor at 1.5.

Taking such factors into consideration, the antenna should be designed with some margin so that it can be placed for operation under such a strong wind as of the average velocity of 90KPH (25MPS), and also it may not suffer any irrevocable deformation by such a strong

wind as of the maximum instantaneous velocity of 135KPH (38MPS).

1.2.1.2 Precipitation

It is a common knowledge among the communications engineers that a severe rainfall may sometimes cause deterioration in the transmission quality. However, the findings of the survey revealed no such severe rainfall in the district of the earth station site.
(Reference 3.8)

A cloudy weather takes place for 70 to 80 days annually in this district. And the thickness of cloud measures about 100-120m.

1.2.1.3 Temperature

According to the attached Reference 5.8, which gives information on temperature in the Asuncion district, the annual average temperature in the suburbs of this city is 24.2°C. The annual average highest temperature is 28.4°C, while the lowest is 18.9°C. Also, the absolute highest temperature is 41.8°C in January, while the lowest is 2.3°C in August.

The change in temperature often takes place being influenced by the wind direction and velocity. The greatest rate of change recorded in the past is the rising of 3°/hour and falling of -6°/hour.

For antenna system designing, considerations should be given to the following factors.

(a) Rising of antenna surface temperature to the caused by sunshine

(b) Degradation of mirror face accuracy to be caused by irregularities of temperature on the main- and sub reflectors

(c) Change in the correlative position between the main- and sub-reflectors and in the angle thereof

(d) Oil for oil pressure motor if it is in use

Speaking of (a) avove, the experiment tried in Japan tells us that

the atmospheric temperature rises + 15°C in case of aluminum panel with no painting finish or with silver dust painting finish and that it rises + 3°C in case of aluminum panel painted in white.

Thus, if the antenna is painted in white with materials that are temperature-proof and of a long life, the surface temperature can be kept under 59°C in a gentle wind even in the case of the aboslute highest temperature. Therefore, no special consideration is needed on this matter.

As for (b), the accuracy of mirror face is liable to degrade as irregularities take place in temperature on the surface of the reflector when there appear both sunny places and shady places around the reflector.

It is known that degradation of 0.10-0.15mm rms will result in case the antenna is radiated by the sun from the oblique direction with the angle of 45°. Supposing that the manufactured reflector has an accuracy of 1.0mm rms, the rate of overall degradation comes to be nearly 1%. Thus, there arises no particular problem in this matter.

It sometimes occurs that as the surface temperature makes a quick rise, elastic deformation follows it, resulting in an excessive degradation of the mirror face accuracy. However, our study on the weather of Paraguay ensures that there is practically no possibility of such an extraordinary phenomenon in Paraguay.

With regard to the degradation of mirror face accuracy of reflector, change in the correlative position between reflectors and change in their angels as cited in (c) above, all these factors have been resolved with the highest manufacturing technique and temperature-proof arrangement. The values of these factors are kept at 0.006mm rms, 0.16mm and 0.007°, respectively, at which no trouble is anticipated on the electrical performance.

If an oil pressure motor is to be used, as indicated in (d) above,

it must be noted that the temperature characteristic of oil considerably differs with summer and winter time.

This makes it necessary that a certain control system will be incorporated in the oil container so as to keep the temperature constant, or else the oil should be replaced with the change of the season.

1.2.1.4 Others

The facts on the weather are given in Data Reference 1 - 8 with respect to those other than described above.

We see no specific problem to be considered for the weather in designing the earth station antenna and communications equipment. But one thing noticeable is that the area in question has a pretty many thunders. Lightining arresters should therefore be installed to provide against the damages of thunders.

1.2.2 Interference

The land contour shown in Table 3. represents a coordination distance of the projected earth station, which was determined upon calculations with justifiable parameters.

Under this coordination distance, there exists little possibility of mutual interference between this earth station and the terrestrial radio relay system of the adjacent country (Brazil) or any other radio system located at a distance roughly equal to the above.

1.2.3 Skylines

The surrounding areas of the site for station are occupied by low hills having a skyline of no more than 3^{o} in elevation. In so far as the skyline is concerned, no difference exists between the respective sites.

1.2.4 National Land Development Program

The each proposed site has been selected in such places as have no possible development program in near future. Their neighboring areas do not contain factories or any other such facilities that might constitute obstacles to the operation of the station.

However, SAN RAFAEL A-1 and A-2 are situated as near as 12Km from Asuncion. And urbanization is now progressing at a rapid rate toward the outskirts of the city. Under the circumstances, the erection of earth station facilities in these areas may possibly prove a yoke on the future development of the city of Asuncion.

1.2.5 *Airport and Flight Route*

There are a military and a civil international airports about 4Km northwest of SAN RAFAEL A-1 and A-2. Their location is shown in Reference 15. In Reference 9 is indicated the circular flight route of the airplanes taking off or landing on the Asuncion international airport. This circular route passes through over the areas of SAN RAFAEL A-1 and A-2. Thus, it will be advisable not to relay on such unfavorable areas for the station site.

1.2.6 *Terrestrial Connecting Link*

For a transmission system to connect the earth station with the central terminal station, one-hop 7GHz microwave relay system with unattended operation is considered most appropriate in view of the fact that the satellite communication link usually carries such broad-bandwidth signals as for colored television video and multiplex telephony.

The INTELSAT-IV satellite is assigned a frequency band for exclusive use in television transmission and equipped with a transponder therefor. And almost all of the existing earth stations have an installation of television receiving system, to say nothing of a system for transmission.

The findings of our survey assure transmission of excellent quality over a single-hop microwave link.

1.2.7 Subsoil Characteristics

So far, soil test has not yet been carried out with respect to the soil of each site. However, information has been obtained on the vertical soil distribution in the site of the radio receiving station, which is given in Reference 10. We presume that no significant difference exists among respective station sites in respect of subsoil characteristics. But it will be necessary, upon decision of the site selection, to conduct a standard interpenetration test. Information should also be obtained on the level of underground water.

1.3 Site Proposed

Table 4 gives a comparison of the sites for the construction of earth station in regard to various factors mentioned previously.

The areas of AREGUA B-1 and B-2 have been indicated in the station sites for selection as a result of the implementation of the second survey, for reasons stated above. These two new sites are located within the range where a single-hop microwave link can be established with the Asuncion central terminal. Reference 11 shows their locations on a map, and Reference 12 represents a terrain of AREGUA B-1 and B-2 and their neighboring areas. The making is given in Table 4 with respect to the precedence of the proposed sites based upon the overall assessment of the finding of our survey.

We are of opinion that AREGUA B-1 (B-2) should be selected as a most suitable area for the station site, except for the standard interpenetration test of soil. AREGUA B-1 is situated on a low hill some 24Km east-south-east of Asuncion.

The geographical location of AREGUA B-1 and its bearings to the

satellite (IS-IV F-2; west longitude 24.5°) are as follows.

Location:	South latitude	25° 21' 40"
	West longitude	57° 22' 10"
	Above sea-level	160 m

The azimuth, elevation and range of the INTELSAT-IV F-2 satellite viewed from the earth station are as shown in Table 5.

Table 5 Azimuth, Elevation and Range of the Atlantic Satellite (IS-IV F-2)

Position in orbits	Azimuth Elevation and Range from Paraguay Earth Station		
	Azimuth in degrees	Elevation in degrees	Range in Km
24.5°W	56.49	43.05	37583.27
25.8°W	53.15	44.13	37498.57

Fig. 2 represents the azimuth, elevation and range of the satellite which is withessed from the Paraguay earth station (AREGUA B-1) as it positioned over the Atlantic Ocean between the west longitude 57°and east longitude 20°.

1.4 Construction Apporach

The land should be procured for the construction of earth station soonest as possible. The area extending 7ha or more will be needed for the site. The sites for buildings and antenna will be determined after the subsoil investigation has been completed, which will be carried out by an engineering contractor prior to the construction.

2. Central Station

The central station equipment for satellite communications will be

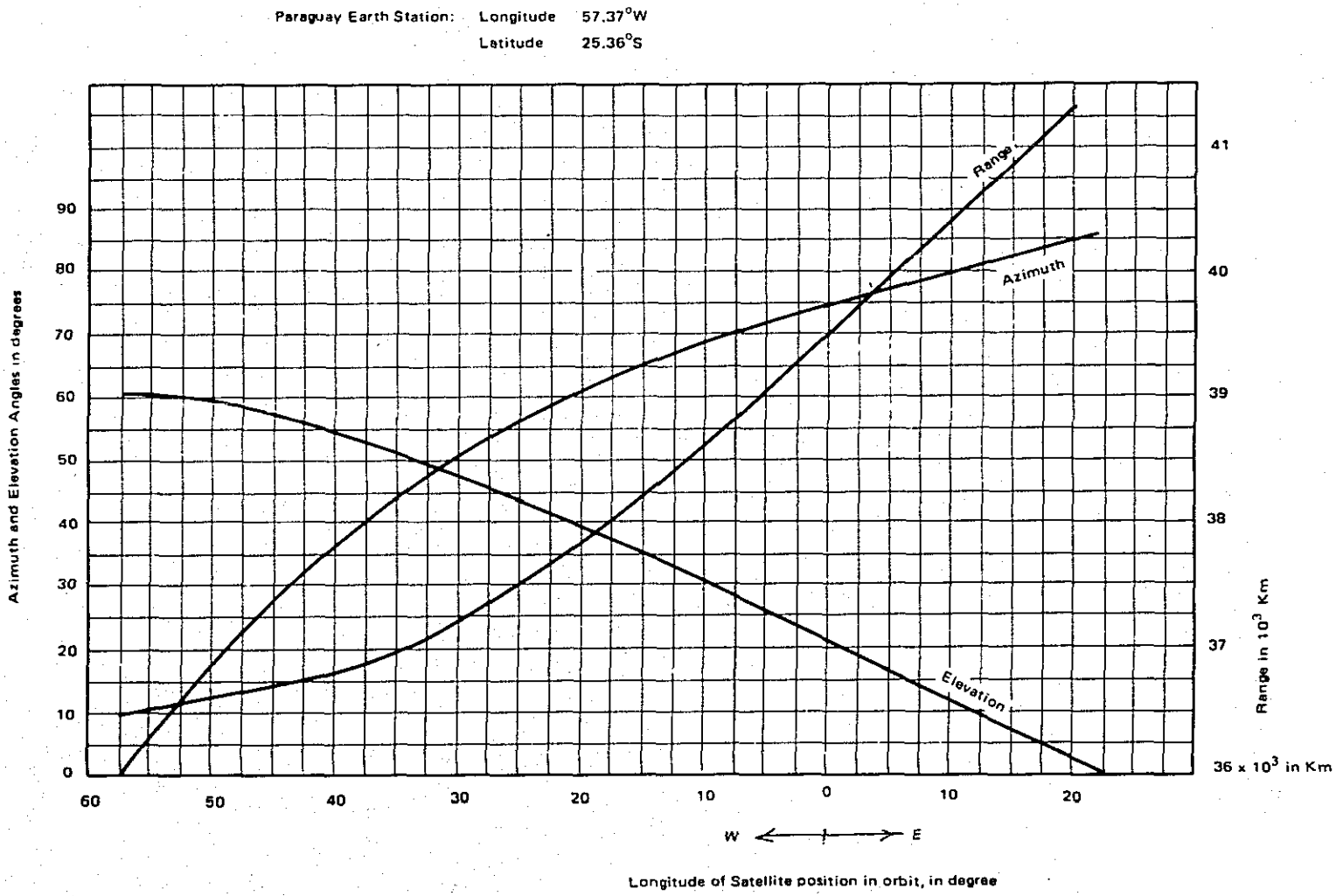


Figure 2 Azimuth Angle, Elevation Angle and Range from Paraguay Earth Station, the Atlantic Ocean Satellite

housed in the existing ANTELCO's Central II Office building located in the city of ASUNCION, and also in the Annex to be erected adjacent to the existing building under a separate project.

The antenna tower on the Central II Office building will be positioned as follows.

South latitude	25^{o} 17' 40"
West longitude	57^{o} 37' 05"
Above sea-level	143m

V. EQUIPMENT AND FACILITIES

1. General

Construction of the satellite communications facilities as mentioned in Chapter II "Implementation Plan and Earth Station Construction Project" will be accomplished in accordance with the manner outlined in Chapter III "System Design Approach".

The installation of equipment and facilities will be conducted with the aim to have access to the INTELSAT-IV series satellites. However, the equipment configuration will include such that will be provided for foreseeable future expansion requirements. Consideration will also be given to such requirement that they may be placed in use for possible new satellite systems in future with minimum modification. And in particular they should be most suitable to the specific situations of Paraguay.

2. Equipment Configuration

The equipment and facilities under this project are mainly composed of earth station equipment, connecting link equipment, and central station equipment. The earth station equipment will be installed in the earth station buildings, the central station equipment in the Central II Office buildings; and the connecting link equipment will be installed partly in the earth station building and partly in the Central II Office building.

The earth station equipment consists of the antenna system unit, transmitter unit, receiver unit, terminal equipment, SPADE system unit, power supply plant, control and service buildings and accessory equipment. The connecting link equipment is mainly composed of 7GHz radio transmitters, receivers and antenna.

The central station equipment comprises terminal equipment for telephone, telegraph and television transmission, international telephone switchboards and power supply apparatus. Fig. 3 indicates a blockdiagram of the

Paraguayan earth station to be constructed under this project.

3. Design Principle

The design of this earth station complex is outlined in Chapter III "System Design Approach". Besides the above approach, the following matters should be taken into consideration.

(1) Designing of earth station equipment will be made for the purpose of communicating with the INTELSAT-IV satellites, with capability of having access to any future satellite system with minimum modification.

(2) The performance reliability of the equipment should be better than 99.8% throughout the year. The principal units of communication equipment which are vital to the reliability should be installed on a dual basis for redundancy purposes.

(3) Equipment should be designed for easy maintenance and operation as far as possible. And arrangement should be made to enable the operation of the equipment from the control room as a rule.

(4) Addition and change (frequencies and channel sizes) of the equipment should be made possible with ease.

(5) Parts and components should be of solid-state construction except those for specific requirements.

(6) Safety of technical operators and repairmen should be insured and their mishandling of equipment minimized.

4. General Requirements

(1) The antenna will be mounted on the basis of azimuth/elevation mode, with wheel-on-track steering features, which enable us to install the radio transmitter and receiver system at the base of the antenna.

(2) For driving of the antenna, an SCR servocontrol electric motor will be used.

(3) The antenna will be of modified Cassegrain type with the main reflector aperture of 28m or more.

(4) Tracking command will be given on an automatic as well as manual basis.

(5) Klystron will be equipped in the transmitter as a power tube for economy and in particular for performance stability.

(6) Helium gas-cooled parametric amplifier will be provided in the first stage of the receiver system.

(7) Change of frequencies or channels may be accomplished by effecting simple adjustment or by replacing panels.

(8) 7GHz microwave connecting link will be a single-hop setup.

(9) For power system, both the earth station and central station will have no-break type installation except for general purpose use. A Diesel-engine generator will be installed for reserve.

(10) The system will provide 525/60 and 625/50 monochrome TV transmission capability. However, the equipment will be so designed as to have such characteristics as capable of 525/60 NTSC color TV transmission.

(11) No television standards converter will be installed.

(12) Switching of international telephone calls will be conducted on the basis of ring-down system.

5. Earth Station Equipment and Facilities

5.1 Antenna System

5.1.1 General

Antenna system is such that the communications antenna transmits radio signals in the 6GHz band coming from the transmitter to a communications satellite in concert with the operation of tracking sub system, and also receives 4GHz signals from the satellite to supply them to the receiver.

It consists of such items of equipment and facilities as the antenna foundation, pedestal (constituting a part of building), reflector, feed, tracking, antenna drive, receiver for tracking, standard timer, movable foresight, meteorological apparatus, etc. Fig. 4 shows a block-diagram of the antenna system.

Both the antenna and tracking subsystems not only involve the greatest cost of all the installations in the earth station complex, but they often affect directly the overall earth station performance. Thus, they should meet the requirements for high performance characteristics and high reliability.

To satisfy such requirements, the antenna should be of modified nearfield Cassegrain type, equipped with a shaped reflector with multi-reflector type primary feed.

Another important factor of the antenna is the availability of easy maintenance and operation. Thus, the mounting will be in the wheel-on-track type. Table 5 gives a comparison between various conventional mounting modes and the one to be introduced under this project.

The feature of this wheel-on-track mode is that the maintenance of communications equipment is possible without regard to the bearings of the antenna, since all of the communications equipment are installed separate from mobile gears of the antenna.

5.1.2 Type of Antenna

(1) This antenna will be of fully steerable modified Cassegrain type with no radome protection. The main reflector will be 28m of greater in diameter so that the equation $G/T \geqq 40.7$dB may be satisfied under clear sky conditions at an elevation angle of 5°.

(2) The mounting will be in the azimuth/elevation mode. Azimuth rotation will be conducted in the wheel-on-track mode.

(3) The antenna pedestal is a supporting structure of the antenna and constitutes a part of the station building. The transmitter, receiver, refrigerator, antenna control unit; all these communications equipment will be installed on a ground-based location.

5.1.3 Drive of Antenna

(1) The drive of antenna will be conducted by means of thyristor-controlled electric motor. The motor will have an anti-backlash mechanism.

(2) The driving rate will be 0.3°/sec maximum, when operating to the quasistationary and stationary satellites.

(3) The wind velocity operation mode will be determined as follows, taking into account the meteorological data of the past in Paraguay.

i.	Hold in any position:	Up to 22m/sec average wind velocity (33/sec instantaneous wind velocity)
ii.	Drive to stow position:	Up to 30m/sec average wind velocity (45m/sec instantaneous wind velocity)
iii.	Survive in stow position:	Up to 45m/sec average wind velocity (60m/sec instantaneous wind velocity)
iv.	Fix in any position:	Up to 30m/sec average wind velocity (45m/sec instantaneous wind velocity)

5.1.4 Tracking Mode

(1) Tracking will be both automatic and manual. Programmed tracking capability will be considered.

(2) Auto-tracking will be on the basis of higher order mode monopulse system, in which reference beacon signal (Σ signal) and error signal (Δ signal) will be transmitted to the tracking receiver on a single channel or two.

(3) Auto-tracking accuracy required will be less than 0.02^{o} rms up to 22m/sec of average wind velocity.

5.1.5 Antenna Performance

The antenna subsystem should meet the following performance specifications.

(1) The Gain-to-noise Temperature Ratio (G/T) of the antenna should be greater than $40.7\text{dB} + 20 \log \frac{f}{4}$ under clear sky conditions at an elevation angle of 5^{o}.

(2) Antenna gain: $\geqq 59.8 + 20 \log \frac{f}{4}$ dB (f; GHz)

(3) Antenna sidelobe pattern:

a. First sidelobe:	More than 14dB down relative to the main lobe
b. Beyond 1^{o} or more to the center of main lobe:	More than 29dB down relative to the main lobe center

(4) Antenna steering range: $\pm 180^{o}$ Azimuth
$0 - 90^{o}$ Elevation

(5) Steerability:

The antenna should perticularly be capable of tracking the satellite that is positioned on the stationary orbit with up to 10^{o} orbital inclination and $\pm 10^{o}$ longitudinal drift.

(6) Frequency bandwidth of feed system:

Receive feed system: 3.7 - 4.2GHz
Transmit feed system: 5.925 - 6.425GHz

(7) Feed polarization:

Circular polarization:

Transmit from earth station: Left-hand
Receive at earth station: Right-hand

The voltage axial ratio of transmit in direction of the satellite should be less than 1.4dB.

(8) Frequency bandwidth of receive system:

3.705 - 4.195GHz

5.2 Transmitter Subsystem

5.2.1 General

This subsystem is such that it converts the video or IF signal, which is supplied from either telephone, SPADE or TV terminal equipment, into the RF signal to provide it to the antenna subsystem after amplifying it to

the specified level of output power.

As illustrated in the blockdiagram of Fig. 5, this subsystem consists of modulator, frequency converter, transmitter, system equalizer, IF patch, etc.

It comprises three kinds of transmit carriers, that is, for FM multiplex telephony, SPADE and television (TV-video and TV-audio).

The TV carrier, when it is not in use for TV transmission, is provided for a common reserve for the FM multiplex telephony and SPADE.

The transmitter will be equipped with an air-cooled or semiwater-cooled Klystron which permits frequency preset within the range of 5,725-6,425MHz. This power tube is preferred for reasons that its power consumption is small; it provides high efficiency; it is easy to handle, stable in operation; and what is more, it is available at low cost.

5.2.2 Transmitter

(1) Three units of transmitters will be provided to cater for transmission carriers as described in Table 6.

Table 6 Output Power and Power Tubes of Transmitter

	e.i.r.p. 10^{0} elevation (dBW)	Output Power (W) (Note 1)	Power tube in use	Remarks
FM multiplex telephony transmitter	74.7	72	1 KW Klystron	Tansmission of Global 24CH carrier
SPADE transmitter	63.5	5.5 x 3	1 KW Klystron	transmission of 3 SPADE carriers
TV transmitter	88 (V) 74.7 (C, S)	740 35	3 KW Klystron	Both TV-V and TV-C transmit TV-S

Note 1: Calculation was made on the basis of 63.0dB of the antenna gain, 0.5dB of feeder loss and 3.2dB of per stage loss of power duplexer.

(2) The transmitter comprises oscillation pre-amplifier, Klystron amplifier, waveguide switch, automatic power regulator, dummy load and power synthesizer.

(3) In the pre-amplifier is included a TWT amplifier which can cover the entire bandwidth of 5,925 - 6,425MHz at saturated power of about 10W.

(4) The Klystron power amplifier will be equipped with a Klystron tube which is of air-cooled or semi-water-cooled type. The Klystron will be of preset tunable type capable of covering the frequency range 5,925 - 6,425MHz. Capability of automatic frequency change will be incorporated.

(5) The output terminal of each transmitter will be provided with a waveguide switch for selection of the antenna or dummy load.

(6) In case of necessity, an automatic power regulator will be provided, when required, in order to regulate the e.i.r.p. within the specified permissible range ($\pm$ 0.5dB/day).

(7) The dummy load of the transmitter will be of aircooled type.

(8) Magic T will be provided as a power synthesizer which synthesizes the output power generated from the three units of transmitters to feed them to the antenna.

5.2.3 Trasmit Frequency Converter (Up Converter)

(1) The up converter is such that it converts IF signals supplied from modulator into RF signals in any desired frequency within the range of 5,925 and 6,425MHz.

(2) The converter will be of tunable type which permits frequency change with ease in the range of 5,925 - 6,425MHz.

(3) The IF BPF will be provided for limitation of the frequency within the specified bandwidth.

(4) Change of the number of channels (IF BPF, etc.) should be made possible by such a simple way as replacing panels.

5.2.4 Modulator

(1) The modulator is such that it converts baseband signals supplied from telephony or TV terminal equipment into IF-FM signals.

(2) The following functions will be included in this equipment. Hybrid circuit, out-of-band BEF, baseband power limiter, pre-enphasis circuit, energy dispersal signal supplement circuit, frequency shift adjust circuit, 60KHz PIL OSC and FM modulation circuit.

(3) Change of the number of channels should be made possible by such a simple way as replacing panels.

5.2.5 Others

(1) Transmit equalizer will be provided to make compensation for the amplitude and delay distortions taking place in the amplification stages succeeding the modulator as well as for distortions caused by the delay in satellite transponders.

(2) IF patch will be provided for testing and patching purposes in respect of IF signals.

5.2.6 Transmission Performance Characteristics

(1) Frequency bandwidth of transmission system:

5,930 - 6,420 MHz

(2) Equivalent isotropically radiated power (e.i.r.p.) at elevation angle 10^{o}.

24CH	74.7dBm
SPADE	Max 63.5dBm/ch
TV	88.0dBm

Note 1. Modification of El. angle (α ^{o})

$-0.06 (\alpha - 10)$ dB

Note 2. Minimum design value of e.i.r.p. will be derived from the addition of 1dB to the equation given in Note 1.

Note 3. Adjustable range will cover 10dB below the value considered in Note 2.

(3) Stability of e.i.r.p.

Nominal value $\pm$ 0.5dB

(4) Carrier frequency tolerance

①$\pm$ 150KHz for all telephony carriers except for the 2.5 and 5MHz global beam and spot beam carriers ($\pm$ 80KHz)

②$\pm$ 250KHz for TV carriers

③$\pm$ 200Hz for SPADE carriers

Long-term is assumed to be at least one month.

(5) Out-of-band emission

Less than 4dBw in any 4KHz band

(6) Intermodulation products

Telephone & Television.

Less than $26 - 0.06 (\alpha - 10)$ dBw/4KHz

α : elevation angle

SPADE:

Less than $23 - 0.06 (\alpha - 10)$ dBw/4KHz

Group Delay Equalization and IF vs. RF Gain/ Frequency Response are shown in Annex-2.

(7) Residual amplitude modulation

Less than - 20 (1 + log f) dB referred to the RF carrier level at the antenna output. (rms value, within 4KHz band, f is the center frequency in KHz of the 4KHz slot)

Above 500KHz: Less than - 74dB

(8) Sense of video modulation

Positive sense of modulation of the television video carrier such that a black-to-white transition at video causes the instantaneous radio frequency of the transmitted carrier to increase.

(9) RF energy dispersal

Energy dispersal for both telephony and television carriers shall be based on the addition of a low-frequency symmetrical triangular waveform to the baseband signal to the FM modulator.

(a) The maximum e.i.r.p. per 4KHz of their transmitter carriers does not exceed the maximum e.i.r.p. per 4KHz of the fully loaded carrier by more than 2dB.

Frequency: 20Hz to 150Hz

Frequency tolerance: $\pm$ 1Hz

(b) Television carriers

A fixed-amplitude symmetrical triangular waveform capable of producing up to 1 MHz peak-to-peak deviation.

Frequency: 20Hz or 30Hz

Phase: The point of inflection occurring during the filed blanking intervals.

5.3 Receiver Subsystem

5.3.1 General

This subsystem is such that it converts the 4GHz RF signals supplied from the antenna subsystem into video of IF signals to provide them to

the telephone, SPADE or TV terminal equipment.

As illustrated in the blockdiagram of Fig. 5, this subsystem consists of receiver, frequency converter, demodulator, pilot oscillator/detector,RF divider, receive equalizer, IF patch, switch, etc.

The initial capacity of receive subsystem will include nine FM multiplex telephony carriers, one TV (TV-V, TV-C, S) carrier and one SPADE carrier.

5.3.2 Receiver

(1) 4GHz RF signal supplied from the antenna system is brought to the low Noise Receiver by way of the waveguide switch.

(2) The Low Noise Receiver includes, as a pre-amplifier, a helium gas-cooled completely solid-state parametric amplifier, and is capable of amplifying RF signals in 3700 - 4200MHz frequency range.

(3) For a main amplifier, it includes a microwave transistor amplifier that amplifies RF signals in the 3700 - 4200MHz frequency range.

(4) The noise temperature of receiver is expected to be lower than 22^{o}K inclusive of that of the waveguide switch.

(5) So far as the parametric amplifier is concerned, it should include two identical units for redundancy.

5.3.3 Receive Frequency Converter (Down Converter)

(1) This converter is such that it converts any RF signal within the 3700 - 4200MHz frequency range supplied from RF divider, into IF Signal.

(2) It will be of a tunable type by which adjustment may be established to any frequency within the 3700 - 4200 MHz band.

(3) IF BPF will be provided for limitation of the frequency bandwidth.

(4) Change of the number of channels (IF BPF, etc.) should be made possible by such a simple way as replacing panels.

5.3.4 Demodulator

(1) This equipment is such that it demodulates IF-FM signals coming from the down converter into TV-video signals.

(2) This equipment will include following functions. FM demodulation circuit, de-enphasis circuit, energy dispersal signal eliminating circuit, pilot detection circuit, out-of-band BPF, squelch circuit.

(3) For demodulation will be used conventional demodulators for 432CH - 1872CH multiplex telephony and TV-video, and the improved threshold type for 24CH - 252CH multiplex telephony.

(4) Change of channels should be made possible by switching operation or by replacing panels.

5.3.5 Others

(1) Pilot oscillator and pilot detector will be provided for function of switching RF common amplifiers.

(2) Receive equalizer will be provided to make compensation for amplitude and delay distortions taking place in the receiver on the stages up to the demodulator.

(3) For the dividing of RF signals in 3700 - 4200MHz, a divider of 1 : 16 will be provided.

(4) For testing and patching of IF signals, IF patch will be provided.

5.3.6 Performance Characteristics of Receiver

Frequency bandwidth:	3700 - 4200MHz
Frequency response:	2dB (peak-to-peak)
Noise temperature:	22^{o}K or below

5.4 Spade System

5.4.1 General

SPADE (Single Channel per Carrier PCM Multiplex Access Demand Assignment Equipment) system is a multi-destination connecting system that has newly been developed with the purpose of improving the utilization of satellite channels.

To such a country as Paraguay, in particular, which is linked with a number of destinations, but has comparatively a small number of circuits per destination, the SPADE system is most suitable to introduce.

In this system, connection can be established, as actual traffic demand arises, by making use of carriers that are pooled in the communications satellite.

The feature of SPADE system is that the satellite frequency band of 36MHz is divided into two separate frequency slot groups of high band and low band, with a spacing of 45KHz. This makes it possible to derive 399 two-way telephone channel units, each of which makes a pair with one high band and one low band frequency slots. Each earth station is thus enabled to use any channel unit at any time for its communication purposes.

5.4.2 Configuration

Fig. 6 shows a configuration diagram of the SPADE system. It is composed of the following equipment.

(a) Terrestrial interface unit
(b) Demand assignment signaling and switching unit
(c) Channel unit
(d) IF subsystem
(e) Time and frequency unit
(f) Maintenance center

Fig. 8 represents the interface between earth station and SPADE terminal.

The specification of this system will be based upon COMSAT's R. F. P. "Contract CSC-ESOC-200" or some others equal to the standard of this Document.

Three channels from among the frequency allocation as shown in Fig. 7 will be provided for use in this system. Signaling will be CCITT No. 5 in respect of transmission to the central station.

5.5 Terminal Equipment

5.5.1 General

This terminal equipment is such that it converts signals incoming from a microwave connecting link into baseband signals for transmission to satellite circuits, and also conducts such functions inversely.

This equipment comprises multiplexing terminal equipment for satellite circuits, engineering service circuit equipment, TV-audio carrier terminal equipment and multiplex terminal equipment for the microwave connecting link. Fig. 9 gives a blockdiagram of its configuration. Signals will be transmitted normally in the voice-grade channels between the domestic circuits and satellite circuits.

The multiplexing terminal equipment for satellite circuits will provide one carrier for transmission and nine carriers for reception. The connecting link multiplexing terminal equipment will have a total capacity of 120CH, with initial installation of 60CH.

5.5.2 Multiplexing Terminal Equipment for Satellite Circuits

(1) For transmission, 4KHz voice signals will be converted into baseband signals Commencing from 12KHz while for reception the baseband signals will be converted into 4KHz voice signals.

(2) For conversion purposes, such equipment will be provided as the channel translator, group translator, super group translator, carrier supply bay, group automatic gain control, etc.

(3) Functions to insert and detect pilot signals and to control voice levels will be provided to this equipment for supervision of the circuit status.

(4) The carrier supply bay provides all necessary carriers to the multiplexing terminal equipment for both satellite and domestic circuits, carrier terminal equipment, ESC signaling, test tone, various pilot signals, etc.

5.5.3 Multiplexing Terminal Equipment for Connecting Link

(1) For transmission, 4KHz voice signals will be converted into baseband signals commencing from 60 KHz while for reception the baseband signals will be converted into 4KHz voice signals.

(2) For such conversion purposes, the channel translator, group translator, super group translator and group automatic gain control will be provided.

(3) For the supervision of circuit status, such functions will be provided to this equipment as the insertion and detection of pilot signals and control of voice levels.

5.5.4 Engineering Service Circuit Equipment

(1) This equipment provides service circuits to connect with other earth stations involved. Connection will be extended, if required, to the central station.

(2) It provides 2 telephone and 10 teleprinter service channels by making use of the frequencies between 4KHz - 12KHz that occupy the frequency band outside the baseband frequencies on the satellite carrier. The equipment will have a function for selective call connections.

5.5.5 TV Carrier Terminal Equipment

(1) This equipment is such that it converts TV, voice (CCITT Rec. Type-A) and cue signals into baseband signals in the frequency range 12KHz - 108KHz, and functions inversely. It is also capable of inserting engineering service circuits in the 4KHz - 12KHz band below the base-band frequencies or taking them out.

5.5.6 Others

(1) If required, in-station service circuits or PBX installation will be provided within the station.

(2) VFP, VPF and IBS will also be provided when necessary.

5.6 Control and Monitor Equipment

This equipment functions to monitor, control and test the operation of major equipment items of the earth station, monitor the circuit status, and have contact with corresponding earth stations as well as the central station for maintenance requirements, and further keep record of various technical data.

This subsystem will comprise the following items of equipment which will be installed in the control room for centralized control and operation.

(1) Antenna control & monitor bay (or console)

Az. El antenna angle display, manual positioning control, fault indication, etc.

(2) Transmitting equipment control & monitor bay (or console)

Transmitter start/stop control, e.i.r.p. monitor, fault indication, circuit status, etc.

(3) Receiving equipment control & monitor bay (or console)

Receiving carrier level, pilot level or noise level monitor, fault indication, circuit status, etc.

(4) TV control/monitor bay (or console)

TV circuit monitor, TV circuit test, etc.

(5) Miscellaneous equipment control & monitor bay (or console)

- SPADE, telephony terminal equipment control & monitor
- Power supply equipment control & monitor bay (or console)
- Telephone set for order-wire

(6) Record equipment

- e.i.r.p. receiving carrier level, pilot level, etc.
- Meteorological data (wind direction, wind velocity, precipitation)

5.7 Test Equipment

(1) This equipment consists of the instrument for in-station loop test of transmitting and receiving equipment in the earth station, SSOG-specified measurement instrument for line-up test via satellite, and measureing instruments for maintenance work.

(2) The test equipment will have a capability of testing μ - μ, IF - μ, μ - IF, IF - IF, BB - IF & μ, μ & IF - BB, and BB - BB for the in-station loop test.

(3) For the in-station loop test, the 6GHz - 4GHz signal translator, test up converter, test down converter, test modulator, test demodulator and TP & TV circuit test bay will be provided. Both test up converter and test down converter will be of all wave type, and both test modulator and test demodulator, of all-channel type.

(4) For line-up test, a microwave power meter, frequency counter, white noise test instrument, IF & BB transmission measuring instrument, etc. will be provided.

(5) For maintenance work, a circuit tester, oscilloscope, signal generator, multi-range volt-ammeter will be provided.

5.8 Power Supply Equipment

5.8.1 General

This equipment is such as to provide electric power to all items of equipment of the earth station. The blockdiagram of this system is shown in Fig. 10.

It normally utilizes the commercial mains for its power source. In the event of a failure of commercial power, the Diesel-engine generator will take over the load to supply the power.

In order to protect the communications operation from possible interruption resulting from power failures, no-break alternator and floating batteries are provided for use in the important items of communications equipment. As seen from Table 7, the receive power is estimated at approx. 350KVA in the initial phase. However, taking into account the future expansion, the power system should be designed for 700KVA with respect to items of equipment down to LVR in the arrangement as shown in Fig. 10.

The interface between the commercial power and earth station power supply system will be at the input of high tension service board which will be set up at the entrance of the site.

5.8.2 Commercial Power Supply

(1) Outdoor closed-type high tension service board (incl. VS) will be installed somewhere near the boarder of the station site.

(2) The power supply will be 6.6KV, 3-phase, 50Hz, AC, with the capacity of 700KVA.

(3) Underground cable will be provided for connection between the high tension service board and the outdoor private substation to be installed adjacent to the station building.

5.8.3 Outdoor Private Substation

(1) Outside the station building will be installed closed-type high tension distribution board (incl. VCB), voltage regulator, power transformer, etc.

(2) The voltage regulator will have a capability of regulating the voltage within the range of 6.6KV $\pm$ 10%, with self-capacity of 70KVA.

(3) Two units of power transformer (6.6KV : 220V) will be provided, with one of them for reserve or expansion purpose.

(4) Design should be made of the high tension distribution board so as to permit future expansion.

5.8.4 Low Tension Distribution Bay and Monitor/Control Bay

(1) In the power room will be installed ACB bay, 200V bay (100V bay, if required) and monitor/control bay (or console) for remote-controlling and monitoring the outdoor substation and Diesel Generator.

5.8.5 No-Break AC Power Supply System

(1) SCR static inverter no-break power supply will be installed to ensure continuous AC power supply to the communications equipment in the event of a mains failure.

(2) This system comprises a rectifier, inverter and batteries.

(3) Operation should be made possible for 10 minutes with the batteries during the outage of commercial power supply.

5.8.6 DC Power Supply System

(1) Floating batteries will be provided in order to supply power to the equipment that operates on DC power.

(2) This system includes rectifier for bloating charge and batteries.

(3) The hold time of batteries will be 10 minutes during the mains outage.

5.8.7 Diesel-Engine Generator

(1) A diesel-engine generator with the capacity of 350KVA will be provided as a standby for commercial power failure.

(2) The generator will start automatically and take over the load within a minute from the commercial power source. Synchronized switch-over with the commercial power supply will also be made possible.

5.8.8 Intermediate Current Supply Bay

If required, an intermediate current supply bay will be provided to distribute necessary power supply to various items of communications equipment.

5.8.9 Remote Monitor/Control Panel

(1) In the control room will be installed a panel for remote monitor of the power supply system and for switch-over, start and stop of the power equipment.

5.8.10 Others

(1) If required, DC power source will be provided for emergency lighting.

(2) Power supply for plug sockets will be provided for the convenience of maintenance work.

5.9 Earth Station Building and Pedestal Facilities

The earth station building and related facilities will be constructed in the site which will be selected and acquired by the ANTELCO from among those five sites that have been proposed by the survey team dispatched by the Japanese Government.

These facilities will accommodate the entire satellite communications equipment and auxiliary equipment and facilities as well as personnel working in the station so that smooth implementation of the earth station operation may be ensured.

5.9.1 Site of Station

Taking into account the augumentation of equipment and facilities in future when a new satellite system (INTELSAT-V) comes to reality, it is desirable for the earth station to have 7ha or more for its site area.

5.9.2 Site of Earth Station Building

Subsoil investigation should be carried out by the contractor prior to the building construction work.

The site for station building will be determined by consultation between ANTELCO and contractor referring to the findings of the investigation.

5.9.3 Scope of Construction Work

The scope of the work for construction of earth station building and related facilities will be as follows.

(1) Subsoil investigation and determination of the site for antenna pedestal and station building

(2) Surveying of the area of the site, felling of trees and land readjustment

(3) Fence on the boundaries, paved walkways within the premises and paving around the station building

(4) Planting of trees and turfing

(5) Signposts and parking lot

(6) Station building

Antenna pedestal and station building, guard house, oil storage, warehouse, garage

(7) Related facilities

Work for exterior lighting, protection from lightning, grounding, ventillation, air-conditioning, water and hot water supply and drainage; electric and lighting facilities; fire alarms and fire fighting appliances; emergency communications facilities (VHF transmitter and receiver); PBX and paging system; fixtures and furnitures.

5.9.4 Structure and Layout of Building

(1) For the convenience of maintenance work and operation, the antenna pedestal and station building should be constructed in a united whole, with both structures linked together.

(2) The antenna pedestal should be constructed on the foundation which is built strong enough to support the antenna structure.

(3) The antenna pedestal and station building will be a onestoried reinforced concrete building.

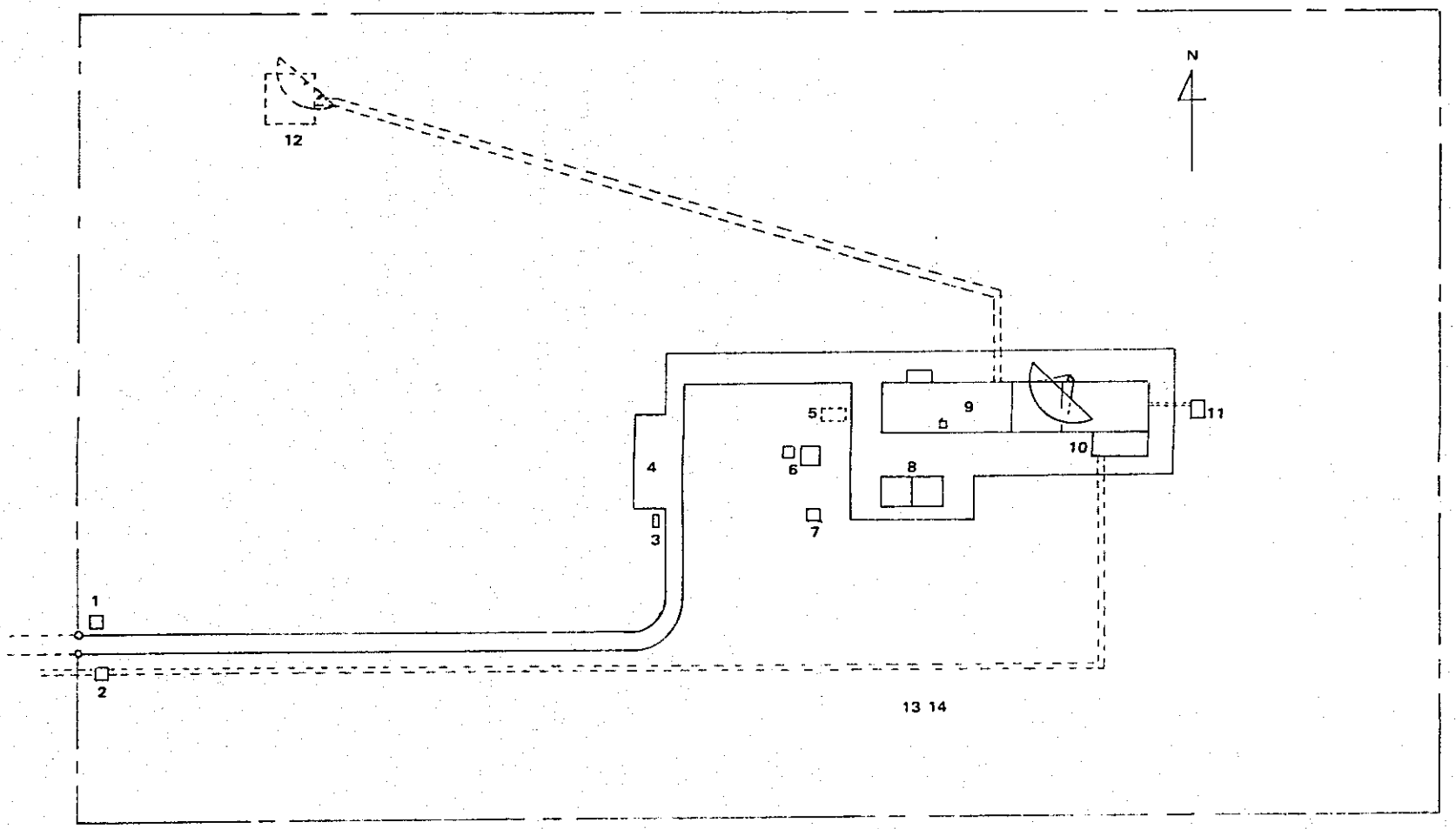
(4) The microwave tower will be erected on the roof of the station building as far as possible.

(5) An example of layout of earth station facilities is shown in **Fig. 11.**

(6) An example of layout of station building is shown in Fig. 12 and approximate floor space of each room in Table 8.

Table 8 Floor Space of Paraguayan Earth Station Building

1.	Antenna pedestal	$250m^2$
2.	Equipment room	$200m^2$
3.	Control room	$80m^2$
4.	Power room	$450m^2$
5.	Service room	$320m^2$
	Total	$1300m^2$



1. A Gate House
2. A house for receiving commercial source
3. A board for information
4. A parking place
5. A Drainage
6. A tank for supplying water
7. A fireplace for burning up
8. A strage and a garage
9. A main building
10. A outside equipment for electric source
11. An oil tank
12. A place for installing antenna in the future
13. Meters for measuring wind direction and velocity
14. Weather Instrument Shelter

Figure 11 Layout of Facilities Arrangement

In addition to the above, spaces for guardhouse, oil storage, small warehouse and garage are needed.

6. Microwave Connecting Link Equipment

6.1 General

This equipment provides 7GHz microwave FM radio relay system that links the earth station and the central station with a single-hop link extending about 25Km.

6.2 Microwave System Configuration

(1) The microwave connecting link will have two routes, one for telephone and telegraph transmission and the other for either TV transmission or reserve for the telephone and telegraph route.

(2) The equipment and facilities will be installed partly in the earth station and partly in the central station. Fig. 9 and 14 give a blockdiagram of microwave connecting link equipment. A propagation profile between the earth station and central station is shown in Fig. 13.

(3) On the central station side, the microwave tower will be erected utilizing a 65m high new tower which will be constructed in the near future. On the earth station side, the tower will be erected on the roof of the station building or somewhere nearby.

(4) In respect of the telephone and telegraph channels, this microwave system will have a capacity of 120 channels in total, and 60 channels will be installed for initial capacity. The breakdown is as follows.

Telephone & telegraph	24CH
Order-wire	12CH
TV-audio & order-wire	12CH
SPADE	3CH
Reserve	9CH
Total	60CH

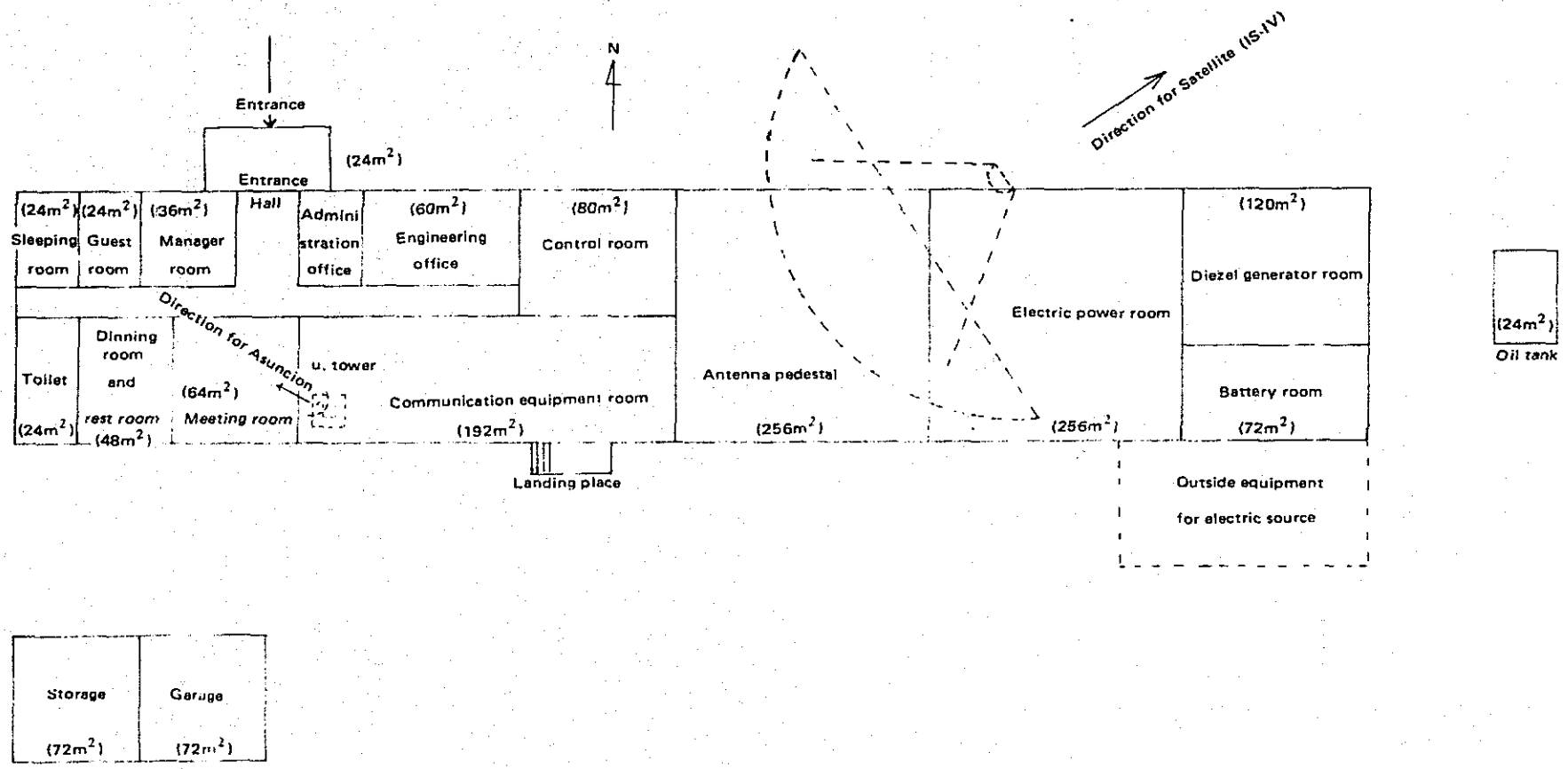


Figure 12 Layout of Building

(5) As regards the TV circuit, transmission will be made possible of one channel of either 525/60, 625/50 monochrome or 525/60 color. The video and audio will be transmitted on the simultaneous basis.

7. Central Station Equipment

7.1 General

The central station equipment is such that it transmits or receives telephone, telegraph, telex and TV signals, that are to be carried over satellite circuits, to and from domestic communications network, and accomplishes similar functions with the earth station system through the terrestrial microwave link.

This equipment comprises 7GHz microwave connecting link equipment, domestic system multiplex-demultiplex terminal equipment, echo suppressor, VFT (voice frequency telegraph) terminal equipment, 2W/4W terminating equipment, international telephone and telex switchboard, TV monitor and control console (or bay) and power supply equipment. A block-diagram of the equipment configuration is shown in Fig. 14.

7.2 Microwave Connecting Link Equipment

The microwave connecting link equipment provides a function of connecting the central station with the earth station. The system configuration as mentioned in paragraph 6.2 will apply here in so far as they are concerned with the central station.

7.3 Multiplex-Demultiplex Equipment for Connecting Link

This equipment is such as to convert, for transmission, 4KHz voice-grade signals into baseband signals commencing from 60KHz and to function inversely for reception. The equipment is the same as the multiplex terminal equipment for domestic network referred to in paragraph 5.5.

7.4 Echo Suppressor

The satellite circuits are operated in a four-wire system while the domestic ones in a two-wire system. This calls for 2W/4W coupling circuits as mentioned in paragraph 7.6 that follows. Any slight unbalance in the matching of this coupling circuit is liable to cause leakage or receive current into the transmit channel. This gives rise to echo phenomenon to which double talking is mostly attributed.

Specifically in such a long distance circuit as satellite, there often takes place double talking troubles due to the echo phenomenon. Thus, the echo suppressor cannot be dispensed with for maintaining the transmission quality.

7.5 VFT Terminal Equipment

The VFT terminal equipment is such that it converts 50-band DC telegraph (and/or telex) signals into frequency-shift modulated signals so as to transmit on a 4KHz voice-grade channel that carries 24 such teleprinter channels. The equipment has a function to work inversely.

7.6 2W/4W Terminating Equipment

This equipment is such as to provide a coupling circuit between the satellite circuit (channel translator) and domestic circuit (switchboard), and consists of hybrid coils, balancing networks and signaling devices for ring-down operation.

7.7 International Telephone Switchboard

(1) Switching of international telephone calls will be manual; the switchboard will provide cordless connection.

(2) Signaling will be accomplished in conformity with CCITT No. 5 with respect to SPADE circuits, and with respect to circuits in other systems, the ring-down method will apply.

(3) Signaling devices, relay groups and other component units necessary for telephone switching will be provided.

7.8 TV Control/Monitor Bay (or Console)

This equipment will be provided for performing monitor and test of TV channels. The equipment will be the same as those in the earth station described in paragraph 5. 6.

7.9 Power Supply Equipment

This equipment is such as to feed necessary power to the equipment mentioned in the preceding paragraph.

No-bread AC power equipment that includes SCR inverter (100V or 200V, AC, 5KVA), floating batteries (-24V and/or -48V, DC), IBS, etc. will be provided for the power sources. Fig. 15 shows a blockdiagram of the power supply system.

7.10 Miscellaneous Equipment

(1) Circuit test bay will be provided for testing of telephone and telegraph circuits.

(2) IDF, VDF and IBS will be provided when required.

VI. OTHERS

1. Construction Schedule

The construction schedule of this project is as shown in Table 9. It will take about 18 months for the earth station construction after the contract has been concluded with a Tenderer.

2. Personnel and Training

2.1 Personnel

It is recommended that both earth station and central station have the following staff and functional organization for the maintenance and operation of earth station equipment and facilities.

2.1.1 Earth Station

Station Master	1
Assist. Station Master	1
Technical Operator	12 (4-shift rotation with 3-member groups)
Maintenance and Circuit Control	6
Administration	5 (incl. guardman)
Total	25

2.1.2 Central Station

Chief	1
Maintenance and Operation	8 (4-shift rotation with 2-member groups)
International Telephone Operator	8 (4-shift rotation with 2-member groups)
Total	17

2.2 Training

To ensure smoother implementation of the earth station operation, training should be given to the technicians and operators described above prior to the operational commissioning of the earth station. The trainers will take both class-room training and on-the-job training at the factory and station site. The curriculum of training is shown in Table 10.

FIGURES

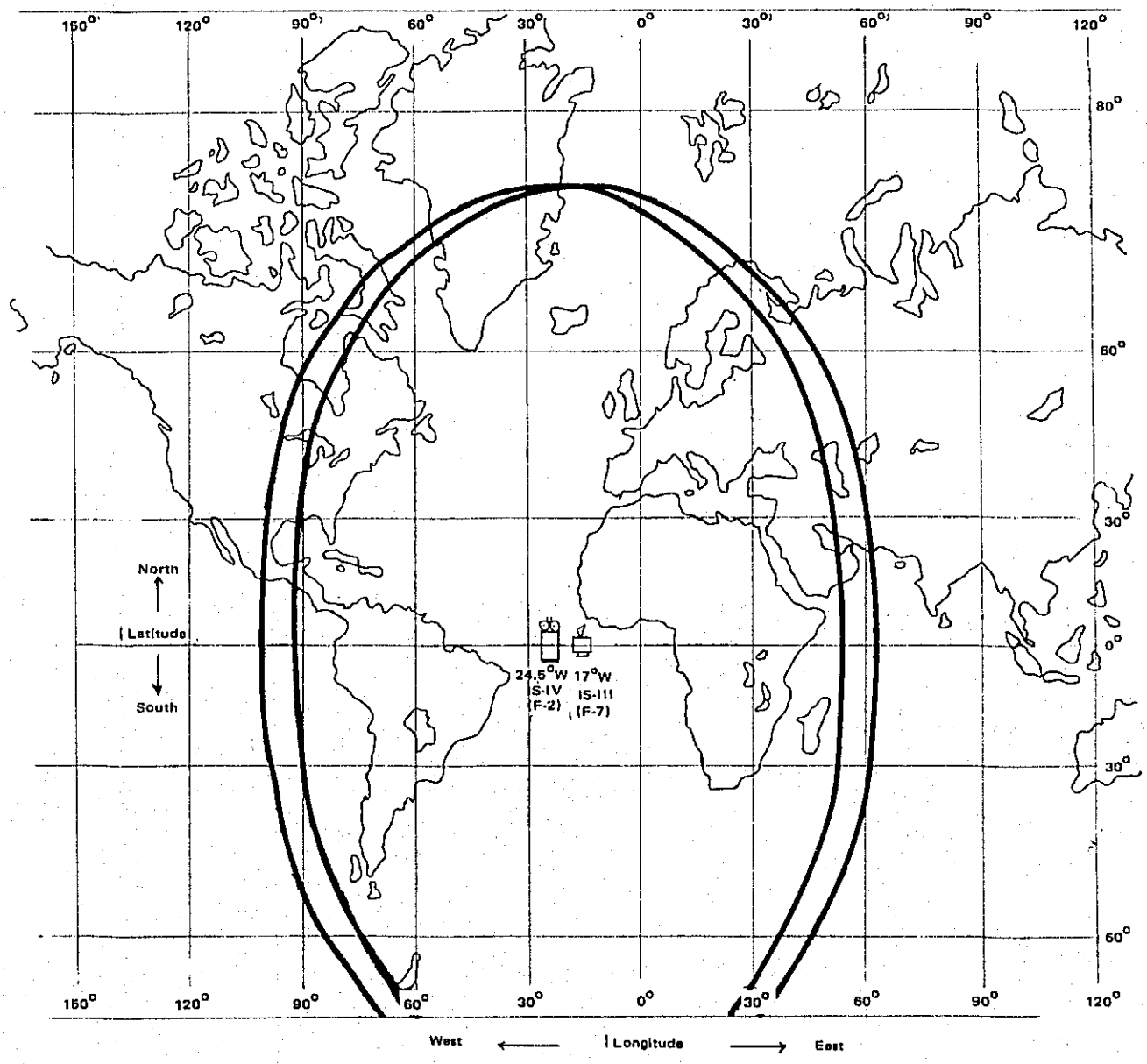


Figure 1 The Converages of IS-III and IS-IV Atlantic Satellites at the Elevation Angle of Five Degrees

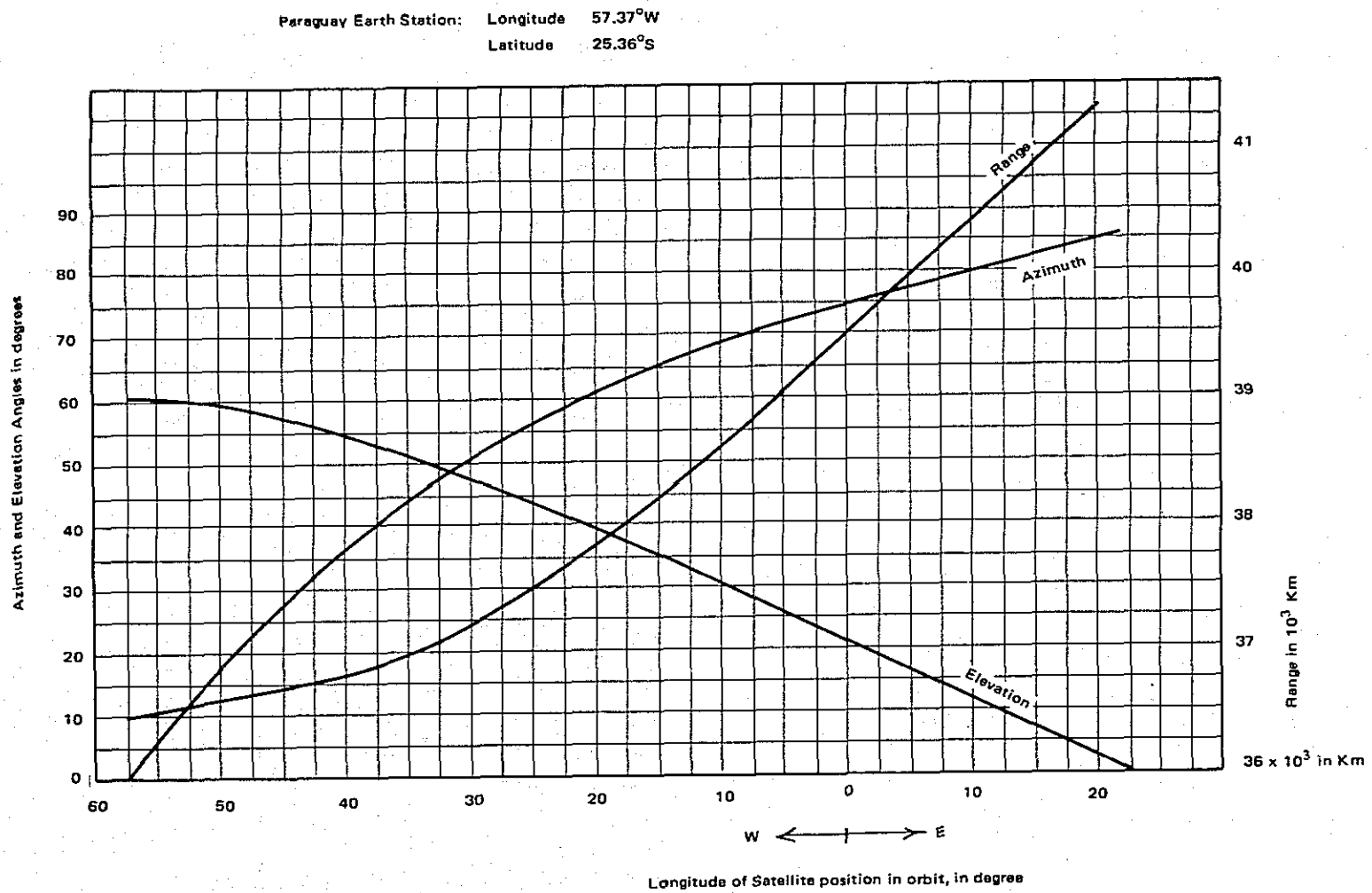


Figure 2 Azimuth Angle, Elevation Angle and Range from Paraguay Earth Station, the Atlantic Ocean Satellite

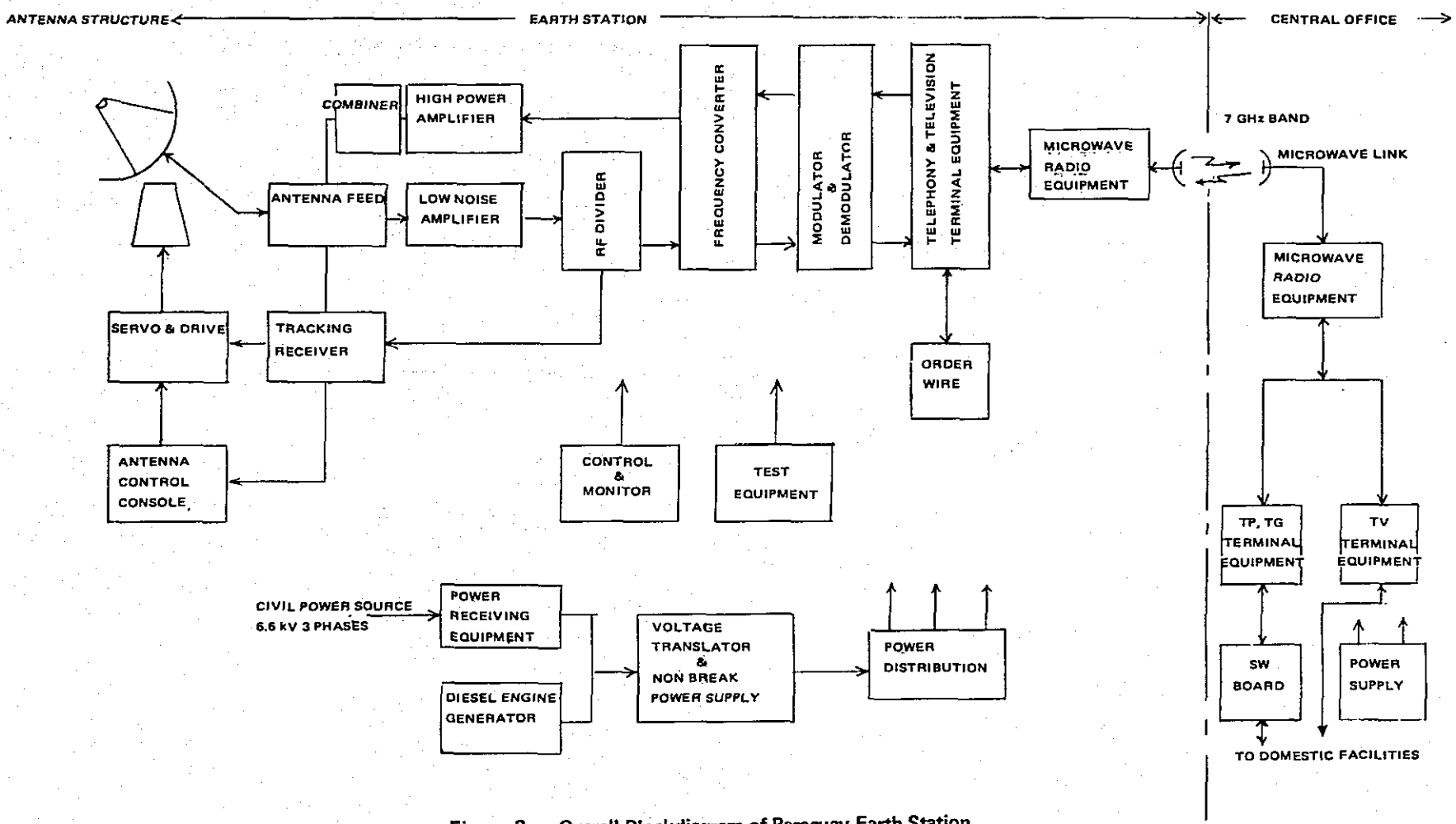


Figure 3 Overall Blockdiagram of Paraguay Earth Station

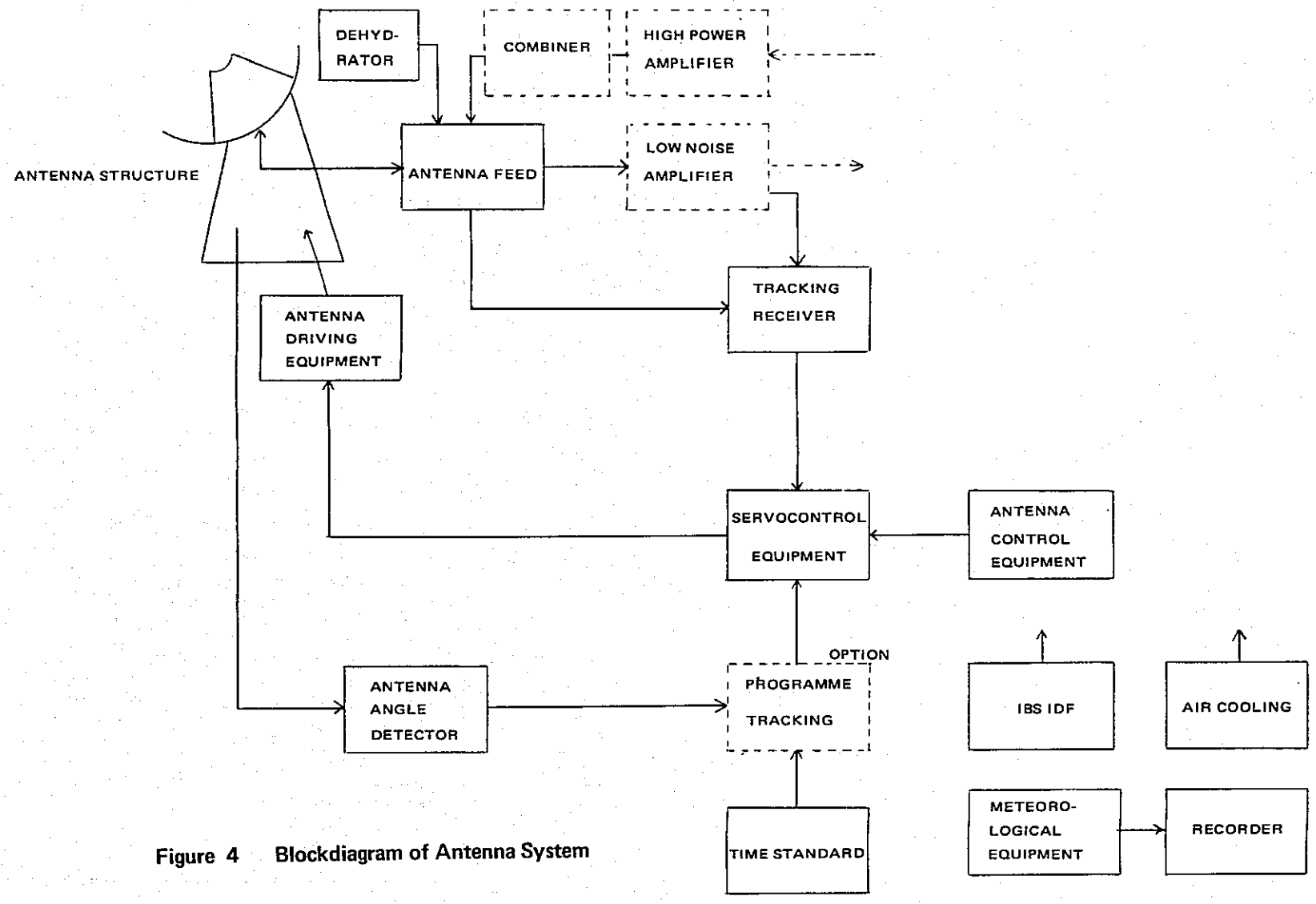


Figure 4 Blockdiagram of Antenna System

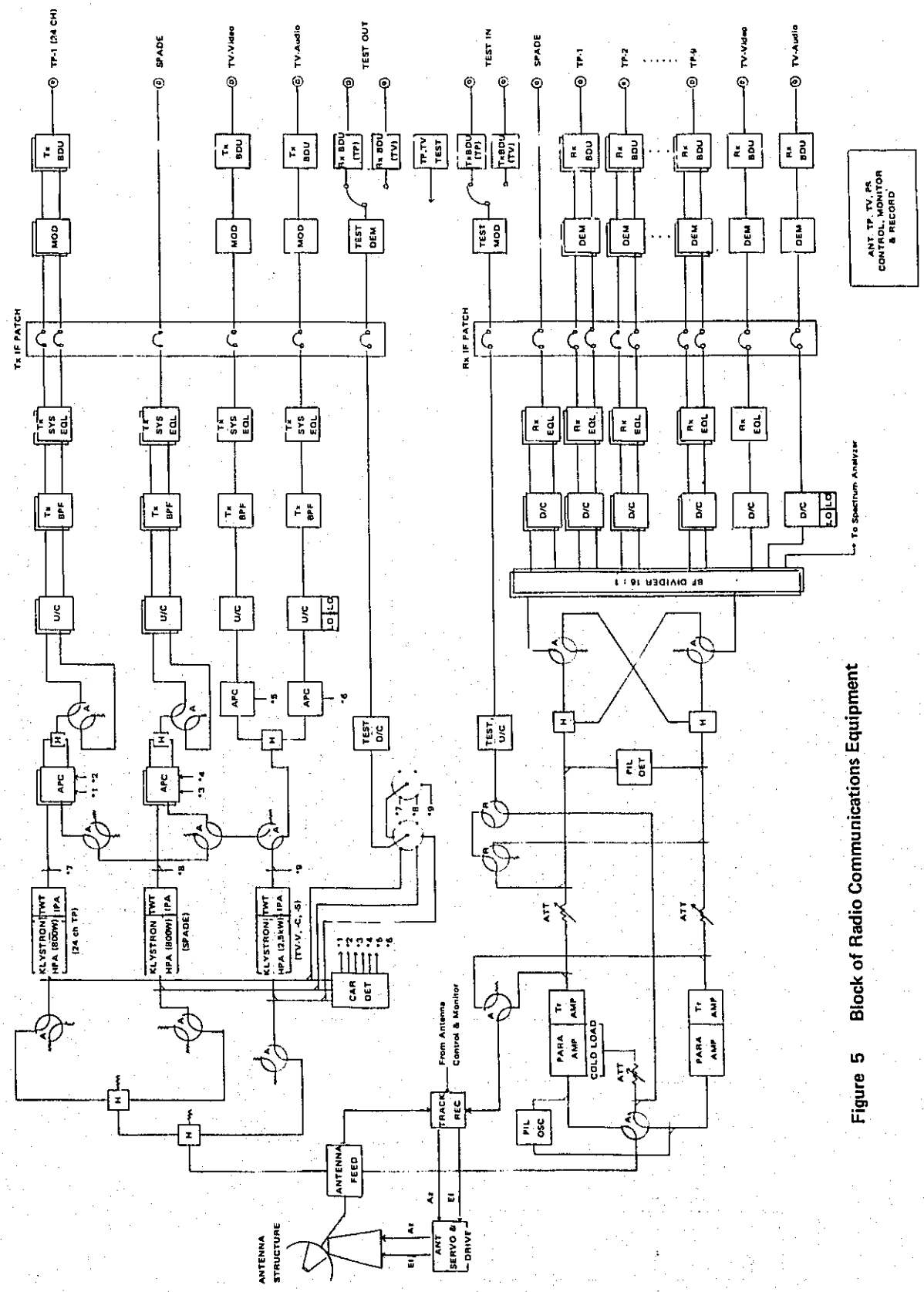


Figure 5 Block of Radio Communications Equipment

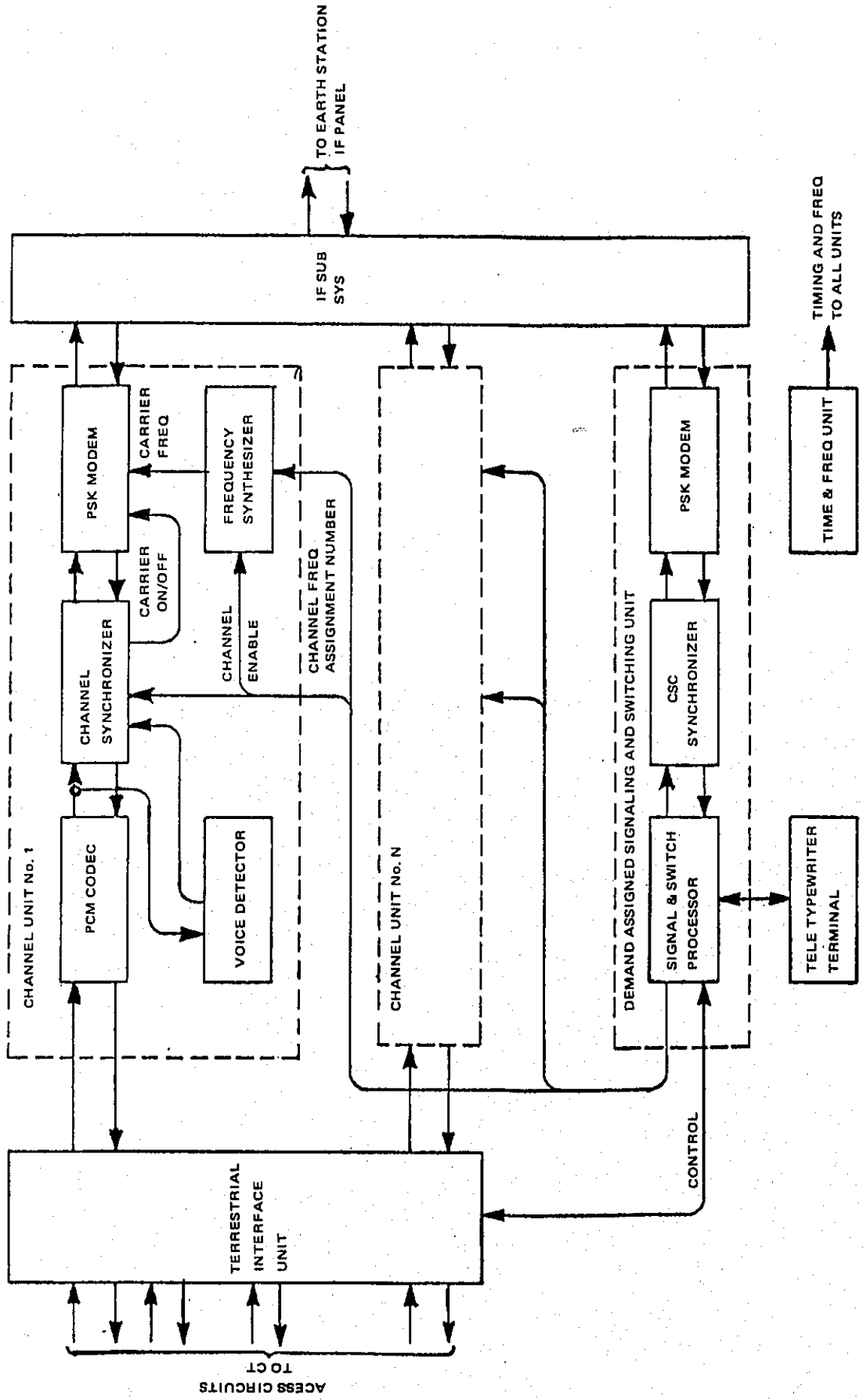


Figure 6 Block Diagram of SPADE Equipment

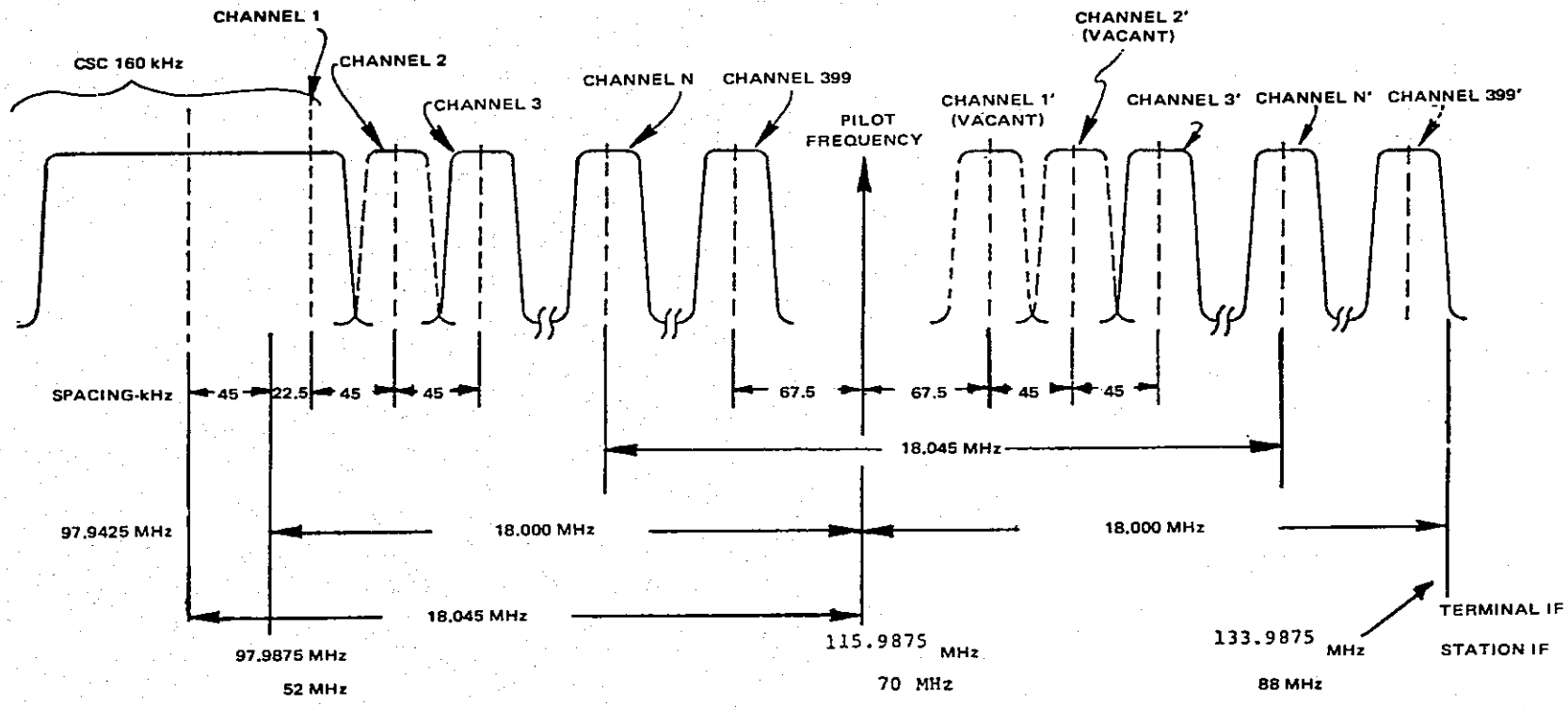


Figure 7 FREQUENCY Allocation of SPADE System

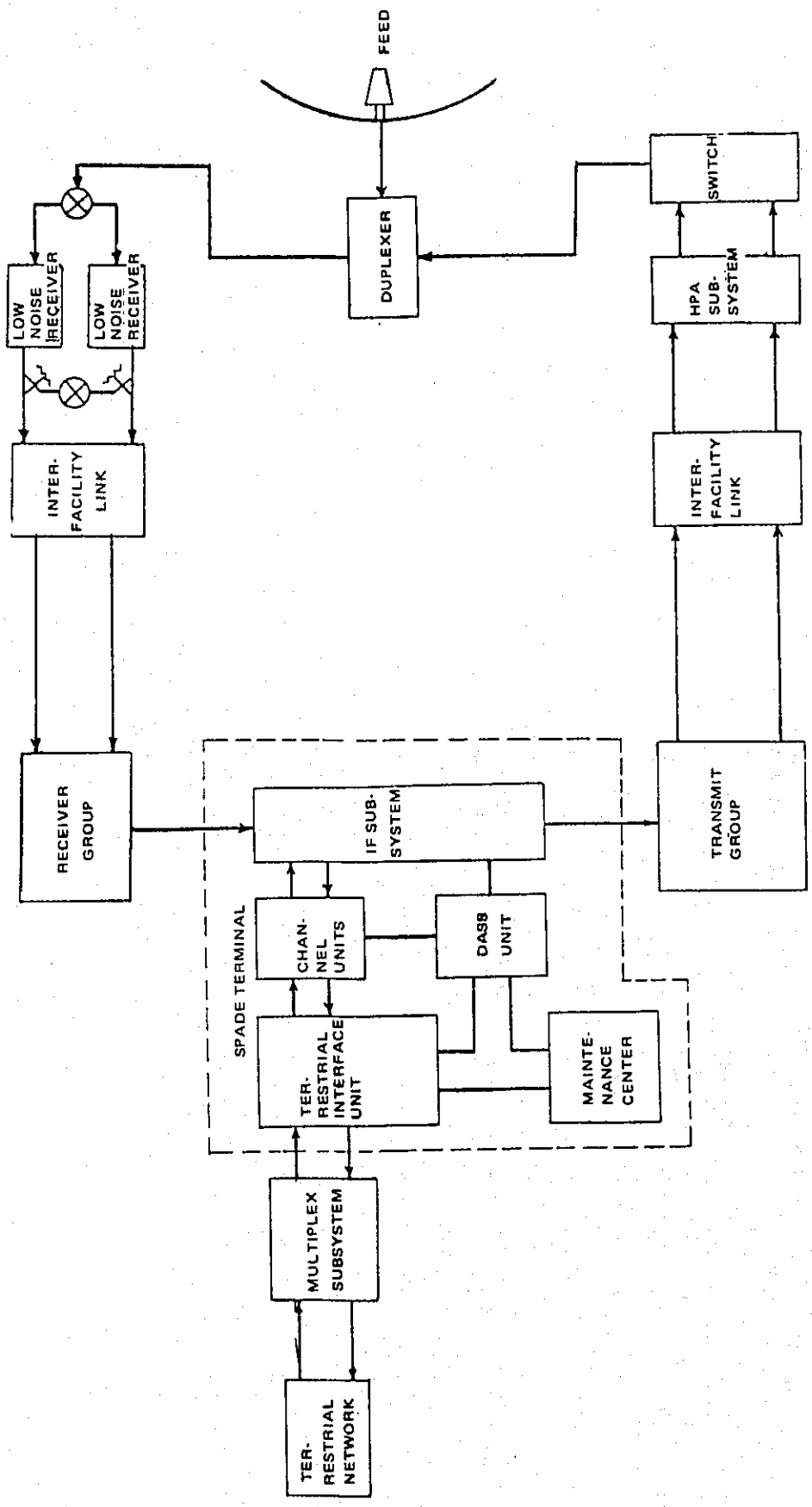


Figure 8 Interface Between Earth Station and SPADE Equipment

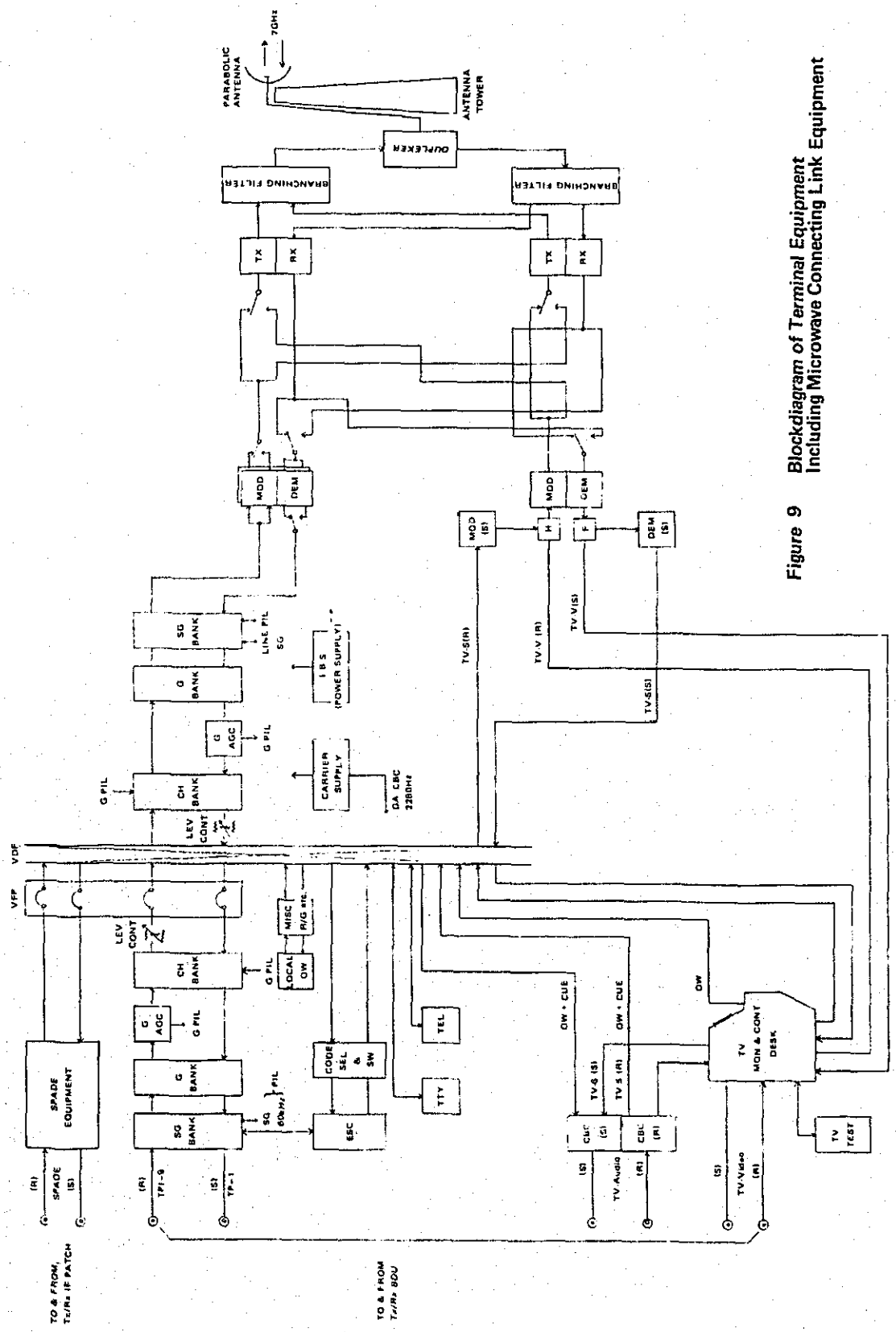


Figure 9 Blockdiagram of Terminal Equipment Including Microwave Connecting Link Equipment

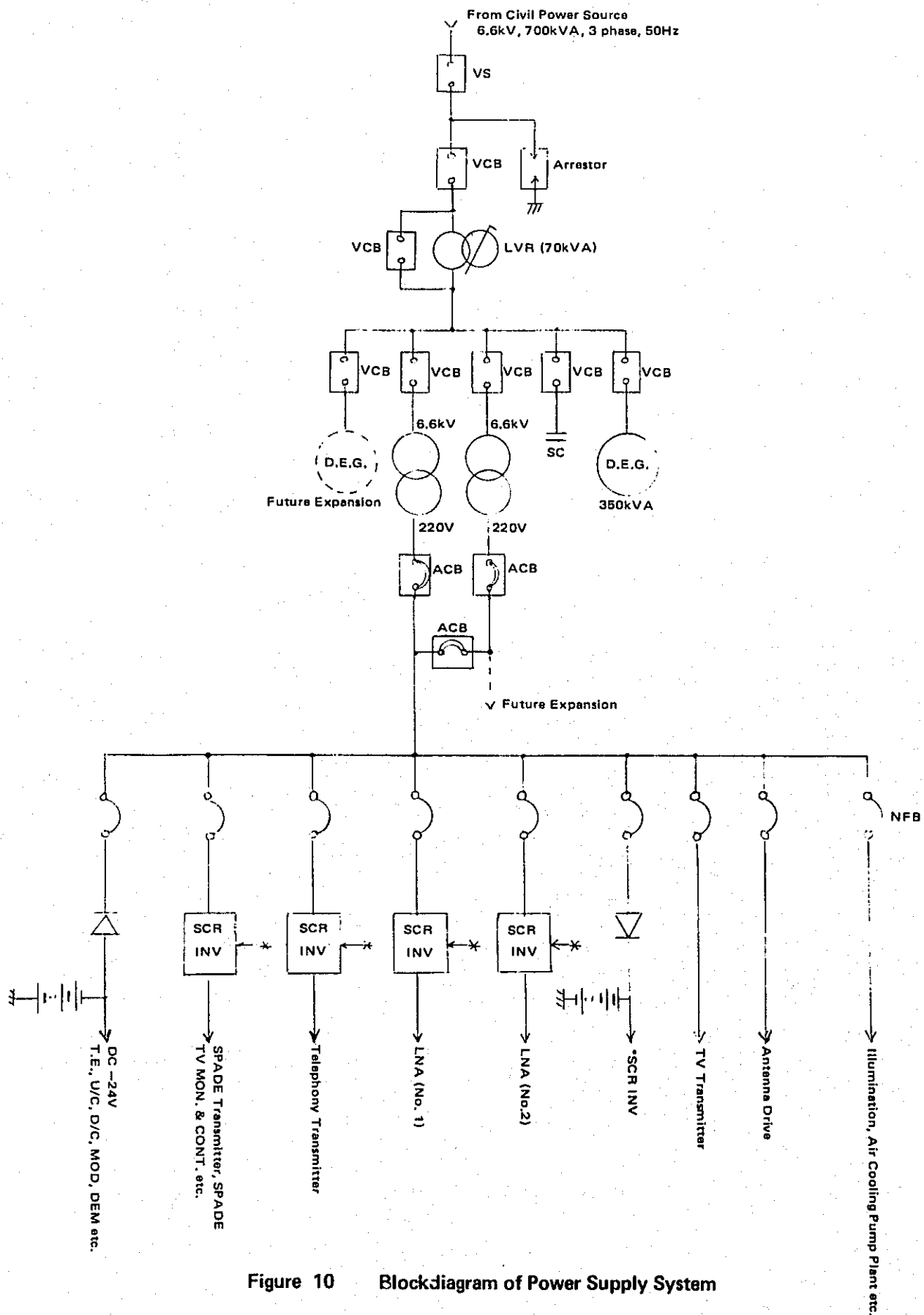
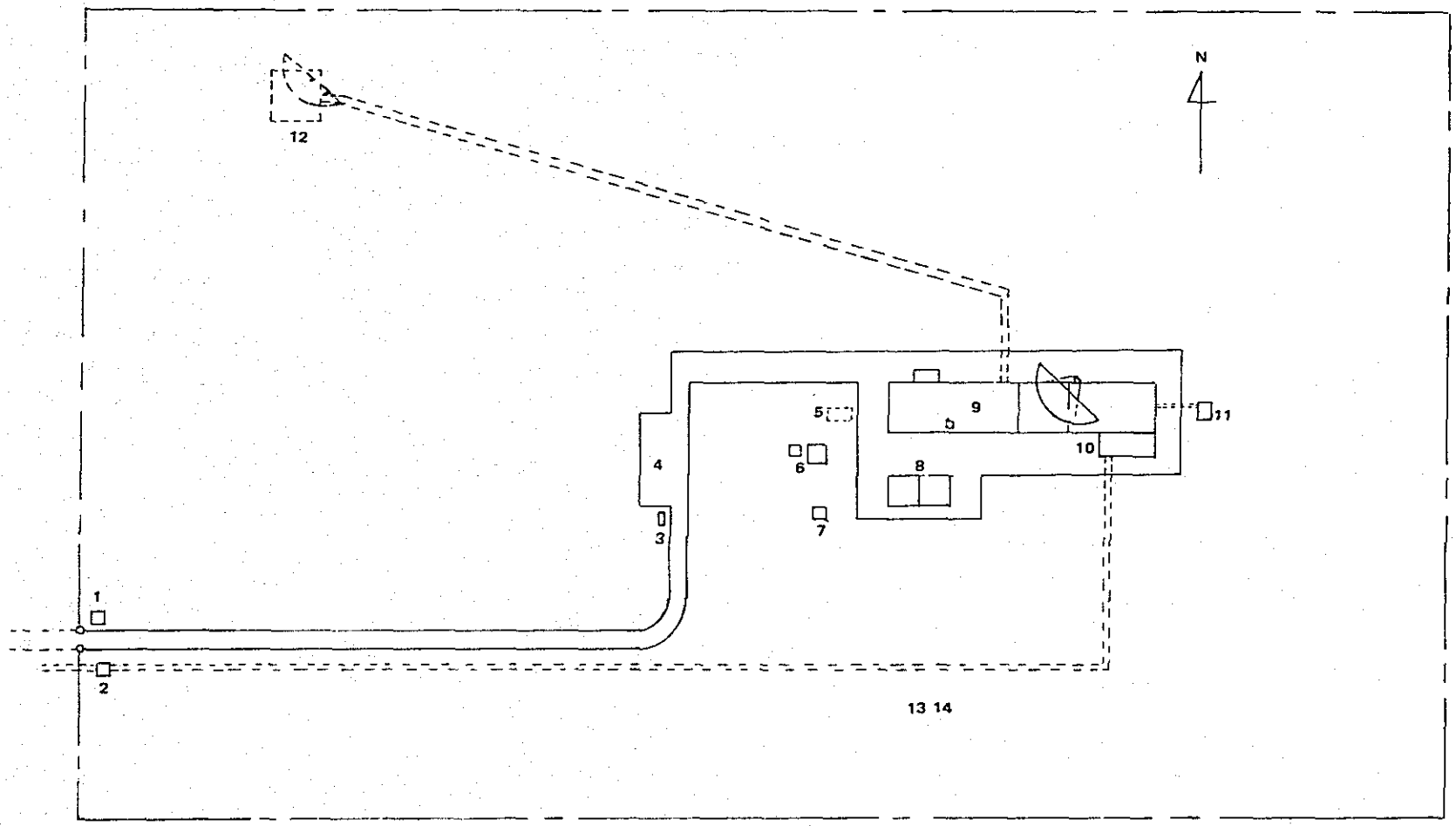


Figure 10 Blockdiagram of Power Supply System



1. A Gate House
2. A house for receiving commercial source
3. A board for information
4. A parking place
5. A Drainage
6. A tank for supplying water
7. A fireplace for burning up
8. A strage and a garage
9. A main building
10. A outside equipment for electric source
11. An oil tank
12. A place for installing antenna in the future
13. Meters for measuring wind direction and velocity
14. Weather Instrument Shelter

Figure 11 Layout of Facilities Arrangement

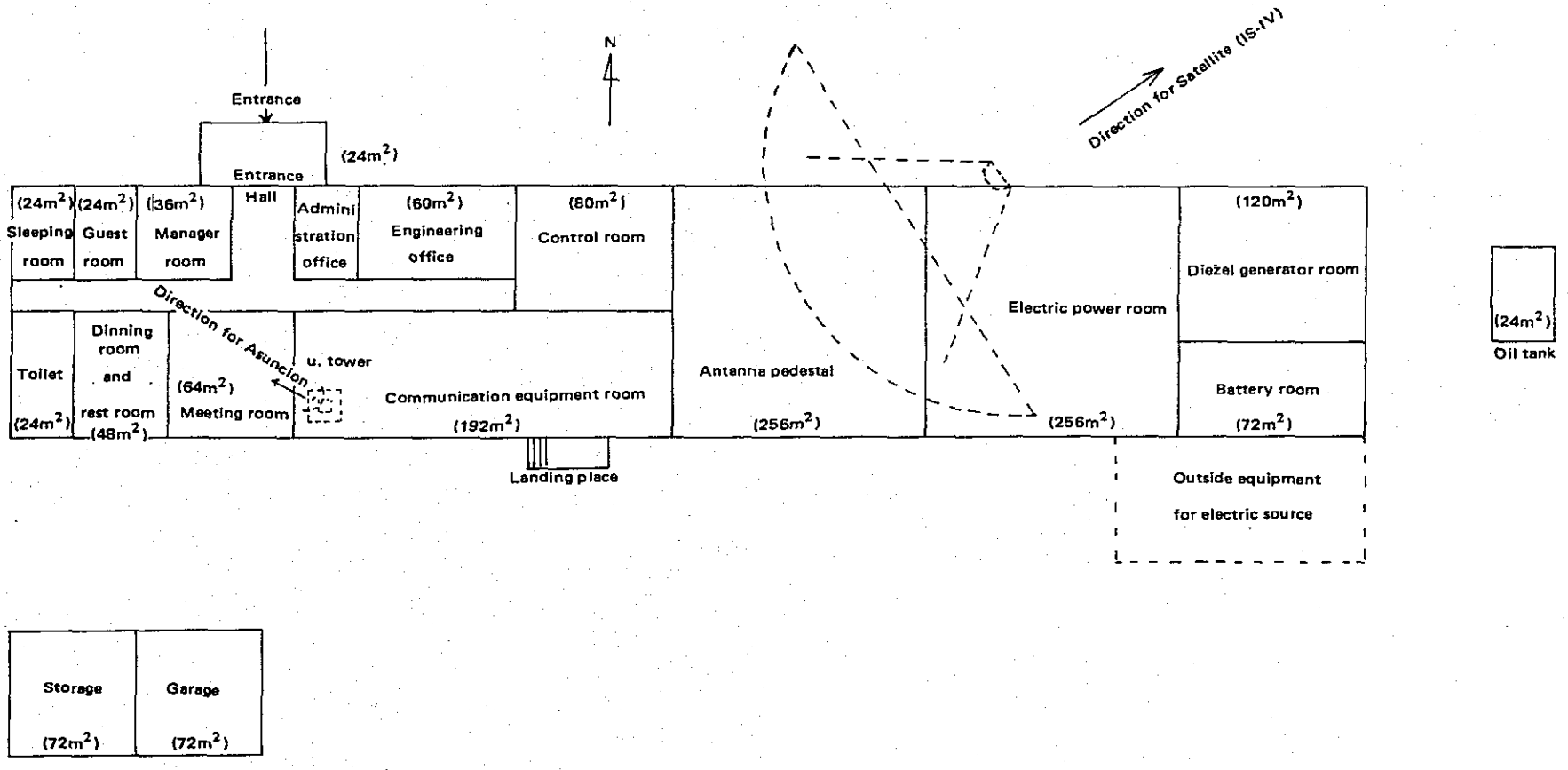


Figure 12 Layout of Building

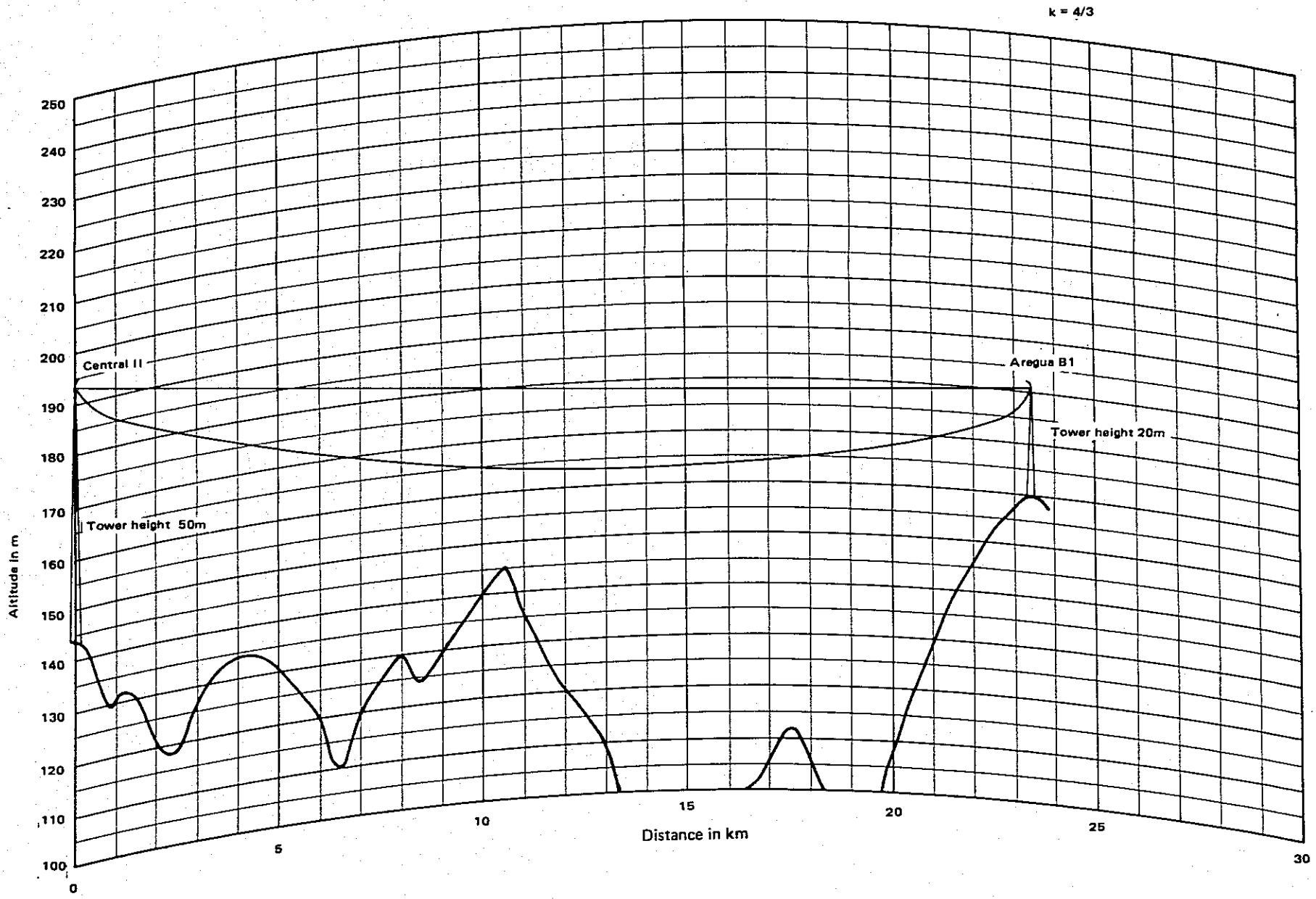


Figure 13 Propagation Profile Between Central II and Aregua BI

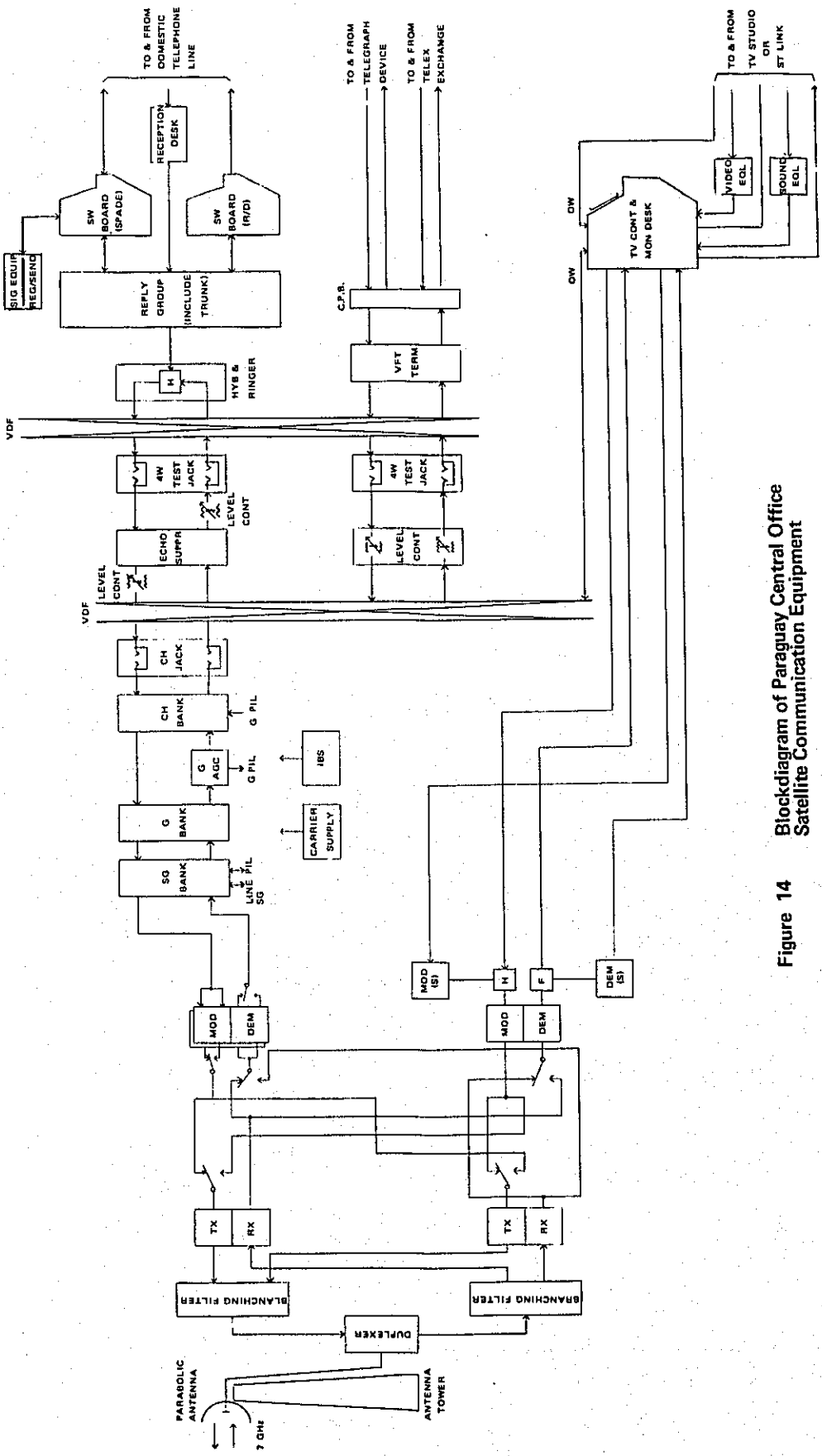


Figure 14 Blockdiagram of Paraguay Central Office Satellite Communication Equipment

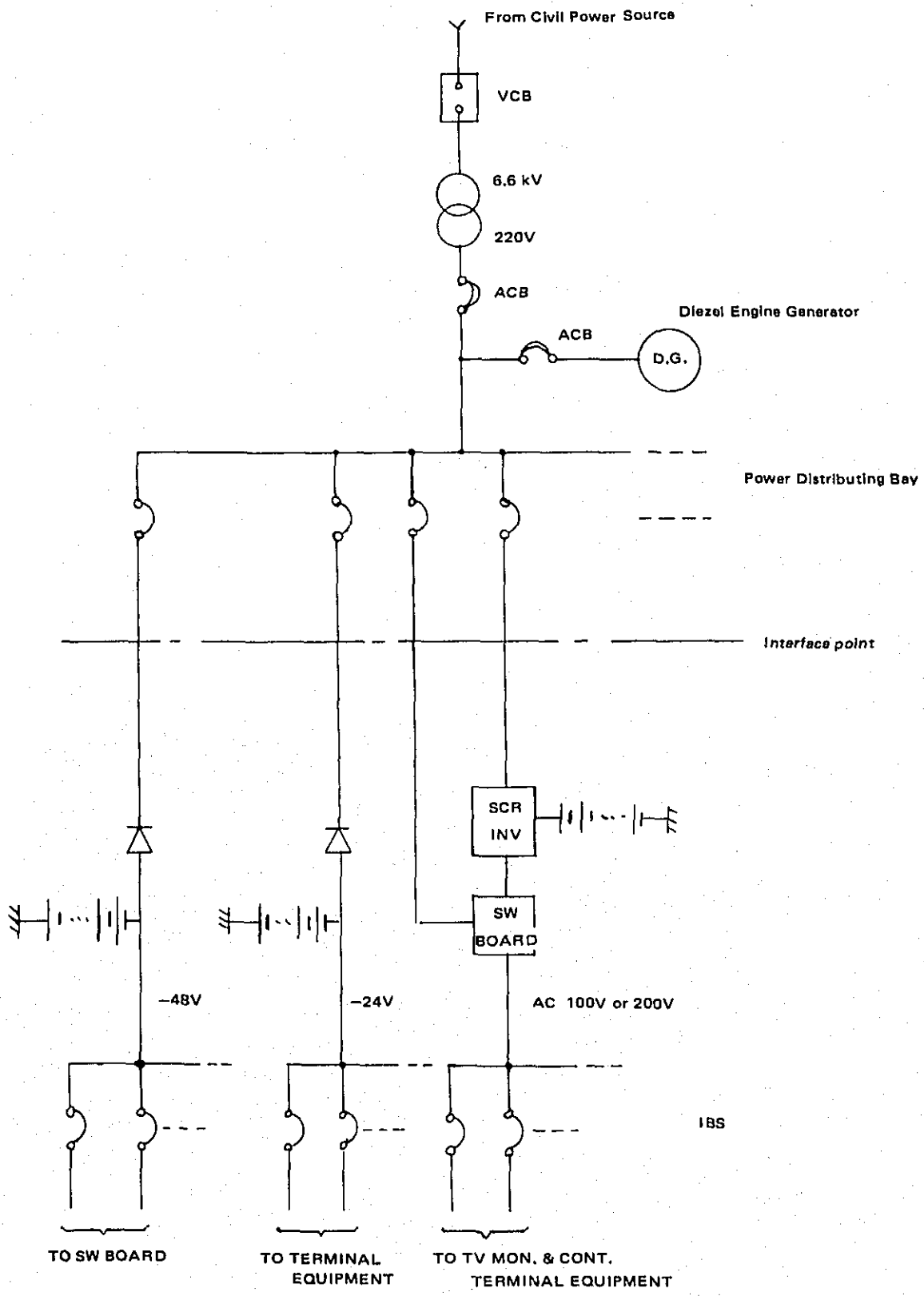


Figure 15 Blockdiagram of Paraguay Central Office Power Supply System

TABLES

Table 1 Satellite Circuits of Paraguay

Number of circuits / Destination	Telephone		Telegraph	
	-1975	-1980	-1975	-1980
Argentine	5	7	2	3
Chile	2	3	1	1
Peru	1	SPADE	3	4
U.S.A.	8	11	7	7
Brazil	1	1	-	-
Spain	1	SPADE	-	-
W. Germany	-	SPADE	7	8
Italy	-	SPADE	-	2
Urguay	-	SPADE	-	2
Total	18 (SPADE)	22 SPADE	20	27

Table 2 Number of Radio Carrier-Waves

Carriers / Item	Transmission		Reception	
	-1975	1976 -1980	-1975	1976 -1980
Telephone (incl. telex and service circuits)	1 (SPADE)	1 SPADE	7 (SPADE)	9
TV-Video	1	1	1	1
TV-Cue and Sound	2	2	2	2
Total	4 (SPADE)	4 SPADE	10 (SPADE)	12 SPADE

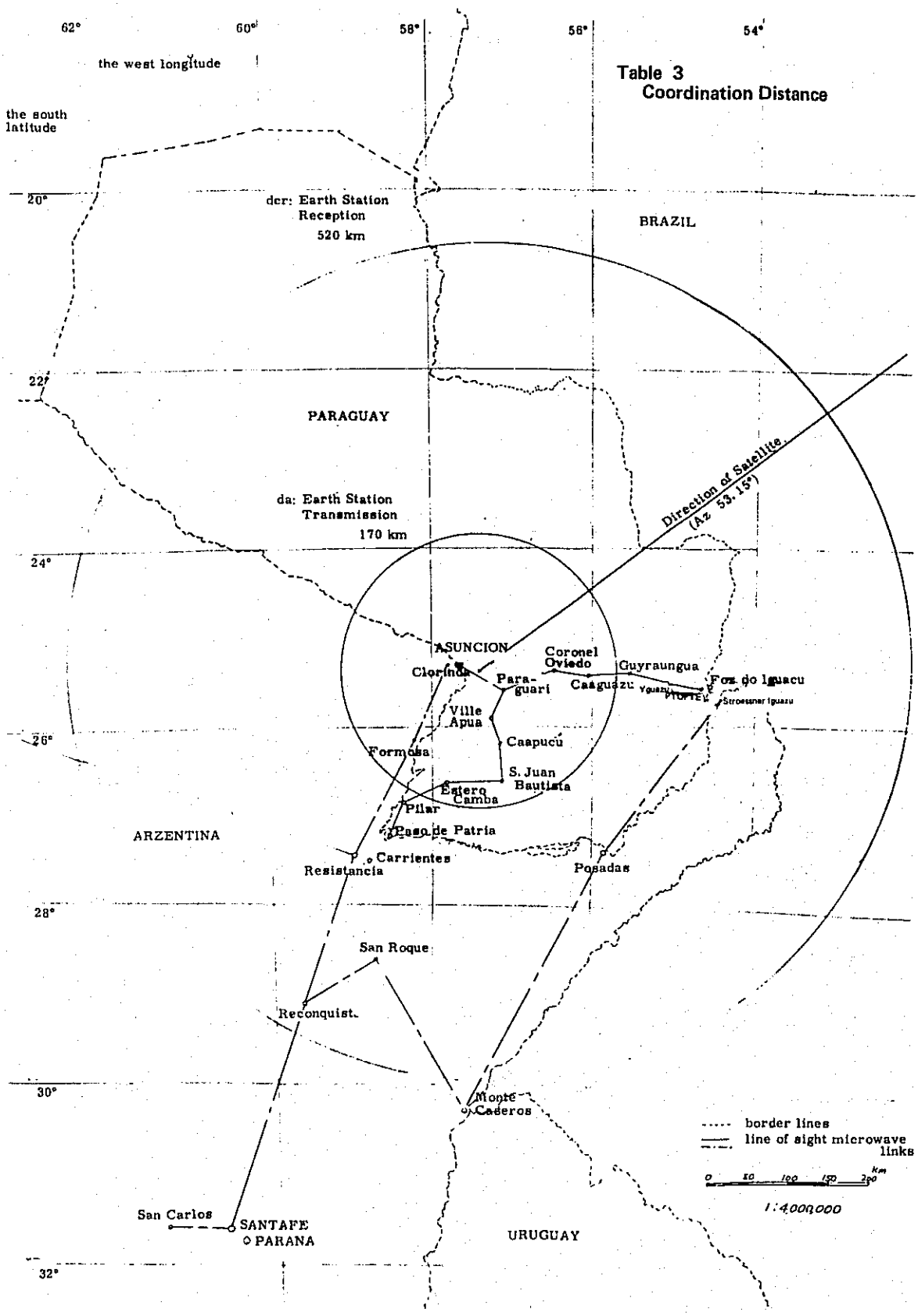


Table 3
Coordination Distance
62°
60°
58°
56°
54°
the west longitude
the south latitude
20°
22°
24°
26°
28°
30°
32°
der: Earth Station Reception
520 km
da: Earth Station Transmission
170 km
BRAZIL
PARAGUAY
ARZENTINA
URUGUAY
Direction of Satellite (Az 53.15°)
ASUNCION
Clorinda
Coronel Oviedo
Guyraungua
Para-guari
Caaguazu
Foz do Iguacu
Ville Apua
Caapucu
Formosa
S. Juan Bautista
Estero Camba
Pilar
Paso de Patria
Carrientes
Resistancia
Posadas
San Roque
Reconquist.
Monte Caseros
San Carlos
SANTAFE
PARANA
border lines
line of sight microwave links
0 50 100 150 200 km
1:4000000

Table 4 The Comparisions for Various Conditions among Proposed Sites

Items	San Rafael A1	San Rafeal A2	Ybgraty	Aregua B1	Aregua B2
Distance from Central II	13.2 km	12.5 km	30.5 km	23.5 km	25.5 km
Area	enough, flat	enough, flat	enough, flat	enough, flat	enough, flat
Land Arrangement	Almost not one antenna must be moved	Necessary Trees must be Cut	Necessary Trees must be Cut	Necessary Trees must be Cut	Necessary Trees must be Cut
Rand Accessibility	Repair 1km Near Luque-San Lorenzo road	Repair 0.5km Near Luque-San Lorenzo road	Construction 1km Near high-way No. 2	Construction km. Near Capiata-Aregua road	Construction km Near Capiata-Aregua road
Power Supply	3 km from transformer station	3 km from transformer station	4 km-long new line must be constructed from Ypacarai	6 km-long new line must be constructed from Capiate	7 km-long new line must be constructed from Capiate
Water Availability	Yes	Yes	Unknown	Yes	Yes
Dwelling Condition	Good	Good	fair, 4km from Ypacarai	good, 1.5km from Aregua	good, 3km from Aregua
Meteorology	Good	Good	Good	Good	Good
Airfield disturbance	Yes	Yes	No problem	No problem	No problem
City enlargement	Problem	Problem	No problem	No problem	No problem
Surroundings	Good	Good	Bad	Very good	Very good
Land Procurement	Exist	Necessary	Necessary	Necessary	Necessary
Visibility to Satellite	Excellent	Excellent	Excellent	Excellent	Excellent
Propagation condition of connecting Link	Good	Good	Poor	Good	Good
Interference	No problem	No problem	No problem	No problem	No problem
External Noise	Slight airway	Slight airway	No problem	No problem	No problem
Ranking	3	4	5	1	2

Table 5 The Method of Supporting AZ Rotation Structure
Bearing, King Post, Wheel on Track Type and Used for Satellite Communication
The Main Features are Following Table.

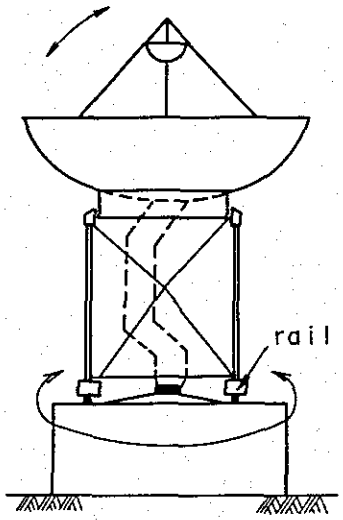
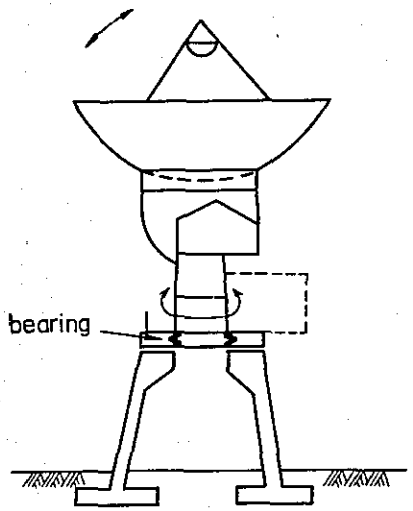
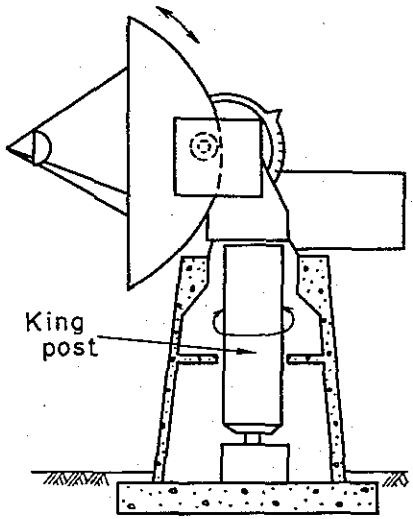
	Wheel on truck type	Bearing supported type	King Post type
Features	Circular rail which is nearly equal to the antenna diameter lays down on the ground (or on the pedestal). The antenna is mounted on it and is driven by rail and wheel.	Large bearing placed among the pedestal and the AZ rotating structure supports the antenna total weights and several moments.	Large hard AZ axis supports the horizontal moments and smaller bearing does the vertical moments.
Building cost and amount of material	less than 0.7	1	1.10 1.15
Maintenability	easier	easy	a little complicate
Figure			

Table 6 Output Power and Power Tubes of Transmitter

	e.i.r.p. 10 elevation (dBW)	Output Power (W) (Note 1)	Power tube in use	Remarks
FM multiplex telephony transmitter	74.7	72	1KW Klystron	Transmission of Global 24CH carrier
SPADE transmitter	63.5	5.5 x 3	1KW Klystron	Transmission of 3 SPADE carriers
TV transmitter	88 (V) 74.7 (C, S)	740 35	3KW Klystron	Both TV-V and TV-C transmit TV-S

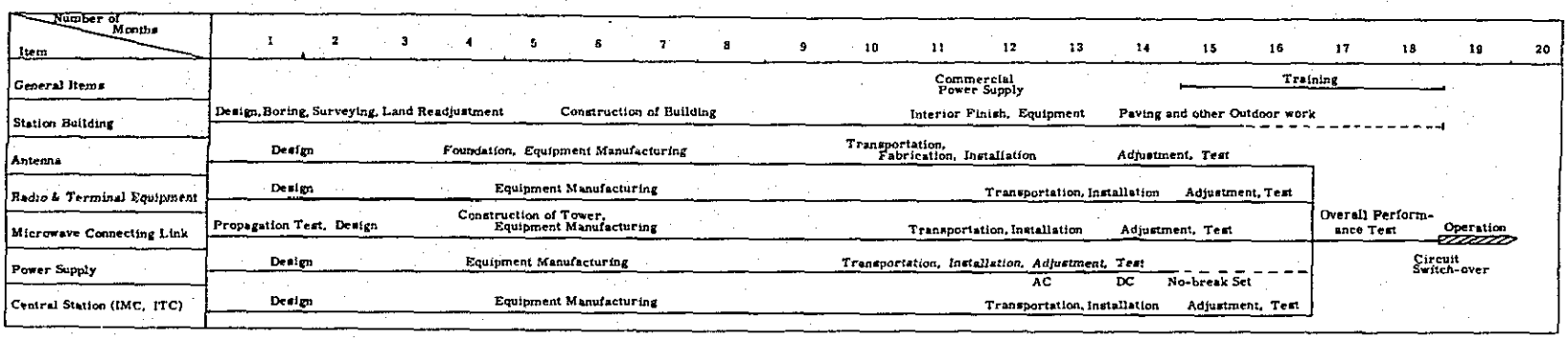
Table 7 Details of Expected Power Consumption

Antenna	100KVA
Antenna Drive	50KVA
Antenna Lighting	10KVA
Antenna Pedestal Air Cooling	30KVA
Antenna Pedestal Miscellaneous	10KVA
Transmitter	50KVA
Receiver	6KVA
Ground Communications Equipment	5KVA
Television Equipment	1KVA
SPADE Equipment	25KVA
Telephone Terminal Equipment	2KVA
Building Air Cooling	70KVA
Water Supply Facilities	10KVA
Building Lighting	10KVA
Diesel Cooling	15KVA
Consent	6KVA
Miscellaneous	50KVA
Total	350KVA

Table 8 Floor Space of Paraguayan Earth Station Building

1.	Antenna pedestal	250m
2.	Equipment room	200m
3.	Control room	80m
4.	Power room	450m
5.	Service room	320m
	Total	1300m

Table 9 Schedule for Construction of Paraguayan Earth Station (after contract settled)



(Note) Manufacture of equipment includes its factory test. No allowance is calculated in this schedule.

Table 10 Training Curriculum for Paraguayan Earth Station and Central Station Personnel

Subject	Earth Station Maintenance		Earth Station Operation		Central Station	
	Supervisor	Technician	Supervisor	Technical Operator	Telephone Operator	Technician
	h.	h.	h.	h.	h.	h.
International Telecommunications & Organization of INTELSAT	7	3	7	3	-	-
Communications Satellite & Satellite Communications System	5	5	5	5	-	-
Circuit Design	10	10	5	5	-	-
Elementary Microwave Engineering	10	10	5	5	-	5
Elementary Television Engineering	5	5	5	3	-	5
Elementary Multiplex Carrier Techniques	3	3	3	3	-	3
Outlines of Earth Station Plant Facilities	30	15	20	10	-	10
Outlines of Microwave Connecting Link	5	3	3	3	-	3
Outlines of Central Station Plant Facilities	5	3	3	3	5	5
Measuring Instruments & Measuring Practice	15	15	5	5	-	5
Earth Station Equipment Operation	5	3	30	20		
International Telephone Traffic Operation	-	-	-	-	15	-
Total (Unit Hour)	100	75	89	65	20	36

ANNEXES

ANNEX 1

BASIC CONSIDERATIONS
FOR
THE ESTABLISHMENT OF SATELLITE COMMUNICATION SYSTEM
IN
PARAGUAY
REPORT

SCHEDULES OF TASK

August	22nd	Arrive in Asunción, Paraguay.
	23rd	Courtesy visit:
		Work with the staff of ANTELCO
	24th	Courtesy visit:
		1) Ministro de Obras Pùblicasy Communicaciones, Gral. Div. (S.R.) Marcial Samaniego.
		2) Consejo de Administracion de ANTELCO.
		Work with the staff of ANTELCO.
	25th	Juramento de la Constitucion Nacional.
	26th	Courtesy visit:
		Ministro de Relaciones Exteriores, Dr. Raùl Sapena Pastor.
		Investigation of Communication Center II
		Work at ANTELCO.
	27th	Work with the staff of ANTELCO.
	28th	Work at Direccion General de Meteorologia
		Work with the staff of ANTELCO.
	30th	Draw up of adjustment plan.
		Work at ANTELCO.
	31st	First survey of earth station site.
		Investigation of Radio National and ANDE Sub Station.
September	1st	Second survey of earth station site.
		Investigation of HF Receiving station.
		Work with ANTELCO staff.
	2nd	3rd survey of earth station site.
		Work with ANTELCO staff.
	3rd	Investigation of environment.
	4th	Work at ANTELCO.
		Investigation of environment.
	6th	Write a summary of investigation.
		Work at ANTELCO.

September	7th	Investigation of Communication Center II. Work with ANTELCO staff.
	9th	Investigation of Communication Center II in relation to telegraph. Work with ANTELCO staff. Investigation of power source.
	10th	Investigation of Communication Center II in relation to telephony. Write a summary of investigation.
	11th	Investigation of interface in relation to telegraph and telephony. Work with ANTELCO staff.
	12th	Preparation of Report. Work at ANTELCO.
	13th	Preparation of Report. Investigation of International Telephone Equipment and Circuits. Work with ANTELCO staff.
	14th	Preparation of Report. Work at ANTELCO.
	15th	Preparation of Report.
	16th	Presentation of Report.
	17th	Presentation of Report and Greeting for Leaving.
	18th	Departure at Asunción.
	19th	
	20th	Making an arrangement with Mr. NISHIDA who performed preliminary survey for constructing earth station as to new survey at Washington.
	21th	Ditto
	22nd	Departure at Washington.
	23rd	Arrive in Tokyo.

CONTENTS

1. General

We already mentioned in our Preliminary Report about the importance and significance of an earth station for Paraguay which is fully cognizant of the ever-advancing trend in this communication field.

The government of Paraguay has been considering to accede to the interim agreements for a global communication satellite system, constructing an earth station to participate in satellite telecommunication network.

The telecommunication expansion project in Paraguay is steadily on its way, thus we recommend you to construct an earth station as soon as possible.

This will certainly bring, in political and economical aspects, a closer connection with other countries, sharing the benefits of the satellite communication.

The preliminary report made some suggestion about the basic considerations for the establishment of satellite communication system in Paraguay.

Upon the second investigation, however, it was found that these preliminary considerations require some amendments and supplement, although they have been fundamentally supported.

We should like to propose here the communications facilities which will be aboe to meet the requirements for future aspects of satellite communications in your country.

2. Fundamental Consideration Concerning the Satellite Communication System

2.1 *Communication Satellites*

In order to establish a global commercial communications satellite system as soon as possible, ICSC decided to adopt for the time being a stationary satellite system.

In the year of 1969, a global satellite communications network came to completion through the medium of INTELSAT III Satellite system (IS-III).

At present, most of commercial satellite communication circuits are being provided by means of IS-III (F-7) satellite and IS-IV (F-2) satellite launched on 26th January 1971.

Fig. 1 shows the coverage of IS-III and IS-IV Atlantic satellites at the elevation angle of five degrees. When the Paraguay earth station becomes operational, it will be possible to establish direct circuits with other countries that exist within its coverage.

The forecast prepared by the ITU Plan Committee indicates a tremendous increase in the volume of international communication traffic. This spurred up ICSC to expedite the IS-IV satellite launching program. It is scheduled that IS-IV satellites will be placed in orbit one each over the Atlantic, Pacific and Indian Region sometime after the year of 1971.

For the details of the IS-V, there remain a number of problems yet unsolved which are now carefully discussed in ICSC. Therefore, we must pay close attention to every movement of ICSC.

2.2 Access Mode

In order to realize a global network by communication satellites, the multiple access technique is a primary requisite for sharing simultaneously one communication satellite by a number of earth stations.

There are two principal methods applicable to the multiple access system.

(a) Multi-destination carrier method, which enables to collect outgoing traffic in some unit channels at the transmitting side and to select the necessary channels for the receiving side.

(b) Random multiple access method, which enables to make free access to any earth station freely composing a network in accordance with traffic demand.

The detail of above description was expressed in the Preliminary Report.

Generally, it is desirable for the multiple access system to be able to deal with many earth stations simultaneously, to be economical in the use of frequency spectrums as well as in power consumption of a satellite and to be flexible enough to meet any unforeseen traffic demand.

At present, the satellite system is operated under the preassigned multiple access mode employed for the multi-destination method.

In the near future the Random multiple access system will be adopted in the satellite communication system.

SPADE (Single Carrier per Channel PCM/PSK Demand Assignment Equipment) system is a typical system of the Random multiple access.

Some countries are now making preparations for field tests of this system. Also, ICSC is taking notice of the practicability of this system.

One Transponder of the IS-IV satellite has been reserved so that the SPADE system would possibly be applied to the IS-IV satellite.

The following countries in the Atlantic Region have indicated their intention to operate in the SPADE network; (operational information memorandum of INTELSAT: ISSUE NUMBER TWO, 23 July, 1971)

Algeria	Spain +	Senegal
Argentina +	Switzerland	Belgium
Brazil +	U.S.A.	Mexico
Canada	Venezuela	Colombia +
Chile +	Kuwait +	Ethiopia
Portugal	Gabon	Malagasy Rep.
Greece +	Cameroon +	Panama
Iran	Democratic Rep. of the Congo +	Morocco
Italy +		
Ivory Coast	France +	
Negeria +	Germany +	
Jordan	Nordic Countries +	
	Peru +	

+ indicates fully executed COMSAT option agreement.

Planned activation dates for those countries on contract are:

USA	September	1971
Germany	January	1972
France	February	1972
Italy	April	1972
Argentina	May	1972
Greece	June	1972
Canada	July	1972
Spain	September	1972
Peru	September	1972
Democratic Rep. of the Congo	November	1972

3. Basic Ideas for the Satellite Communication System in Paraguay

The following basic ideas are based on the basic consideration for the establishment of satellite communications system in Paraguay and most of them are mentioned in the Preliminary Report.

The design of facilities and the establishment of satellite communication system should be based on the following principal points.

(1) The earth station should satisfy the performance characteristic of the standard earth station having availability better than 99.8 percent.

(2) The earth station should be capable of operation with the Atlantic IS-IV satellite.

(3) The earth station should be located within the distance which can be covered by a single-hop microwave system from Asuncion.

(4) Life of equipment should not be less than fifteen years.

(5) The facilities of initial installations will have a capacity sufficient for the traffic demand to be expected in 1980. Considerations must be given to the feasibility of equipment increase and also to the adaptability to foreseeable new communication systems in the future.

(6) The telephone service should be operated manually by the ring-down method for the time being, while telex should be in manual operation except for outbound calls to five specific destinations which will be handled under semiautomatic switching system.

(7) International television transmission via Satellite should be available. Monochrome television transmission only will be served at the outset, but the television system should be designed to have the capability of color television transmission.

(8) The equipment and facilities should be of the most economic configuration under the conditions given as above.

(9) Training of personnel for this purpose should be performed in advance of the construction.

(10) A few specialists should be placed for the coordination and promotion of the project.

(11) The multi-destination method by FDM/FM and SPADE system should be adopted for the satellite communication system.

4. Traffic Estimation for the Paraguay Earth Station

For the telecommunication traffic load on the Paraguay earth station, we should consider not only the traffic incoming to and outgoing from Paraguay, but also the transit traffic of the neighbouring countries which will utilize the earth station by means of terrestrial connection links to Paraguay.

Consideration of the estimated Volume of traffic demand was mentioned in the preliminary report.

With regard to the traffic unit for satellite utilization, a group of 24 voice channels and SPADE system are considered from the technical and economical point of view.

If the traffic overflows from FDM-FM, we will be able to use the SPADE system.

Transmission of telex or telegraph channels usually employs a carrier telegraph system allotting up to 24 telegraph channels to one voice channel.

From the standpoint mentioned above, the estimated traffic is shown below.

(a) Initial plan (- 1975)
7 Destinations - Argentine, Chile, Perú.
USA, Brazil, Spain, Germany.

(b) Future plan (1976 - 1980)
9 Destinations - Add Italy, Uruguay

(c) Number of circuits

Destination	Telephone ch		Record ch	
	- 1975	- 1980	- 1975	- 1980
Argentine	5	7	2	3
Chile	2	3	1	1
Peru	1	SPADE	3	4
USA	8	12	7	7
Brazil	1	1	-	-
Spain	1	SPADE	-	-
Germany	-	SPADE	7	8
Italy	-	SPADE	-	2
Uruguay	-	SPADE	-	2
Total	18	22	20	27

Number of carriers is shown below

a) Initial plan (- 1975)

	Transmitting	Receiving
Telephone Record service Engineering service	1 (SPADE)	7 (SPADE)
TV Video	1	1
TV - Cue & Sound	2	2
Total	4 (SPADE)	10 (SPADE)

b) Future plan (1975 - 1980)

	Transmitting	Receiving
Telephone Record service Engineering service	1 add SPADE	9 add SPADE
TV Video	1	1
TV - Cue & Sound	2	2
Total	4 add SPADE	12 add SPADE

Radio frequency bandwidth of 2.5MHz should be allocated corresponding to the above capacity for the operation by IS-IV satellite.

5. Earth Station Performance Characteristics

5.1 *Technical Requirements for Earth Station*

The performance characteristics to be satisfied by the standard and non-standard earth stations are specified by ICSC so that circuits via IS-IV satellite should be attainable to the prescribed quality of international communication circuits.

Therefore, it is desirable to prepare equipment of the earth station so as to meet the standard performance characteristics of the ICSC and the recommendations of CCIR and CCITT.

Furthermore, the equipment should be considered against the local environment in Paraguay.

Annex I shows the mandatory technical characteristic of a standard earth station.

The basic ideas are shown in Preliminary Report (Documents number, ICSC-37-38, ICSC-45-13).

5.2 Antenna Pedestal and Equipment Room

A conventional satellite communication antenna was proposed by the preliminary report.

This antenna has an elevated equipment room for feed assembly and low noise amplifier (LNR). And sometimes another elevated equipment room is provided for high power amplifier (HPA) in order to minimize the WG loss of transmit path.

Therefore, in order to eliminate demerits of the conventional antenna and for conveniences to its maintenance work, we propose a new type antenna. It is a distinctive feature of this antenna that all electronic equipments such as LNR, HPA, Tracking Down converter, etc. can be installed on the ground floor, not in the elevated equipment room.

5.3 Antenna Performance and Receiving System Noise-Temperature

As recommended by ICSC, it is desirable for the receiving antenna to have at least 40.7dB of gain to temperature ratio (G/T) at an elevation angle of 5^{o} under clear sky condition, where G is the antenna gain at 4 GHz referred to the input of the low noise amplifier expressed in dB relative to an isotropic radiator and T is receiving system noise temperature referred to the input of the low noise amplifier expressed in dB above 1^{o} Kelvin. This value is sometimes called "figure of merit" of an earth station.

Therefore, the station should be so designed as to have a G/T ratio greater than 40.7dB under clear sky conditions at an elevation angle of 5^{o}.

This is equivalent to an antenna having approximately 28 meters diameter aperture whose gain is 58 dB and noise temperature 54^{o} K or

below at an elevation angle of 5^{o}.

Basic ideas of antenna design are shown in Annex-2.

5.4 Tracking Mode

There are three system of manual, automatic and program control in antenna tracking. Among them the program control system is not necessarily used for a satellite on the synchronous orbit.

Therefore, both automatic and manual tracking systems should be adopted for the tracking of antenna.

Basic requirements are shown in the Preliminary Report and Annex-2.

5.5 Transmitter

The required equivalent isotropically radiated power (e.i.r.p) for each carrier is specified by the ICSC as shown in Annex-1.

The high power amplifies should be prepared for the transmission of telephony, television and SPADE.

A Klystron having saturated output power of 3 kW should be used for the television transmitter and the other Klystrons having saturated output power of 1 kW should be used for telephone and SPADE.

Arrangements should be made for the television transmitter to make it possible to transmit telephone and SPADE signal in the event of failure of telephone and SPADE transmitters.

The other items are shown in Annex-3 and the preliminary report.

5.6 Receiver

As a low noise amplifier, it is desirable to adopt two Helium-gas cooled parametric amplifiers which are superior in the noise temperature.

Basic technical items are shown in Annex-4 and the preliminary report.

5.7 Base Band Equipment

Basic ideas are shown in the Preliminary Report.

Base band equipment consists of multiplexing equipment, SPADE terminal equipment, television terminal equipment, control equipment and others.

It is desirable to design the base band equipment so as to meet the standard performance characteristics of the ICSC and the recommendations of CCIR and CCITT.

A blockdiagram of the base band equipment is shown in Fig. 2.

5.8 Power Supply

Basic ideas are shown in the Preliminary Report.

Power supply system is necessary to keep a high reliability, the blockdiagram of this power supply system is shown in Fig. 3.

5.9 Overall Earth Station System

Fig. 4 shows an overall blockdiagram of the Paraguay earth station.

6. Site Location

The general requirements for site location are considered as follows:

(a) To be isolated from harmful radio noise, especially from the terrestrial microwave links.

(b) To be clear for an elevation angle of more than 3^{o}.

(c) To be convenient for access road, with power supply and water supply being available.

(d) To be easy to provide connection links.

(e) To be sufficiently separated from the airport.

(f) To have a necessary distance from any main road with heavy traffic.

(g) To be able to occupy a site area of more than 7 ha.

(h) To be able to isolate high tension wires of more than 220kV over 1 Km from satellite earth station.

Considering the above-mentioned conditions, especially to avoid the existing noise source and to have an easy access road, power supply and connection links, we recommend the place of 7 ha which is located in the vicinity of Aregua B1 for the Paraguay earth station.

It should be strictly prohibited hereafter to construct any equipment or facilities which will be a harmful noise source in the vicinity of the earth station.

The geographical location of sites is shown in Fig. 5 and Fig. 6.

The comparisons for various conditions among these sites are shown in Table-1.

7. Connection Link

Microwave link is proposed for the connection link between the Telecommunication Center II and the earth station.

The link should consist of a single-hop.

Neither 4 GHz and 6 GHz band which are shared with satellite communication, nor frequencies which may cause harmful interference by the higher harmonics should be used as the frequencies of the microwave link for access to the earth station.

Therefore, 7 GHz band FM-radio-relay system should be used for the connection link.

The requirements of the connection link and facilities are shown in Annex-5 and the Preliminary Report.

The blockdiagram of connection link is shown in Fig. 2.

8. Facilities in the Communication Center

The telephone circuits from the earth station will be connected to a four line international transit switching system for ring-down exchange operation in the communication center. Further, echo suppressors will be inserted in the space channels in order to prevent echo phenomenon.

The telegraph and telex circuits will be connected to the respective send/receive terminal positions in the Telecommunication Center II.

Television monitoring and controlling equipment shall be installed in the communication center having the function of ITC (International Television Center).

The general items are shown in the Preliminary Report and Annex-6.

9. Earth Station Building

The new antenna system that we would like to recommend, has a pedestal room that accommodates two units of Helium-gas cooled parametric amplifier, three Klystron high power amplifiers, and Antenna automatic control equipment. The pedestal room will be expanded for accommodating equipment and facilities other than the above-mentioned equipment. The expanded building is called main building.

The main building consists of equipment rooms accommodating modulation and demodulation equipment, base-band equipment, SPADE system equipment, monitor and control equipment, power supply equipment and air-cooling equipment and office rooms accommodating workshop, store room, visitor's room, dining room, etc.

The basic ideas are shown in Table-2 and the Preliminary Report.

It may be necessary to construct buildings for accommodating some personnel.

10. Recommended System

The recommended system for the Paraguay earth station is summarized here, taking into consideration the above-mentioned conditions.

Our proposals, which have been made in conformity with the ICSC standards and relevant CCITT/CCIR Recommendations, are as follows:

(1) Access Satellite

For access to IS-IV over the Atlantic Ocean.

(2) Communication Service Classes

Telephone, telegraph, telex, television (monochrome, with the function of color television) and SPADE.

(3) Direct Access Countries

To Argentine, Chile, Peru, U. S. A., Brazil, Spain, and Germany until 1975, and to Italy and Uruguay from 1976.

(4) Service Hours

24 hours.

(5) Site Location

Site of 7 ha in extent in the vicinity of Aregua.
(Aregua B1)

(6) Antenna System

One fully steerable antenna being more than 28-meter diameter aperture, which is of wheel-on-track type with feed system capable of covering full R. F. transmit and receive bands and capable of circular polarization on either hand.

Tracking modes are both manual and auto-tracking.

(7) R. F. Transmitter

Two transmitters with an output power of 800 W for telephony and SPADE transmission, and one more transmitter of 2.5 kW for television transmission or stand-by for telephony and SPADE. Tunable throughout the 500 MHz range of 5.925 GHz to 6.425 GHz using Klystron.

(8) Low-noise R. F. Receiving Amplifier

Two low-noise receiving amplifiers, including one for stand-by, to ensure the required G/T 40.7 dB associated with more than 28-meter antenna using Helium-gas cooled parametric amplifiers, throughout the entire 500 MHz range covering 3.7 GHz to 4.2 GHz.

(9) Baseband Equipment

To rearrange multiplex telephone signals coming from a connecting link into baseband signals for satellite circuits or functions inversely, including engineering service circuits and television transmission equipment connecting with the tie link to the Communication Center.

To connect a link of 60 channels including 24 channels for telephone signals 12 channels for service calls, 12 channels for TV sound arrangement and 3 channels for SPADE, 9 channels for reserve and 1 TV circuit.

(10) Test Equipment

To make satellite loop and in-station loop tests, for tracking function, for control and supervision of transmitting frequency and for measurement of antenna function.

(11) Connection Link

A 7 GHz band 960 channel single-hop microwave link consisting of one telephone and one stand-by (for TV transmission when necessary) connects the communication center with the earth station.

(12) SPADE System

In the Preliminary Report we did not propose SPADE system. But as we already explained, we find it is necessary to make preparation for it.

(13) Power Supply

Power receiving equipment of more than 350 KVA including no-break AC and DC power source to be used for transmitting equipment, receiving equipment and baseband equipment for earth station. No-break AC power of 15 KVA for Communication Center.

11. Approval for Coordination Distance

In relation to construction of an earth station, we should like to point out that coordination with other administrations is required when earth stations operate in shared frequency bands.

The international coordination on frequency assignment to earth station is specified in the new Radio Regulation (1971. 7. Geneva, WARC). But there is no problem in this regard for the construction of an earth station in Paraguay.

12. Construction Schedule

The construction of earth station will require eighteen months at least after contract.

A scheduled date is shown in Fig. 7.

13. Training Schedule

The persons who will work in the earth station and communication center should have training before starting operation.

A shedule date is shown in Fig. 8.

14. Estimation of Expense

It is shown in Fig. 9

15. Organization

15.1 Earth Station

For the operation of system, about 25 persons having a special knowledge in this field are required.

Chief of satellite earth station	1
Assistant of satellite earth station	1
Number of persons in shift duty 3 persons/4 groups	12
Maintenance and circuit control	6
General affairs (including a chief)	5
Total	25 persons

15.2 Organization of the Communication Center

concerning satellite system equipment

Chief of satellite system equipment	1
Number of persons in shift duty 2 persons/4 groups	8
Maintenance and circuit control (including a chief)	6
Total	15 persons

16. Approval of Satellite Utilization

Necessary procedures for the owner of an earth station are shown in the Preliminary Report as follows:

- to obtain allotment of frequency bands
- application for approval of a standard earth station

for access to the space segment

(ICSC-47-27E W/6/70, ICSC-46/15E W/4/70 (Rev 1))

- to submit necessary information to the ICSC
- to obtain the admission of verification test
- verification test

  In-station test

  Straightway test with TOCC

For reference:

(1) Procedure for the assignment of Intelsat radio frequency carriers.

ICSC-44-13E W/12/69

(2) Procedure for submission of applications for approval of earth stations for access to the space segment.

ICSC-47-27E W/6/70

ICSC-46-15E W/6/70 (Rev 1)

(3) Intelsat system monitoring and earth station performance verification procedures.

ICSC-43-18E W/10/69

(4) Terms and conditions for allotment of satellite utilization.

ICSC-51-33E W/1/71

(5) In addition, the following items are written in SSOG (Satellite System Operations Guide) issued from ICSC.

(a) SSOG VOLUME I BOOK I

Organization and Functions

System and Earth Station Planning

System Implementation

(b) SSOG VOLUME I BOOK II

System Management

Administrative and Miscellaneous

(c) SSOG VOLUME II --- Operations and Maintenance

Section 1	-	General Information
Section 2	-	Satellite System Management, Coordination and Control
Section 3	-	Satellite Radio Link Operation and Maintenance
Section 4	-	Engineering Service Circuits
Section 5	-	Satellite Radio Link Initial Line-up Procedures
Section 6	-	Line-up Procedures and Performance Objectives for Supergroups, Groups and channels at Earth Station equipped with Multiplex Equipment.
Section 7	-	Emergency Procedures
Section 8	-	Local Station Information

17. Conclusion

We have made a feasibility survey for a month in connection with the implementation project for the construction of a satellite earth station in Paraguay.

Our basic ideas relating to the most desirable satellite communication system in Paraguay and the construction program of earth station are contained in this report.

It would be our great pleasure if this report contributes much to the promotion of an earth station construction project in Paraguay.

Exploitation of the global satellite communication system is going on in a rapid pace. So, we sincerely hope that Paraguay would also realize this significant project on an earliest possible occasion.

In conclusion, we, the members of earth station survey team, should like to express our deepest gratitude to the government and the people of Paraguay for their kindest assistance and cooperation extended to us.

*Note

Annex: deleted

Figure and Table: Contracted as following

Fig. No. of Annex 1	Fig. No. contracted by this report
1	1
2	9, 14
3	10
4	3
5	(Reference 11)
6	(Reference 12)
7	(Table 9)
8	(Table 10)
9	Refer to plan-1 (January 1972)

Table No. of Annex 1	Table No. Contracted by this report
1	4
2	8

Annex-2 *Mandatory Technical Characteristics of a Standard Earth Station*

Mandatory Technical Characteristics	*Intelast III System (ICSC-37-38E)*	*Intelast IV System (ICSC 45-13E)*
1. System Gain-to-Niose Temperature Ratio	Aim G/T: 40.7 dB (5 elevation angle under clear sky condition) G : Greater than 57 dB (at 4GHz) Approval G/T: 40.7+20 log f/4 G : 57 +20 log f/4 (f: GHz) (Operating elevation angle, under clear sky in light wind, for any frequency in the bands 3705 to 3970 and 3970 to 4195 MHz)	The same to the left
2. Transmit Antenna sidelobe Pattern	Sidelobe levels at or more than 1 away from the mainlobe center shall be at least 29 dB below the mainlobe maximum.	The same to the left

	IS-III	IS-IV
3. Antenna Steerability	Antenna steerability shall be compatible with quasistationary satellites at earth station elevation angles not less than 5 with up to 10 orbit inclination and $\pm$10 longitudinal drift.	The same to the left
4. Antenna Tracking Modes	Manusl and auto-tracking capability shall be provided. If auto-tracking is to be achieved by a means that involves amplitude modulation of transmitted carriers, then not only must the requirement of paragraph 10 be met in respect of stability of level of e.i.r.p. but, in addition, there must be agreement with the ICSC on the frequency of such modulation.	The same to the left
5. Feed System Radio Bandwidth	Receiving feed system 3.7 to 4.2 GHz Transmitting feed system 5.925 to 6.425 GHz	The same to the left

	IS-III	IS-IV
6. Feed Polarization	Circular polarization, transmission and reception being of opposite hand. The voltage axial ratio of transmission in the direction of the satellite shall no exceed 1.4.	Circular polarization, left-hand for transmission from the earth station and right-hand for reception by the earth station. The same to the left
7. Receiving System Bandwidth	3705 to 3930 and 3970 to 4195 MHz. Notes: (a) Beacon reception a few MHz outside the 225 MHz. (b) In the case of a few stations requiring relatively few telephony circuits, it may be possible to provide adequate reception by covering one of the 225 MHz bands only.	3705 to 4195 MHz
8. Transmitting System Bandwidth and Capability	5.930 to 6.155 and 6.195 to 6.420 GHz	5.930 to 6.420 GHz

	IS-III	IS-IV
9. Equivalent Isotropically Radiated Power (e.i.r.p.)	Per voice channel 61 dBW For TV transmission 86 dBW Provision for control of e.i.r.p. is necessary. (A range of 6 dB below nominal) Compensation for additional absorption losses it may be necessary to increase the e.i.r.p. 2 dB for earth station with radomes.	Carrier Size (channels) / Required e.i.r.p. (elev. angle=10, dBW) Global Beam / Spot Beam 24: 74.7 / -- 60: 77.8 / 81.4 96: 79.5 / -- 132: 80.6 / 83.9 192: -- / 84.7 252: 82.8 / 85.4 432: 85.1 / 88.4 612: -- / 90.1 792: -- / 91.5 972: 90.9 / -- 1872: -- / 98.6 TV: 88.0 / -- Required e.i.r.p. for other elev. angles shall be modified by the equation of $-0.06(\alpha-10)$dB. (α is the elev. angle in degrees) Provision for adjustment of e.i.r.p. over a range of 10 dB below the maximum shall be provided.

	IS-III	IS-IV
10. e.i.r.p. Stability	Within ±0.5 dB of the nominal value. (except under severely adverse weather conditions)	The same to the left
11. Carrier Frequency Tolerance	+150 kHz for telephony carriers ±250 kHz for TV carriers Long-term is assumed to be at least one month.	±150 kHz for all telephony carriers except for the 2.5 and 5 MHz global beam and spot beam carriers (±80 kHz) ±250 kHz for TV carriers ±200 Hz for SPADE carriers Long-term is assumed to be at least one month.
12. RF Out-of Band Emission	Less than 4 dBW in any 4 kHz band within the 5925 to 6425 MHz frequency range excluding the multicarrier intermodulation products.	The same to the left
Intermodulation Products	Less than 23 dBW in any 4 kHz band within the frequency range of 5925 to 6425 MHz.	Less than 26-0.06 (α -10) dBW/4kHz (the frequency range of 5925 to 6425 MHz α is the elev. angle of the earth station antenna in degrees.

	IS-III	IS-IV
13. Group Delay Equalization and IF to RF Gain/ Frequency Response	(a) For residual group delay in the satellite transponder Linear Component 3.0 ns/MHz Parabolic Component 0.10 ns/MHz (b) For any group delay in station transmit equipment The limits after equalized Bandwidth Unit (MHz) 5 10 20 40 (TV) Equalization Bandwidth (MHz) 4.0 8.0 14.4 32 Linear Group Delay-ns/ MHz (positive or negative) 6 1.2 0.3 0.1 Parabolic Group Delay- ns/MHz^2 10 0.7 0.1 0.025 Ripple Component-ns (peak-to peak) 6 3 2 2	(a) For residual group delay in the satellite transponder Maximum range See Fig. 1 (b) For group delay in the station transmit equipment The limits after equalized See Fig. 2 Table 1&2
14. Residual Amplitude Modulation	Less than -40 dB referred to the RF carrier level at theantenna output. (rms value, at any frequency above 4 kHz in the baseband)	4 kHz to 500 kHz: Less than -20 (1+log f) dB referred to the RF carrier level at the antenna output. (rms value, within 4 kHz band, f is the center frequency in kHz of the 4 kHz slot) Above 500 kHz: Less than -74 dB.

	IS-III	IS-IV
15. Telephony Baseband Assembly	All basebands shall commence at 12 kHz. Frequencies below this value are reserved for order-wire circuits and energy dispersal inputs. A bandstop filter shall be provided at each baseband input, the attenuation exceeding 50 dB over a minimum frequency band of (0.005 fc+2) kHz where fc is 116 or 607 kHz for basebands of 24, 60 or 132 channels respectively.	Frequencies below 12 kHz are reserved for engineering service channels and energy dispersal inputs.
16. Sense of Video Modulation	Positive sense of modulation of the television video carrier such that a black-to-white transition at video causes the instantaneous radio frequency of the transmitted carrier to increase.	The same to the left

	IS-III	IS-IV
17. RF Energy Dispersal	Energy dispersal for both telephony and television carriers shall be based on the addition of a low-frequency symmetrical triangular wavefoam to the baseband signal to the FM modulator. (a) Telephony (FDM-FM) Carriers The maximum e.i.r.p. per 4 kHz of their transmitted carriers does not exceed the maximum e.i.r.p. per 4 kHz of the fully loaded carrier by more than 2 dB. Frequency 20 Hz to 150 Hz Frequency tolerance $\pm$1 Hz (b) Television Carriers A fixed-amplitude symmetrical triangular waveform capable of producing up to 2 MHz peak-to-peak deviation. Frequency: 20 or 30 Hz Phase: The points of inflection occurring during the filed blanking intervals.	The same to the left (b) --- 1 MHz peak-to-peak deviation ---

	IS-III	IS-IV
18. Pre-Emphasis	(a) Telephony (FDM-FM) Basebands CCIR Recommendation No. 275-1 (b) Television CCIR Recommendation No. 405 (c) Program Sound Channels CCITT Recommendation No. J. 21.	The same to the left
19. e.i.r.p. for SPADE Carriers		Maximum e.i.r.p. 63.5 dBW (*per channel, at 10 elevating angle*) Corresponding operation nominal e.i.r.p. 61.0 to 63.5 dBW Stability $\pm$0.5 dB of the nominal value E.i.r.p. at other operating elev. angle earth stations = $\left[(\text{e.i.r.p. at } 10)-0.06(\alpha - 10)\right]$ dBW α is the elevation angle in degrees.
20. Carrier Frequency Tolerance for SPADE Carriers		Within $\pm$200 Hz (shall be controlled)

	IS-III	IS-IV
21. RF Out-of-Band Emission for SPADE Carriers		Less than $\left(23-0.06\ (\alpha-10)\right)$ dBW/4kHz (within SPADE band, interaction among FM carriers and SPADE carriers)
22. IF to RF Gain Grequency Response for SPADE Carriers		Within $\pm$0.5 dB over the transponder passband
23. E.i.r.p. for PCM/PSK Single-Channel-Per-Carrier Preassigned Carriers		Maximum reuqired e.i.r.p. 63.5 dBW 10 elevation angle Operating nominal e.i.r.p. 53.5 to 63.5 dBW Stability Within $\pm$0.5 dB of the nominal value E.i.r.p. at other operating elev. angle earth station $= \left((\text{e.i.r.p. at } 10)-0.06\ (\alpha-10)\right)$ dBW α is the elevation angle in degrees.

	IS-III	IS-IV
24. Carrier Frequency Tolerance For PCM/PSK Single-Channel-Per Carrier Preassigned Carriers		Within $\pm$200 Hz of its allocated value.
25. RF Out-of Band Emission For PCM/PSK Single-Channel-Per Carrier Preassigned Carriers		Less than 23-0.06 (α -10) dBW/4 kHz (within the single channel PA band, interaction among single channel PA carriers and FM carriers)
26. Engineering Service Circuits		Channels Inverted sidebands of virtual carrier frequencies 3 kHz and 12 kHz Telegraph engineering service channels Within each of the 4 kHz channels at 2.7, 2.82, 2,94, 3.06, and 3.18 kHz Voice circuits Four-wire basis Alignment level at the reference point of the voice circuits the same as for all other voice channels on the carrier

	IS-III	IS-IV
		Crosstalk attenuation Less than 60 dB Signaling 2280 Hz, -6 ± 1 dBmO (CCITT Rec. M.61, Vol. IV, Blue Book) Telegraph circuits Freauency-shift modulated voice frequency telegraph system Main level -24 ± 1 dBmO Modulation rate 50 bauds Stop condition Low frequency to line (Alphabet No. 2)
27. In-Service Baseband Noise Measurements		At a transmitting earth station, an attenuation exceeding 50 dB over a minimum frequency band of ± (0.005 fc+2) kHz shall be provided at each baseband input so as to provide adequate baseband input attenuation in the noise-measuring slot. The center frequency "fc" of the noise-measuring bands is specified in the following table:

	IS-III	IS-IV	
		Baseband Capacity (Channels)	Center Frequency (fc, kHz)
		24	116
		60	277
		96	448
		132	607
		192	884
		252	1157
		432	1976
		612	2794
		792	3612
		972	4430
		1872	8932

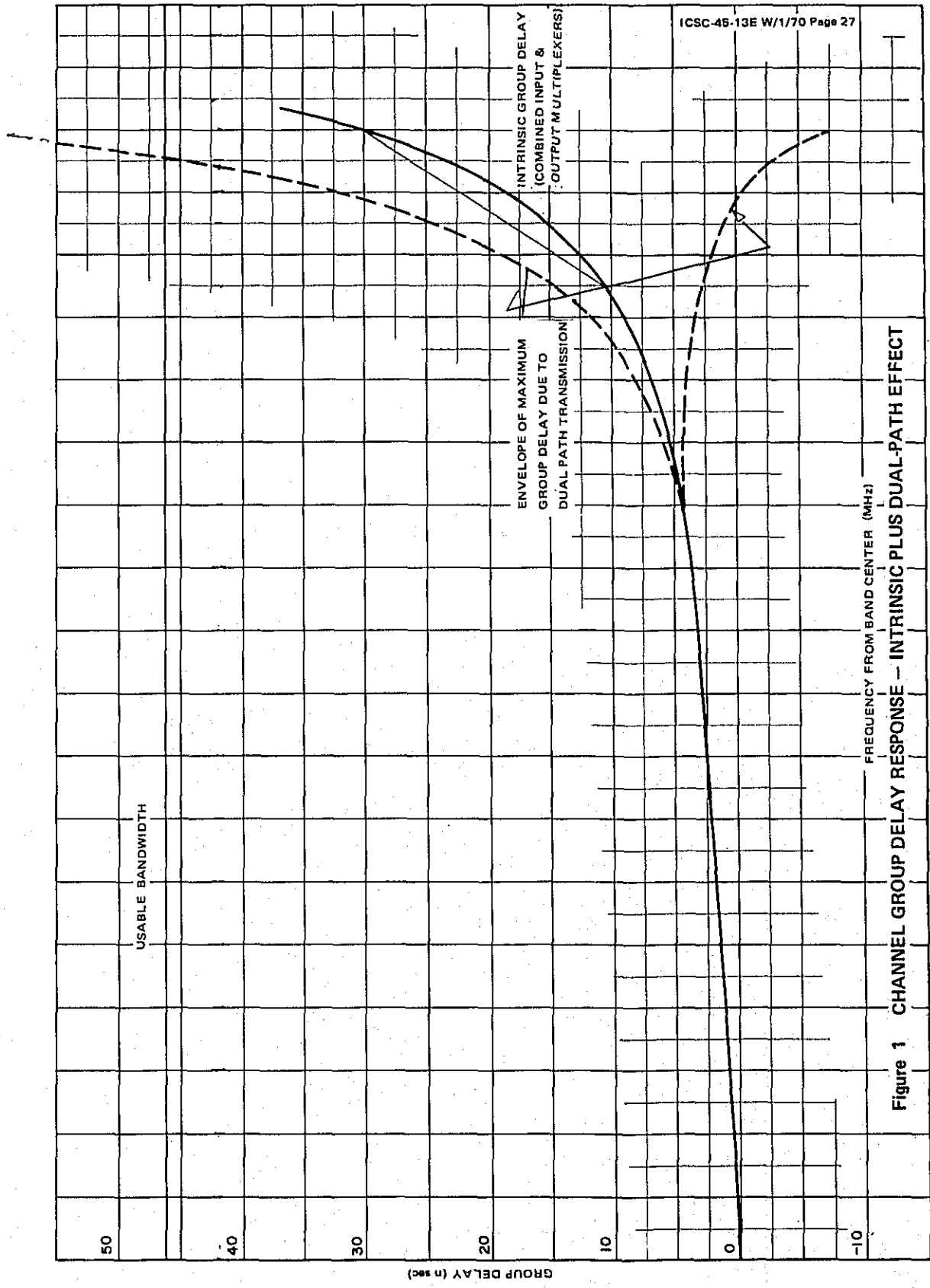
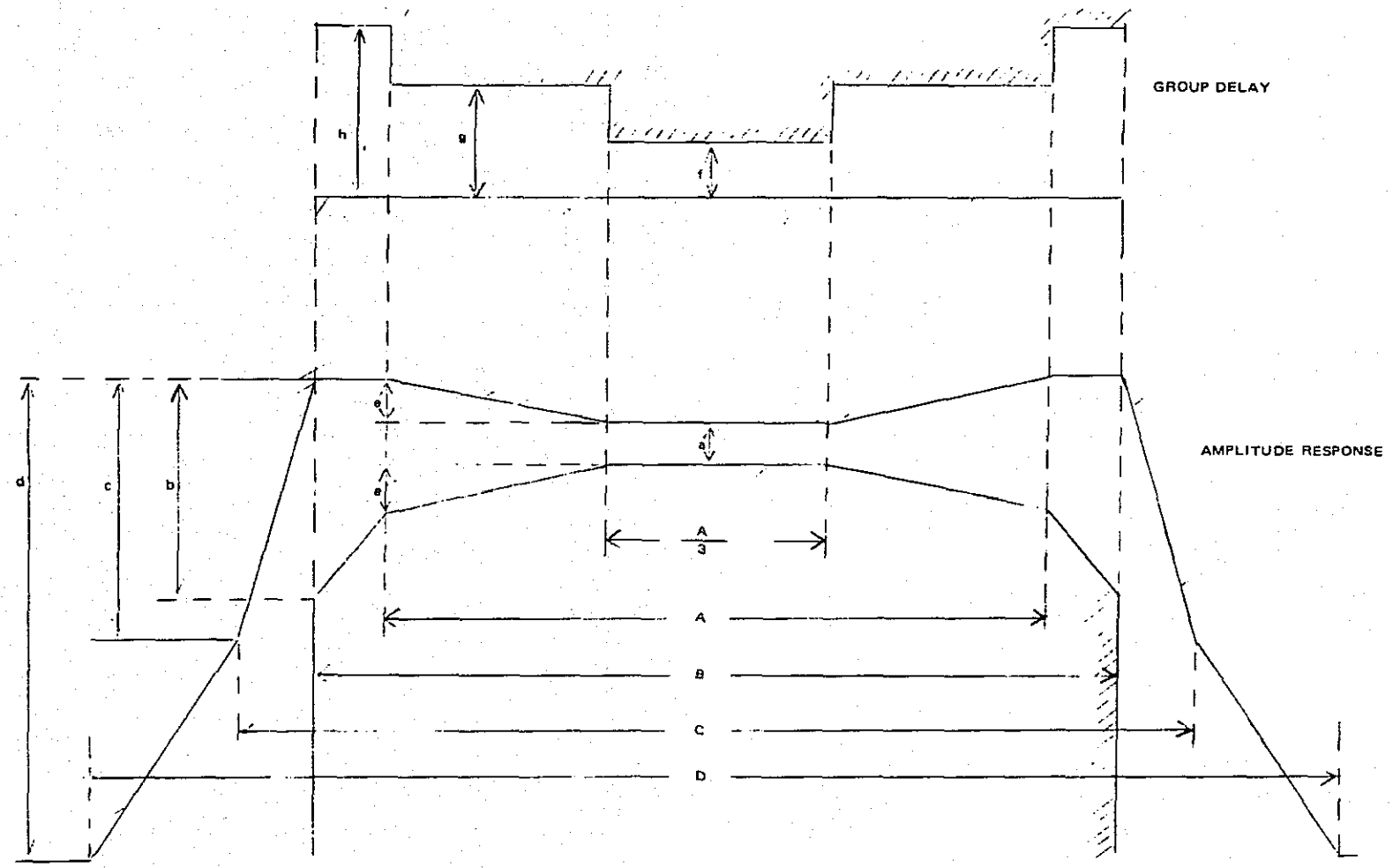


Figure 1 CHANNEL GROUP DELAY RESPONSE – INTRINSIC PLUS DUAL-PATH EFFECT



NOTES: (1) FIGURES ARE SYMMETRICAL RELATIVE TO CENTER FREQUENCY
(2) FIGURES ARE NOT DRAWN TO SCALE
(3) AMPLITUDE SCALE IS LINEAR IN dB
(4) FREQUENCY SCALE IS LINEAR IN MHz

Figure 2

Table I

Transmit and Receive Equipment Group Delay Characteristics

Carrier Size (MHz)	A (MHz)	B (MHz)	f (ns)	g (ns)	h (ns)
2.5	1.8	2.25	10.0	10.0	20
5	3.6	4.5	8.0	8.0	20
7.5	5.4	6.75	7.0	7.0	20
10	7.2	9.0	6.0	6.0	18
15	10.8	13.5	4.0	5.0	15
20	14.4	18.0	4.0	5.0	15
25	18.0	22.5	3.0	5.0	15
36.0	28.0	36.0	3.0	5.0	15
Video	24.0	30.0	5.0	5.0	15

Table 2

Transmit and Receive Equipment Gain/Frequency Characteristics

There is no out-of-bank filtering requirement at the transmit earths station.

The recommended receive noise bandwidth is given in Table 3.5.

Carrier Size (MHz)	A (MHz)	B (MHz)	C (MHz)	D (MHz)	a (dB)	b (dB)	c (dB)	d (dB)	e (dB)
2.5	1.8	2.25	2.75	8.0	0.7	1.5	3.0	25	0
5	3.6	4.5	5.25	13.0	0.5	2.0	3.0	25	0
7.5	5.4	6.75	7.75	17.0	0.4	2.5	4.0	25	0
10	7.2	9.0	10.25	19.0	0.3	2.5	5.0	25	0.1
15	10.8	13.5	15.5	25.0	0.3	2.5	5.5	25	0.1
20	14.4	18.0	20.5	28.0	0.3	2.5	7.5	25	0.1
25	18.0	22.5	25.75	34.0	0.3	2.5	8.0	25	0.2
36.0	28.8	36.0	45.25	60.0	0.6	2.5	10.0	25	0.3
Video	24.0	30.0	--*	--*	0.5	2.5	--*	--*	0.3

Table 3

Preferred Transmit and receive Equipment Gain/Frequency Characteristics

Change as Described Above for Table 3.3 (b)

Carrier Size (MHz)	A (MHz)	B (MHz)	C (MHz)	D (MHz)	a (dB)	b (dB)	c (dB)	d (dB)	e (dB)
2.5	1.9	2.25	3.5	7.75	0.7	1.0	8.0	35	0
5	3.8	4.5	5.25	9.75	0.5	2.0	5.0	35	0
7.5	5.75	6.75	7.75	11.75	0.4	2.5	7.0	35	0
10	7.65	9.0	10.25	14.5	0.3	2.5	8.0	35	0.1
15	11.5	13.5	15.50	23.5	0.3	2.5	7.0	35	0.1
20	15.25	18.0	20.5	29.0	0.3	2.5	8.0	35	0.1
25	19.0	22.5	25.75	35.2	0.3	2.5	9.0	35	0.2
36.0	31.0	36.0	45.25	68.5	0.6	2.5	10.0	35	0.3
Video	25.5	30.0	--*	--*	0.5	2.5	--*	--*	0.3

* Values to be supplied later.

REFERENCES

FRECUENCIA MENSUAL Y ANUAL DE LA DIRECCION DEL VIENTO EN ESCALA 1000

LOCALIDADES	Periodo	CLM	N	NE	E	SE	S	SW	W	NW
SAN LORENZO	57/66	264	102	184	37	55	140	156	26	36
ASUNCION	39/66	131	57	193	232	130	177	50	14	16
CAACUPE	61/66	257	45	276	152	125	92	37	2	14

MAXIMA INTENSIDAD DEL VIENTO

LOCALIDADES	Período	Año	Mes	Direc.	Velocidad
SAN LORENZO	57/70	1967	E	SW	100 K.P.H.
" "	"	1967	O	N	100 K.P.H.
ASUNCION	33/70	1953	F	NW	122 K.P.H.
CAACUPE	61/70	1963	JUN.	NE	65 K.P.H.
"	61/70	1963	S.	NE	65 K.P.H.

NOTA: La Institución no dispone de información de movimientos telúricos dentro del país, por no disponer el Servicio de Sismógrafo u otro instrumental registrador similar.-

DIRECCION DE METEOROLOGIA
REPUBLICA DEL PARAGUAY
ASUNCION

CENTENARIO DE LA EPOPEYA NACIONAL 1864 1870

DIRECCION DE METEOROLOGIA

Reference 2

A S U N C I O N

LAT: 25°17'06" LONG: 57°39'10" ELEVA: 115.8 MTS.

T O R M E N T A S DE V I E N T O O

P E R I O D O : 1933/69

F R E C U E N C I A M E D I A M E N S U A L Y A N U A L

E	F	M	A	M	J	J	A	S	O	N	D	ANUAL
1.01	0.70	0.53	0.61	0.32	0.20	0.19	0.68	0.78	1.22	1.13	1.25	8.68

FRECUENCIA MEDIA ANUAL POR INTENSIDAD EN KM P. H.

50/61	62/74	75/88	89/102	103/117	118 Y +	ANUAL
4.87	2.48	0.88	0.38	0.05	0.02	8.68

FRECUANCIA MEDIA ANUAL POR DIRECCION

N	NE	E	SE	S	SW	W	NW	ANUAL
0.58	0.41	0.26	0.72	0.38	2.36	0.48	0.49	8.68

NOTA: EN CLIMATOLOGÍA SE CONSIDERA TORMENTAS DE VIENTO, CUANDO LA VELOCIDAD DEL VIENTO ES IGUAL Ó SUPERIOR A 50.- KM. P. H.-

Cuadro I
Table I

Registro de Lluvias en Asunción - 1929 a Mayo 1965
Record of Rainfalls in Asunción - 1929 to May 1965

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Rainfall related to time — AMOUNT DURATION CANTIDAD DURACION	Total de lluvia caída en ese día / Total Rainfall in this day — AMOUNT DURATION CANTIDAD DURACION
Jan.	Enero	14/1929	11.2 mm. 00 h. 05 m. -	38.2 mm. 01 h. 30 m. -
Oct.	Oct.	28/1929	23.0 mm. 00 h. 10 m. -	29.0 mm. 10 h. 20 m. -
Nov.	Nov.	26/1939	20.0 mm. 00 h. 12 m. -	27.0 mm. 02 h. 20 m. -
Jan.	Enero	2/1931	10.0 mm. 00 h. 02 m. -	73.0 mm. 02 h. 20 m. -
Feb.	Feb.	25/1931	60.0 mm. 00 h. 50 m. -	63.0 mm. 01 h. 40 m. -
Apr.	April	9/1931	7.0 mm. 00 h. 01 m. -	39.2 mm. 03 h. 20 m. -
Oct.	Oct.	8/1961	5.0 mm. 00 h. 01 m. -	53.1 mm. 04 h. 40 m. -
Dec.	Dicie.	28/1931	17.0 mm. 00 h. 07 m. -	38.3 mm. 02 h. 20 m. -
Jan.	Enero	2/1932	65.5 mm. 00 h. 36 m. -	76.3 mm. 04 h. 00 m. -
Apr.	Abril	1/1932	17.0 mm. 00 h. 08 m. -	100.0 mm. 05 h. 30 m. -
Apr.	Abril	19/1932	8.0 mm. 00 h. 01 m. -	46.9 mm. 06 h. 10 m. -
Sep.	Setie.	20/1932	76.8 mm. 00 h. 40 m. -	90.4 mm. 02 h. 40 m. -
Jan.	Enero.	31/1933	20.0 mm. 00 h. 11 m. -	27.3 mm. 01 h. 10 m. -
Feb.	Febr.	28/1933	15.0 mm. 00 h. 05 m. -	34.2 mm. 02 h. 20 m. -
Dec.	Dicie.	21/1933	75.0 mm. 00 h. 35 m. -	80.1 mm. 01 h. 35 m. -
Mar.	Marzo	25/1934	10.0 mm. 00 h. 01 m. -	65.1 mm. 03 h. 20 m. -
Nov.	Novie.	11/1935	13.5 mm. 00 h. 05 m. -	60.0 mm. 04 h. 20 m. -
Aug.	Agost.	21/1936	16.0 mm. 00 h. 05 m. -	28.0 mm. 01 h. 10 m. -
Mar.	Marzo	4/1937	18.5 mm. 00 h. 05 m. -	25.2 mm. 00 h. 33 m. -
Mar.	Marzo	15/1937	94.0 mm. 00 h. 40 m. -	137.8 mm. 05 h. 00 m. -
May.	Mayo	13/1937	15.0 mm. 00 h. 05 m. -	40.4 mm. 01 h. 00 m. -
Dec.	Dicie.	8/1937	17.0 mm. 00 h. 10 m. -	30.0 mm. 01 h. 20 m. -
Mar.	Marzo	12/1938	17.0 mm. 00 h. 03 m. -	37.3 mm. 01 h. 05 m. -
Mar.	Marzo	21/1938	13.0 mm. 00 h. 03 m. -	47.2 mm. 01 h. 30 m. -
May	Mayo	14/1939	50.0 mm. 00 h. 28 m. -	66.0 mm. 02 h. 35 m. -
Dec.	Dicie.	19/1939	85.0 mm. 00 h. 50 m. -	126.0 mm. 03 h. 00 m. -
Feb.	Febre.	10/1940	18.0 mm. 00 h. 02 m. -	42.5 mm. 01 h. 10 m. -
Jan.	Enero	31/1941	15.0 mm. 00 h. 02 m. -	80.0 mm. 08 h. 00 m. -
Mar.	Marzo	12/1941	20.0 mm. 00 h. 04 m. -	63.0 mm. 04 h. 05 m. -
Apr.	April	13/1941	19.0 mm. 00 h. 06 m. -	107.9 mm. 03 h. 30 m. -
Feb.	Febr.	5/1942	17.0 mm. 00 h. 03 m. -	20.8 mm. 00 h. 40 m. -
Mar.	Marzo	4/1942	13.0 mm. 00 h. 01 m. -	50.0 mm. 01 h. 50 m. -
Mar.	Marzo	25/1942	13.0 mm. 00 h. 01 m. -	94.5 mm. 05 h. 00 m. -
Apr.	Abril	13/1942	11.0 mm. 00 h. 01 m. -	102.9 mm. 04 h. 04 m. -
Feb.	Febre.	25/1943	18.5 mm. 00 h. 03 m. -	20.2 mm. 00 h. 25 m. -
Jan.	Enero	7/1944	18.0 mm. 00 h. 15 m. -	18.0 mm. 00 h. 15 m. -
Mar.	Marzo	16/1944	32.0 mm. 00 h. 20 m. -	32.0 mm. 00 h. 20 m. -

FECHA			Intensidad de lluvia caída en función del tiempo. Intensity of Reinfall related to time — AMOUNT DURATION CANTIDAD DURACION	Total de lluvia caída en ese día. Total Rainfall in this day — AMOUNT DURATION CANTIDAD DURACION
Mar.	Marzo	29/1944	20.0 mm. 00 h. 07 m. -	43.6 mm. 00 h. 40 m. -
Jul.	Julio	5/1944	15.0 mm. 00 h. 40 m. -	32.5 mm. 03 h. 20 m. -
Nov.	Novie.	10/1944	20.0 mm. 00 h. 03 m. -	80.0 mm. 01 h. 00 m. -
Jan.	Enero	5/1945	10.0 mm. 00 h. 10 m. -	33.1 mm. 03 h. 30 m. -
Jan.	Enero	20/1945	20.0 mm. 00 h. 15 m. -	22.8 mm. 00 h. 50 m. -
Feb.	Febre.	14/1945	57.0 mm. 01 h. 10 m. -	116.1 mm. 03 h. 25 m. -
Feb.	Febre.	18/1945	16.0 mm. 00 h. 10 m. -	18.0 mm. 00 h. 50 m. -
Feb.	Febre.	26/1945	20.0 mm. 00 h. 10 m. -	27.8 mm. 04 h. 10 m. -
Mar.	Marzo	1/1945	19.0 mm. 00 h. 40 m. -	34.9 mm. 06 h. 30 m. -
Mar.	Marzo	6/1945	08.0 mm. 00 h. 02 m. -	20.0 mm. 02 h. 35 m. -
Oct.	Octubre	20/1945	26.0 mm. 00 h. 40 m. -	39.3 mm. 01 h. 35 m. -
Nov.	Novie.	4/1945	18.0 mm. 00 h. 20 m. -	85.6 mm. 04 h. 00 m. -
Nov.	Novie.	21/1945	11.0 mm. 00 h. 20 m. -	23.6 mm. 02 h. 30 m. -
Jan.	Enero	8/1946	10.0 mm. 00 h. 20 m. -	68.2 mm. 04 h. 35 m. -
Jan.	Enero	13/1946	13.0 mm. 00 h. 30 m. -	35.1 mm. 06 h. 25 m. -
Jan.	Enero	25/1946	17.0 mm. 00 h. 15 m. -	18.3 mm. 00 h. 55 m. -
Jan.	Enero	28/1946	18.0 mm. 00 h. 15 m. -	21.1 mm. 00 h. 50 m. -
Mar.	Marzo	9/1946	20.0 mm. 00 h. 08 m. -	47.0 mm. 01 h. 05 m. -
Mar.	Marzo	13/1946	18.0 mm. 00 h. 20 m. -	47.3 mm. 07 h. 15 m. -
Apr.	Abril	30/1946	19.0 mm. 00 h. 30 m. -	26.9 mm. 03 h. 15 m. -
1947			Sin datos - No information	
Mar.	Marzo	5/1948	10.0 mm. 00 h. 10 m. -	20.6 mm. 00 h. 30 m. -
Mar.	Marzo	11/1948	12.5 mm. 00 h. 07 m. -	91.2 mm. 07 h. 00 m. -
Mar.	Marzo	22/1948	19.5 mm. 00 h. 09 m. -	85.2 mm. 06 h. 20 m. -
Apr.	Abril	25/1948	20.0 mm. 00 h. 08 m. -	128.3 mm. 06 h. 30 m. -
1949 - 1951			Sin datos - No information	
Jan.	Enero	21/1952	20.0 mm. 00 h. 06 m. -	60.6 mm. 11 h. 40 m. -
Feb.	Febre.	24/1952	35.4 mm. 00 h. 17 m. -	133.4 mm. 06 h. 40 m. -
Mar.	Marzo	10/1952	20.0 mm. 00 h. 11 m. -	28.1 mm. 01 h. 50 m. -
Mar.	Marzo	29/1952	21.5 mm. 00 h. 15 m. -	88.1 mm. 14 h. 10 m. -
Jul.	Julio	12/1952	10.2 mm. 00 h. 02 m. -	38.7 mm. 07 h. 10 m. -
Oct.	Octub.	17/1952	15.5 mm. 00 h. 07 m. -	69.9 mm. 08 h. 30 m. -
Jan.	Enero	7/1953	40.6 mm. 00 h. 25 m. -	56.2 mm. 05 h. 30 m. -
Apr.	Abril	13/1953	30.4 mm. 00 h. 20 m. -	80.5 mm. 07 h. 15 m. -
May.	Mayo	1/1953	50.8 mm. 00 h. 30 m. -	101.9 mm. 06 h. 30 m.
May.	Mayo	7/1953	24.4 mm. 00 h. 11 m. -	62.3 mm. 06 h. 15 m. -
Sep.	Setie.	19/1953	20.0 mm. 00 h. 02 m. -	44.1 mm. 04 h. 15 m. -
Nov.	Novie.	27/1953	10.0 mm. 00 h. 03 m. -	37.0 mm. 06 h. 40 m. -
Jan.	Enero	13/1954	36.0 mm. 01 h. 20 m. -	91.4 mm. 10 h. 00 m. -
Jan.	Enero	18/1954	30.3 mm. 00 h. 20 m. -	78.4 mm. 04 h. 45 m. -
Feb.	Febre.	13/1954	09.5 mm. 00 h. 03 m. -	89.0 mm. 11 h. 33 m. -
Apr.	April	26/1954	31.6 mm. 00 h. 10 m. -	178.9 mm. 10 h. 40 m. -

Hoja 3
Sheet 3

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Reinfall related to time. AMOUNT DURATION CANTIDAD DURACION	Total de lluvia caída en ese día. / Total Rainfall in this day. AMOUNT DURATION CANTIDAD DURACION
May	Mayo	28/1954	71.0 mm. 03 h. 00 m. -	188.5 mm. 05 h. 30 m. -
Jun.	Junio	3/1954	09.0 mm. 00 h. 15 m. -	10.8 mm. 01 h. 00 m. -
Oct.	Octub.	8/1954	15.0 mm. 00 h. 35 m. -	88.6 mm. 12 h. 10 m. -
Oct.	Octub.	29/1954	10.0 mm. 00 h. 05 m. -	27.1 mm. 02 h. 20 m. -
Dec.	Dicic.	27/1954	10.4 mm. 00 h. 12 m. -	35.2 mm. 07 h. 00 m. -
Apr.	Abril	14/1955	28.0 mm. 00 h. 40 m. -	66.4 mm. 12 h. 00 m. -
May	Mayo	13/1955	53.0 mm. 01 h. 30 m. -	76.4 mm. 11 h. 05 m. -
May	Mayo	28/1955	23.0 mm. 00 h. 35 m. -	24.0 mm. 00 h. 40 m. -
Jun.	Junio	8/1955	18.0 mm. 00 h. 40 m. -	24.9 mm. 04 h. 10 m. -
Jun.	Junio	30/1955	36.0 mm. 01 h. 30 m. -	44.5 mm. 17 h. 10 m. -
Jul.	Julio	27/1955	05.0 mm. 00 h. 05 m. -	05.0 mm. 01 h. 30 m. -
Aug.	Agost.	13/1955	09.0 mm. 00 h. 10 m. -	14.0 mm. 04 h. 30 m. -
Oct.	Octub.	4/1953	13.0 mm. 00 h. 10 m. -	34.9 mm. 00 h. 35 m. -
Oct.	Octub.	7/1955	14.0 mm. 00 h. 30 m. -	14.8 mm. 02 h. 30 m. -
Nov.	Novie.	16/1955	12.0 mm. 00 h. 40 m. -	27.2 mm. 04 h. 15 m. -
Dec.	Dicie.	1/1955	14.0 mm. 00 h. 30 m. -	16.9 mm. 03 h. 10 m. -
Dec.	Dicie.	11/1955	23.0 mm. 01 h. 10 m. -	23.2 mm. 01 h. 40 m. -
Dec.	Dicie.	20/1955	22.0 mm. 01 h. 20 m. -	45.6 mm. 02 h. 10 m. -
Jan.	Enero	5/1956	59.0 mm. 01 h. 30 m. -	104.7 mm. 14 h. 55 m. -
Jan.	Enero	9/1956	09.0 mm. 00 h. 30 m. -	20.0 mm. 00 h. 55 m. -
Jan.	Enero	16/1956	09.0 mm. 00 h. 30 m. -	12.3 mm. 03 h. 30 m. -
Jan.	Enero	19/1956	27.0 mm. 01 h. 00 m. -	46.0 mm. 02 h. 45 m. -
Jan.	Enero	25/1956	25.0 mm. 01 h. 20 m. -	60.4 mm. 17 h. 45 m. -
Mar.	Marzo	13/1956	28.0 mm. 00 h. 30 m. -	33.7 mm. 08 h. 55 m. -
Mar.	Marzo	17/1956	44.0 mm. 01 h. 40 m. -	55.0 mm. 08 h. 00 m. -
Mar.	Marzo	21/1956	49.0 mm. 01 h. 30 m. -	59.1 mm. 08 h. 50 m. -
Mar.	Marzo	22/1956	31.0 mm. 01 h. 10 m. -	42.5 mm. 02 h. 45 m. -
Mar.	Marzo	27/1956	30.0 mm. 00 h. 40 m. -	51.1 mm. 06 h. 00 m. -
Mar.	Marzo	31/1956	20.0 mm. 00 h. 40 m. -	42.0 mm. 06 h. 35 m. -
Apr.	Abril	4/1956	17.0 mm. 01 h. 20 m. -	36.7 mm. 08 h. 45 m. -
Apr.	Abril	6/1956	31.0 mm. 01 h. 35 m. -	61.8 mm. 15 h. 50 m. -
Apr.	Abril	10/1956	16.0 mm. 00 h. 20 m. -	23.0 mm. 07 h. 00 m. -
Apr.	Abril	21/1956	35.0 mm. 00 h. 40 m. -	70.4 mm. 10 h. 10 m. -
May	Mayo	30/1956	13.0 mm. 01 h. 10 m. -	35.0 mm. 08 h. 05 m. -
Jul.	Julio	2/1956	14.0 mm. 00 h. 20 m. -	35.0 mm. 13 h. 30 m. -
Aug.	Agost.	10/1956	19.0 mm. 00 h. 20 m. -	26.9 mm. 04 h. 50 m. -
Sep.	Setie.	9/1956	38.0 mm. 01 h. 30 m. -	42.4 mm. 07 h. 50 m. -
Oct.	Octub.	7/1956	27.0 mm. 01 h. 30 m. -	35.6 mm. 08 h. 30 m. -
Oct.	Octub.	14/1956	52.0 mm. 04 h. 00 m. -	57.2 mm. 07 h. 50 m. -
Oct.	Octub.	16/1956	27.0 mm. 01 h. 00 m. -	46.6 mm. 07 h. 00 m. -
Oct.	Octub.	21/1956	20.0 mm. 00 h. 20 m. -	54.8 mm. 07 h. 25 m. -
Oct.	Octub.	27/1956	12.0 mm. 00 h. 30 m. -	34.3 mm. 11 h. 30 m. -
Dec.	Dicie.	6/1956	45.0 mm. 01 h. 40 m. -	80.9 mm. 05 h. 20 m. -
Dec.	Dicie.	18/1956	09.0 mm. 00 h. 50 m. -	13.7 mm. 05 h. 50 m. -
Dec.	Dicie.	22/1956	17.0 mm. 00 h. 40 m. -	52.3 mm. 01 h. 45 m. -

Hoja 4
Sheet 4

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Rainfall related to time. AMOUNT CANTIDAD	DURATION DURACION	Total de lluvia caída en ese día. / Total Rainfall in this day. AMOUNT CANTIDAD	DURATION DURACION
Jan.	Enero	6/1957	07.0 mm.	00 h. 10 m. -	10.8 mm.	01 h. 25 m. -
Jan.	Enero	8/1957	30.0 mm.	01 h. 20 m. -	61.5 mm.	04 h. 30 m. -
Jan.	Enero	13/1957	12.0 mm.	01 h. 30 m. -	16.1 mm.	07 h. 10 m. -
Jan.	Enero	20/1957	19.0 mm.	00 h. 40 m. -	21.5 mm.	06 h. 50 m. -
Jan.	Enero	24/1957	38.0 mm.	01 h. 10 m. -	87.5 mm.	03 h. 50 m. -
Jan.	Enero	30/1957	14.0 mm.	00 h. 10 m. -	17.0 mm.	06 h. 40 m. -
Feb.	Febre.	1/1957	31.0 mm.	01 h. 10 m. -	45.5 mm.	10 h. 40 m. -
Feb.	Febre.	5/6/1957	34.0 mm.	00 h. 50 m. -	73.6 mm.	15 h. 20 m. -
Feb.	Febre.	13/1957	10.0 mm.	00 h. 50 m. -	26.2 mm.	10 h. 30 m. -
Feb.	Febre.	25/1957	21.0 mm.	01 h. 10 m. -	34.2 mm.	01 h. 45 m. -
Mar.	Marzo	8/1957	22.0 mm.	01 h. 40 m. -	40.5 mm.	05 h. 30 m. -
Apr.	Abril	13/1957	39.0 mm.	01 h. 50 m. -	60.8 mm.	08 h. 55 m. -
Apr.	Abril	20/1957	22.0 mm.	01 h. 10 m. -	52.3 mm.	06 h. 40 m. -
May.	Mayo	5/1957	17.0 mm.	00 h. 40 m. -	43.5 mm.	18 h. 00 m. -
May.	Mayo	23/1957	26.0 mm.	01 h. 40 m. -	30.8 mm.	05 h. 35 m. -
Jun.	Junio	1/1957	25.0 mm.	02 h. 40 m. -	83.6 mm.	18 h. 20 m. -
Jun.	Junio	26/1957	36.0 mm.	01 h. 30 m. -	50.4 mm.	02 h. 15 m. -
Jul.	Julio	29/1957	13.0 mm.	01 h. 00 m. -	14.0 mm.	03 h. 00 m. -
Aug.	Agost	17/1957	21.0 mm.	01 h. 10 m. -	23.4 mm.	02 h. 40 m. -
Sep.	Setie	14/1957	07.0 mm.	01 h. 00 m. -	15.1 mm.	06 h. 50 m. -
Oct.	Oct.	10/1957	20.0 mm.	01 h. 10 m. -	36.7 mm.	16 h. 55 m. -
Oct.	Oct.	25/1957	07.0 mm.	00 h. 40 m. -	06.3 mm.	01 h. 05 m. -
Nov.	Nov.	11/1957	20.0 mm.	01 h. 20 m. -	52.0 mm.	06 h. 45 m. -
Nov.	Nov.	16/1957	08.0 mm.	01 h. 20 m. -	13.0 mm.	03 h. 20 m. -
Dec.	Dic.	5/1957	20.0 mm.	01 h. 00 m. -	24.0 mm.	03 h. 55 m. -
Dec.	Dic.	28/1957	36.0 mm.	00 h. 40 m. -	46.0 mm.	01 h. 20 m. -
Dec.	Dic.	30/1957	08.0 mm.	00 h. 20 m. -	21.7 mm.	03 h. 50 m. -
Jan.	Enero	1/1958	14.0 mm.	00 h. 30 m. -	30.2 mm.	05 h. 10 m. -
Jan.	Enero	10/1958	12.0 mm.	00 h. 10 m. -	13.3 mm.	00 h. 45 m. -
Feb.	Febre.	23/1958	31.0 mm.	00 h. 50 m. -	57.1 mm.	05 h. 40 m. -
Mar.	Marzo	13/1958	18.0 mm.	00 h. 30 m. -	23.9 mm.	03 h. 55 m. -
Mar.	Marzo	29/1958	58.0 mm.	01 h. 20 m. -	86.9 mm.	04 h. 10 m. -
Apr.	Abril	8/1958	22.0 mm.	01 h. 30 m. -	28.3 mm.	06 h. 55 m. -
May	Mayo	1/1958	41.0 mm.	01 h. 20 m. -	136.2 mm.	04 h. 50 m. -
May	Mayo	10/1958	16.0 mm.	01 h. 20 m. -	16.2 mm.	03 h. 20 m. -
May	Mayo	18/1958	18.0 mm.	01 h. 00 m. -	22.7 mm.	02 h. 40 m. -
Jun.	Junio	4/1958	10.0 mm.	01 h. 30 m. -	13.1 mm.	04 h. 30 m. -
Jul.	Julio	8/1958	17.0 mm.	00 h. 50 m. -	17.5 mm.	03 h. 35 m. -
Jul.	Julio	14/1958	20.0 mm.	02 h. 05 m. -	32.1 mm.	14 h. 25 m. -
Jul.	Julio	28/1958	10.0 mm.	00 h. 15 m. -	17.0 mm.	02 h. 55 m. -
Jul.	Julio	31/1958	18.0 mm.	01 h. 10 m. -	18.2 mm.	15 h. 20 m. -
Aug.	Agost	28/1958	10.0 mm.	00 h. 20 m. -	11.7 mm.	01 h. 05 m. -

Hoja 5
Sheet 5

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Rainfall related to time		Total de lluvia caída en ese día. / Total Rainfall in this day.	
			AMOUNT	DURATION	AMOUNT	DURATION
			CANTIDAD	DURACION	CANTIDAD	DURACION
Sep.	Setie.	5/1958	17.0 mm.	00 h. 30 m. -	28.4 mm.	04 h. 20 m. -
Sep.	Setie.	21/1958	12.0 mm.	01 h. 00 m. -	19.4 mm.	04 h. 40 m. -
Sep.	Setie.	22/1958	60.0 mm.	01 h. 20 m. -	95.7 mm.	13 h. 40 m. -
Sep.	Setie.	23/1958	20.0 mm.	01 h. 00 m. -	70.0 mm.	20 h. 50 m. -
Oct.	Oct.	2/1958	11.0 mm.	00 h. 50 m. -	24.3 mm.	08 h. 20 m. -
Oct.	Oct.	10/1958	33.0 mm.	01 h. 40 m. -	36.4 mm.	03 h. 30 m. -
Oct.	Oct.	22/1958	21.0 mm.	03 h. 00 m. -	28.2 mm.	06 h. 30 m. -
Nov.	Nov.	3/1958	11.0 mm.	00 h. 50 m. -	19.4 mm.	04 h. 10 m. -
Nov.	Nov.	9/1958	30.0 mm.	00 h. 40 m. -	45.8 mm.	07 h. 50 m. -
Nov.	Nov.	16/1958	23.0 mm.	01 h. 40 m. -	37.3 mm.	05 h. 30 m. -
Nov.	Nov.	19/1958	16.0 mm.	01 h. 00 m. -	16.7 mm.	02 h. 00 m. -
Dec.	Dicie.	1/1958	40.0 mm.	01 h. 30 m. -	52.1 mm.	05 h. 40 m. -
Dec.	Dicie.	5/1958	11.0 mm.	00 h. 05 m. -	11.2 mm.	01 h. 45 m. -
Dec.	Dicie.	8/1958	48.0 mm.	00 h. 50 m. -	48.3 mm.	05 h. 00 m. -
Dec.	Dicie	12/1958	29.0 mm.	00 h. 30 m. -	38.2 mm.	01 h. 40 m. -
Dec.	Dicie	14/1958	57.0 mm.	01 h. 20 m. -	102.8 mm.	09 h. 45 m. -
Dec.	Dicie	18/1958	18.0 mm.	00 h. 30 m. -	22.5 mm.	03 h. 10 m. -
Jan.	Enero	3/1959	22.0 mm.	01 h. 00 m. -	34.8 mm.	03 h. 15 m. -
Jan.	Enero	30/1959	14.0 mm.	00 h. 10 m. -	14.7 mm.	01 h. 35 m. -
Feb.	Febre.	3/1959	13.0 mm.	00 h. 30 m. -	15.0 mm.	07 h. 50 m. -
Feb.	Febre.	6/1959	46.0 mm.	01 h. 20 m. -	129.7 mm.	05 h. 35 m. -
Feb.	Febre.	7/1959	17.0 mm.	00 h. 40 m. -	25.4 mm.	05 h. 35 m. -
Feb.	Febre.	14/1959	51.0 mm.	01 h. 30 m. -	55.7 mm.	01 h. 25 m. -
Feb.	Febre.	21/1959	13.0 mm.	00 h. 10 m. -	19.8 mm.	03 h. 45 m. -
Mar.	Marzo	17/1959	36.0 mm.	01 h. 10 m. -	49.2 mm.	18 h. 00 m. -
Apr.	Abril	3/1959	84.0 mm.	01 h. 50 m. -	106.8 mm.	16 h. 15 m. -
Apr.	Abril	7/1959	22.0 mm.	00 h. 10 m. -	47.6 mm.	08 h. 30 m. -
Apr.	Abril	10/1959	55.0 mm.	01 h. 00 m. -	118.7 mm.	06 h. 15 m. -
Apr.	Abril	22/1959	54.0 mm.	01 h. 30 m. -	103.3 mm.	11 h. 00 m. -
May	Mayo	10/1959	31.0 mm.	01 h. 10 m. -	40.0 mm.	06 h. 10 m. -
May	Mayo	30/1959	28.0 mm.	00 h. 40 m. -	20.7 mm.	00 h. 30 m. -
Jun.	Julio	15/1959	07.0 mm.	00 h. 30 m. -	07.0 mm.	06 h. 30 m. -
Aug.	Agost	14/1959	08.0 mm.	00 h. 10 m. -	14.8 mm.	08 h. 10 m. -
Aug.	Agost	28/1959	14.0 mm.	00 h. 50 m. -	23.8 mm.	03 h. 15 m. -
Sep.	Setie	11/1959	13.0 mm.	00 h. 10 m. -	32.7 mm.	- -
Sep.	Setie	24/1959	48.0 mm.	00 h. 50 m. -	-	07 h. 30 m. -
Oct.	Oct.	20/1959	14.0 mm.	00 h. 20 m. -	19.9 mm.	- -
Nov.	Novie	10/1959	22.0 mm.	00 h. 30 m. -	-	11 h. 20 m. -
Nov.	Novie	11/1959	12.0 mm.	00 h. 40 m. -	58.1 mm.	05 h. 00 m. -
Nov.	Novie	17/1959	24.0 mm.	00 h. 40 m. -	48.8 mm.	06 h. 55 m. -
Nov.	Novie	29/1959	39.0 mm.	01 h. 30 m. -	40.8 mm.	- -
Dec.	Dicie	16/1959	60.0 mm.	01 h. 30 m. -	-	

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Rainfall related to time		Total de lluvia caída en ese día. / Total Rainfall in this day.	
			AMOUNT	DURATION	AMOUNT	DURATION
			CANTIDAD	DURACION	CANTIDAD	DURACION
Jan.	Enero	30/1960	25.0 mm.	00 h. 30 m. -	29.6 mm.	01 h. 40 m. -
Feb.	Febre	16/1960	26.0 mm.	00 h. 40 m. -	89.1 mm.	03 h. 00 m. -
Apr.	Abril	3/1960	31.0 mm.	01 h. 00 m. -	37.7 mm.	08 h. 15 m. -
Jun.	Junio	10/1960	13.0 mm.	00 h. 20 m. -	31.7 mm.	12 h. 05 m. -
Jun.	Junio	13/1960	18.0 mm.	00 h. 20 m. -	49.3 mm.	13 h. 10 m. -
Jul.	Julio	30/1960	16.0 mm.	00 h. 50 m. -	33.0 mm.	02 h. 55 m. -
Aug.	Agos.	24/1960	33.0 mm.	01 h. 50 m. -	40.5 mm.	07 h. 10 m. -
Sep.	Setie.	7/1960	28.0 mm.	01 h. 30 m. -	49.2 mm.	05 h. 25 m. -
Sep.	Setie.	13/1960	13.0 mm.	00 h. 30 m. -	21.0 mm.	05 h. 15 m. -
Oct.	Oct.	2/1960	13.0 mm.	00 h. 40 m. -	30.0 mm.	10 h. 15 m. -
Oct.	Oct.	19/1960	39.0 mm.	01 h. 10 m. -	63.9 mm.	11 h. 55 m. -
Oct.	Oct.	25/1960	46.0 mm.	01 h. 30 m. -	46.6 mm.	05 h. 30 m. -
Nov.	Novie.	14/1960	25.0 mm.	01 h. 20 m. -	53.6 mm.	08 h. 40 m. -
Nov.	Novie.	24/1960	27.0 mm.	01 h. 00 m. -	33.2 mm.	02 h. 50 m. -
Dec.	Dicie.	28/1960	15.0 mm.	00 h. 20 m. -	15.8 mm.	00 h. 30 m. -
Jan.	Enero	6/1960	15.0 mm.	01 h. 00 m. -	30.0 mm.	04 h. 15 m. -
Jan.	Enero	21/1961	07.0 mm.	00 h. 05 m. -	07.5 mm.	00 h. 45 m. -
Feb.	Febre	2/1961	11.0 mm.	00 h. 20 m. -	22.5 mm.	01 h. 05 m. -
Feb.	Febre	7/1961	09.0 mm.	00 h. 40 m. -	43.9 mm.	08 h. 35 m. -
Feb.	Febre	22/1961	36.0 mm.	01 h. 00 m. -	49.7 mm.	03 h. 25 m. -
Feb.	Febre	26/1961	15.0 mm.	01 h. 20 m. -	30.6 mm.	03 h. 48 m. -
Mar.	Marzo	12/1961	13.0 mm.	00 h. 20 m. -	36.7 mm.	03 h. 50 m. -
Mar.	Marzo	16/1961	14.0 mm.	00 h. 50 m. -	28.4 mm.	02 h. 20 m. -
Apr.	Abril	13/1961	23.0 mm.	01 h. 30 m. -	68.7 mm.	13 h. 55 m. -
Apr.	Abril	22/1961	47.0 mm.	00 h. 40 m. -	78.7 mm.	01 h. 20 m. -
Jun.	Junio	10/1961	32.0 mm.	01 h. 00 m. -	54.0 mm.	10 h. 15 m. -
Jul.	Julio	21/1961	12.0 mm.	00 h. 40 m. -	21.7 mm.	01 h. 40 m. -
Oct.	Oct.	19/1961	46.0 mm.	01 h. 10 m. -	87.9 mm.	06 h. 15 m. -
Nov.	Novie	13/1961	23.0 mm.	01 h. 30 m. -	43.2 mm.	07 h. 00 m. -
Nov.	Novie	19/1961	34.0 mm.	01 h. 10 m. -	53.8 mm.	13 h. 15 m. -
Nov.	Novie	21/1961	23.0 mm.	00 h. 40 m. -	41.7 mm.	05 h. 30 m. -
Dec.	Dicie	23/1961	34.0 mm.	01 h. 00 m. -	74.0 mm.	16 h. 40 m. -
Jan.	Enero	1/1962	34.0 mm.	00 h. 50 m. -	80.2 mm.	06 h. 10 m. -
Jan.	Enero	2/1962	26.0 mm.	01 h. 20 m. -	28.0 mm.	02 h. 20 m. -
Jan.	Enero	7/1962	24.0 mm.	01 h. 00 m. -	24.3 mm.	03 h. 10 m. -
Jan.	Enero	22/1962	23.0 mm.	00 h. 50 m. -	37.0 mm.	04 h. 30 m. -
Jan.	Enero	23/1962	42.0 mm.	01 h. 40 m. -	100.9 mm.	07 h. 50 m. -
Feb.	Febre	2/1962	23.0 mm.	01 h. 00 m. -	45.5 mm.	21 h. 15 m. -
Feb.	Febre	18/1962	56.0 mm.	01 h. 10 m. -	44.0 mm.	09 h. 50 m. -
Mar.	Marzo	4/1962	27.0 mm.	00 h. 40 m. -	40.9 mm.	05 h. 10 m. -
Mar.	Marzo	9/1962	26.0 mm.	01 h. 00 m. -	26.4 mm.	01 h. 40 m. -
Mar.	Marzo	29/1962	28.0 mm.	00 h. 40 m. -	34.5 mm.	08 h. 15 m. -
Apr.	Abril	15/1962	33.0 mm.	01 h. 20 m. -	47.6 mm.	02 h. 45 m. -

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Rainfall related to time		Total de lluvia caída en ese día. / Total Rainfall in this day	
			AMOUNT	DURATION	AMOUNT	DURATION
			CANTIDAD	DURACION	CANTIDAD	DURACION
Apr.	Abril	28/1962	24.0 mm.	01 h. 40 m. -	34.9 mm.	03 h. 30 m. -
May	Mayo	11/1962	22.0 mm.	01 h. 10 m. -	40.2 mm.	11 h. 05 m. -
Jul.	Julio	14/1962	08.0 mm.	01 h. 00 m. -	16.7 mm.	12 h. 20 m. -
Sep.	Setie	19/1962	05.0 mm.	00 h. 10 m. -	24.0 mm.	09 h. 20 m. -
Sep.	Setie	27/1962	11.0 mm.	01 h. 20 m. -	11.6 mm.	03 h. 05 m. -
Oct.	Oct.	1/1962	19.0 mm.	00 h. 40 m. -	38.1 mm.	10 h. 30 m. -
Oct.	Oct.	3/1962	22.0 mm.	00 h. 10 m. -	14.2 mm.	01 h. 20 m. -
Oct.	Oct.	6/1962	26.0 mm.	01 h. 20 m. -	46.2 mm.	14 h. 40 m. -
Nov.	Novie	5/1962	13.0 mm.	01 h. 10 m. -	13.4 mm.	01 h. 20 m. -
Nov.	Novie	6/1962	11.0 mm.	00 h. 20 m. -	12.5 mm.	07 h. 20 m. -
Dec.	Dicie	26/1962	14.0 mm.	01 h. 10 m. -	24.2 mm.	03 h. 20 m. -
Jan.	Enero	6/1963	22.0 mm.	00 h. 20 m. -	23.1 mm.	01 h. 40 m. -
Jan.	Enero	27/1963	12.0 mm.	00 h. 40 m. -	34.1 mm.	08 h. 25 m. -
Feb.	Febre	10/1963	32.0 mm.	01 h. 10 m. -	34.8 mm.	05 h. 20 m. -
Feb.	Febre	14/1963	09.0 mm.	00 h. 30 m. -	15.2 mm.	06 h. 00 m. -
Feb.	Febre	28/1963	07.0 mm.	00 h. 30 m. -	15.4 mm.	02 h. 25 m. -
Mar.	Marzo	9/1963	23.0 mm.	01 h. 00 m. -	29.8 mm.	12 h. 20 m. -
Mar.	Marzo	21/1963	38.0 mm.	01 h. 20 m. -	59.3 mm.	07 h. 15 m. -
Mar.	Marzo	22/1963	23.0 mm.	01 h. 30 m. -	39.5 mm.	10 h. 00 m. -
Mar.	Marzo	25/1963	11.0 mm.	00 h. 30 m. -	11.6 mm.	00 h. 50 m. -
Apr.	Abril	3/1963	12.0 mm.	00 h. 40 m. -	19.1 mm.	05 h. 30 m. -
Apr.	Abril	14/1963	41.0 mm.	01 h. 40 m. -	42.0 mm.	02 h. 55 m. -
Apr.	Abril	15/1963	28.0 mm.	01 h. 20 m. -	80.1 mm.	15 h. 50 m. -
May	Mayo	3/1963	45.0 mm.	01 h. 20 m. -	51.9 mm.	03 h. 10 m. -
May	Mayo	13/1963	28.0 mm.	00 h. 50 m. -	31.2 mm.	05 h. 10 m. -
May	Mayo	16/1963	26.0 mm.	01 h. 00 m. -	33.7 mm.	08 h. 00 m. -
Jul.	Julio	15/1963	06.0 mm.	00 h. 20 m. -	08.8 mm.	07 h. 45 m. -
Aug.	Agost.	15/1963	09.0 mm.	00 h. 30 m. -	09.0 mm.	02 h. 00 m. -
Sep.	Setie	9/1963	23.0 mm.	00 h. 50 m. -	23.4 mm.	08 h. 50 m. -
Sep.	Setie	20/1963	24.0 mm.	01 h. 20 m. -	41.0 mm.	05 h. 50 m. -
Nov.	Novie	7/1963	21.0 mm.	01 h. 20 m. -	62.9 mm.	06 h. 15 m. -
Nov.	Novie	19/1963	49.0 mm.	01 h. 20 m. -	51.6 mm.	05 h. 40 m. -
Dec.	Dicie	1/1963	18.0 mm.	00 h. 30 m. -	20.9 mm.	01 h. 50 m. -
Dec.	Dicie	17/1963	46.0 mm.	01 h. 50 m. -	82.9 mm.	11 h. 20 m. -
Dec.	Dicie	31/1963	33.0 mm.	01 h. 40 m. -	45.2 mm.	04 h. 35 m. -
Jan.	Enero	26/1964	50.0 mm.	00 h. 50 m. -	52.5 mm.	04 h. 55 m. -
Feb.	Febre	15/1964	11.0 mm.	00 h. 20 m. -	12.0 mm.	02 h. 50 m. -
Mar.	Marzo	13/1964	33.0 mm.	00 h. 40 m. -	33.0 mm.	00 h. 40 m. -
Mar.	Marzo	25/1964	14.0 mm.	00 h. 20 m. -	75.9 mm.	- -
Mar.	Marzo	26/1964	64.0 mm.	01 h. 50 m. -	88.7 mm.	- -
Apr.	Abril	7/1964	33.0 mm.	01 h. 20 m. -	64.2 mm.	06 h. 10 m. -
Apr.	Abril	16/1964	54.0 mm.	02 h. 00 m. -	109.5 mm.	15 h. 15 m. -
Apr.	Abril	24/1964	07.0 mm.	00 h. 20 m. -	15.7 mm.	07 h. 15 m. -
Apr.	Abril	27/1964	16.0 mm.	00 h. 30 m. -	38.8 mm.	07 h. 35 m. -
May.	Mayo	12/1964	05.0 mm.	00 h. 10 m. -	25.2 mm.	06 h. 30 m. -
Jun.	Junio	4/1964	09.0 mm.	01 h. 00 m. -	18.6 mm.	08 h. 20 m. -

FECHA			Intensidad de lluvia caída en función del tiempo / Intensity of Rainfall related to time — AMOUNT DURATION CANTIDAD DURACION	Total de lluvia caída en ese dia / Total Rainfall in this day — AMOUNT DURATION CANTIDAD DURACION
Aug.	Agost.	24/1964	07. 0 mm. 00 h. 30 m. -	24. 8 mm. 08 h. 50 m. -
Sep.	Setie.	30/1964	12. 0 mm. 00 h. 30 m. -	17. 5 mm. 06 h. 40 m. -
Nov.	Novie.	4/1964	48. 0 mm. 01 h. 50 m. -	60. 5 mm. 11 h. 35 m. -
Nov.	Novie.	15/1964	10. 0 mm. 00 h. 20 m. -	11. 8 mm. 05 h. 50 m. -
Nov.	Novie.	20/1964	20. 0 mm. 01 h. 00 m. -	33. 0 mm. 04 h. 25 m. -
Dec.	Dicie.	2/1964	12. 0 mm. 00 h. 30 m. -	33. 0 mm. 04 h. 00 m. -
Dec.	Dicie.	11/1964	25. 0 mm. 01 h. 10 m. -	50. 5 mm. 02 h. 05 m. -
Dec.	Dicie.	12/1964	11. 0 mm. 00 h. 30 m. -	40. 9 mm. 09 h. 20 m. -
Dec.	Dicie.	20/1964	08. 0 mm. 00 h. 20 m. -	59. 0 mm. 01 h. 35 m. -
Dec.	Dicie.	27/1964	08. 0 mm. 00 h. 10 m. -	32. 5 mm. 01 h. 35 m. -
Jan.	Enero	3/1965	11. 0 mm. 00 h. 30 m. -	26. 9 mm. - -
Jan.	Enero	13/1965	13. 0 mm. 00 h. 50 m. -	16. 5 mm. - -
Jan.	Enero	15/1965	26. 0 mm. 01 h. 20 m. -	61. 5 mm. - -
Jan.	Enero	16/1965	46. 0 mm. 01 h. 50 m. -	116. 7 mm. - -
Feb.	Febre	4/1965	08. 0 mm. 00 h. 20 m. -	38. 4 mm. 02 h. 40 m. -
Feb.	Febre	11/1965	08. 0 mm. 00 h. 40 m. -	37. 8 mm. 03 h. 10 m. -
Feb.	Febre	13/1965	25. 0 mm. 01 h. 20 m. -	42. 0 mm. 04 h. 25 m. -
Mar.	Marzo	19/1965	03. 0 mm. 00 h. 02 m. -	39. 3 mm. 06 h. 30 m. -
Mar.	Marzo	1/1965	11. 8 mm. 00 h. 20 m. -	56. 3 mm. 01 h. 50 m. -
Mar.	Marzo	9/1965	11. 8 mm. 00 h. 10 m. -	64. 3 mm. 02 h. 20 m. -
Apr.	Abril	6/1965	16. 0 mm. 00 h. 05 m. -	18. 4 mm. 00 h. 45 m. -
Apr.	Abril	9/1965	20. 0 mm. 00 h. 15 m. -	70. 4 mm. 11 h. 05 m. -
Apr.	Abril	18/1965	05. 0 mm. 00 h. 05 m. -	32. 1 mm. 08 h. 10 m. -
Apr.	Abril	23/1965	03. 0 mm. 00 h. 01 m. -	37. 7 mm. 05 h. 05 m. -
May.	Mayo	6/1965	54. 6 mm. 00 h. 45 m. -	62. 2 mm. 04 h. 00 m. -

CUADRO II
TABLE II

Registro de Intensidades Máximas
Precipitaciones Pluviales en Asunción
Clasificadas mes a mes - 1929 a 1965

Record OF Maximum Intensities
Rainfalls in Asunción, classified month
by month - 1929 to 1965

Precipitación Máxima en :
Maximun Rainfall in :

Meses - Months	10 min.	20 min.	30 min.	60 min.	120 min.
Enero - Jan.	33.0 mm	60.0 mm	63.5 mm	65.5 mm	72.0 mm
Febrero - Feb.	18.5 "	35.4 "	58.0 "	60.5 "	70.0 "
Marzo - Mar.	22.0 "	41.5 "	60.0 "	105.0 "	131.0 "
Abril - Apr.	22.0 "	28.0 "	35.0 "	55.0 "	84.0 "
Mayo - May	25.0 "	40.0 "	50.0 "	60.0 "	80.5 "
Junio - June	18.0 "	30.0 "	43.0 "	63.0 "	82.0 "
Julio - July	10.2 "	15.0 "	19.0 "	21.0 "	26.0 "
Agosto - Aug.	13.0 "	20.0 "	23.0 "	27.0 "	28.0 "
Septiembre- Sept.	22.0 "	41.0 "	63.0 "	83.0 "	85.5 "
Octubre - Oct.	40.0 "	41.0 "	41.0 "	42.0 "	57.0 "
Noviembre - Nov.	20.0 "	21.0 "	25.0 "	47.0 "	51.0 "
Diciembre - Dec.	23.0 "	45.0 "	65.0 "	80.0 "	118.0 "

TEMPERATURA MEDIA MENSUAL Y ANUAL en °C.

LOCALIDADES	Período	E	F	M	A	M	J	J	A	S	O	N	D	ANUAL
SAN LORENZO	61/68	27.4	26.8	24.9	22.0	19.2	17.3	17.0	19.1	20.3	23.5	25.7	27.3	22.5
ASUNCION	35/68	28.6	27.9	26.3	22.9	20.7	18.7	18.0	19.9	21.5	24.0	26.2	28.2	23.6
CAACUPE	61/68	25.8	25.3	23.7	21.3	18.9	17.1	16.8	18.9	19.8	22.4	24.3	25.9	21.7

TEMPERATURA MAXIMA ABSOLUTA °C

SAN LORENZO	57/68	40.1	40.0	39.7	36.1	33.0	31.0	32.0	36.1	38.5	40.7	40.3	40.6	40.7
ASUNCION	29/68	42.0	40.8	40.0	36.7	33.5	32.9	33.0	38.7	39.1	40.3	39.9	41.9	42.0
CAACUPE	61/68	39.0	37.5	38.0	35.0	31.5	30.5	30.0	35.5	37.0	39.0	38.5	39.5	39.5

TEMPERATURA MINIMA ABSOLUTA °C

SAN LORENZO	57/68	10.5	11.4	7.3	4.7	-1.6	-0.7	-1.2	-2.7	1.7	5.6	8.1	12.0	-2.7
ASUNCION	29/68	14.8	14.0	10.0	6.4	3.9	1.5	2.5	1.2	3.9	9.0	10.2	13.1	1.5
CAACUPE	61/68	13.0	12.0	7.0	5.0	3.2	-1.0	-3.5	-1.5	2.0	7.5	10.5	12.0	-3.5

DIRECCION DE METEOROLOGIA
ASUNCION

HUMEDAD RELATIVA

LOCALIDADES	Período	E	F	M	A	M	J	J	A	S	O	N	D	ANUAL
SAN LORENZO	61/68	69	73	75	78	80	78	77	72	73	68	67	67	73
ASUNCION	61/68	63	68	70	72	74	77	72	65	66	64	62	60	68
CAACUPE	61/68	69	73	74	76	77	75	74	69	72	65	67	67	72

PRECIPITACION MEDIA MENSUAL Y ANUAL EN mm,

LOCALIDADES	Período	E	F	M	A	M	J	J	A	S	O	N	D	ANUAL
SAN LORENZO	57/66	153	213	147	222	99	84	55	59	120	137	177	197	1.661
ASUNCION	41/66	160	148	184	165	121	80	47	35	80	221	136	130	1.409
CAACUPE	61/66	154	198	178	175	109	80	44	48	78	120	161	191	1.536

HELADAS

En la Zona comprendida entre Luque y San Lorenzo, el promedio de heladas al año es de 1.00, y su máxima intensidad registrada fué de -2.7°C. en San Lorenzo.-

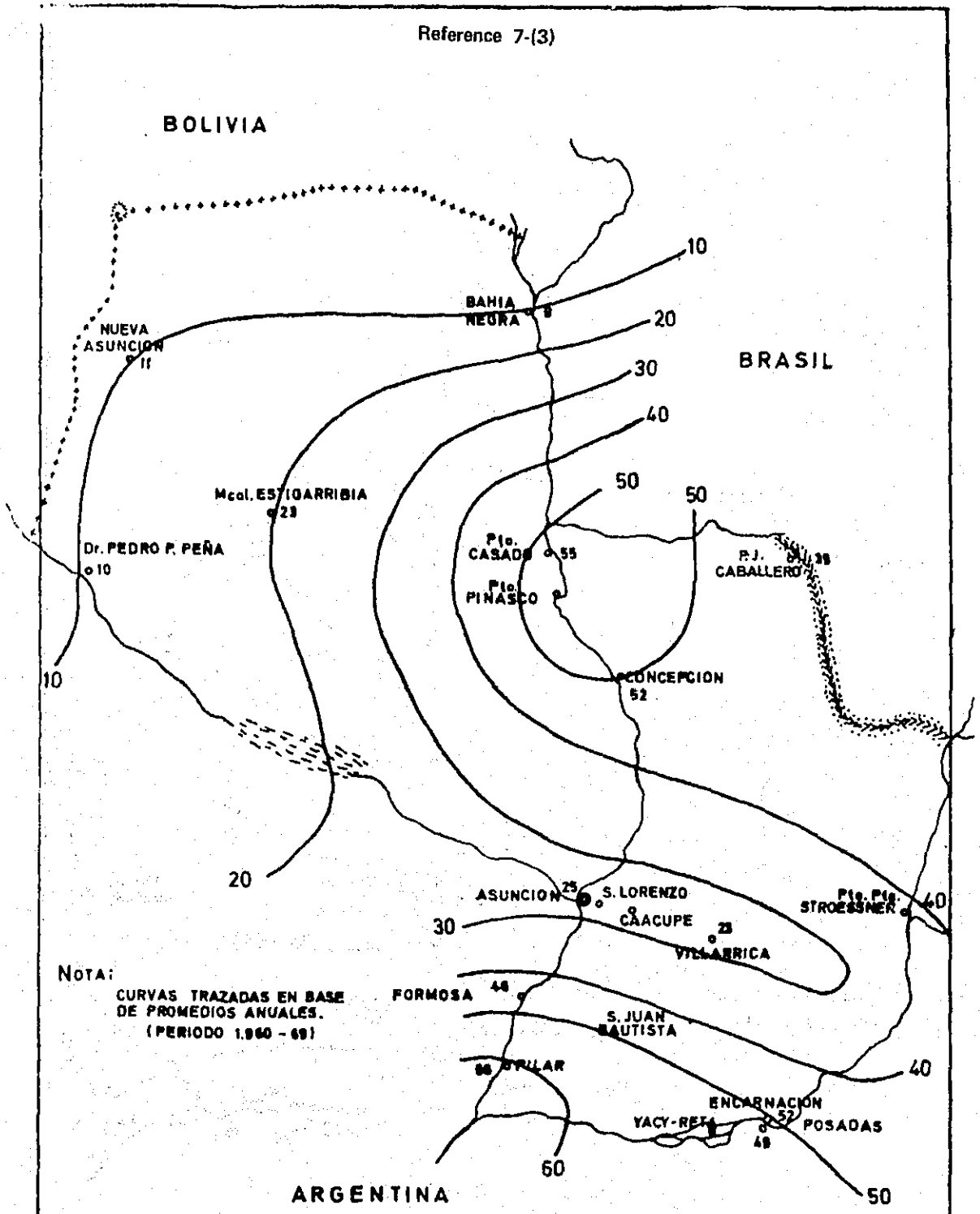
PARAGUAY

FRECUENCIA MENSUAL Y ANUAL DE TORMENTAS ELECTRICAS

No.	ESTACIONES	PERIODO	E	F	M	A	M	J	J	A	S	O	N	D	ANUAL
86017	NVA. ASUNCION	61/66	2	1	1	3	1	0	1	0	1	1	2	2	15
86033	BAHIA NEGRA	41/66	2	2	1	1	1	0	0	0	1	2	2	2	14
86062	P. P. PENA	62/66	3	3	2	1	0	0	0	0	0	1	1	2	13
86068	MCAL. ESTIGARRIBIA	41/66	3	2	2	2	1	0	1	1	1	2	3	3	21
86086	PTO. CASADO	41/66	3	4	3	2	2	0	1	2	3	4	3	3	30
86088	PTO. PINASCO	61/66	3	3	2	3	1	0	0	3	2	2	2	2	23
86097	P. J. CABALLERO	61/66	3	4	3	3	2	1	2	1	1	3	3	5	31
86134	CONCEPCION	61/66	5	5	5	6	3	2	1	4	6	5	5	6	53
86216	SAN LORENZO	37/66	2	3	3	4	2	1	1	2	3	3	4	3	33
86217	ASUNCION	35/66	2	2	2	2	1	1	1	1	2	4	3	2	23
86220	CAACUPE I. A. N.	61/66	1	1	1	0	0	1	1	0	0	0	0	0	5
86233	VILIARRICA	43/66	2	1	2	1	2	1	1	2	2	3	2	1	20
86249	P. PTE. FRANCO	43/65	1	1	1	1	1	0	1	1	1	2	2	1	13
86255	PILAR	41/66	5	4	4	4	2	2	2	2	4	5	4	4	42
86260	S. J. BAUTISTA (MNES)	56/66	2	2	2	2	1	1	0	1	2	2	2	1	18
86294	CAPITAN MIRANDA	64/66	3	2	3	2	1	3	3	2	3	2	2	3	29
86296	YASY RETA	63/66	2	1	4	2	1	2	1	1	2	4	3	1	24
86297	ENCARNACION	41/66	3	3	3	2	2	2	3	2	3	3	2	2	30

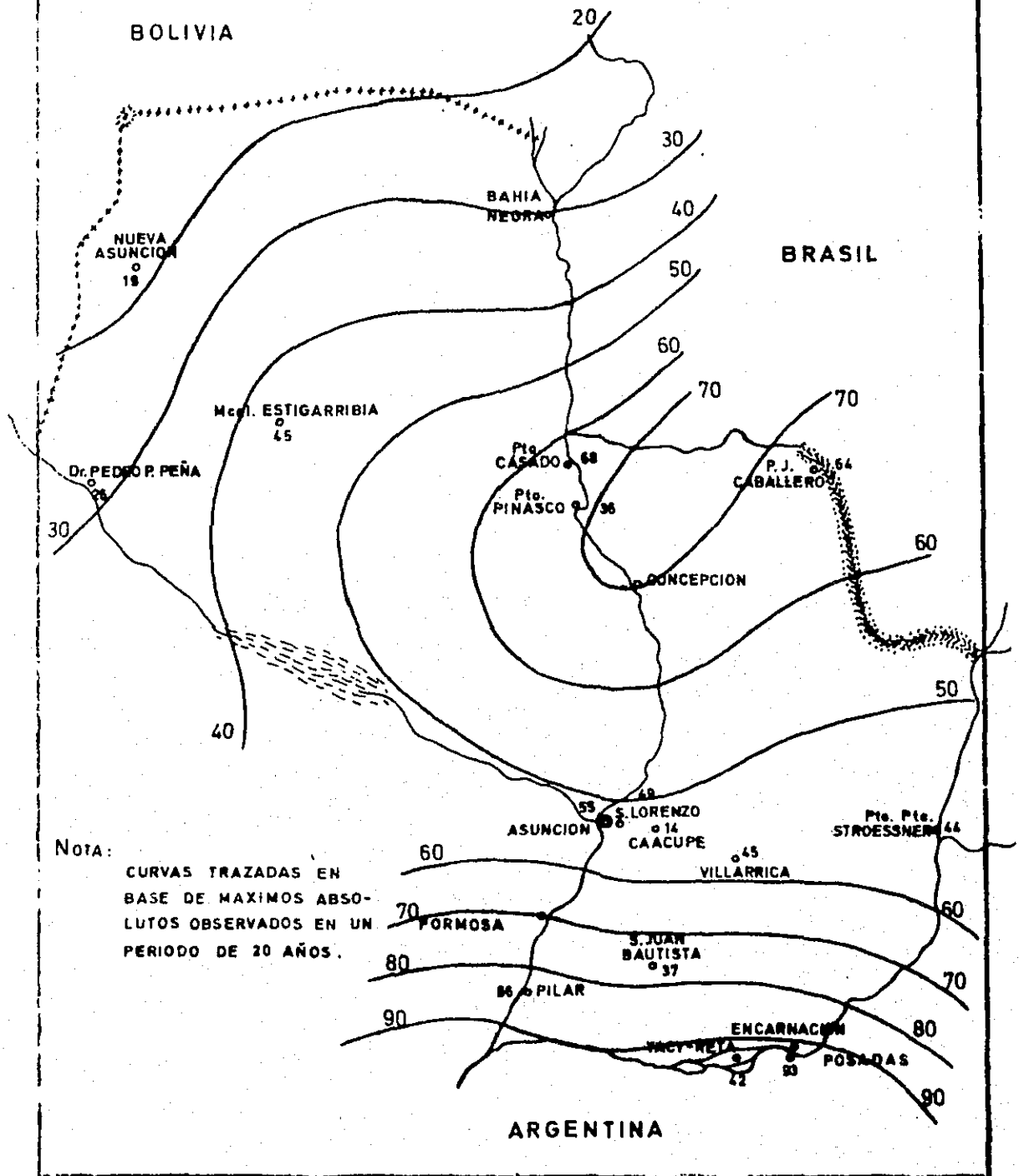
FUENTE: MINISTERIO DE DEFENSA NAC. - DIRECCION DE METEOROLOGIA - DEPARTAMENTO DE CLIMATOLOGIA. -

Reference 7-(3)



ANDE	CARTA DE NIVELES ISOCERAUNICOS	
	Fecha: 22 - VI - 70	Firma:	FIGURA Nº 2

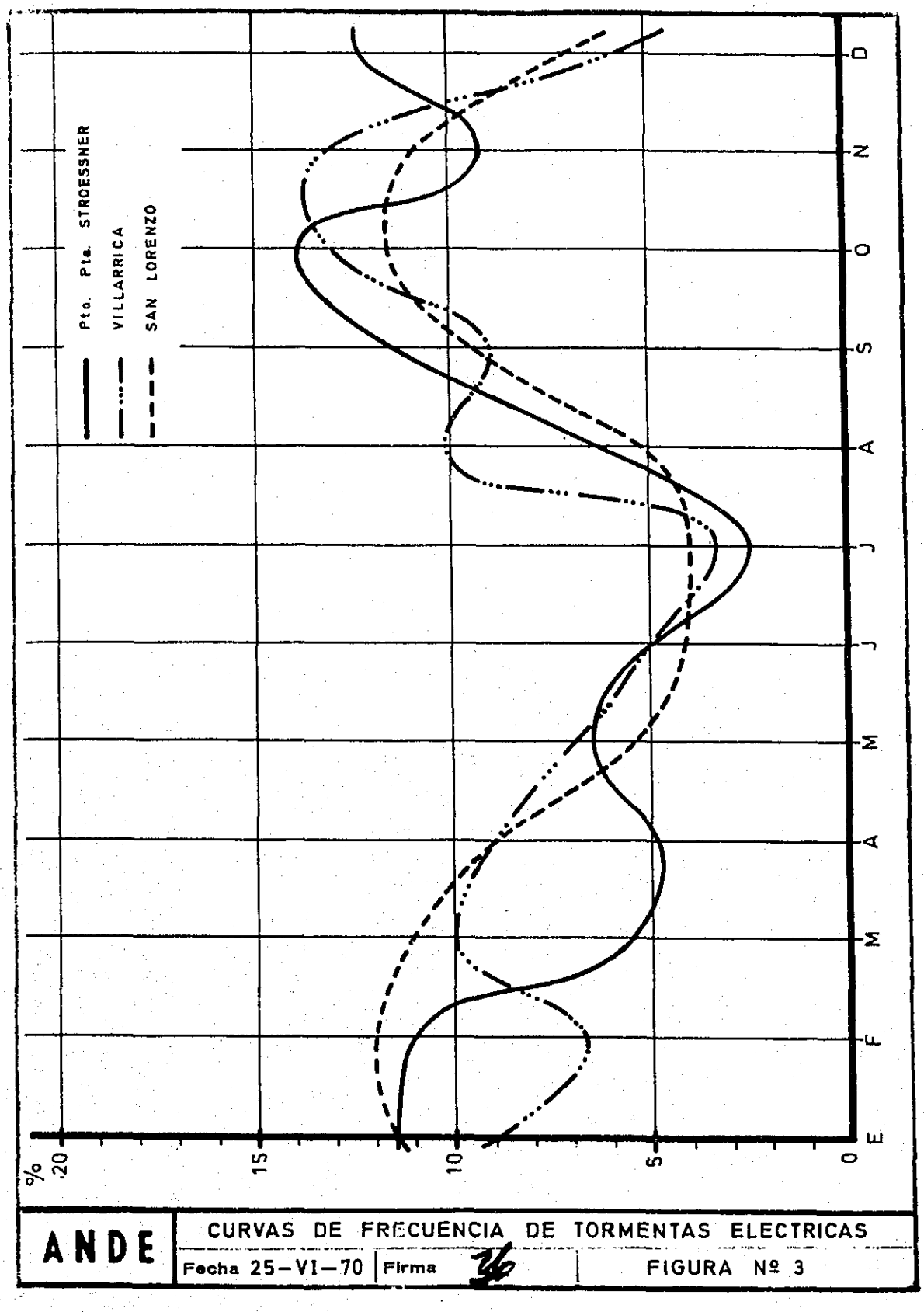
Reference 7-(4)



NOTA:
CURVAS TRAZADAS EN BASE DE MAXIMOS ABSOLUTOS OBSERVADOS EN UN PERIODO DE 20 AÑOS.

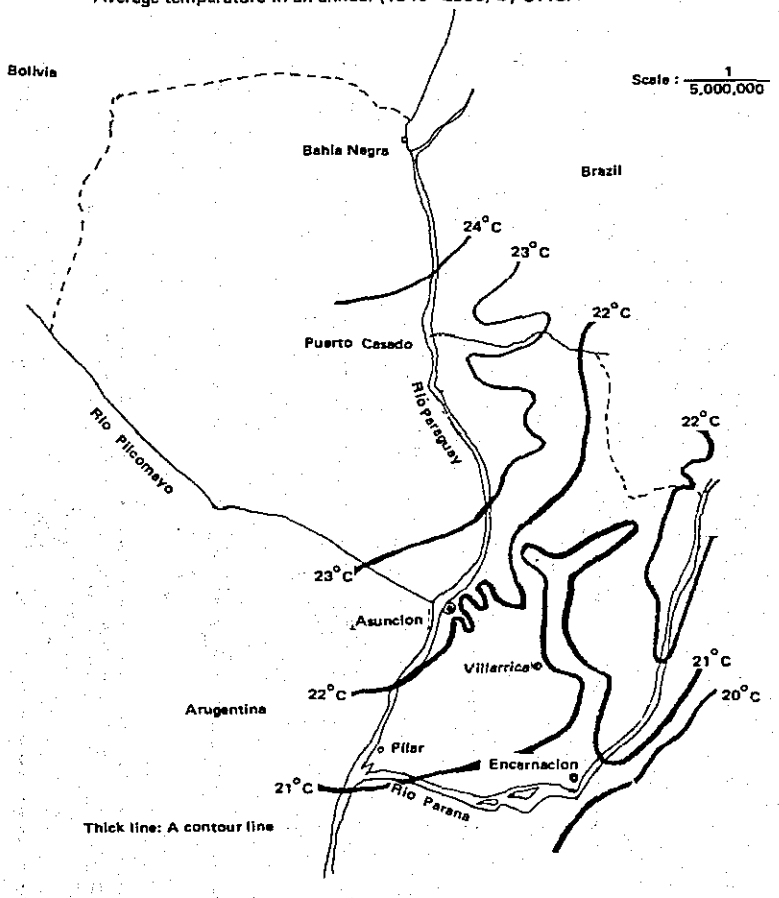
ANDE	CARTAS DE NIVELES ISOCERAUNICOS	
	Fecha 25-VI-70 | Firma VLB	FIGURA Nº 1

Reference 7-(5)



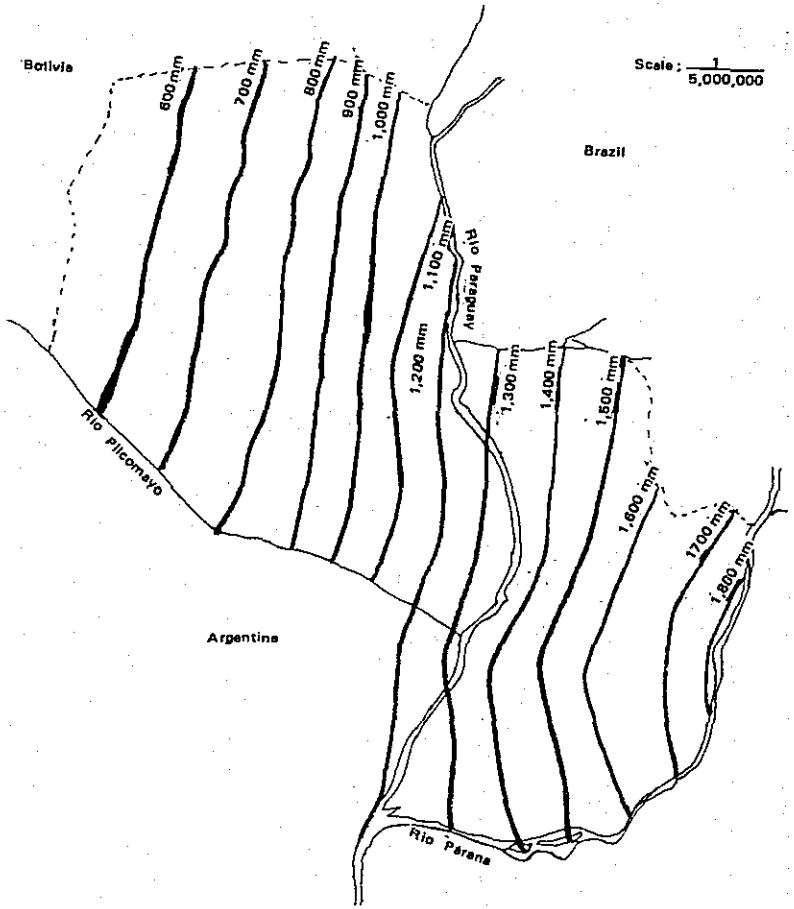
ANDE	CURVAS DE FRECUENCIA DE TORMENTAS ELECTRICAS	
	Fecha 25–VI–70 | Firma	FIGURA Nº 3

Average temperature in an annual (1940–2950) by STICA



Remarks: The sketch shows the average temperature for 11 years from 1940 through 1950 (by STICA). The thick lines represent the average temperature in contour lines. The fact that the average temperature shows an up trend in the northward direction can be attributed to the terrain of highlands.

Average Rainfall volume in an annual (1940–1950) by STICA



Remarks: The sketch shows the average precipitation for 11 years from 1940 through 1950.

Asuncion

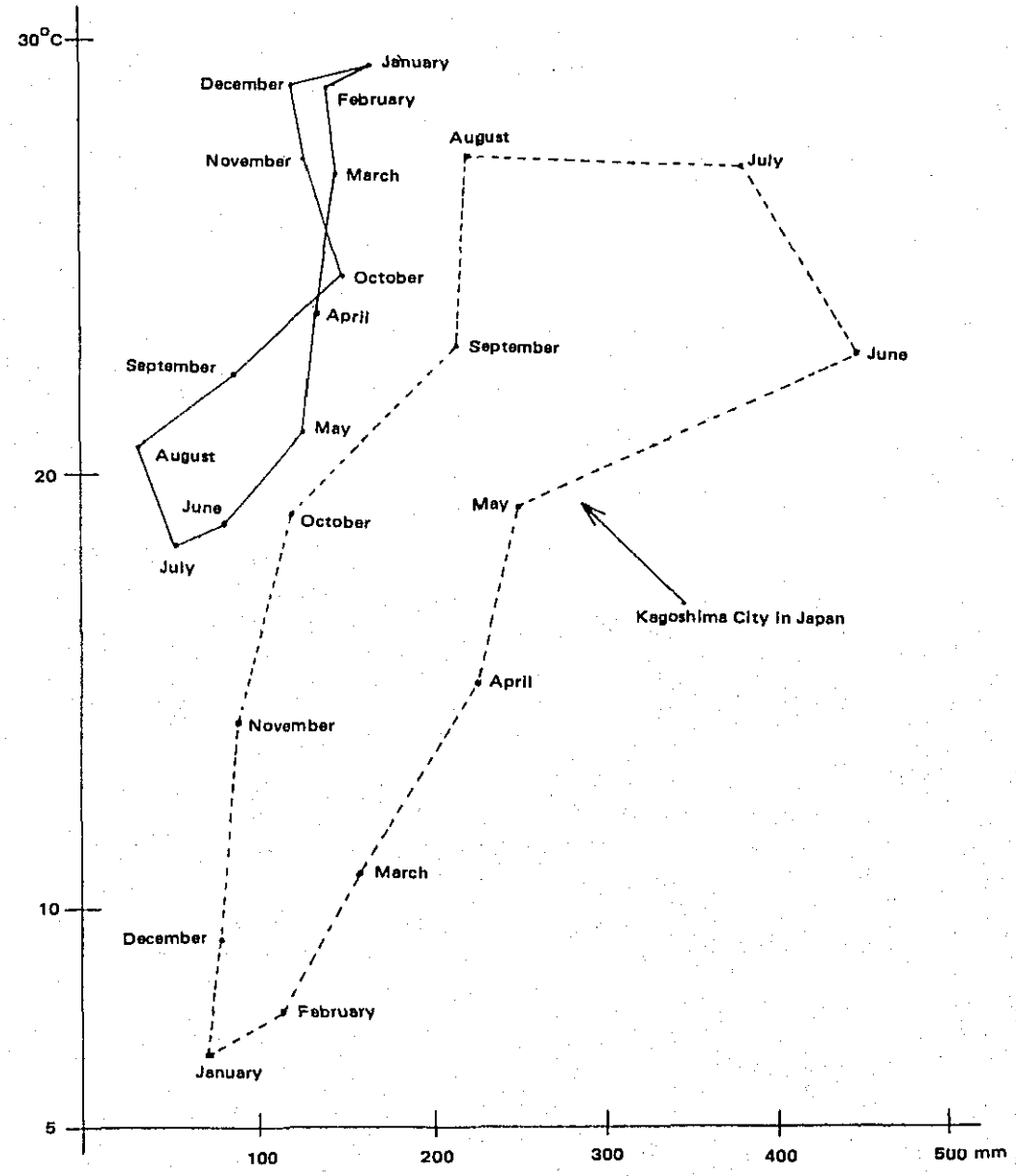
Location: West longtitude 56°30' South latitude 25°17'
Above Sea Level: 139 m
Statistic Years: 1941 - 1960

Month / Item	1	2	3	4	5	6	7	8	9	10	11	12	Annual total of average
Atmospheric Pressure (mb)	1001.1	1001.6	1003.4	1006.6	1007.6	1008.8	1009.8	1007.9	1006.0	1004.6	1002.4	1001.2	1005.1
Absolute Maximum Temperature	41.8	40.8	39.9	35.8	33.0	32.0	32.6	38.0	39.1	39.1	39.5	41.2	41.8
Extreme Maximum Temperature	38.5	37.3	36.2	33.1	31.3	28.9	29.9	33.5	35.3	35.9	36.7	38.3	34.6
Maximum Mean Temperature	33.9	33.2	31.5	27.8	25.0	22.5	22.6	25.3	26.3	29.1	30.4	32.9	28.4
Mean Temperature	29.3	28.8	26.9	23.6	20.9	18.8	18.3	20.6	22.3	24.7	27.0	28.9	24.2
Minimum Mean Temperature	23.4	23.3	21.9	18.7	16.8	14.8	14.0	15.2	16.7	18.6	20.5	22.5	18.9
Extreme Minimum Mean Temperature	18.2	18.1	16.1	11.5	8.8	6.9	5.6	7.2	9.3	12.1	14.8	17.0	12.1
Absolute Minimum Temperature	14.8	14.0	11.5	6.4	3.9	2.5	2.5	2.3	3.9	9.0	12.0	13.1	2.3
Mean Temperature Difference	10.5	9.9	9.6	9.1	8.2	7.7	8.6	10.1	9.6	10.5	9.9	10.4	9.5
Absolute Temperature Difference	18.2	16.5	16.8	17.9	16.5	16.3	16.8	19.7	18.2	19.4	19.0	18.2	19.7
Vaporization (Torr)	18.3	18.6	17.3	14.7	13.2	12.3	11.3	11.4	12.6	14.4	15.5	16.2	14.7
Vaporization (mb)	24.4	24.8	23.1	19.7	17.7	16.3	14.7	14.8	16.7	19.2	20.9	21.6	19.5
Average Coudy Skies	5	5	4	4	4	5	5	4	4	5	4	4	5
Average Precipitation	167.4	142.1	159.5	138.0	131.2	86.7	54.0	30.3	87.0	145.5	128.5	121.8	1392.0
Reiny Days	8	7	7	6	6	6	6	4	6	8	7	6	77
Hail Days		0.05	0.05		0.1	0.05		0.3	0.4	0.4	0.1	0.05	1.5
Frost Days													
Magnetic Storm Days	1.8	1.9	0.9	1.2	0.9	0.7	0.8	0.7	2.2	3.0	1.9	2.3	18.3
Fine Days	1.1	0.6	0.7	0.6	0.3	0.2	0.1	0.5	0.9	1.1	1.2	1.3	8.6
Clean Fine Days	2.9	1.8	3.8	6.2	6.9	4.5	7.0	9.0	7.0	4.9	4.7	5.5	64.2
Cloudy Days	4.0	3.2	4.5	9.2	5.8	8.2	6.2	5.8	6.0	5.7	3.4	3.8	65.8
Fog	0.05	0.1	0.4	0.8	1.1	1.5	1.7	1.1	1.0	0.3	0.2	0.05	8.3
Dew Point	22	22	22	19	17	14	12	14	15	18	19	20	18
Relative Temperature (%)	63	66	69	69	73	76	21	64	65	64	61	58	66

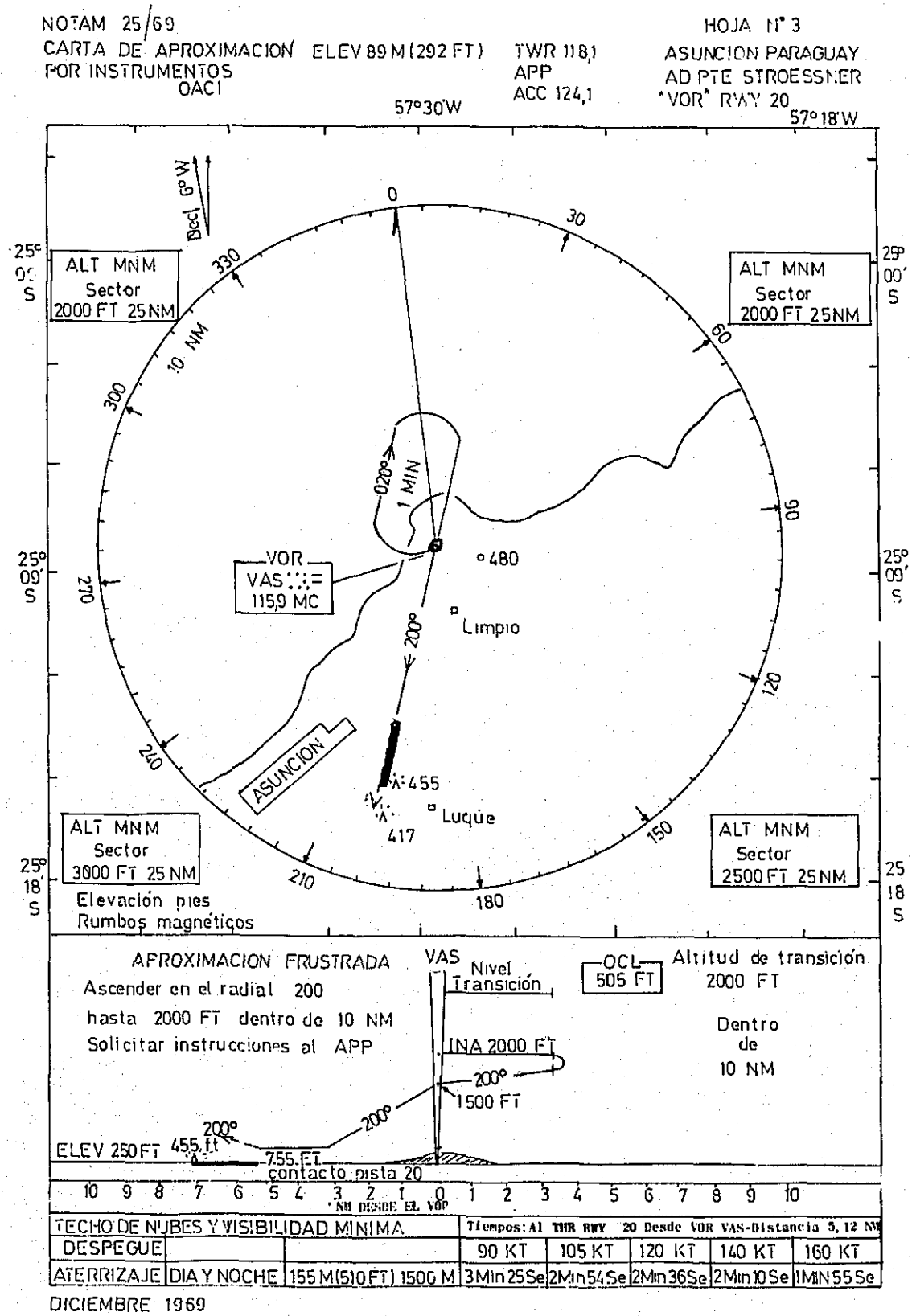
Economy Planning Agency, Republic of Paraguay

Reference 8-(3)

Temperature and Rainfall Volume in Asumcion



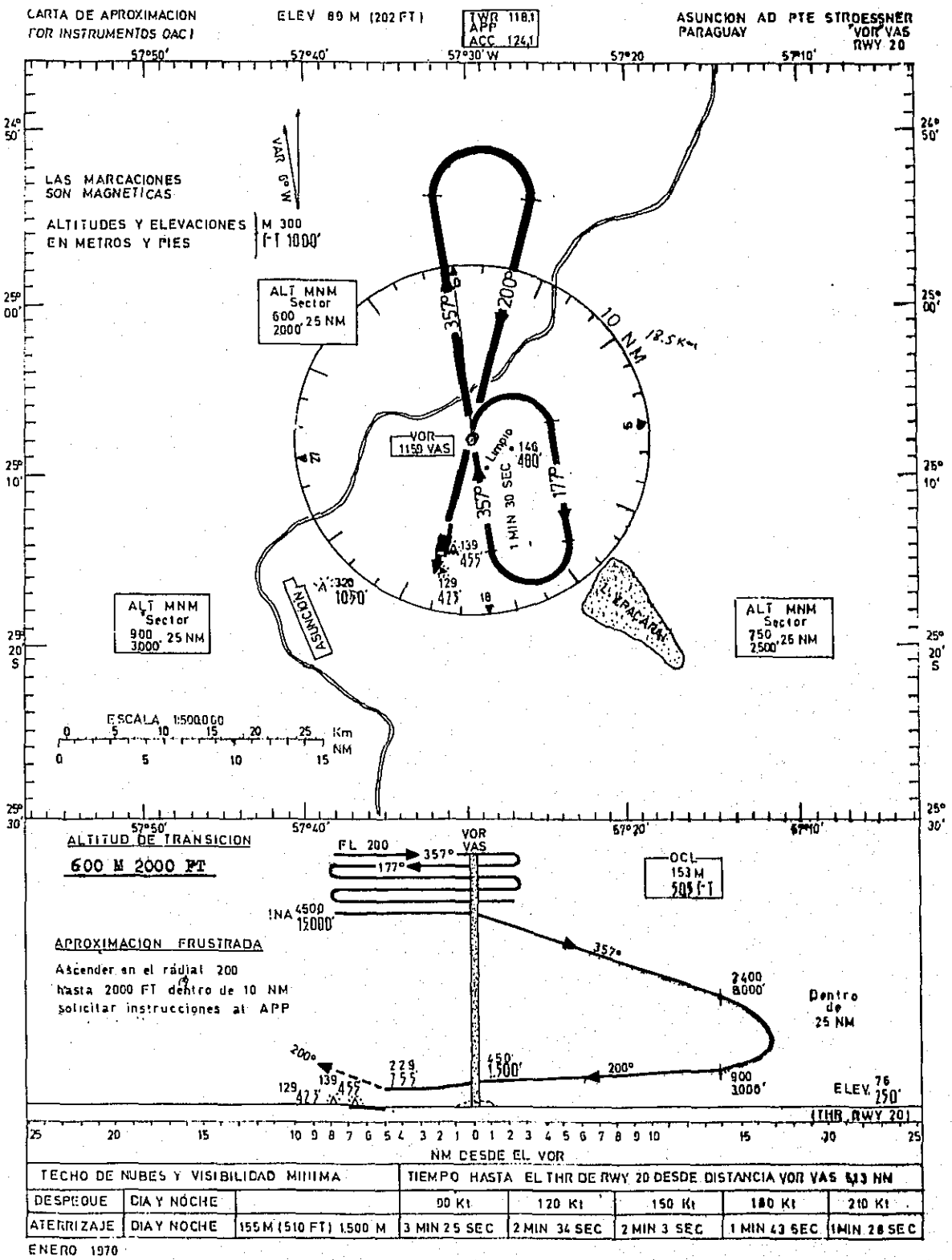
Reference 9-(1)



TECHO DE NUBES Y VISIBILIDAD MINIMA			Tiempos: Al THR RWY 20 Desde VOR VAS-Distancia 5, 12 NM				
DESPEGUE			90 KT	105 KT	120 KT	140 KT	160 KT
ATERRIZAJE	DIA Y NOCHE	155 M (510 FT) 1500 M	3 Min 25 Se	2 Min 54 Se	2 Min 36 Se	2 Min 10 Se	1 MIN 55 Se

DICIEMBRE 1969

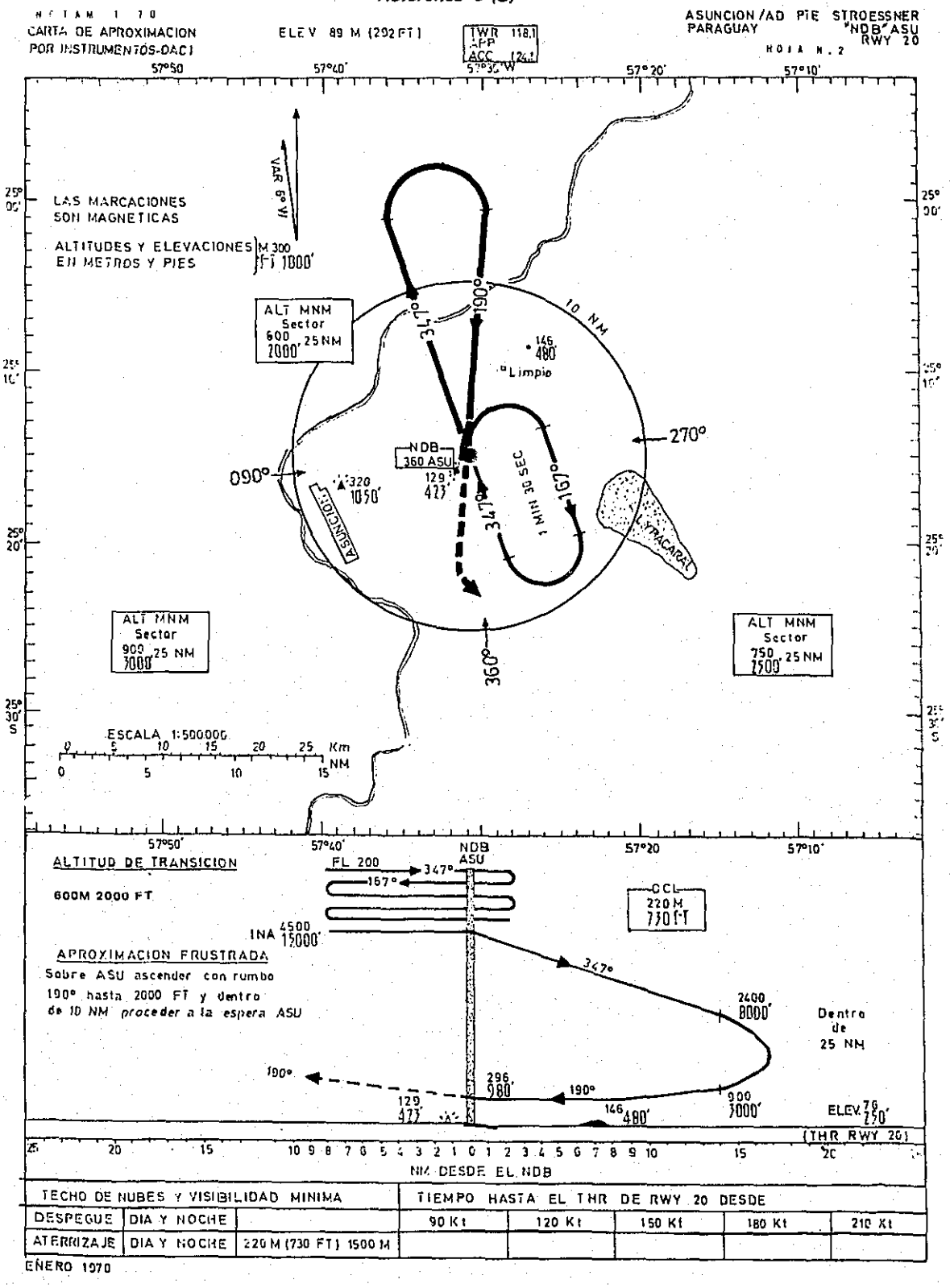
Reference 9-(2)



TECHO DE NUBES Y VISIBILIDAD MINIMA			TIEMPO HASTA EL THR DE RWY 20 DESDE DISTANCIA VOR VAS 5.3 NM				
DESPEGUE	DIA Y NOCHE		90 Kt	120 Kt	150 Kt	180 Kt	210 Kt
ATERRIZAJE	DIA Y NOCHE	155 M (510 FT) 1.500 M	3 MIN 25 SEC	2 MIN 34 SEC	2 MIN 3 SEC	1 MIN 43 SEC	1 MIN 28 SEC

ENERO 1970

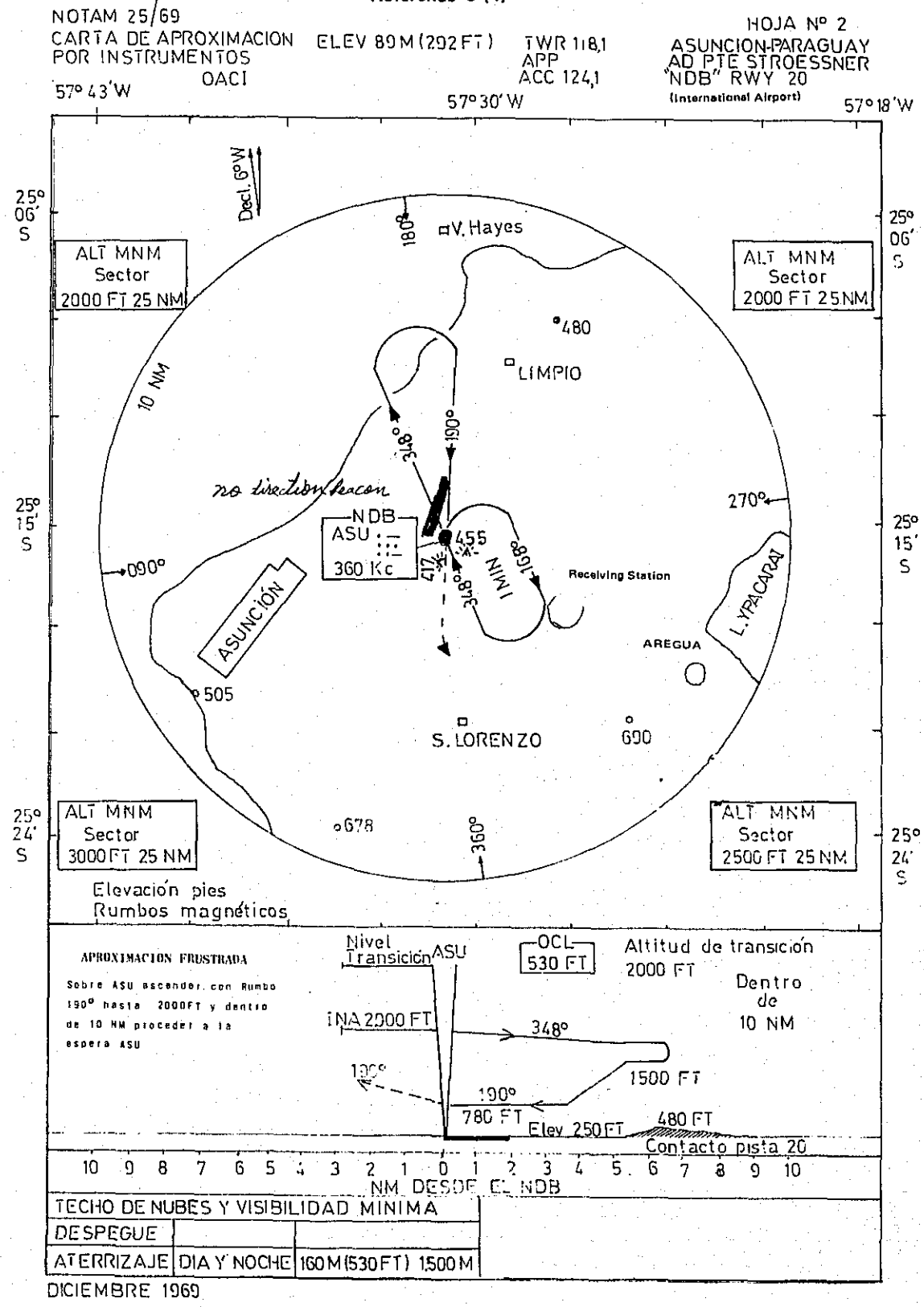
Reference 9-(3)



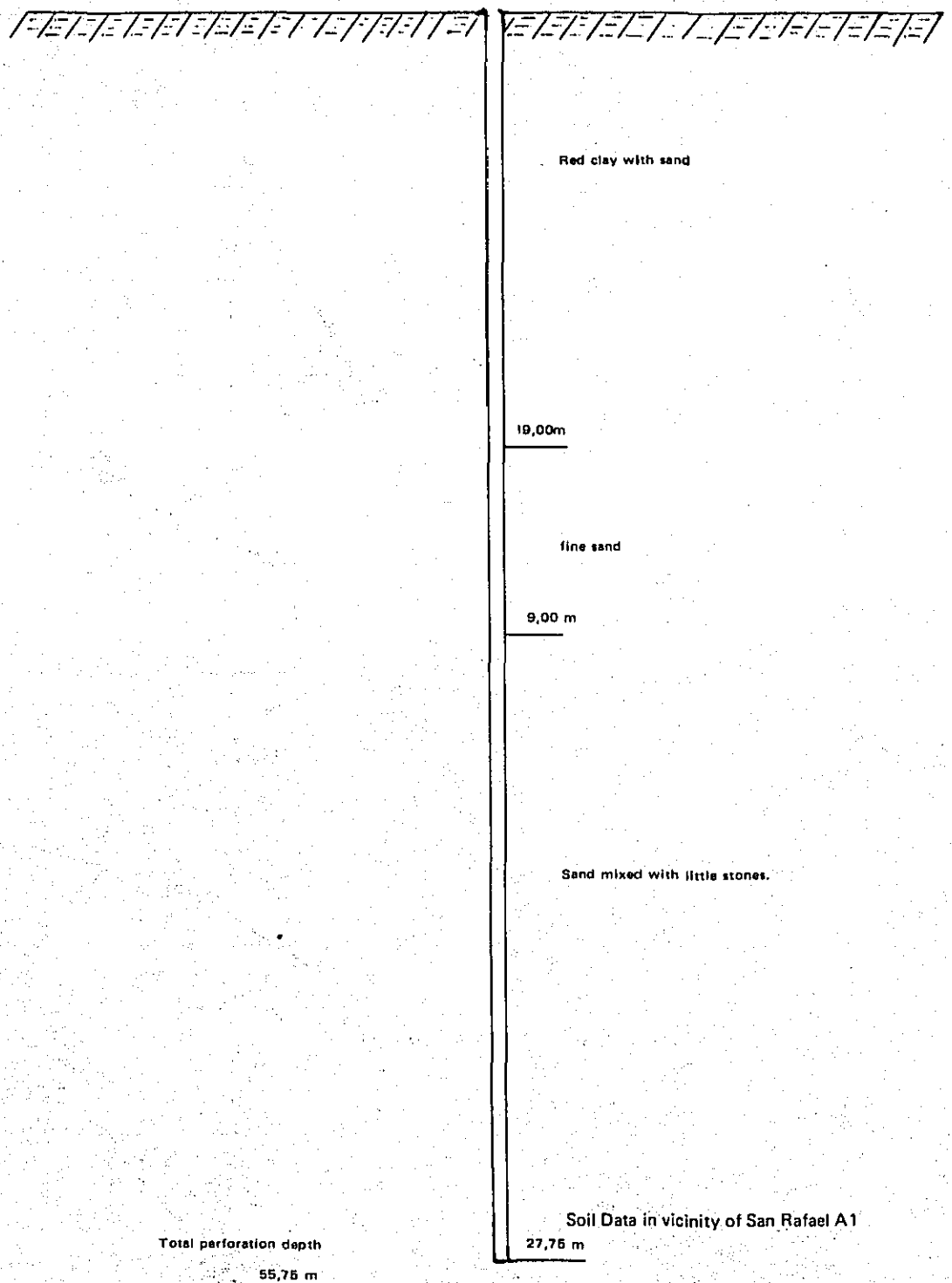
TECHO DE NUBES Y VISIBILIDAD MINIMA			TIEMPO HASTA EL THR DE RWY 20 DESDE				
DESPEGUE	DIA Y NOCHE		90 Kt	120 Kt	150 Kt	180 Kt	210 Kt
ATERRIZAJE	DIA Y NOCHE	220 M (730 FT) 1500 M					

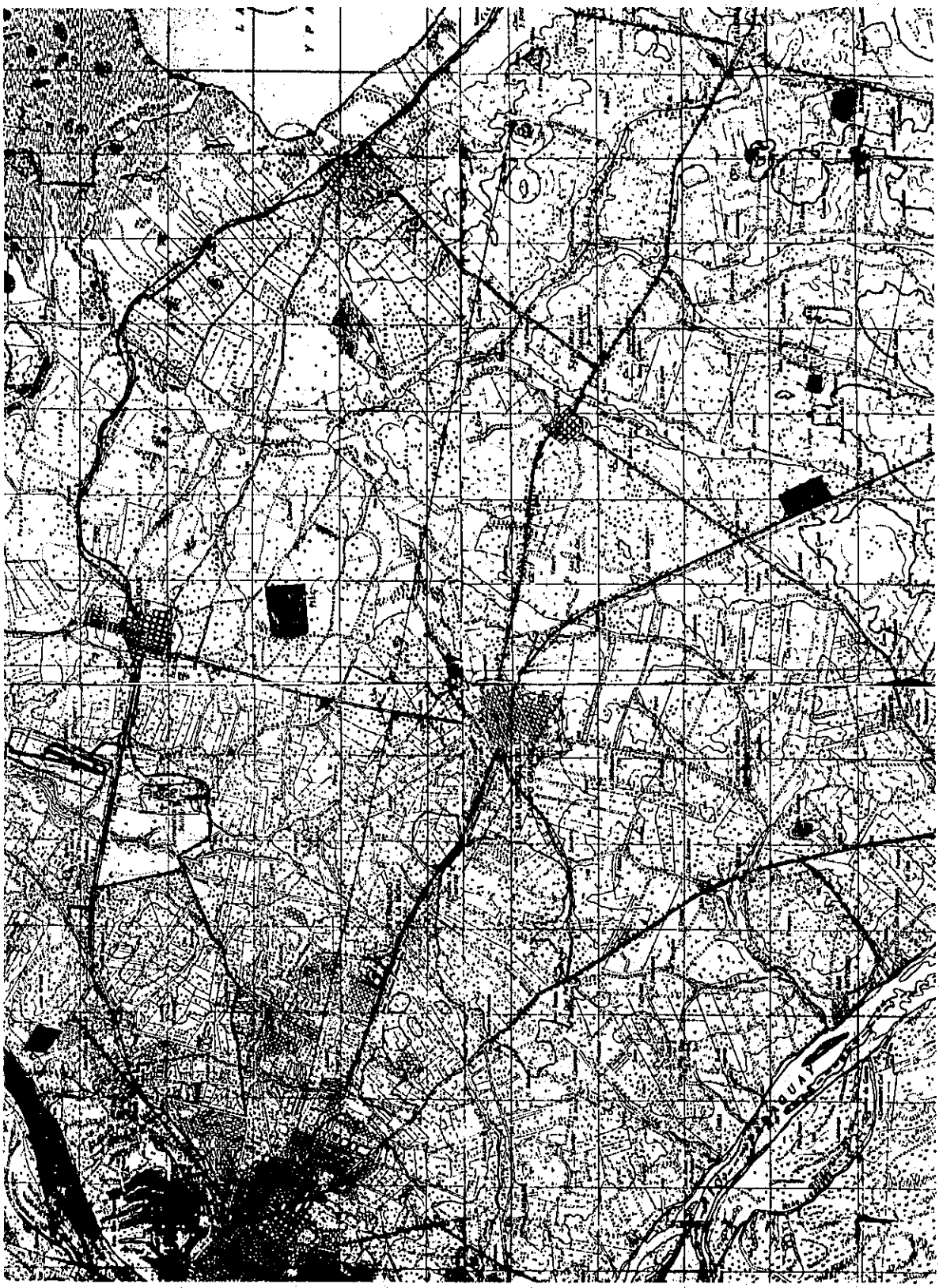
ENERO 1970

Reference 9-(4)



Reference 10





Reference 12 Topographical Map of Aregua B1 and Aregua B2