



INPE 322-RI/103

*INFORMATION TO THE UNITED NATIONS
RELATIVE TO THE BRAZILIAN ERTS
FACILITY COMPOSITION AND COSTS*

April 1973

cc.: 10

1. GENERAL CONSIDERATIONS

1.1 Brazilian ERTS Facility Composition

The Brazilian ERTS facility is composed of four parts, namely:

- Tracking and Receiving Station (ERG)
- Image Processing Station (EPI)
- Photographic Processing Station (EPF)
- Data Bank (BD)

The Figures 1, 2 and 3 show the block diagrams of ERG, EPI and EPF.

1.2 Location and Coverage

The ERG has been installed at Cuiabá (Mato Grosso State) located in the South Western part of Brazil ($15^{\circ}27'S$ and $56^{\circ}04'W$). This place was chosen because it can provide coverage of the whole Brazilian Territory.

The EPI, EPF and BD will be installed at Cachoeira Paulista (São Paulo State), a place located at 130 miles from São Paulo City, near the highway that connects São Paulo to Rio de Janeiro.

The Fig. 4 presents the ERG coverage for 2 and 5 degrees antenna elevation angles. As a consequence of the ERG location other South American countries could also be covered if they desire to. As can be seen in the figure, these countries are:

Total Coverage	Partial Coverage
Bolivia	Argentine
Paraguay	Chile
Uruguay	Peru
British Guyana	Ecuador
Surinam	Colombia
French Guyana	Venezuela

1.3 Data Amounts

1.3.1 Recording Times

The amount of data to be recorded at the ERG has been calculated considering the antenna elevation angle equal or greater than 5 degrees, that is a pessimistic estimate since under favorable atmospheric propagation conditions it will be possible to record lower angle passes.

The Table 1 shows the time spent per pass per day along 18 days that is the satellite coverage reaptibility cycle. During the

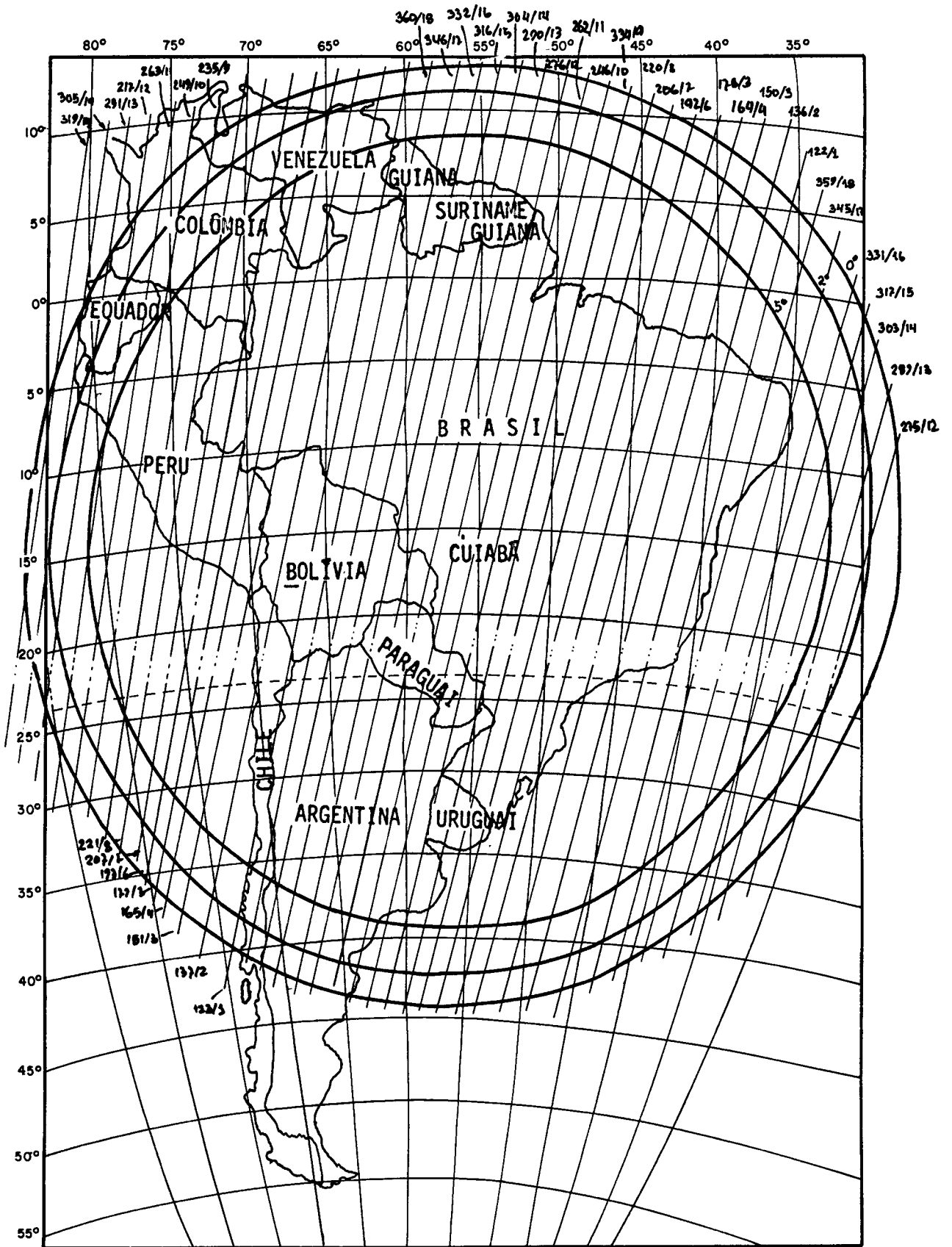


FIG. 4 - TRACKING AND RECEIVING STATION COVERAGE.

Table 1 - RECORDING TIMES FOR CONTINENTAL COVERAGE

DAY	TIME (SECONDS)							
	PASS NUMBER		BRAZIL		OTHER COUNTRIES		TOTAL	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
1	122	123	300	300	-	450	300	750
2	136	137	300	240	-	330	300	570
3	150	151	360	210	-	285	360	495
4	164	165	375	210	-	270	375	480
5	178	179	480	210	-	270	480	480
6	192	193	525	210	-	360	525	570
7	206	207	525	90	30	390	555	480
8	220	221	525	15	75	450	600	465
9	234	235	420	-	210	375	630	375
10	248	249	249	-	240	270	645	270
11	262	263	420	-	270	210	690	210
12	276	277	450	0	330	150	780	150
13	290	291	330	-	450	45	780	45
14	304	305	330	-	480	-	810	-
15	318	319	315	-	510	-	825	-
16	332	333	270	-	510	-	780	-
17	345	346	60	240	-	540	60	780
18	359	360	135	300	-	510	135	810

first day it has been assumed the orbits nr. 122 and 123 for illustrative purposes; in the second day orbits 136 and 137, and so on. The calculation was made just for continental coverage, either for Brazil or other countries as well. For an elevation angle of 5 degrees, 35 orbits cross the whole coverage area of the ERG; 32 of them correspond to the continental areas.

The solar illumination of the scenes depends on the latitude and on the seasons; this is shown in Fig. 5. Within the area covered by the ERG, the solar angle is always greater than 17 degrees, that is considered satisfactory.

1.3.2 Magnetic Tape Requirements

The system uses two types of tape recorders: Ampex FR-1928 (for MSS) and RCA TR70- CVR- 3E (for RBV). The magnetic tapes for Ampex FR 1928 are provided in 9,200 feet reels, or, in terms of recording time, 1840 seconds.

The magnetic tapes for RCA TR-70 are provided in reels of 1,200, 2,400, 3,600, 4,600 or 5,600 feet, or, in terms of recording time, 738, 1,476, 2,214, 2,952 and 3,444 seconds (speed of 19,5 inches per second).

The table 2 presents the number of reels for both tape recorders and the corresponding costs. The calculation was made considering

SOLAR ELEVATION ANGLE

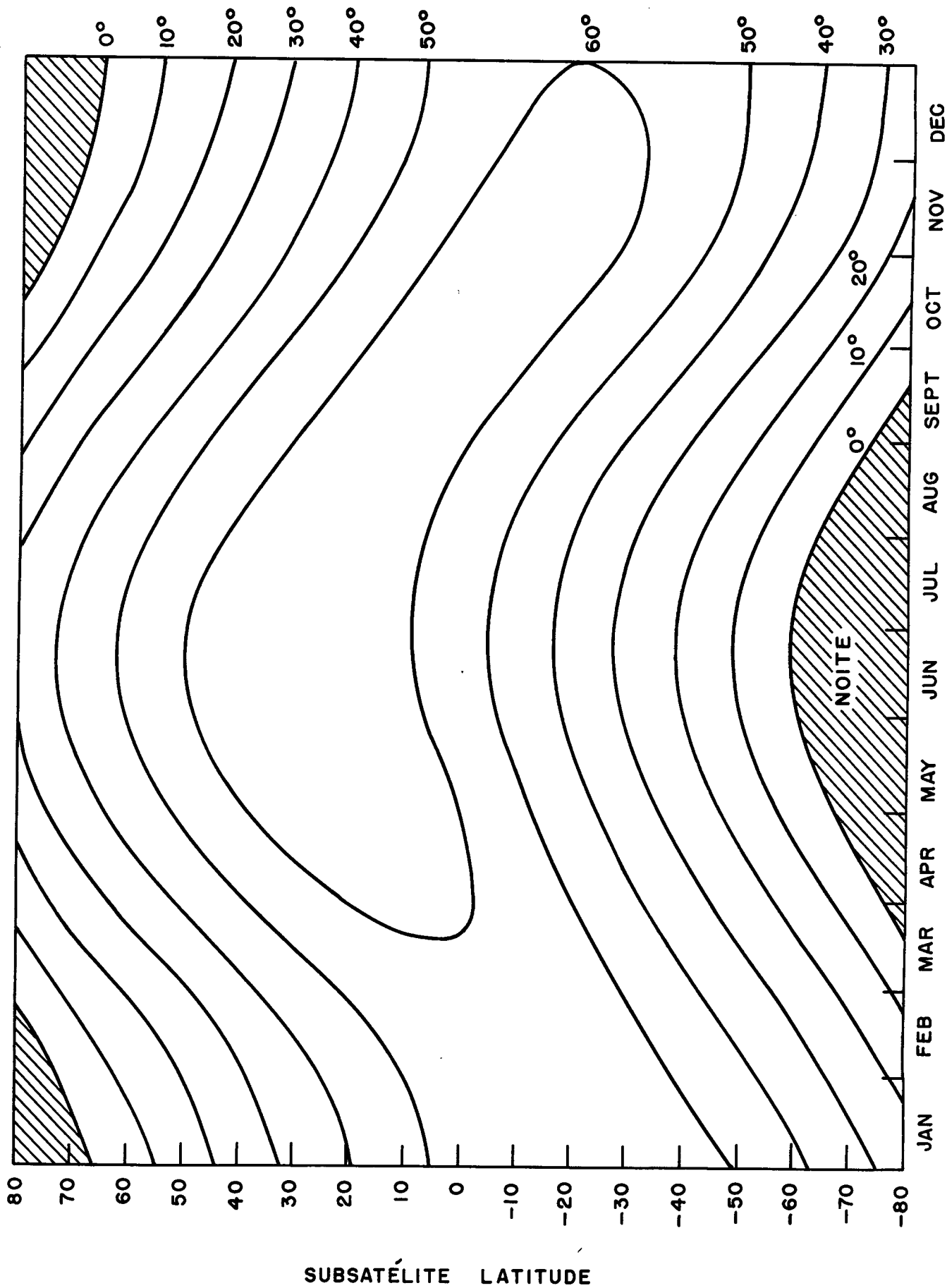


FIG.5 - SOLAR ELEVATION ANGLE

Table 2 - MAGNETIC TAPES QUANTITY AND COSTS

TOTAL CONTINENTAL COVERAGE	AMPEX FR 1928	RCA TR 70-CVR-3E	TOTAL US\$ (18 days)	ANNUAL COST* US\$
	11 reels (9200 feet): US\$ 3300	1 reels (2400 feet): US\$ 110 1 reels (4800 feet): US\$ 220 3 reels (3600 feet): US\$ 750 2 reels (5600 feet): US\$ 520	US\$ 4,900.00	US\$ 98,000.00
BRAZIL	5 reels (9200 feet): US\$ 1500	1 reel (1200 feet): US\$ 55 1 reel (4800 feet): US\$ 220 1 reel (3600 feet): US\$ 165 2 reels (2400 feet): US\$ 220	US\$ 2,160.00	US\$ 43,200.00

* Assuming the tapes will be preserved.

the largest number of consecutive entire passes recorded per reel as well as the lengths of the passes.

1.3.3 Quantity of Images

Based on the data of Table 1, the number of scenes (100 x 100 mm) which will be received per cycle (18 days) and per day were calculated for the continental coverage of Brasil and total continental coverage. It was considered that 30% of the images (bulk) will not be used due to cloud coverage. From the remaining 70%, 20% will be transformed into color composite products. Also from the remaining 70%, 30% will be transformed into precision images. All of the precision products will be turned into color composite. The Tables 3, 4, 5 and 6, illustrate these calculations. It was considered just a piece of each product.

Table 3 - QUANTITY OF IMAGES RECEIVED

	BRAZIL		TOTAL CONTINENTAL COVERAGE	
	RBV	MSS	RBV	MSS
Time/18 days	8550 seg.	8550 seg.	16560	16560
Scenes/18 days	342	342	662	662
Scenes/day	19	19	36	36
Images/Day	57 (3x19)	76 (4x19)	108 (3x36)	144 (4x36)
Scenes with small percentage of cloud cover (70% total)	14	14	26	26
Images with small percentage of cloud cover (70% total)	42 (3x14)	56 (4x14)	78(3x26)	104 (4x26)

Table 4 - BULK PRODUCTS PER DAY

	BRAZIL		TOTAL CONTINENTAL COVERAGE	
	RBV	MSS	RBV	MSS
B & W paper print	42	56	78	104
B & W transparency	42	56	78	104
Color paper print (20% total)	10	12	15	20
Color transparency (20% total)	10	12	15	20
TOTAL	104	136	186	248

Table 5 - PRECISION PRODUCTS PER DAY

	BRAZIL		TOTAL CONTINENTAL COVERAGE	
	RBV	MSS	RBV	MSS
B & W paper print (30% of bulk)	12	16	24	30
B & W transparency (30% of bulk)	12	16	24	30
Color paper print	12	16	24	30
Color transparency	12	16	24	30
TOTAL	48	64	96	120

Table 6 - TOTAL NUMBER OF IMAGES PER DAY

	BRAZIL	TOTAL CONTINENTAL COVERAGE
Bulk	240	434
Precision	112	216
TOTAL	352	650

2. SYSTEM COSTS

2.1 Tracking and Receiving Station

2.1.1 Investment Costs (see Table 7)

2.1.2 Annual Operational Costs (see Table 8)

2.2 Image Processing Station

2.2.1 Investment Costs (see Table 9)

2.2.2 Annual Operational Costs (see Table 10)

2.3 Photographic Processing Station

2.3.1 Investment Costs (see Table 11)

2.3.2 Annual Operational Costs (see Tables 12, 13, 14 and 15)

2.4 Data Bank Operational Costs (see Table 16)

2.5 Total Costs (see Tables 17 and 18)

TABLE 7 - TRACKING AND RECEIVING STATION INVESTMENT COSTS

ANTENNA SUBSYSTEM	US\$
1. Antenna	32,973.00
2. Pedestal	57,074.00
3. Base Extension	9,711.00
4. Antenna Feeder and 2 parametric amplifier	150,151.00
4a. Feeder modification for $\eta = 60\%$	3,210.00
4b. Pass band USB Filter	1,070.00
4c. Phase Shift Control Unit	980.00
5. Reflector Mount	13,971.00
6. Multicoupler	293.00
7. 2 Receivers/Converters MSS/RBV	32,343.00
8. 1 Tracking Receiver	14,184.00
9. 1 RF Panel	373.00
10. 1 Programmer	16,554.00
11. Consoles	4,919.00
12. RF Cables	234.00
13. Servo cables set	612.00
14. Antenna control	6,816.00
15. Servo amplifier	2,380.00
16. Power amplifier	4,995.00
17. Tracking converter	6,390.00
18. Scan Code Generator	3,738.00
19. Test dipole	2,000.00
20. Scan Sector	1,650.00
20a. Scan sector control unit	1,864.00
21. Paper tape recorder	3,450.00
22. Manuals	3,000.00
23. Packing	4,000.00
24. Training	5,000.00
25. Installation	17,000.00
26. Transport USA/BRAZIL	350.00
ANTENNA SUBSYSTEM:	401,275.00

TABLE 7 (Cont.)

RECORDING SUBSYSTEM	US\$
27. RBV Recording	374,573.00
27a. SPEVOR and Test Generator	
27b. RBV Recorder (RCA TR 70)	
28. MSS Recording	333,054.00
28a. MSS bit synchronizer	
28b. Demultiplexer, Test Generator	
28c. MSS Recorder (Ampex FR 1928)	
28d. Data Formatter	
29. Quick Look Monitor	162,683.00
30. Real Time PCM Reception and Recording	44,404.00
30a. PCM Demodulator	
30b. PCM bit synchronizer	
30c. PCM Recorder	
31. PCM Test Generator and Test/Modulator Generator	29,602.00
32. Training and Manuals	52,209.00
33. Installation and Test	62,539.00
RECORDING SUBSYSTEM	1,059,064.00
TOTAL	1,460,339.00

Table 8 - TRACKING AND RECEIVING STATION ANNUAL OPERATIONAL COSTS

ITEMS	COST (US\$)
1. Expendable Supplies - Magnetic Tapes - Other Expendable Supplies (electricity, gasoline, etc.)	98,000.00 12,000.00
2. Personnel - 3 Electronic Engineers - 4 Technician/Operators - 1 Secretary - 2 Drivers - 2 Janitors	81,300.00
3. Maintenance Contracted Services	125,000.00
4. Spare Parts (estimate)	150,000.00
TOTAL	466,300.00

TABLE 9 - IMAGE PROCESSING STATION INVESTMENT COSTS

ITEMS	COST (US\$)
1. Signal Processing	593,789.00
1a. SPEVOR and RBV Test Generator	
1b. MSS Interface	
2. Data Playback System	589,504.00
2a. PCM Recorder	
2b. PCM Recorder Controls	
2c. RBV Recorder	
2d. RBV Recorder Control	
2e. MSS Recorder	
2f. MSS Test Generator and Recorder Control	
3. Multispectral Data Processing	256,868.00
3a. Moving Window Display and Control	
4. Film Recording	790,616.00
4a. Electron Beam Recorder (EBR)	
4b. EBR Control	
4c. Digitizer	
5. Computer	623,449.00
5a. 2 Central Processing Units (CPU) PDP-11	
5b. Memory (56K)	
5c. 2 Arithmetics Extensions	
5d. Magnetic Tape Units and Control	
5e. Dual DEC Tape with Control	
5f. 2 Real time clocks	
5g. Disc and Control	
5h. Terminal Display (CRT)	
5i. Typewriter Terminal	
6. Printing and Perforating Units	20,000.00
7. Training and Manuals	52,000.00
8. Installation and Tests	137,500.00
TOTAL	3,063,936.00

Table 10 - IMAGE PROCESSING STATION ANNUAL OPERATIONAL COSTS

ITEMS	COST (US\$)
1. Expendable Supplies - Digital Magnetic Tapes (CCT) - Film - Other Expendable Supplies	220,000.00
2. Personnel - 7 Engineers - 5 Technician/operators - 1 Secretary - 2 Drivers - 2 Janitors	136,000.00
3. Spare Parts (estimate)	300,000.00
4. Maintenance contracted services	230,000.00
TOTAL	886,000.00

Table 11 - PHOTOGRAPHIC PROCESSING STATION INVESTMENT COST

ITEMS	COST (US\$)
2 B&W Processors	40,000.00
1 Color Film Processor	70,000.00
1 Color Paper Print Processor	18,000.00
1 Paper Print B&W Processor	10,000.00
1 Enlarger and Copier for Automatic Color Composition	152,000.00
3 Light Tables	1,000.00
3 Microscopes	1,000.00
3 Densitometers	5,000.00
1 Microdensitometer	20,000.00
1 Sensitometer	3,000.00
TOTAL	320,000.00

Table 12 - PHOTOGRAPHIC PROCESSING COSTS PER DAY FOR BRAZILIAN TERRITORY COVERAGE

BULK PROCESSING	US\$
98 B&W 70 mm paper copies	5,0
98 B&W 70 mm transparency copies	50,0
98 B&W 9 1/2" paper copies	20,0
98 B&W 9 1/2" transparency copies	200,0
22 Color 9 1/2" paper copies	33,0
22 Color 9 1/2" transparency copies	77,0
TOTAL/DAY	385,0
PRECISION PROCESSING	
28 B&W 70 mm paper copies	1,5
28 B&W 70 mm transparency copies	15,0
28 B&W 9 1/2" paper copies	6,0
28 B&W 9 1/2" transparency copies	60,0
28 Color 9 1/2" paper copies	45,0
28 Color 9 1/2" transparency copies	100,0
TOTAL/DAY	385,0

Table 13 - PHOTOGRAPHIC PROCESSING COSTS PER DAY FOR
TOTAL CONTINENTAL COVERAGE

BULK PROCESSING	US\$
182 B&W 70 mm paper copies	9,0
182 B&W 70 mm transparency copies	90,0
182 B&W 9 1/2" paper copies	36,0
182 B&W 9 1/2" transparency copies	360,0
35 Color 9 1/2" paper copies	52,5
35 Color 9 1/2" transparency copies	122,5
TOTAL/DAY	<u>670,0</u>
PRECISION PROCESSING	
54 B&W 70 mm paper copies	2,5
54 B&W 70 mm transparency copies	25,0
54 B&W 9 1/2" paper copies	10,0
54 B&W 9 1/2" transparency copies	100,0
54 Color 9 1/2" paper copies	52,5
54 Color 9 1/2" transparency copies	189,0
TOTAL/DAY	<u>407,5</u>

Table 14 - PHOTO PROCESSING ANNUAL COSTS

	BRAZIL	TOTAL CONTINENTAL COVERAGE
Bulk	US\$ 140,525.00	US\$ 244,550.00
Precision	US\$ 82,860.00	US\$ 150,560.00
TOTAL	US\$ 223,385.00	US\$ 395,110.00

Table 15 - PHOTOGRAPHIC PROCESSING STATION ANNUAL OPERATION AND MAINTENANCE COSTS

ITEMS	COST (US\$)
1. Expendable Supplies - Bulk and Precision Processing	395,110.00
2. Personnel - 1 Analyst - 1 Technician - 7 Operators - 8 Auxiliaries - 1 Janitor	75,000.00
3. Contracted Maintenance Services	30,000.00
4. Spare Parts	30,000.00
TOTAL	530,110.00

Table 16 - DATA BANK ANNUAL OPERATIONAL COSTS

ITEMS	COST (US\$)
1. Expendable Supplies	50,000.00
2. Personnel - 3 Engineers - 1 Librarian - 4 Auxiliaries - 1 Secretary	45,000.00
3. Contracted Services	25,000.00
TOTAL	120,000.00

Table 17 - TOTAL INVESTMENT COSTS

ITEMS	COST US\$
Tracking and Receiving Station	1,460,369.00
Image Processing Station	3,069,396.00
Photo Processing Station	320,000.00
Test Equipment	82,000.00
Building and Infrastructure	464,058.00
Initial Supply	109,607.00
TOTAL	5,500,000.00

Table 18 - TOTAL ANNUAL OPERATIONAL COSTS

ITEMS	COST US\$
Tracking and Receiving Station	466,300.00
Image Processing Station	886,000.00
Photo Processing Station	530,110.00
Data Bank	120,000.00
TOTAL	2,002,410.00

3.0 - INVESTMENT COSTS FOR SIMPLIFIED TRACKING AND RECEIVING STATIONS

3.1 - RBV Reception and Recording

The Table 19 present the investment costs for a station that would be able to receive and record only the RBV signal. As in the case of the Brazilian ERTS Facility, a photographic camera could be adapted to the Quick Look Monitor to provide images without corrections that could, however be used for preliminary data interpretation. This possibility is particularly applicable to RBV imagery since this sensor is a photographic camera like one.

If the signals are to be processed at an Image Processing Station, PCM equipment has to be added to this alternative of Tracking and Receiving Station.

3.2 - MSS Reception and Recording

The Table 20 shows the investment cost to receive and record only the MSS signal. The same as above, images without corrections could be provided through a photographic camera adapted to the Quick Look Monitor. The images would have however, larger distortions than the RBV ones because they do not have the Earth's rotation correction that would be introduced at an Image Processing Station in the case of a complete system.

If the signals are to be processed at an Image Processing Station, PCM equipment has to be added to this alternative of Tracking and Receiving Station.

Table 19 - INVESTMENT COSTS FOR A RBV RECORDING SIMPLIFIED TRACKING AND RECEIVING STATION

ITEMS	COST US\$
ANTENNA SUBSYSTEM See Equipment list of Table 7. Includes one backup receiver/RBV	401,275.00
RBV RECORDING Spevor and Test Generator Quick Look Monitor RBV Recording (RCA TR70)	537,256.00
PCM TEST AND TEST/MODULATOR GENERATOR	29,602.00
TRAINING AND MANUALS	30,000.00
INSTALLATION AND TEST	30,000.00
TOTAL	1,026,133.00
REAL TIME PCM RECEPTION AND RECORDING PCM Demodulator PCM Bit Synchronizer PCM Recorder	44,404.00
TOTAL	1,070,537.00

Rmks: - The costs for Training and Manuals, and Installation and Test are estimates.

Table 20 - INVESTMENT COSTS FOR A MSS RECORDING SIMPLIFIED TRACKING AND RECEIVING STATION

ITEMS	COSTS US\$
ANTENNA SUBSYSTEM See equipment list at Table 7. Includes one backup receiver/MSS	401,275.00
MSS RECORDING MSS Bit Synchronizer Demultiplexer, Test Generator MSS Recorder Ampex FR-1928 Data Formatter	495,737.00
PCM TEST AND TEST/MODULATOR GENERATOR	29,602.00
TRAINING AND MANUALS	30,000.00
INSTALLATION AND TEST	30,000.00
TOTAL	986,614.00
REAL TIME PCM RECEPTION AND RECORDING PCM Demolator PCM Bit Synchronizer RCM Recorder	44,404.00
TOTAL	1,031,018.00

Rmks: The costs for Training and Manuals, and Installation and Test are estimates.