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PROJECT SACI

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EDUCATION TELEVISION VIA SATELLITE - THE BRAZILIAN CASE - PROJECT SACI

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ABSTRACT

This report presents a brief descript of Project SACI major activities for the Conference on the Use of Satellites for Educational Purposes on Developing Countries (Munich 12-13 October, 1972).

It includes the options of launching vehicles, ground station development, software production for school and for communities, and costs involved.

The Project is composed of three segments, namely (I) a voice and slow-scan link between INPE and a University in the United States, (II) a pilot experiment in the State of Rio Grande do Norte (RN) in the Brazilian Northeast, and (III) the national program as part of a Brazilian domestic communication satellite which is planned for 1975-76. Emphasis will be put on the Segment 02 concerning the pilot education experiment presently underway.

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CHAPTER I

LAUNCHING VEHICLES

1.0 - Introduction:

Presented herewith are some general characteristics of the launch vehicle categories:

1. THOR/DELTA
2. ATLAS/AGENA
3. ATLAS/OVI-B
4. ATLAS/CORALIE/OVI-B
5. ATLAS/EUROPA II
6. ATLAS/CENTAUR
7. TITAN/CENTAUR

1.1 - THOR/DELTA

The launching vehicle of the THOR/DELTA series are manufactured by McDonnell-Douglas Corporation. The first launching occurred on May 13, 1960. The vehicles are composed of three stages, and are approximately 28 meters long. The three stages are:

First stage: THOR

Second stage: DELTA

Third stage: TE 364-3

The third stage can be alterated so as to provide more payload capacity for the vehicle.

In Table 1, four alternatives for the payload to be placed in geo-stationary orbit are presented, with a view to the different vehicle characteristics. On the last line, the payload that can be placed in geo-stationary orbit is listed.

Table 1: Alternatives for the THOR booster

Alternatives	Payload in geo-stationary orbit (kg)
nº 1	250
nº 2	300
nº 3	290
nº 4	325
THOR/AGENA	340

1.2 - ATLAS/AGENA

The capacity of the ATLAS stage, coupled with the AGENA stage, corresponds to a payload of 36 kg to be placed in geo-stationary orbit, launched at Cape Kennedy, with a stationary orbit of 185 km.

The inclusion of the three ignitions in the AGENA stage, dispenses with the use of an apogee motor.

1.3 - ATLAS/OVI-B

The ATLAS series herein described represents a range of capacities from lower average to higher average (ATLAS/CENTAUR). The vehicles of this series are manufactured by General Dynamics-Convair Aerospace Division.

The acoustics and vibration tests of the ATLAS/ Orbital Vehicle 1-B combination will terminate before the end of 1972. The first unit produced should be available the first quarter of 1972. According to data from NASA and the U.S. Air Force, the ATLAS/OVI-B will cost the same price as the THOR/DELTA 2914, and can place approximately 100 kg more in orbit.

The payload capacity of the ATLAS/OVI-B, when launched from Guiana Space Center (Kourou) is:

. 480 kg for a parking orbit of 185 km
. 380 kg for a parking orbit of 300 km

The performance of the ATLAS series vehicles for placing payloads in geo-stationary orbit when launched from the Guiana Space Center, is increased by approximately 130 kg in payload, as compared to launching from Kennedy Space Center.

The THOR/DELTA 2914, launched from Cape Kennedy, has the payload capacity to place 325 kg in geo-stationary orbit.

1.4 - <u>ATLAS/CORALIE/OVI-B</u>

An insertion of the French stage, CORALIE, between the stages ATLAS and OVL-B, provides an increase in capacity of the vehicle mentioned above, to the following payload for geo-stationary orbit, if launched from Guiana:

. 560 kg for a parking orbit of 185 km
. 460 kg for a parking orbit of 300 km

1.5 - <u>ATLAS/EUROPA II</u>

In Europe, the EUROPA II stage is normally preceded by the BLUE STREAK stage. A substitution of ATLAS for the BLUE STREAK stage permits an increase of 170% in the payload to be placed in geo-stationary orbit. As a result, the ATLAS/EUROPA II, if launched from Guiana is:

TABLE 2

VEHICLES	PAYLOAD FOR GEO-STATIONARY ORBIT (kg)	LENGTH(m)	OBSER.
THOR/DELTA = 1	250	≃ 28	(3)
THOR/DELTA = 2	300	≃ 28	(3)
THOR/DELTA = 3	290	≃ 28	(3)
THOR/DELTA = 4	325	≃ 28	(3)
THOR/AGENA	340	≃ 28	(3)
THOR/DELTA 2914	325	≃ 28	(3)
ATLAS/AGENA	360		(1), (3)
ATLAS/OVI-B	480	35,9	(1), (4)
	380		(2), (4)
ATLAS/CORALIE/OVI-B	560	39,0	(1), (4)
	460		(2), (4)
ATLAS/EUROPA II	540	40,4	(1), (4)
	490		(2), (4)
ATLAS/CENTAUR	1080		(1), (4)
	1030		(2), (4)
	870		(3)
TITAN/CENTAUR	3200		(1), (3)

. 540 kg for a parking orbit of 185 km

. 490 kg for a parking orbit of 300 km

1.6 - ATLAS/CENTAUR

This vehicle has the most capacity of those in the series ATLAS. It was used for the launching of INTELSAT IV, which weighed approximately 710 kg. The payload, if launched from Cape Kennedy, can be up to 870 kg. If launched in Kourou, this can be increased to:

. 1080 kg for a parking orbit of 185 km

. 1030 kg for a parking orbit of 300 km

1.7 - TITAN/CENTAUR

In this item the ITIAN III E/CENTAUR D-1T is considered, which can be launched in a parking orbit of 185 km. The capacity, in terms of payload to be placed in geo-stationary orbit, is 3200 kg.

1.8 - SUMMARY OF LAUNCHING CAPACITIES

In Table 2, the launching capacities of the twelve above mentioned vehicles, in respect to payload to be placed in geo-stationary orbit, is summarized.

The observations of the righthand column are the following:

(1) Parking orbit of 185 km

(2) Parking orbit of 300 km

(3) Launching at Kennedy Space Center

(4) Launching at Guiana Space Center

1.9 - APPROXIMATE COSTS OF LAUNCHING VEHICLES

The approximate costs of the launching vehicles above described, are the following:

1. THOR/DELTA nº1:	US$6.5 to 8.9 million
2. THOR/DELTA nº2,3,4:	US$9.1 million
3. THOR/AGENA:	US$10 million
4. ATLAS/CENTAUR:	US$18 million
5. TITAN/CENTAUR:	US$28 million

The costs sited here include the cost of the vehicle and all launching expenses such as: tests, transportation, personnel, fuel, NASA administrative charges, etc.

All of these costs represent only approximate values, since the real launching cost will depend on the number of launchings to be made at the time.

WEIGHTS AND POWERS OF SOME COMMUNICATIONS SATELLITES

Table 3 presents the weight to power relation of some of the more known satellites, from 1963 up to the present, and including some which are only proposals. In this last group, there are:

a) MISSAC: analyzed in a study, published by the University of Michigan, on a satellite for South American.

b) HS 310: Proposed by Hughes Aircraft Company for Australia.

c) HS 326: Proposed by Hughes Aircraft Company for the Andean countries and for Brazil.

d) HS 336: proposed by Hughes Aircraft Company for Brazil (in 2.5 GHz).

e) Eight configurations proposed by Hughes Aircraft Company in 1969 for India.

f) GE LIGHTWEIGHT: proposed by GE for domestic systems.

g) Educational Satellite - GE: This satellite was proposed

TABLE 3

DESCRIÇÃO DO SATÉLITE	PESO (kg)	EIRP (dBW)	ANO DE LANÇAMENTO	ESTABILIZAÇÃO	SERVIÇOS	OBS.
SYNCOM	39	7.5	1963	spinning		
MISSAC (Ref. 3)	180	52	1972/74	3 eixos	30 canais de voz em FM	
INTELSAT I	39	14	1965	spinning	240 canais de voz	
INTELSAT II	87	17.5	1967	spinning	240 canais de voz	
INTELSAT III	146	28	1968	spinning	1200 canais de voz & TV	
INTELSAT IV	710	22	1971	spinning	6000 canais de voz & TV	(1)
		33.7			(12 transponders de 36 MHz)	(2)
HS - 310 (Hughes)	161	45.2		spinning	8 transponders de 40 MHz	
HS - 326 (Hughes)	180	30.3		spinning	6 transponders/30 MHz	
		32			4 transponders/30 MHz	
		35			2 transponders/30 MHz	
ATS-1	320	20	1968	spinning	Aplicações Tecnológicas	
ATS-3	320	30	1968	spinning	Aplicações Tecnológicas	
MILCOMSAT	730		1969	spinning	Comunicações Militares	(3)
ATS-F	1250	52	1974	3 eixos	Aplicações Tecnológicas	(4)

TABLE 3

DESCRIÇÃO DO SATÉLITE				PESO (Kg)	EIRP (dBW)	ANO DE LANÇAMENTO	ESTABILIZAÇÃO	SERVIÇOS	OBS
Proposta da Hughes A.Co. para a India	Usando THOR/ DELTA	Configuração convencional	UHF	218	49.5		spinning	1 canal de TV	
			Microondas	224	49.4			2 canais de TV e 1"transponder" de telefonia	
		Configuração com potencia aumentada	UHF	218	52.0			2 canais de TV	
			Microondas	224	51.9			2 canais de TV e 3 ou 4 "transponders" de telefonia	
	Usando ATLAS CENTAUR	Classe Intelsat IV	UHF & Microondas	461	49.5			1 canal de TV e 2 "transponders" de telefonia	UHF
					48				M.ONDAS
			Microondas	465	52			2 canais de TV e 3 ou 4 "transponders" de telefonia	
		Classe Intelsat IV aumentada	UHF & Microondas	606	52.5			2 canais de TV e 3 ou 4 "transponders" de telefonia	UHF
					49.8				M.ONDAS
			Microondas	606	54.5			3 canais de TV e 6 "transponders" de telefonia	
GE LIGHTWEIGTH SATELLITE				324	50		3 eixos	TV e Telefonia	
HS 336 (Hughes)				272	42.7		spinning	2 canais de TV	
					32.7			2 "transponders" de 16 canais de voz	
SATÉLITE EDUCATIONAL - GE				318	51.4		3 eixos	3 canais de TV	
					42.4			2 "transponders" com 15 canais de voz em cada um	

Tabela 3: CARACTERÍSTICAS DE ALGUNS DOS PRINCIPAIS SATÉLITES EXISTENTES

As observações são as seguintes:

(1): este é o valor de EIRP para cobertura global (17^{o})

(2): este é o valor de EIRP para cobertura com o "spot beam" ($4,5^{o}$)

(3): este satélite inclui aplicações de comunicações individuais de pontos no campo, para pontos em áreas desenvolvidas.

(4): este é o valor de EIRP para os experimentos de ITV em 2.5 GHZ for Brazil, and presented at INPE in June, 1971.

h) ATS-F: For various NASA scientific experiments.

The costs of these eight configurations, for the spatial segment (satellite in orbit, including launching costs), are presented in Table 4.

Table 4: Costs (in millions of dollars) of the eight configurations proposed to India in 1969.

Using THOR/DELTA				Using ATLAS/CENTAUR			
Conventional Configuration		Increased Power		Intelsat IV Class		Intelsat IV Class (Augmented)	
UHF	Micro-waves	UHF	Micro-waves	UHF & Micro-waves	Micro-waves	UHF & Micro-waves	Micro-waves
24.8	19.8	26.1	21.0	48.5	41.0	62.2	53.5

We observe that with the satellites of the series INTELSAT, there was a marked drop in cost between the first and the last units of this series. This fact, in addition to the fact that the cost data of the two configurations of the Intelsat IV class are from 1969, leads us to consider that probably the 1972 costs of these configurations have diminished to less than half.

In Figure 2, we present a graph of the EIRP values in Table 3, in relation to the year of launching of the various satellites. Figure 3 presents a graph of the weight values of Table 3, also in relation to the year of launching.

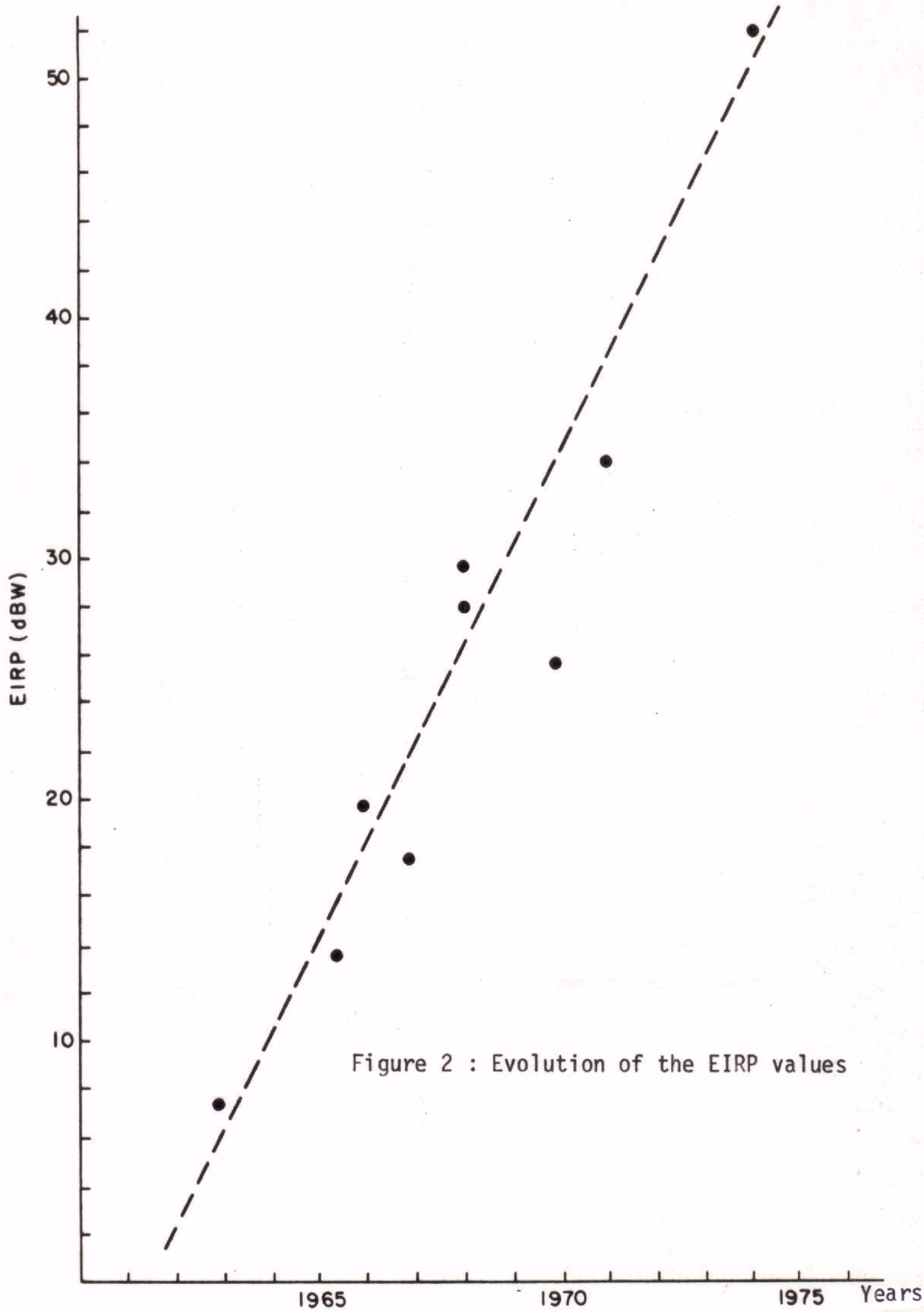


Figure 2 : Evolution of the EIRP values

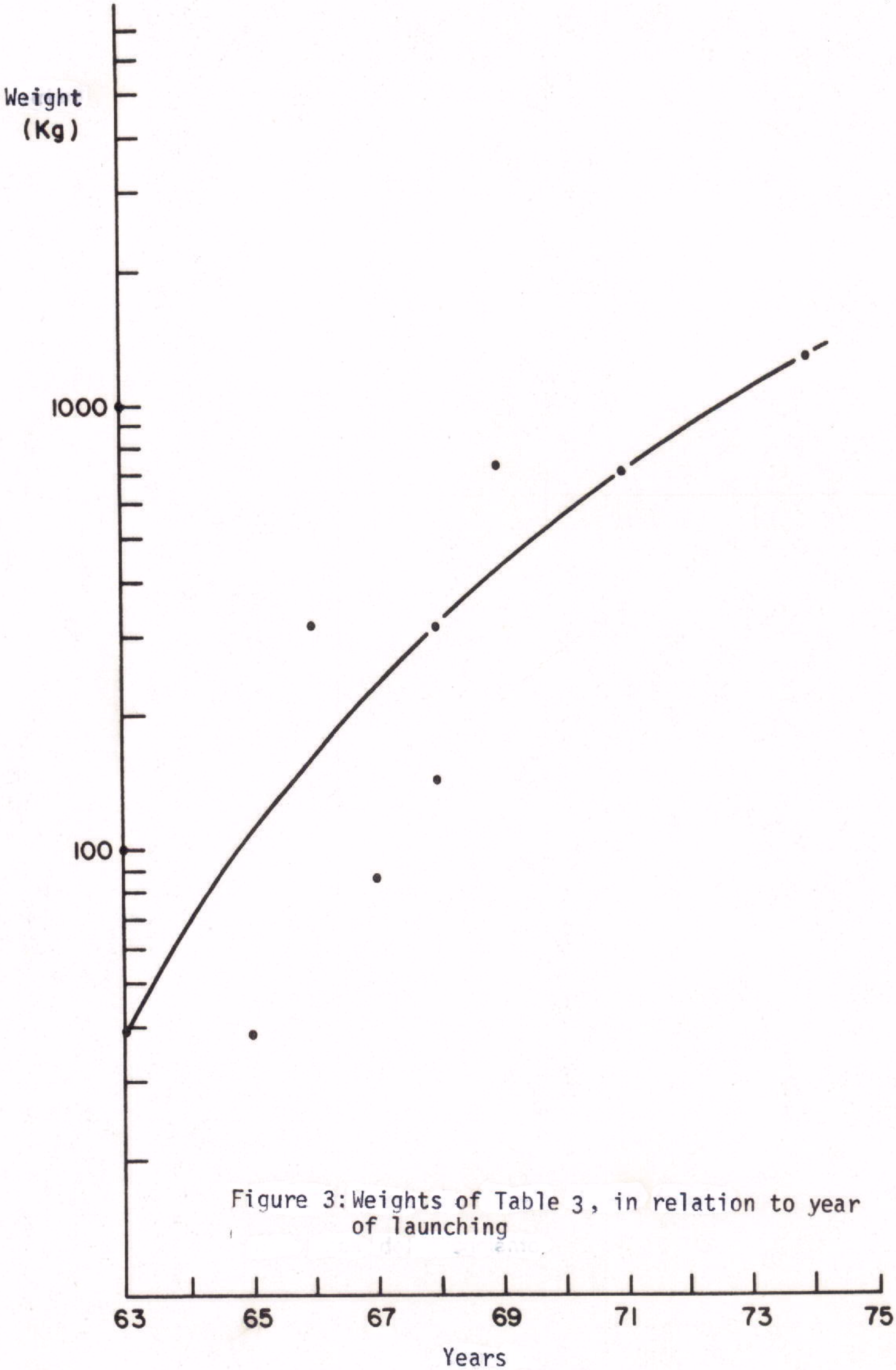


Figure 3: Weights of Table 3, in relation to year of launching

CHAPTER II

GROUND STATIONS

2.0 - INTRODUCTION

In the following, we describe the estimated costs for some types of ground stations, as well as the services that can be provided by them. Listed are ten stations proposed by foreign firms, and six stations described in LAFE-165, published by INPE. The costs of these last six stations were estimated by means of a series of contacts with national telecommunications equipment firms.

2.1 - HEWLETT PACKARD

The Hewlett Packard ground station was developed for the ITV (Instructional Television) experiment, which will take place in the RockyMountains, U.S.A., using the ATS-F satellite after its launching in the beginning of 1974.

This station has the capacity to receive one television channel in the 2.5 GHz band, and costs US$800 (FOB U.S.A.) per unit, in lots of approximately 5000 units.

The antennas have a diameter of approximately two meters, and the figure of merit is on the order of 3 to 4 dB/^{o}K.

2.2 - HUGHES AIRCRAFT COMPANY

The Hughes Aircraft Company, in a report on a domestic satellite system for Brazil made in March 1970, estimated the cost of three types of stations, as described below.

2.2.1 - Direct Reception of One TV Channel

These terminals directly receive from the satellite, in the 4 GHz band, one TV channel which can be distributed to up to eight video monitors. The receiving antennas have a diameter of three meters, and a figure of merit of the order of 16.5 dB/^{o}K.

The costs of these terminals, installed in Brazil, depend on the quantity of the order, as described in Figure 4.

2.2.2 - Retransmitting Stations

These stations receive two TV channels, in the 4 GHz band, from the satellite, and retransmit in VHF or UHF to the area to be served. The receiving antennas have a diameter of 4.5 meters, and a figure of merit on the order of 19.5 dB/^{o}K.

The cost of these stations, installed in Brazil, and for an order of 1500, is the following:

- US$186,300.00 to cover an area of from 10 to 15 km radius.
- US$281,300.00 to cover an area of from 20 to 30 km radius.

2.2.3 - Multi-Service Stations

These stations have the capability to provide the following services:

- Receive two TV channels
- Receive 12 telephony transponders, each one with 12 voice channels
- Receive one service transponder
- Transmit one telephony transponder with 12 voice channels and 3 service channels

The receiving antennas have a diameter of 13 meters and a figure of merit of the order of 29 dB/^{o}K. The power of the ground transmitter, to transmit a carrier with 15 voice channels, is 11w.

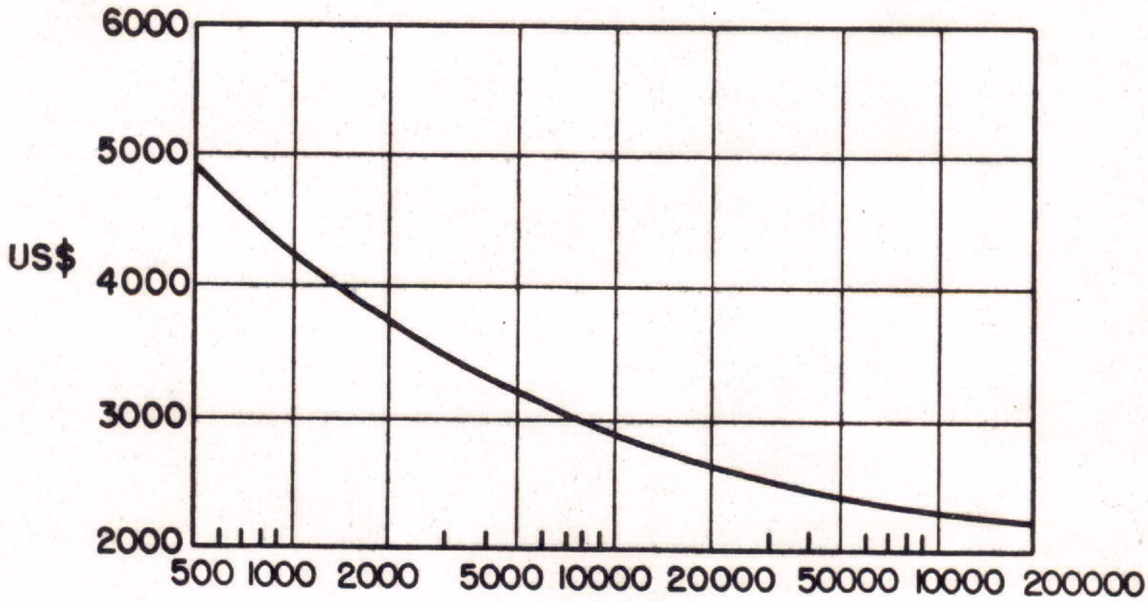
The cost of these stations are the following:

- US$793,500.00 for one station
- US$ 488,880.00 for one station if the order is for 40 units.

The capacity can be increased to receive 50 telephony transponders, each one with 12 voice channels. In this case, the cost would be:

- US$ 1,007,500.00 for one station
- US$ 667,080.00 for one station if the order is for 40 units.

Figure 4: Cost of direct reception stations - Hughes - in relation to quantity desired.



QUANTITY

2.3 - <u>GENERAL ELECTRIC - SPACE SYSTEMS ORGANIZATION</u>

2.3.0 - <u>Introduction</u>

The stations presented below were proposed by GE to INPE in May, 1972, for experiments with Intelsat IV, using two stations. These stations were developed for use by GE in an American Domestic System, for connection between GE installations.

Five configurations were presented: one basic configuration and four configurations with some additions to the basic one.

2.3.1 - Configuration 1: Basic

This configuration has two two-way telephony channels with an antenna of 4.6 meters diameter, and a station figure of merit on the order of 16 dB/^{O}K. The ground transmitter power is 300 w.

The cost of this station is US$170,500.00.

2.3.2 - Configuration 2

This includes two two-way telephony channels plus the reception capability for one television channel. For this, the antenna must be changed to 8 meters in diameter.

The operation of telephony and television services cannot be simultaneous due to the small EIRP value of the satellite, using an antenna for global coverage.

The figure of merit of this station is on the order of 21 $dB/^{o}K$.

The cost of this station is US$213,500.00.

2.3.3 - Configuration 3

This configuration includes the following services:

- 2 two-way telephony channels
- Reception of one TV channel
- Transmission of one TV channel

The addition of the transmission of one TV channel makes it necessary to use a 3 w ground transmitter.

The cost of this station reaches US$250,500.00.

2.3.4 - Configuration 4

In this configuration, we add two more two-way telephony channels to the above configuration. The cost then increases to US$265,500.00.

2.3.5 - Configuration 5

This configuration provides the same services as configuration 4, but includes equipment for "demand assignment" (DAMA). The cost resulting in this inclusion is US$282,500.00.

2.3.6 - Other Configurations

There are other possible configurations, which are based on two possibilities:

a) Improve any one of configurations 2 to 5 to permit the simultaneous use of TV and telephony services, by using an antenna with a 12 meter diameter. This will add US$48,000.00 to the cost of the stations.

b) Improve any one of configurations 2 to 5 to permit the simultaneous use of TV and telephony services, by using the spot beam of the Intelsat IV antenna. This would result in the EIRP increase of 11.5 dB, permitting the use of a 4.6 meter antenna, with 2 dB more in relation to signal-noise. If these extra 2 dB are not desired, a 3.6 meter antenna could be used.

The use of the Intelsat IV spot beam is

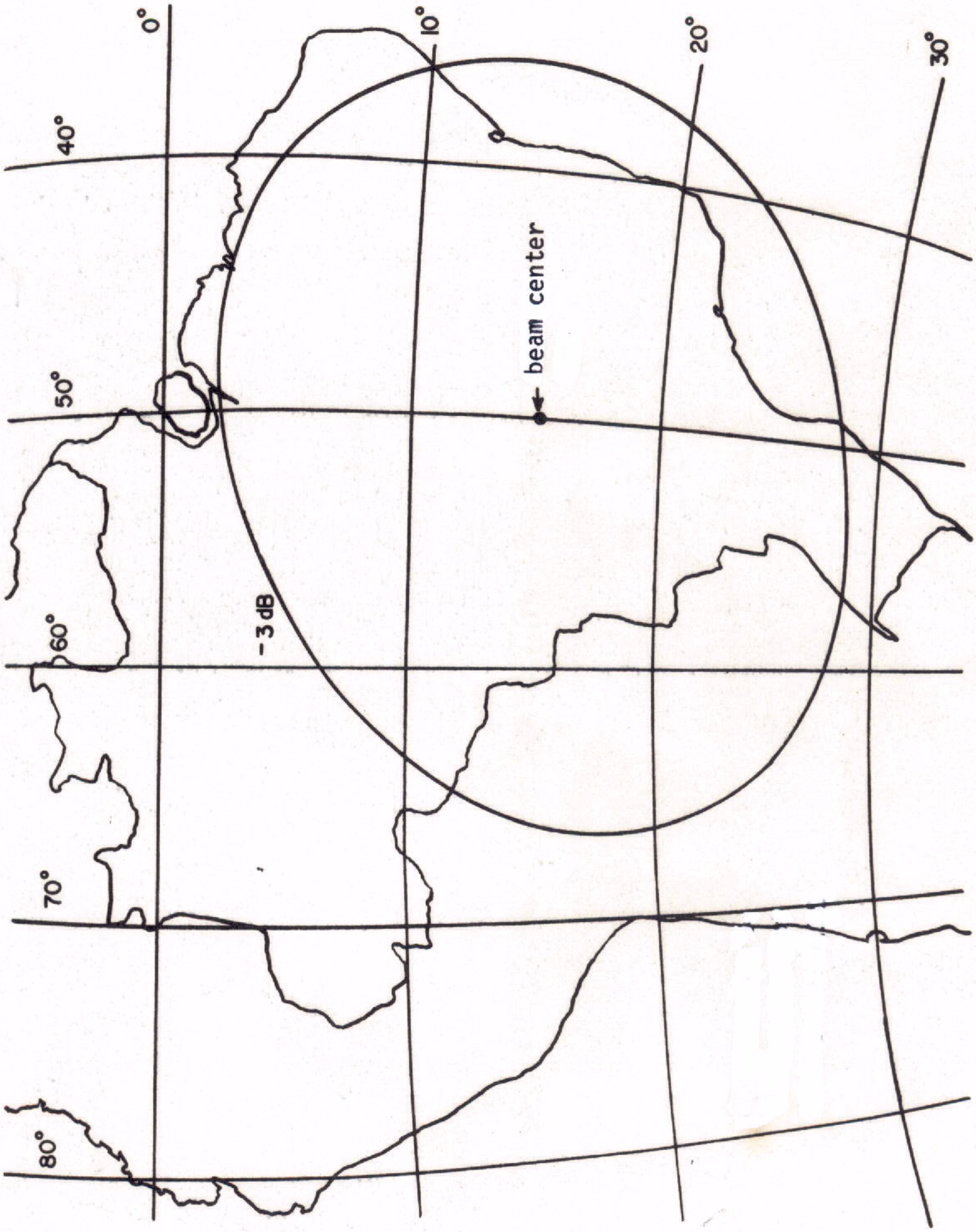


Fig. 5: Configuration of -3dB for the Intelsat IV spot beam

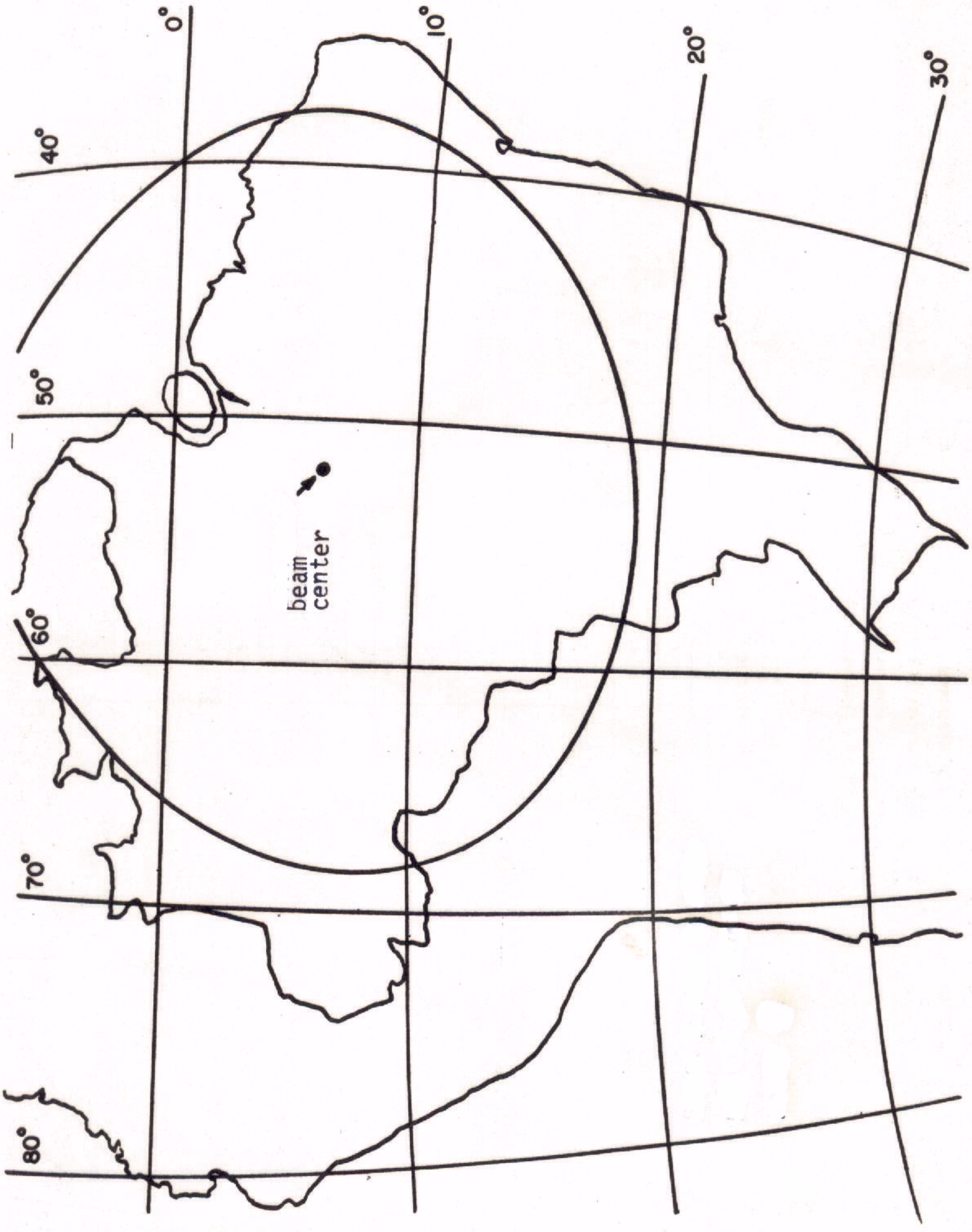


Fig. 6: Configuration of -3dB for the Intelsat IV spot beam

exemplified in Figure 5 with the beam center pointing to 15^{o}S, 50^{o}W (near Brasilia), and in Figure 6 with the beam center pointing to 6^{o}S, 52^{o}W.

The coverage of Figure 6 exemplifies the application of Intelsat IV use for the Amazon region.

2.4 - NATIONAL MANUFACTURING ESTIMATE

These are the estimates published in LAFE-165, of December 1971.

2.4.1 - Direct Reception Station

These stations receive directly from the satellite, in the 2.5 GHz band, from 1 to 3 TV channels and 3 to 9 radio channels. The antennas would have approximately a diameter of 2 meters and a figure of merit on the order of 1.5 dB/^{o}K.

The cost of these stations, not including installation, would be:

- US$450.00 for reception of one TV channel and 3 of radio
- US$770.00 for reception of 2 TV channels and 6 of radio
- US$1,060.00 for reception of 3 TV channels and 9 of radio

These costs are estimated for an order of approximately 100,000 units.

2.4.2 - Retransmitting Stations

These stations receive from the satellite and retransmit to a determined area, from 1 to 3 TV channels in VHF or UHF and from 3 to 9 radio channels in the radio transmission band of FM (88 to 108 MHz). The receiving antennas would have an approximate diameter of 3 meters and a figure of merit on the order of 3 $dB/^{o}K$.

The costs of these stations not including installation, for 110 units would be:

- US$53,315.00 for reception and retransmission of 1 TV channel and 3 radio channels
- US$106,525,00 for reception and retransmission of 2 TV channels and 6 radio channels
- US$159,651.00 for reception and retransmission of 3 TV channels and 9 radio channels.

2.5. - SUMMARY

Table 5 summarizes the costs for these ten types of stations proposed by foreign firms, and the six types analyzed in LAFE-165.

TABLE 5

FABRICAÇÃO	SERVIÇOS	G/T (dB^{o}k)	QUANTIDADE	CUSTO (US$)
Hewlett Packard	Recepção 1 canal TV em 2.5 GHZ	3-4	5000	800
Hughes Aircraft	Recepção 1 canal TV em 4 GHZ	16.5	5000	3250
	Recepção em 4 GHZ de 1 canal TV e retransmissão para uma área de 10 a 15 km de raio.	19.5	1500	186300
	Recepção em 4GHZ de 1 canal TV e retransmissão para uma área de 20 a 30 Km de raio.			281300
	Recepção 2 canais TV em 4 GHZ e 144 canais de voz; transmitir 15 canais de voz.	29	1	793500
			40	488880
	Recepção 2 canais TV em 4 GHZ e 600 canais de voz; transmitir 15 canais de voz.		1	1007500
			40	667080
GENERAL Eletric - S.S.O	2 canais bidirecionais de telefonia	16	2	170500
	2 canais bidirecionais de telefonia e recepção de 1 canal de TV.	21	2	213500
	2 canais bidirecionais de telefonia, recepção e transmissão de 1 canal de TV.		2	250500
	4 canais bidirecionais de telefonia, recepção e transmissão de 1 canal de TV (*)		2	265500

TABLE 5

FABRICAÇÃO	SERVIÇOS	G/T (dB/^{o}k)	QUANTIDADE	CUSTO (US$)
NACIONAL	Recepção de 1 canal TV e 3 rãdio em 2.5 GHZ	1,5	100 000	450
	Recepção de 2 canais TV e 6 rãdio em 2.5GHZ			770
	Recepção de 3 canais TV e 9 de rãdio em 2.5 GHZ			1060
	Recepção em 2.5 GHZ de 1 canal de TV e 3 de rãdio e retransmissão.	3	100	53315
	Recepção em 2.5 GHZ de 2 canais de TV e 6 de rãdio e retransmissão.			106525
	Recepção em 2.5 GHZ de 3 canais de TV e 9 de rãdio e retransmissão.			159651

Tabela 5: Resumo dos custos das estações descritas acima.

(*) A possibilidade de uso de "demand assigment" para os canais de telefonia, leva o custo da estação para US$ 282500,00.

ATTACHMENT A

PROPOSALS FOR AN AMERICAN DOMESTIC SYSTEM

To illustrate, we present in Table A.1 eleven proposals made by organizations in the United States for an American system of domestic satellites. The data included in this Table is of July 1972.

The observations on the Table are the following:

(1): One transponder is equivalent to 1 TV channel or approximately 1000 voice channels.

(2): This investment includes satellites in orbit, spare satellite on ground, and ground stations.

(3): This return covers operation costs, depreciation, taxes, and investment returns.

(4): Only for ground stations.

TABLE A.1

PROPOSTA	NUMERO DE SATELITES EM ORBITA	NUMERO DE "TRANSPONDERS"(1) POR SATÉLITE.	FABRICANTE PROPOSTO	INVESTIMENTO (2) US$ milhões	RETÔRNO (3) ANUAL MÉDIO ESTIMADO (US$ milhões)
Western Union Telegraph	2	12	Hughes	69	21
Hughes Aircraft (pela Hughes e pela G.T.E.)	2	12	Hughes	49	9
G.T.E	-	-	—	26(4)	46
Western Tele-Communications	2	12	North American Rockwell	67	22
RCA	2	24	Não decidido	112	60
Comsat	3	24	Não decidido	244	69
Comsat (pela American Telephone & Telegraph	3	24	Não decidido	145	37
A.T.&.T	-	-	-	90(4)	65
MCI Lockeed Satellite	2	48	Lockeed	169	68
Fairchild (primeira proposta)	2	96	Fairchild	190	63
Fairchild (segunda proposta)	2	24	Fairchild	165	55

Tabela A.I: Propostas para o sistema americano de satélites domésticos.

CHAPTER III

TECHNICAL CONSIDERATIONS

3.0 - Introduction

This chapter is an up-dating of up and down-link calculations to the Rio Grande do Norte Experiment, Project SACI, utilizing the ATS-F transponder which will attend to the ETV Experiments, in the 2.5 GHz band allocated by the World Administrative Radio Conference for Space Telecommunications, held at Geneva in June 1971.

3.1 - ATS-F 2.5 GHz Transponder Characteristics

The data (1), (2) on the 2.5 GHz transponder planned to the ETV Experiment, are shown in Table 6.

Performing the up-link calculations, we'll use the frequency 6150 MHz, considering the satellite reception via the earth coverage horn, which permits us to install the transmitting station at INPE, in Cachoeira Paulista, São Paulo.

Additional prototypes of direct receiving station to our nation wide system are being developed at INPE and thus we have to choose

TABLE 6

ATS-F 2.5 GHz Transponder Data

PARAMETERS	UP-link		Down-link	
Frequency (MHz)	6150		2569.2	2670
Antenna Type	Horn	Paraboloid	Paraboloid	Paraboloid
Gain (dB)	22.6	49.9	41	41
Half-power beam width	12°	0.4°	0.9°	0.9°
Diameter (feet)	-	30	30	30
Polarization	linear	linear	LCP	LCP
Ellipticity (dB over FOV)	-	-	2.5	2.5
Effective Isotropic Radiated Power (EIRP) (dBW)			53	52.5
Receiver Noise Figure (dB)	7.8		-	-

the frequencies in the 2.5 GHz band for its operation. We are also considering the use of the frequency 2670 MHz in the down-link, to permit us to build our prototypes at this same frequency. The 2.5 GHz band covers from 2500 to 2650 MHz.

3.2 - ATS-F Antenna Coverage

The ATS-F transmitting antenna coverage is shown in Fig.7 with the satellite located at 94ºW, and with the beam center pointing to 6,5ºS, 38ºW.

With this situation, the elevation angle to the ground receiving antenna will be from 23º to 32º approximately.

3.3 - Down-Link Calculations

3.3.1 - Specified Parameters

This section presents the parameters that constitute the input data to a computer program, which calculates the parameters presented in a later section.

A brief discussion is made of some of those input parameters.

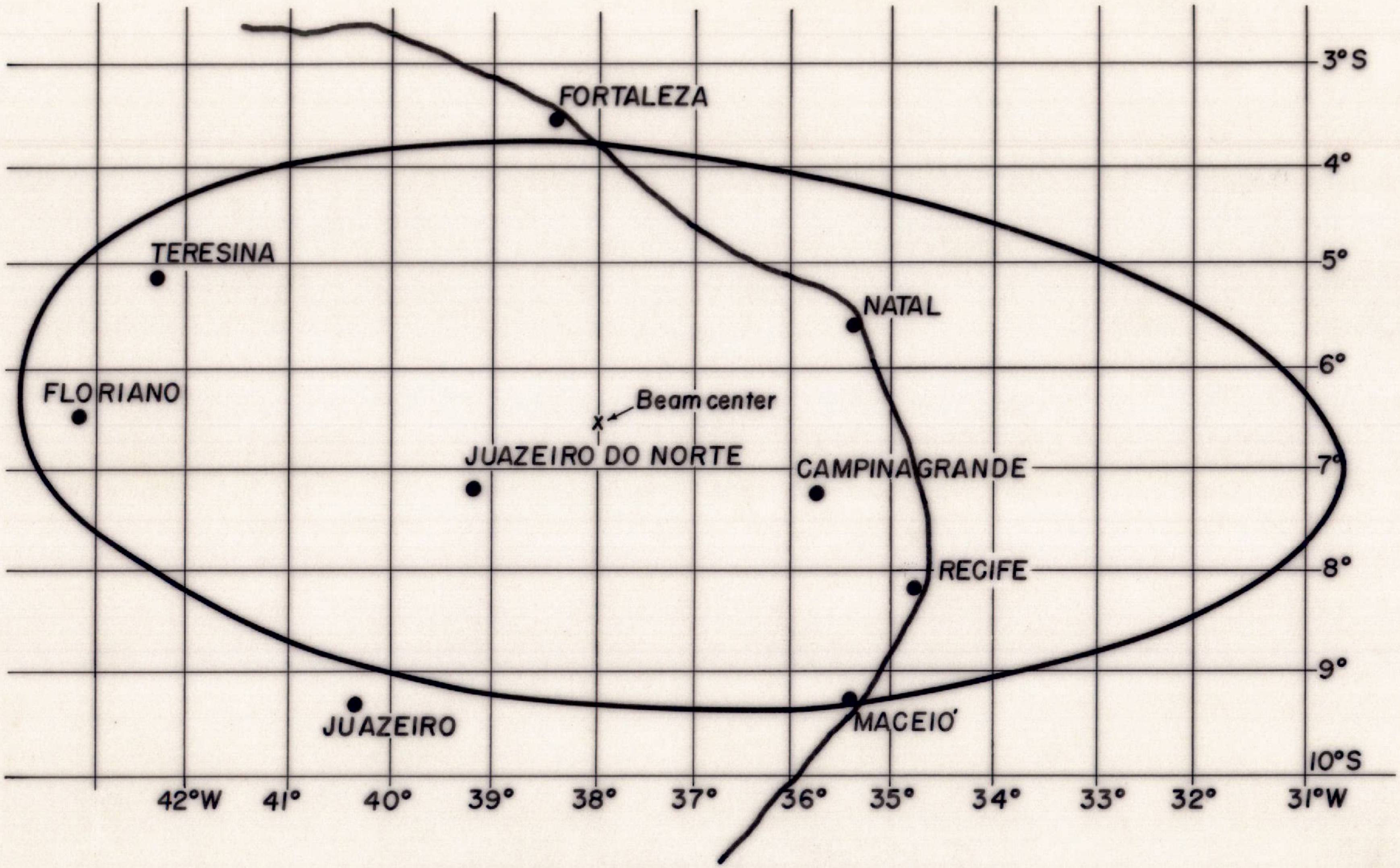


Figure 7: ATS-F TRANSMITTING ANTENNA COVERAGE

SATELLITE LONGITUDE: 94ºW (*)

BEAM CENTER LONGITUDE: 38ºW (**)

BEAM CENTER LATITUDE: 6.5ºS (**)

FREQUENCY: 2670 MHz (*)

SPACECRAFT POINTING ERROR:± 0.1º (*)

GROUND ANTENNA POINTING ERROR:± 0.75º

POINTING LOSSES: 0.7 dB

The greatest polarization mismatch, between the ATS-F and the ground receiving antennae, will occur when both antennae have the maximum permissible ellipticities, and in such a situation, that the two polarization losses may be added.

The specification on the ATS-F antenna, is for an axial ratio of less than $\varepsilon_S = 1.75$, within the 3 dB contour. As we know, the polarization is only circular in the maximum field direction of the main lobe.

The ground receiving antenna has a great simplified feed assembly, as compared to the ATS-F. So we'll suppose an ellipticity also equal to 1.75.

The polarization mismatch loss is given by (2).

$$\frac{P}{P_M} = \frac{1}{2} \quad 1 + \frac{4\varepsilon_S\varepsilon_G}{(\varepsilon_S^2 + 1)(\varepsilon_G^2 + 1)} + \frac{(\varepsilon_S^2 - 1)(\varepsilon_G^2 - 1)}{(\varepsilon_S^2 + 1)(\varepsilon_G^2 + 1)} \cos 2\alpha \quad (1)$$

where ε_S and ε_G are the ellipticities of the satellite antenna and of the ground receiving antenna respectively, and α is the angle between major axes both antenna . If in a first step we suppose $\varepsilon_S = 1$ and $\varepsilon_G = 1,75$, we get from (1):

$$P/P_M = 0,93$$

which corresponds to a polarization loss of 0,32 dB. In a second step, supposing $\varepsilon_S = 1,75$ and $\varepsilon_G = 1$, we get again a loss of 0,32 dB.

Then we finally have a polarization mismatch loss of less than 0,7 dB.

COVERAGE LOSS: 3 dB

GROUND ANTENNA EFFICIENCY: 50%

EFFECTIVE ISOTROPIC RADIATED POWER: 52.5 dBW (*)

GROUND RECEIVER NOISE FIGURE: 6 dB

GROUND ANTENNA NOISE TEMPERATURE: 70ºK

This equivalent temperature is defined (3) by the formula:

$$T_A \triangleq \frac{1}{4\pi} \int_0^{2\pi} \int_0^{\pi} T(\theta,\phi)\ G\ (\theta,\phi) \text{sen}\ \theta\ \ d\theta\ \ d\phi, \quad (2)$$

where: - $T(\theta,\phi)$ is the sky noise temperature, in the direction θ,ϕ .

- $G(\theta,\phi)$ is the ground antenna gain, in the direction θ,ϕ.

If we suppose the antenna has a symmetrical beam, pointing to the zenith, and that half the power of the side lobes is distributed in the upper hemisphere, and half in the lower hemisphere, and finally that the man made noise is received at arrival angles less than 10º, the formula (2), after integration, gives:

$$T_A = \frac{\pi\eta}{4\ell n2} T_S \,(1+0,5r) + 0.087r\, T_M + 0.5r\, T_G \qquad (3)$$

where:- η is the total efficiency of the receiving antenna -r is the ratio of the antenna side lobe power to main lobe power, given by

$$r\Delta \frac{P_S}{P_M} = \frac{0.88}{\eta} - = 0.76 \text{ with } \eta = 0.5$$

- T_S and T_M are effective sky noise and man made noise temperatures.
- T_G is the ground temperature, normally taken equal to 290ºK.

In 2.5 GHz, we have $T_S \simeq 4$ºK and $T_M \simeq 66$ºK.

With these values, we have to the antenna effective noise temperature.

$$T_A \simeq 70ºK$$

MARGIN ABOVE THRESHOLD: 4 dB

This value is recommended by CCIR, to achieve a certain quality in terms of a signal-to-noise ratio, during 99% of the time, simultaneously the carrier-to-noise ratio being above the threshold during 99.9% of the time.

GROUND RECEIVER BANDWITH: 30 MHz

BASEBAND BANDWITH: 4.5 MHz, to a conventional video signal.

Some values presented in this section, are followed by some symbols. They mean:

* : this value has been specified by NASA

**: see Section 3.2

£ : this value has already been presented in the Experiment Proposal of May, 1970.

3.3.2 - Out-put Parameters

These are the parameters calculated from those specified in the previous Section.

POWER FLUX DENSITY: 114.8 dBW/m^2

FREE SPACE LOSS: 192.7 dB

TOTAL LOSSES: 197.1 dB

SYSTEM EFFECTIVE NOISE FIGURE: 940ºK

CARRIER-TO-NOISE RATIO AT THE THRESHOLD: 9.3 dB

By curve-fitting(4) a typical threshold line, we obtain to the carrier-to-noise ratio, the expression:

$$(CNR)_T = 3.83 + \frac{20}{3} \log \frac{B_{RF}}{B_b} , \qquad (4)$$

where:

B_{RF} is the RF bandwith, and B_b is the baseband bandwith, as already seen, equal to 30 MHz and 4.5 MHz respectively. These values, applied to (4), lead us to:

$$(CNR)_T = 9.3 \text{ dB} \qquad (5)$$

CARRIER-TO-NOISE RATIO WITH THE TOTAL MARGIN: 13.3 dB

GROUND RECEIVING ANTENNA GAIN: 33.8 dB

GROUND RECEIVING ANTENNA DIAMETER: 2.5m

3.4 - Up-Link Calculations

3.4.1 - Specified Parameters

Such as in Section 3.3.1, we present the input data to the Computer program which performs the up-link calculations, with a brief discussion about some of those parameters.

FREQUENCY: 6150 MHz (*)

GROUND TRANSMITTING STATION LOCATION:

We will consider that the transmitting station will be located at Cahoeira Paulista, with coordinates 45ºW, 23ºS. It will result in an elevation angle of 29º, to the transmitting antenna.

SATELLITE FEED LOSS AND ANTENNA MISALIGNMENT: 3 dB(£)

ATMOSPHERIC LOSSES: 3.5 dB

This figure was already presented in the Experiment Prposal of May, 1970, where the calculations using Holzer's method resulted in atmospheric losses equal to 3.2 dB. Therefore, we have a new situation, with the transmitting station at Cachoeira Paulista, resulting in an additional atmospheric loss os <u>approximately</u> 0.3 dB.

TRANSMITTING RF POWER: 1 kW

SATELLITE RECEIVER NOISE FIGURE: 7.8 dB(*)

CARRIER-TO-NOISE RATIO DEGRADATION: 1 dB (£)

SATELLITE RECEIVING ANTENNA GAIN: 22.6 dB (*)

SATELLITE RECEIVER BANDWITH: 40 MHz (*)

GROUND TRANSMITTING ANTENNA EFFICIENCY: 50%

3.4.2 - <u>Output Parameters</u>

FREE-SPACE LOSS: 199.7 dB

TOTAL LOSSES: 206.2 dB

GROUND TRANSMITTING ANTENNA GAIN: 52.6 dB

GROUND TRANSMITTING ANTENNA DIAMETER: 10m

GROUND TRANSMITTING STATION EFFECTIVE ISOTROPIC RADIATED POWER: 82.6 dBW

3.5 - <u>Video Quality</u>

The usual FM equation for peak-to-peak signal-to-rms weighted noise is:

$$(SNR)_v = \frac{3}{2} \frac{(\Delta f)^2}{(f_v)^3} \frac{C}{N_o} . W. k \qquad (6)$$

where:

- Δf is the peak signal deviation
- f_v is the highest baseband frequency, equal to 4.5 MHz for a 525-line system
- (C/N_o) is the predetection carrier-to-noise power density ratio
- W is the weighting and pre-emphasis improvement, equal to 12.5 dB
- k is the peak to rms factor, equal to 6 dB using Carson's rule:

$$B = 2(\Delta f + fv) \qquad (7)$$

and establishing a bandwith equal to 25 MHz, compatible with the 30 MHz RF receiver bandwith, we get:

$$\Delta f = 8 \text{ MHz} \qquad (8)$$

The value of (C/N_o) can be found from the expression (5):

$$\frac{C}{N_o} = 10^{.383} \frac{(B_{RF})^{5/3}}{(B_b)^{2/3}} \qquad (9)$$

which lead us to $(C/N_o) = 2.5 \times 10^8$, or 84 dB.

All these values, applied to (6), give us a video quality equivalent to a signal-to-noise ratio equal to:

$$(SNR)_v = 43 \text{ dB}, \qquad (10)$$

what is 3 dB more than the TASO 2 quality.

CHAPTER IV

EDUCATIONAL DESIGN

This chapter presents the updated version of Segment 02 Educational Project.

The content of this chapter is distributed as follows.

4.0 - General Guidelines
- Work hypotheses
- Educational Objectives
- Chronogram of Activities

4.1 - Criteria for the delimitation of the geographical area of the Experiment

4.2 - Criteria for selecting schools

4.3 - Study of the affected area

4.4 - Implantation Model
- 4.4.1 - Operational Structure
- 4.4.2 - Courses to be administered
- 4.4.3 - Supervisor and Teacher Training
- 4.4.4 - Up-grading courses for elementary lay teachers
- 4.4.5 - Up-dating courses for elementary teachers
- 4.4.6 - Elementary teaching (first four grades)

4.5 - Audiovisual resources and forms of utilization methods.

4.0 - General Guidelines

Starting from the assumption, mentioned in various public documents, that the application of technological systems and processes in the educational field may - in less time and with less cost than the traditional system - solve some of the most serious educational problems existing in the country; we started the SACI Project which aims at introducing advanced technological resources into the Brazilian educational system.

The studies concerning the feasibility of such a Project were started in 1967. One of them, the Rio Grande do Norte Educational Experiment (SACI/Segment 02) will utilize new educational resources via ground system and via satellite, and has been planned to reach that Northeastern Brazilian State, where the differences existing in the environment present a wide range of problems that are characteristics of almost all Brazilian regions, this being and ideal experimental area for a later extrapolation for the national system.

The formulation of hypotheses for the Experiment has been limited by the technical and economic resources, time and personnel available but without losing sight of the scale of priorities established by the Rio Grande do Norte Experiment diagnosis.

Inasmuch as the above-mentioned limitations do not permit that all the various educational levels be involved in the Experiment, we have established as immediate and main targets (1) the primary school level (the first four years of study), and (2) the qualifying of primary teachers, as well as their being brought up to date.

The experiment beside providing us with the desired information, could alleviate some of the bottlenecks in the current RN primary school situation; (1) the high percentage of school drop-outs caused by the social economic and educational conditions of the region and (2) the high rate of repeaters due to the inadequacies of the school system.

The qualification of uncertified primary teachers ("lay teachers") will be carried out in several levels having in mind the existence in the elemntary school system of teachers with the most diversified levels of instruction, e.g., primary: complete and incomplete; ginásio (junior high school): complete and incomplete; rural normal school training: complete and incomplete; normal school training (at high school level): complete and incomplete. Considering that the deficiencies on the part of the teachers are not due alone to insufficient formation, but, also the use of outmoded didactic techniques, we will provide a course on pedagogical modernization for the teachers already graduated.

Based on the proposed objectives we have formulated the following work hypotheses:

1. The system involving technological and educational innovations presents better results in terms of student achievement than does the traditional system.
2. The qualification of elementary "lay teachers" becomes more cost-effective through the technological system than through the traditional system.
3. The proposed experiment should reach a greater number of the primary school age population and with greater efficienty than is presently reached through the traditional system.

The educational objectives of the Experiment are:

1. To test on a reduced scale and under controlled conditions the efficiency and effectiveness of an educational program for the first four years of elementary school using audio-visual media, including television, radio and slow-can, via ground system and via satellite, with signal reception at schools and an active participation of

teachers in order to lay the foundations for programming on a national scale.

2. To develop techniques for the production of teleducational programs for different subject areas and grade levels as well as evaluation techniques for the teaching-learning process.
3. To train teachers in the utilization of audio-visual media equipment and provide them through the utilization of these media with up-grading and up-dating courses.
4. To offer better educational opportunities to a considerable portion of the local school population.
5. Based on a formative evaluation, to develop and improve the school curriculum in such a way as to make it more adequate to the needs of the groups involved in the experiment.
6. To analyze the results in terms of cost/benefit and cost/effectiveness, comparing them with corresponding data from the conventional system.
7. To verify the "degree of acceptance" of new technologies in the school system of the selected area.

Therefore, the project should permit:

1. The identification of counties in which it is possible to obtain data on a large range of local educational situations in such a way that their extrapolation to other states may be feasible.
2. An accurate and reliable quantification of student achievement in both the traditional system and the technological system in order to permit a comparison of the results and an evaluation of effectiveness.
3. An implementation of the experiment through the joint action of individuals, public and private entities, thus obtaining local involvement and participation.
4. An adequacy to the state educational situation considering the educational priorities already defined.

The elaboration of this experimental project is based upon studies of the local situation, on the formulated hypotheses, the proposed objectives, the requirements of the system to be implanted and, above all, on the resources available for action and control.

The experiment will cover the priorities already mentioned during the period of 4 years, from 1972 on. The following Table 7 presents a chronogram of the activities to be developed.

As inferred from Table 7, the experiment will be carried out in four phases or missions, beginning with a relatively simple situation in 1972 and gradually increasing in complexity in the following years. This phase implantation aims at facilitating the improvement of the methods and processes utilized, thus securing the accomplishment of the proposed objectives.

In 1972, at the discretion of the teachers, the programs of the Up-grading Course (1st phase) may be transmitted to the students during their school period in order to arouse their interest and familiarize them with the system to be implanted in 1973.

TABLE 7

MISSION	COURSES AND TRAINING	MODALITY
1972	1. Supervisor and Teacher Training 2. Up-grading Course "lay" Teachers 1st. phase - primary level	1. Operational demonstration 2. Ground system TV and Ra
1973	1. Supervisor and Teacher Training 2. Up-grading Course "lay" Teachers 2nd. phase - "ginásio" level 3. Elementary school course (Grades 1)	1. Operational demonstration 2. Ground system TV and Ra 3. Ground system TV and Ra and/or satellite
1974	1. Supervisor and Teacher Training 2. Up-grading Course "lay" Teachers 3rd. phase - normal school level (high school) 3. Elementary school course (Grades 1-2)	1. Operational demonstration 2. Ground system TV and Ra 3. Ground system TV and Ra and/or satellite
1975	1. Supervisor and Teacher Training 2. Up-dating Course for elementary Teachers 3. Elementary school course (grade 1-4)	1. Operational demonstration 2. Ground system TV and Ra 3. TV, Ra and SS via satellite

4.1 - Criteria for delimitation of the area of the Experiment

The geographical area to be involved encompasses 71 of the 150 of RN counties, and contains 540 of the 3439 public schools existing in the State. During the selection, of these counties the following criteria were observed:

1. Involvement of the greatest concentration of counties within a geographical area in order to facilitate communication and control.
2. Inclusion of both rural and urban population in: (1) the coastal area, (2) the "agreste" (an intermediate area between the wet coast and the "sertão") and (3) the "sertão" (the driest area).
3. Inclusion of the greatest possible number of SEEC (State Secretary of Education) Regional Centers in order to make possible the utilization of the public school administrative structure.
4. Inclusion of the economic poles of the State in order to coincide with the study underway of economically viable communities".
5. Availability of the greatest possible number of schools in order that a better selection of experimental and control groups can be achieved.

6. Technical restrictions on the coverage of TV and Ra signals of conventional transmitting stations.

4.2 - Criteria for selection of schools

In order to validate and generalize from the results, the schools which are involved were chosen in accordance with the following criteria:

1. All schools must belong to the public school system (state or county).
2. The inclusion of the three categories of public schools: "Grupo Escolar" (GE), "Escola Reunida" (ER) and "Escola Isolada"(EI) from both the rural and urban zones.
3. The use of a random selection process, but keeping in mind the existing proportions among the three categories of school. At a later stage we avoided some schools which could not receive the TV signals due to mountains.
4. A sampling which was not less than 25% of the school population of the Experiment area.

GE . A school with a separate classroom for each class, a teacher for each class, a principal, a secretary, etc.
ER . A school with several classrooms and teachers but without any administrative staff.
EI . A school with one room and one teacher.

Considering that the main objective is to test the efficiency and the effectiveness of new technologies applied to education, a comparative analysis must be carried out between the technological system and the traditional system.

To this effect, the schools involved in the Experiment were divided into the following three groups:

1. Experiment Group (Exp G) - composed of 500 schools chosen at random from among the 2.100 already selected. All teachers teaching in the schools of this Group do take part in the Up-grading Course. The students of both morning and afternoon shifts of these schools will receive their classes through the technological system (TV and/or radio) in 1973.
2. Control Group I (CG-I) - composed of 50 schools chosen at random. These teachers take part in the training and in the Up-grading Course in accordance with the criterion established for the Experiment. However, the students of these schools will be taught under the traditional system.
3. Control Group II (CG-II) - composed of 50 schools also selected at random. Teachers and students will continue with the traditional system and will receive no benefit from the treatment offered to Exp.G and CG-I.

4.3 - Study of the Area Involved

In order to adopt the proposed technological system to the real needs of the region and to obtain the support of the communities involved, our research embraced the following four types of survey:

1. Teacher Characteristics - with the aim of obtaining detailed information on their needs, values, areas of interest, educational background, professional experience and personal aspirations, involving the three categories of elementary teachers existing in the public school system.
2. Student Characteristics - with the aim of obtaining detailed information on their needs, values, learning difficulties and personal aspirations.
3. School Characteristics - with the aim of obtaining detailed information concerning location, administrative dependence, category, construction type, installations, quantity and quality of permanent school material.
4. Community Leadership - with the aim of identifying the communities leadership in order to get their support for the Experiment, considering that the participation of people and/or community agencies

which hold power or exert influence on the community is of vital importance when it is intended to introduce in such communities a technological innovation mainly in the educational field.

The characteristics of teachers and students were determined by means of a representative sampling method. The survey of the characteristics of the schools covered the universe of schools involved. The community leaders were identified by means of a crisscrossing study of the opinions collected in a questionaire applied to each county.

The data-collecting tool utilized has been the questionaire of directed answers which makes easy the interpretation and the statistical analysis. After the electronic processing of the data an analysis was performed as well as a report presenting the results.

The results of these surveys provided subsidies for the:

1. preparation of the didactic programming to be transmitted during the Experiment;
2. elaboration of the evaluation system to be used during the Experiment;
3. modifications and adaptations which were made necessary in the schools selected for the Exp.G;

4. specifications for transmission and reception equipment for TV and radio;
5. involvement of the local leadership in supporting the Experiment;
6. comparative analysis of the influence of technology on the communities of the area.

4.4 - Implantation Model

In regard to the phases of the Experiment, which for operational purposes we will call MISSIONS, we will describe in this chapter how we expect to achieve the proposed goals for each mission.

4.4.1 - Operational Structure

In developing and carrying out the Experiment, the existing organizations within the area are used to the extent possible.

Thus, the implantation and control of the Experiment is conducted presently within the structure presented in Table 8.

NOTES:

1) Ministerial, state and county agencies are providing material and technical assistance to INPE within their possibilities.

2) INPE is in charge of the coordination of the Experiment.

3) Local Working Groups correspond to the following teams:

a - training team: which prepared supervisors and teachers to carry out their functions during the Experiment.

b - transmission team: which handles problems related to the distribuction of radio and TV signals.

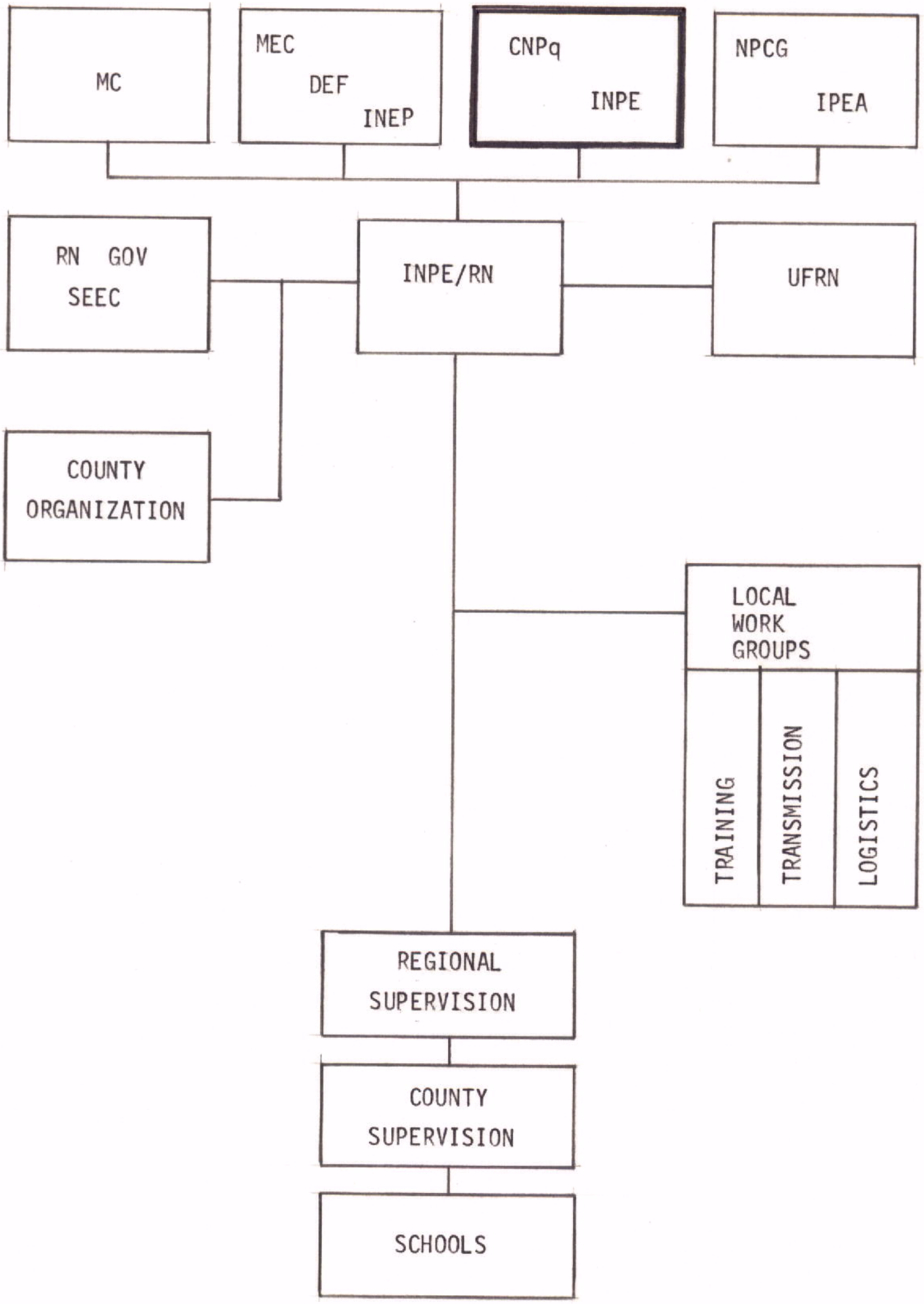
c - logistic team: which are in charge of transport, communication and maintenance.

4) The regional supervisors serve the counties under the jurisdiction of the Regional Centers. The regional supervisors were designated by the State Office of Education and Culture. In addition to having diplomas they should have had specialized courses in supervision. Their main function will be to coordinate the county supervisors, acting as a liaison between them and INPE.

5) The county supervisors are certified teachers who may or may not have already been acting as supervisors in either the state or county school system.

Each supervisor is responsible for about 10 schools and work in close and direct contact with the teachers and students.

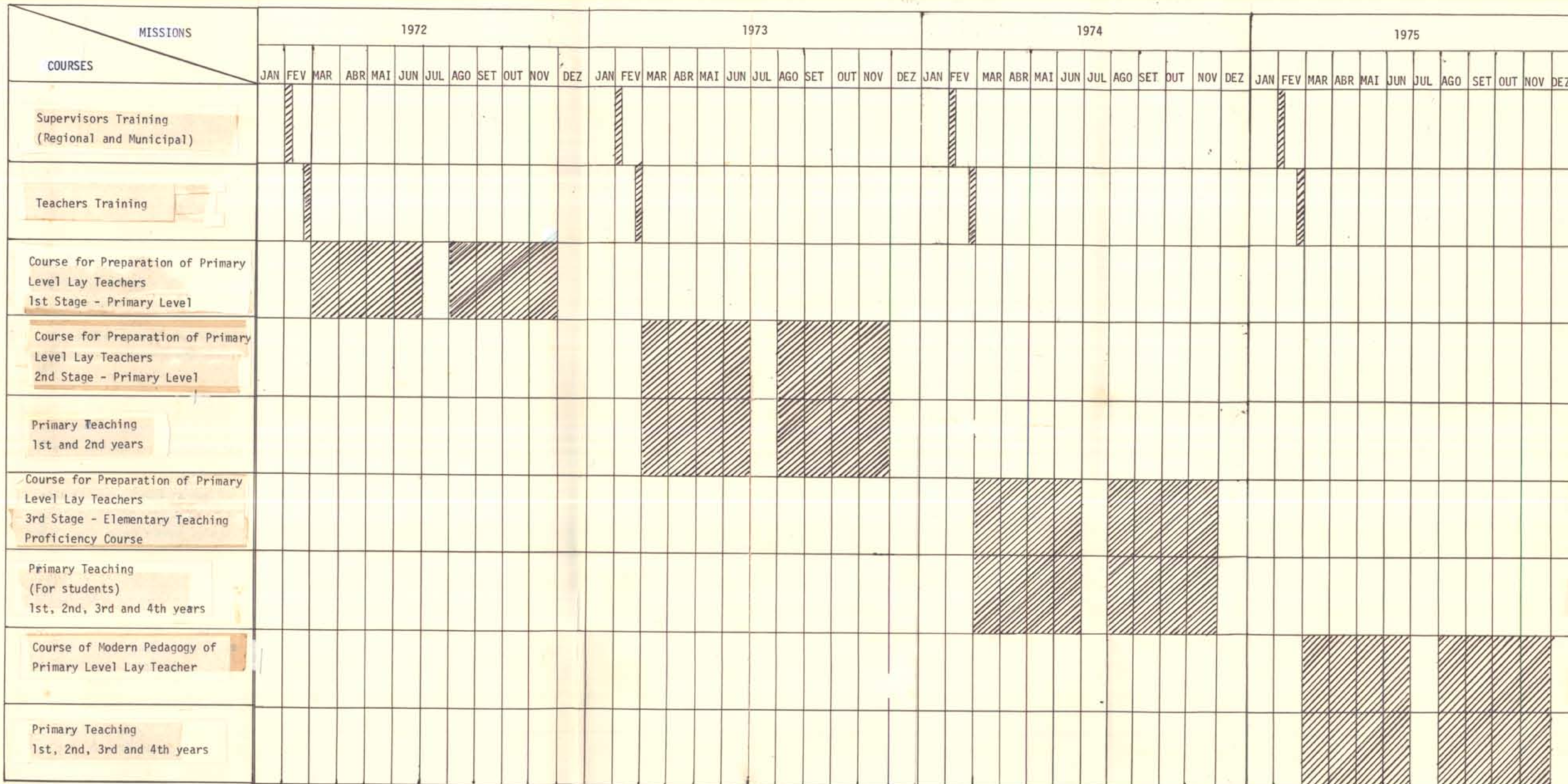
TABLE 8


MC
MEC
DEF
INEP
CNPq
INPE
NPCG
IPEA
RN GOV
SEEC
INPE/RN
UFRN
COUNTY
ORGANIZATION
LOCAL
WORK
GROUPS
TRAINING
TRANSMISSION
LOGISTICS
REGIONAL
SUPERVISION
COUNTY
SUPERVISION
SCHOOLS

4.4.2 - Courses to be administered

Shown first is a chronogram of the courses for the entire period of the Experiment (Table 9) and then a detailed structure of each of them.

TABLE 9


MISSIONS
COURSES
1972
1973
1974
1975
JAN FEV MAR ABR MAI JUN JUL AGO SET OUT NOV DEZ
Supervisors Training (Regional and Municipal)
Teachers Training
Course for Preparation of Primary Level Lay Teachers 1st Stage - Primary Level
Course for Preparation of Primary Level Lay Teachers 2nd Stage - Primary Level
Primary Teaching 1st and 2nd years
Course for Preparation of Primary Level Lay Teachers 3rd Stage - Elementary Teaching Proficiency Course
Primary Teaching (For students) 1st, 2nd, 3rd and 4th years
Course of Modern Pedagogy of Primary Level Lay Teacher
Primary Teaching 1st, 2nd, 3rd and 4th years

Nº/AULA	ASSUNTO	OBJETIVOS GERAIS	CONTEÚDO	REF/BIBLIOG.

TABLE 9

1972

COURSES \ MISSIONS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
Supervisors Training (Regional and Municipal)		///										
Teachers Training		///										
Course for Preparation of Primary Level Lay Teachers 1st Stage - Primary Level			///	///	///	///		///	///	///	///	
Course for Preparation of Primary Level Lay Teachers 2nd Stage - Primary Level												
Primary Teaching 1st and 2nd years												
Course for Preparation of Primary Level Lay Teachers 3rd Stage - Elementary Teaching Proficiency Course												
Primary Teaching (For students) 1st, 2nd, 3rd and 4th years												
Course of Modern Pedagogy of Primary Level Lay Teacher												
Primary Teaching 1st, 2nd, 3rd and 4th years												

1973

COURSES \ MISSIONS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
Supervisors Training (Regional and Municipal)		///										
Teachers Training		///										
Course for Preparation of Primary Level Lay Teachers 1st Stage - Primary Level												
Course for Preparation of Primary Level Lay Teachers 2nd Stage - Primary Level			///	///	///	///		///	///	///	///	
Primary Teaching 1st and 2nd years			///	///	///	///		///	///	///	///	
Course for Preparation of Primary Level Lay Teachers 3rd Stage - Elementary Teaching Proficiency Course												
Primary Teaching (For students) 1st, 2nd, 3rd and 4th years												
Course of Modern Pedagogy of Primary Level Lay Teacher												
Primary Teaching 1st, 2nd, 3rd and 4th years												

1974

COURSES \ MISSIONS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
Supervisors Training (Regional and Municipal)		///										
Teachers Training		///										
Course for Preparation of Primary Level Lay Teachers 1st Stage - Primary Level												
Course for Preparation of Primary Level Lay Teachers 2nd Stage - Primary Level												
Primary Teaching 1st and 2nd years												
Course for Preparation of Primary Level Lay Teachers 3rd Stage - Elementary Teaching Proficiency Course			///	///	///	///		///	///	///	///	
Primary Teaching (For students) 1st, 2nd, 3rd and 4th years			///	///	///	///		///	///	///	///	
Course of Modern Pedagogy of Primary Level Lay Teacher												
Primary Teaching 1st, 2nd, 3rd and 4th years												

1975

COURSES \ MISSIONS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
Supervisors Training (Regional and Municipal)		///										
Teachers Training		///										
Course for Preparation of Primary Level Lay Teachers 1st Stage - Primary Level												
Course for Preparation of Primary Level Lay Teachers 2nd Stage - Primary Level												
Primary Teaching 1st and 2nd years												
Course for Preparation of Primary Level Lay Teachers 3rd Stage - Elementary Teaching Proficiency Course												
Primary Teaching (For students) 1st, 2nd, 3rd and 4th years												
Course of Modern Pedagogy of Primary Level Lay Teacher			///	///	///	///		///	///	///	///	
Primary Teaching 1st, 2nd, 3rd and 4th years			///	///	///	///		///	///	///	///	

A - Training of Supervisors (Regional and County)

a. Objectives

1. To acquaint all supervisors with the program to be implanted.
2. To prepare them for the specific functions which they will perform during the Experiment.
3. To stimulate them to take an active part in the Experiment.
4. To train them to manipulate the TV and Radio receivers.
5. To train them in the application of the working techniques to be used in each phase of the Experiment.

b. Duration: 1 (one) week for each training session.

c. Place: Natal.

d. Training aspects

- Theoretical

1. Teleducation as an agent of development.
2. Technical and Pedagogical media in teleducation.
3. Objectives and Structure of the Experiment.
4. Modern concept of supervision.
5. Supervision, control and evaluation.

- Practical

  1. Handling of TV and Radio sets.
  2. Introduction to the Up-grading Course for lay teachers via TV and Radio.
  3. Familiarization with evaluation material.
  4. Familiarization with accompanying material.

B - Teacher Training

a. Objectives

1. To acquaint elementary "lay" teachers with the program to be implanted.
2. To stimulate and prepare them for the reception of the Up-grading Course.
3. To train them in handling the technological resources and supplementary material for the elementary school courses (Grades 1-4).
4. To present to them the supervision scheme and to acquaint them with the nature of the relationship supervisor/teacher in the Experiment.
5. To orientate them in the use of the evaluation material.

b. Duration: 1 (one) week for each foreseen training.

c. Place: seats of the 5 Regional Centers.

d. Training aspects

- Theoretical

  1. Objectives and structure of the Experiment.
  2. Use of technical and pedagogical resources in teleducation.
  3. Importance of the Up-grading Course for "lay" teachers.

- Practical

  1. Handling of TV and Radio sets.
  2. Organized reception of telelessons and/or radio lessons of the Up-grading Course.
  3. Familiarization with the accompanying material.
  4. Familiarization with evaluation material.

C - Up-grading Course for "lay" teachers of elementar schools

First Phase - Basic education corresponding to the first four grades of the elementary school.

a. Objectives

1. General Objective: To up-grade and specialize the existing "lay" teachers responsible for the teaching of the first four grades of the elementary schools.

2. Specific Objective: To qualify the primary level "lay" teacher for the second phase of the Up-grading course "ginásio" level.

b. Clientele - all Exp.G and CG.I primary level (complete and incomplete) teachers.

c. Duration: from 2 October 1972 through June 1973. Until December the daily programming is comprised of 30 minutes (2 classes of 15 minutes), 5 days per week (2 hours and 30 minutes); from December on the daily programming will be 3 classes of 15 minutes each.

d. Content:

1. Portuguese
2. Mathematics
3. Social Studies
4. Natural Sciences and Health
5. Moral and Civic Education
6. Pedagogical Notions
7. Didactic Notions

e. Media: TV and Ra via ground system.

f. Broadcasting Schedule:

1. TV - 11:30 a.m. to 12:30 p.m. and 6:30 p.m. to 7:30 p.m.
2. Ra - 8:00 p.m. to 9:00 p.m.

g. Auxiliary didactic material:

Programmed instruction booklets complementing the classes transmitted by TV and Ra.

Second Phase: Basic education corresponding to the last four years of the elementary school ("ginásio" level).

a. Objectives

1. General Objective: To up-grade and specialize the existing "lay" teachers responsible for the teaching of the first four grades of the elementary schools.
2. Specific Objective: To qualify the "ginásio" level "lay" teachers for the third phase of the up-grading course - normal school level.

b. Clientele - all Exp.G and CG-I "ginásio" level (complete and incomplete) "lay" teachers.

c. Duration: from August 1973 to March 1974 with daily programming of 45 minutes, 5 days per week (3 hours and 45 minutes).

d. Content:

1. Basic subject-matters

   - Portuguese
   - Mathematics
   - Social Studies
   - Natural Sciences and Health
   - Moral and Civic Education

2. Pedagogical Education

   - Fundamentals of Education
   - General Didactics
   - Special Didactics on basic subject matters.

e. Media: TV and Ra via ground system.

f. Broadcasting Schedule (local time)

1. TV - 11:30 a.m. to 12:30 a.m.
   6:30 p.m. to 7:30 p.m.
2. Ra - 8:00 p.m. to 9:00 p.m.

g. Auxiliary didactic material:

Programmed instruction complementing the classes transmitted by TV and Ra.

Third Phase: Secondary education corresponding to the normal school level.

a. Objectives:

1. General Objective: To up-grade and specialize the existing "lay" teachers responsible for the teaching of the first four grades of the elementary schools.

2. Specific Objective: To complete the up-grading course designed for "lay" teachers of the elementary school system, as well as to qualify them for the up-dating pedagogical course.

b. Clientele - all Exp.G and CG-I teachers who have not the normal school degree.

c. Duration: from April to December 1974, with a period of 30 days vacation (July) and daily programming of 45 minutes (3 classes of 15 minutes), 5 days per week (3 hours and 45 minutes).

d. Content:

1. Educational Philosophy
   - Introduction to Philosophy
   - Philosophy of Education
   - Forms and Types of Education
   - The School, the Teacher and the Student

2. Educational Psychology
   - Concepts, Areas of Study and Limitation
   - Evolutive Psychology of the Child
   - Psychology of Learning
   - The Exceptional Child
3. Educational Biology
   - Introduction to Biology
   - Biological Characteristics of the Student
   - School Hygiene
   - The Commonest Diseases Among Students
4. Educational Sociology
   - Introduction to Sociology
   - Individual, Group and Society
   - Culture and Personality
   - Social Function of the School
5. General Didactics
   - Pedagogy and Didactics
   - The Teaching-Learning process
   - Methods, Procedures, Techniques and Didactic Resources
   - Planning, Orientation and Learning Control
6. Portuguese
   - Introduction to the History of Portuguese Language
   - Functional Grammar
   - Language Didactics
   - Composition

7. Mathematics

   - Operation with Sets and Natural Numbers
   - Sets of Rational Numbers
   - Decimal and Non-Decimal Measuring Systems
   - Didactics of the Mathematics

8. Social Studies

   - Geography and Related Sciences
   - Earth and Universe
   - Geography of Brazil
   - Geography of Rio Grande do Norte
   - Nature and Function of History
   - Periods of Brazil History
   - RN within Brazil History
   - Didactics of Social Studies

9. Natural Sciences

   - Structure and Dynamics of Matter
   - Heat - Fire and Light
   - The Life in the Nature
   - Didactics of Natural Sciences

10. Moral and Civic Education

   - Religion and Moral
   - Moral and Civic Formation
   - Basic Elements of the Nationality
   - Didactics of Moral and Civic Education

e. Media: TV and Ra via ground system

f. Broadcasting schedule (local time)

1. TV - 11:30 a.m. to 12:30 a.m.

   6:30 p.m. to 7:30 p.m.

2. Ra - 8:00 p.m. to 9:00 p.m.

g. Auxiliary didactic material

1. Programmed instruction texts, complementing the classes transmitted by TV and Ra.
2. Selected texts on the subject matters.

D - Up-dating course on pedagogy for elementary school teachers

a. Objectives

1. General Objective: To specialize the existing teachers responsible for the teaching of the first grades of the elementary schools.
2. Specific Objective: To complement the formation of the participants of the up-grading course and up-dating the certified elementary teachers.

b. Clientele: All Exp.G and CG-I teachers.

c. Duration: from March to November 1975 with a period of 30 days vacation (July) and a daily programming of 45 minutes (3 classes of 15 minutes), 5 days per week (3 hours and 45 minutes).

d. Content:

1. Educational Philosophy
   - Pragmatic Education and Existencial Education
   - A new pedagogical Humanism
   - New School and Ancient School
   - Education for a Changing Civilization
2. Educational Psychology
   - Evolutive Psychology of the Adolescent
   - Factors Interfering in the Learning
   - Personal and Social Adjustment
   - Evaluation and Educational Mesarument
3. Educational Biology
   - The School and Nourishment Needs of the Students
   - Teacher Hygiene (physical and mental)
   - The Rural School Facilities and its Hygiene
   - School Action Against Rural Endemic Diseases
4. Educational Sociology
   - School Systems
   - The School in the Urban and Rural Environment
   - Influence of Mass Communication Media on Educational Process

- Education as Economic Developing Factor

5. School Administration
   - General Principles on School Administration
   - General Vision of the School System
   - Elementary School Administration
   - Problems related to promotion, drop-outs and repeaters.

e. Media: TV and Ra via satellite.

f. Broadcasting schedule (local time)

1. TV - 11:30 a.m. to 12:30 a.m.
   6:30 p.m. to 7:30 p.m.
2. Ra - 8:00 p.m. to 9:00 p.m.

g. Auxiliary didactic material

1. Programmed instruction texts complementing the classes transmitted by TV and Ra.
2. Selected texts on the subject matters.

E - Elementary Courses (Grades 1-4)

a. Objectives

1. To develop the reasoning and activities of expression of the child.

2. To integrate the child in his physical and social environment according to the democratic tendencies of the modern society.
3. To stimulate satisfaction in working as well as in physical and useful activities by means of initiation in techniques which enable the child to face the environmental and present needs.

b. Clientele: Children from 7 to 14 years old enrolled in the first four grades of the elementary schools which compose the Exp.G.

c. Duration:

Alternatives do determine the school year

According to chapter 1 article 11, of the law which establishes the foundation and guidelines for the curriculum of the elementary school, decreed in August 11, 1971, by the President of the Republic, the school year has to have at least "180 days of effective school work". Thus the school period of the Experiment will be one between the following two alternatives.

Alternative 1

34 weeks with 6 days of activities, totalling 204 days. The school year beginning would be February 15 and the end November 30 with 4 weeks of vacation in July.

Five days a week would be used for activities via TV and Ra and one day (Saturday) for revision and/or exploration of the subjects taught during the week, through classroom exercises.

Alternative 2

36 weeks with 5 days of activities, totalling 180 days. The beginning of the school year would be February 15 and the end between November 30 and December 10 (depending upon the holidays).

On both cases part of Saturday will be used for community activities including health, hygiene, nutrition, etc.

d. Content

The instructional programming will be based on the State Program of Rio Grande do Norte State and on the last governmental deliberations encompassing 5 subjects matters or areas of study: Portuguese, Mathematics, Natural Sciences and Health, Social Studies and Moral and Civic Education.

e. Media: 1973 - TV and Ra via ground system

1974 - TV and Ra via ground system

1975 - TV, Ra and Slow-can via satellite.

f. Auxiliary didactic material

- Programmed instruction texts complementing the classes transmitted by TV and Ra.
- Teacher Manuals
- Exercise books.

4.4.3 - Audiovisual aids and forms of utilization

a. For the elementary school (grades 1-4)

In order to achieve the goals of the Experiment we have the following technological resources at our disposal:

- Television - TV - via ground system and via satellite
- Radio - Ra - via ground system and via satellite
- Slow-scan (SS) - via satellite
- Fac-Simile (FS) - via satellite

For future use of these media on national scale programs several alternatives are being tested during the experiment giving special consideration to the pedagogical activities and the technical restrictions of engineering. These media may be tested individually or through the combination of two of them for the same school population.

Based on these possibilities the Exp.G schools are distributed in sub-groups according to the audiovisual medium used, as Table IV.

As the table 10 shows, in 1973 and 1974 we will have two sub-groups with TV and two with Ra so that in 1975 with the use of the satellite and other technological resources we will have sub-groups of schools in almost identical proportions.

The inequality verified in the sub-group in 1975 is caused by the experiment with slow-can whose equipment somewhat sophisticated, restricts its use to only 10 schools, number hoped to be sufficient for testing its possible educational application. We have thought it better to substract these schools from the sub-groups utilizing the combination of media, keeping in equal proportions the sub-groups utilizing medium individually.

The combination of media in the groups of TV + PR (Programmed Raio) and TV + Ra will be performed so as to use the programing prepared for the sub-groups in which these media will be used individually. The adequacy of the subjects of a discipline to the media will determine the program to be transmitted by Ra or TV in accordance with the modern principles of media selection in teleducation.

b. <u>For the Up-grading Course for "lay" Teachers and Pedagogical Up-grading Course</u>

For the three phases of the Up-grading Course for "lay"

TABLE 10

	1973			1974			1975	
SUB-GROUPS	Nº OF SCHOOLS	%	SUB-GROUPS	Nº OF SCHOOLS	%	SUB-GROUPS	Nº OF SCHOOLS	%
Ra	100	20	Ra	100	20	Ra	100	20
Ra	100	20	Ra	100	20	RP	100	20
TV	100	20	TV	100	20	TV	100	20
TV	100	20	TV	100	20	TV+RP	95	19
						SS	10	2
TV+Ra	100	20	TV+Ra	100	20	TV+Ra	95	19
TOTAL	500	100	-	500	100	-	500	100

teachers (1972, 1973, 1974) will be used TV and Ra via ground system. The Exp.G teachers are distributed in the sub-groups already established for the implantation of the technological system in the elementary school system (Grades 1-4) beginning in 1973.

The pedagogical Up-grading Course for elementary school teachers will be transmitted by TV and Ra via satellite. The teachers will be kept in the same sub-groups of the Up-grading Course period.

NOTE: Our studios in São José dos Campos are producing 3-4 TV and 5-10 Ra programs daily. By November 72 our TV studio at the area of the experiment (Natal) will be operational in order to help with the production of the classes for the 1st grade students.