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DATA PROCESSING PLAN FOR ORBITING SOLAR OBSERVATORY (OSO-B2)

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DATA PROCESSING PLAN
FOR
ORBITING SOLAR OBSERVATORY
(OSO-B 2)

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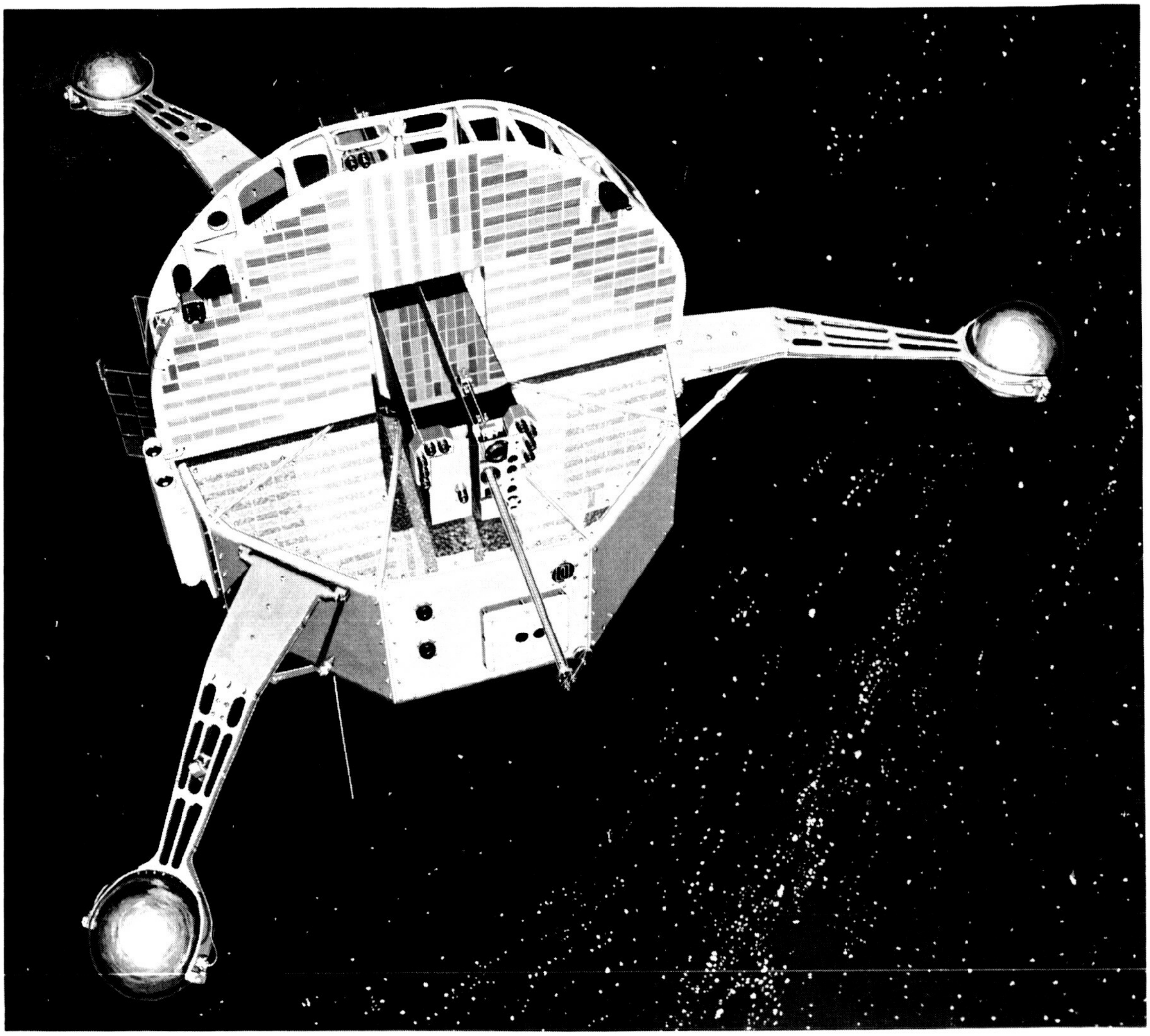
SUMMARY

This plan gives a general description of the structure, mission, and telemetry of OSO-B2, followed by a detailed description of the data-processing responsibilities and procedures of the Data Processing Branch in processing the OSO-B2 telemetered data.



Frontispiece-OSO-B2 Spacecraft

DATA PROCESSING PLAN FOR ORBITING SOLAR OBSERVATORY (OSO-B2)

INTRODUCTION

This document presents the Data Processing Branch's operations plan for the processing of telemetered experimental data obtained from the OSO-B2 Orbiting Solar Observatory. The plan covers the various phases of the data-processing operations from acquisition of the data at a telemetry ground station recording site through the final acceptance of the processed data by the participating experimenters of the OSO-B2 project. Operations performed by personnel other than that of the Data Processing Branch will be described only in general terms. The overall project organization for the Orbiting Solar Observatory satellite is shown in Figure 1.

SPACECRAFT SUMMARY

Mission

The OSO-B2 satellite is second in a series of orbiting solar observatories in the solar-physics portion of the NASA Space Sciences Program. The mission of the OSO-B2 satellite is to conduct pointed experiments to map the sun and solar disc in ultraviolet light and X-ray emissions, and to map portions of the celestial sphere for direction and intensity of ultraviolet light, for gamma radiation, and for the polarized component of zodiacal light (see Figure 2).

Spacecraft

The OSO-B2 spacecraft is designed primarily as a stabilized platform for solar-oriented scientific instruments. The main body of the OSO-B2 spacecraft is a wheel of aluminum alloy material made up of nine wedge-shaped compartments. Five of these compartments will contain equipment for four experiments, and four compartments will house the electronic controls and batteries, telemetry equipment, and radio-command equipment (Figure 3). A fan-shaped sail, mounted on top of the wheel by means of a rotating shaft, carries the solar cells and pointed experiments. The azimuth shaft assembly is shown in Figure 4.

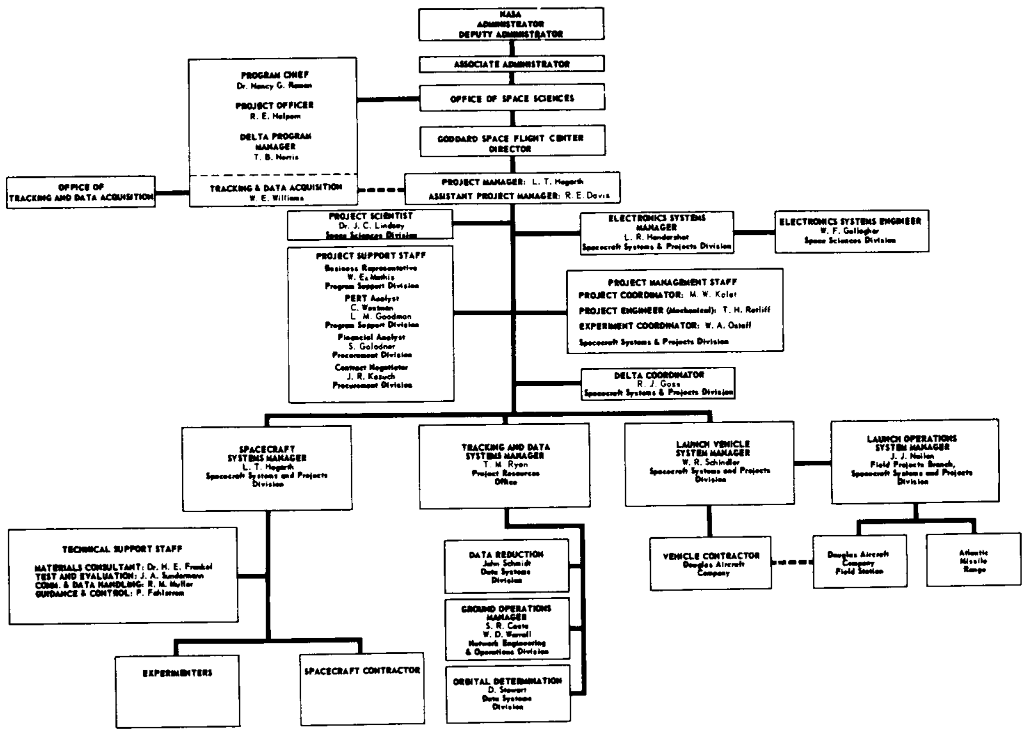


Figure 1-OSO-B2 Project Management Organization Chart

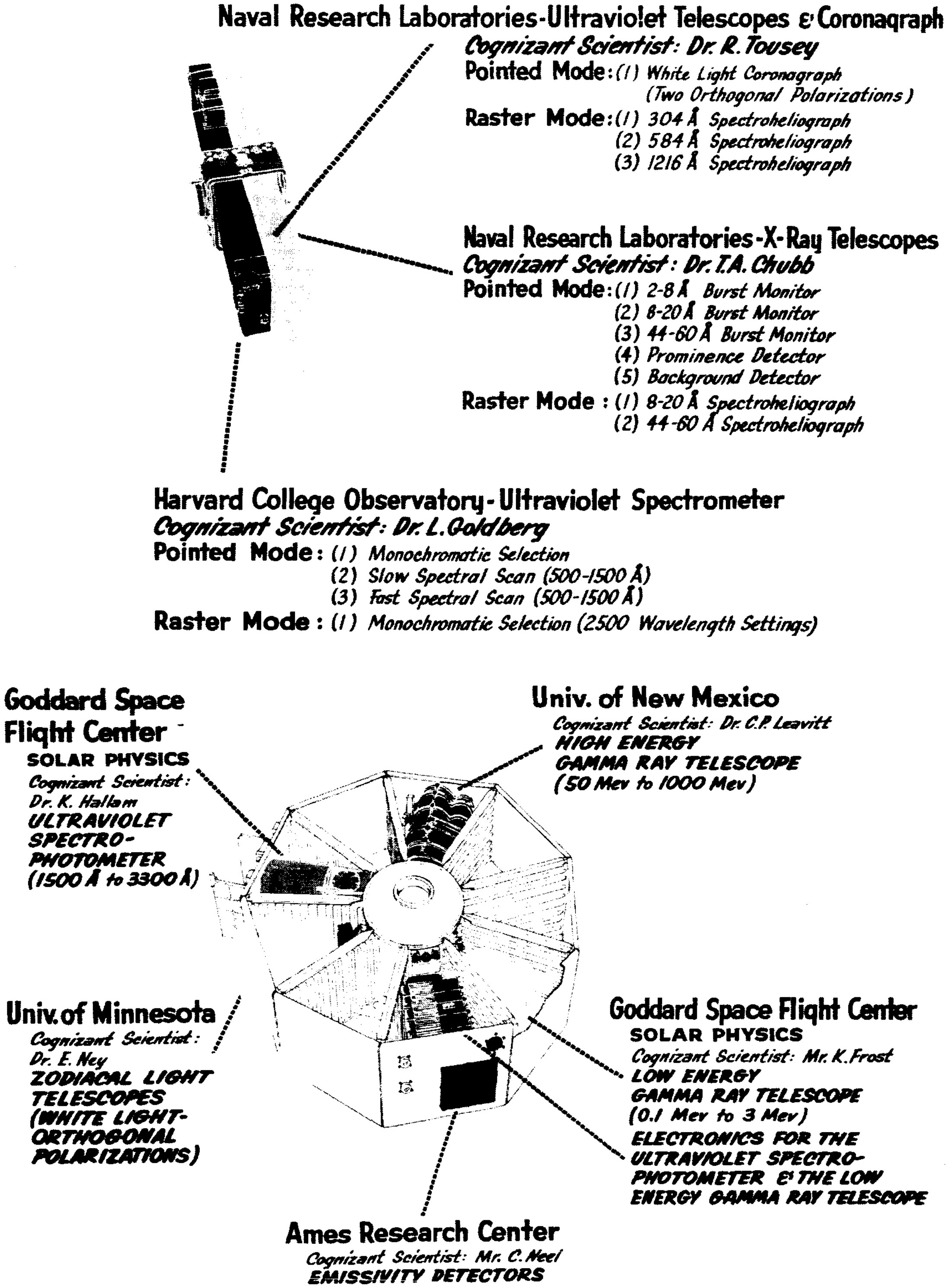


Figure 2-OSO-B2 Experiments

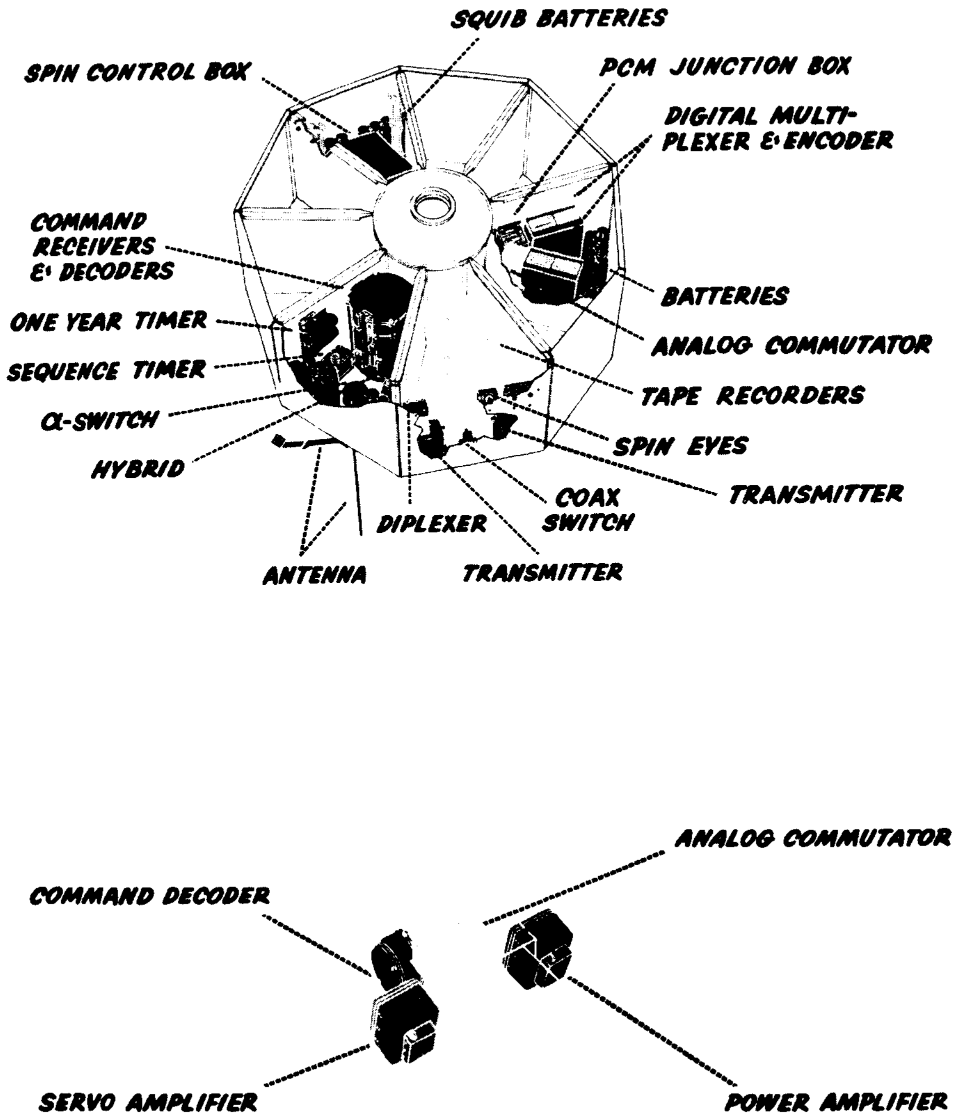


Figure 3-Wheel and Sail Electronic Systems

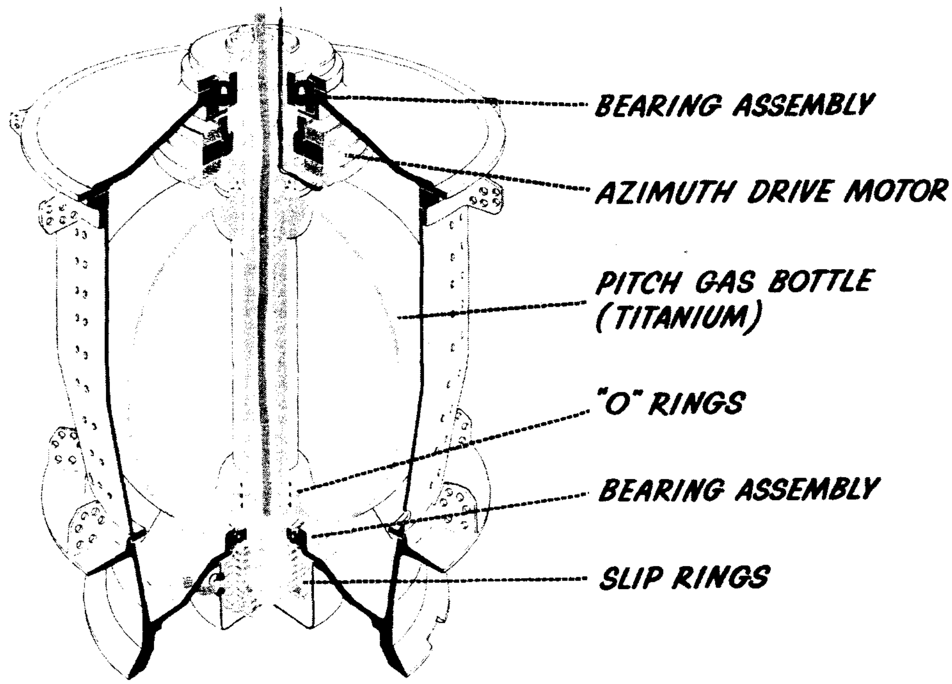


Figure 4-Azimuth Shaft Assembly

Orbit

The spacecraft will be launched from the Eastern Test Range by a Delta launch vehicle. Orbital plans require a launch azimuth of 108 degrees, which will produce an orbital inclination of 33 degrees. The planned orbit is circular at an altitude of 300 ±30 nautical miles. The period of orbit will be about 95 minutes between the south-to-north crossings of the equator. The expected minimum useful lifetime of the satellite is 6 months. Figure 5 shows the early orbital flight sequence.

Telemetry

The OSO-B2 has a biphase PCM digital telemetry system with 8-bit words in 32-word frames. Figure 6 shows the satellite telemetry format.

There are two 48-word subcommutators, both of which are supercommutated in the main frames. (See Table I for subcommutator channel assignments.)

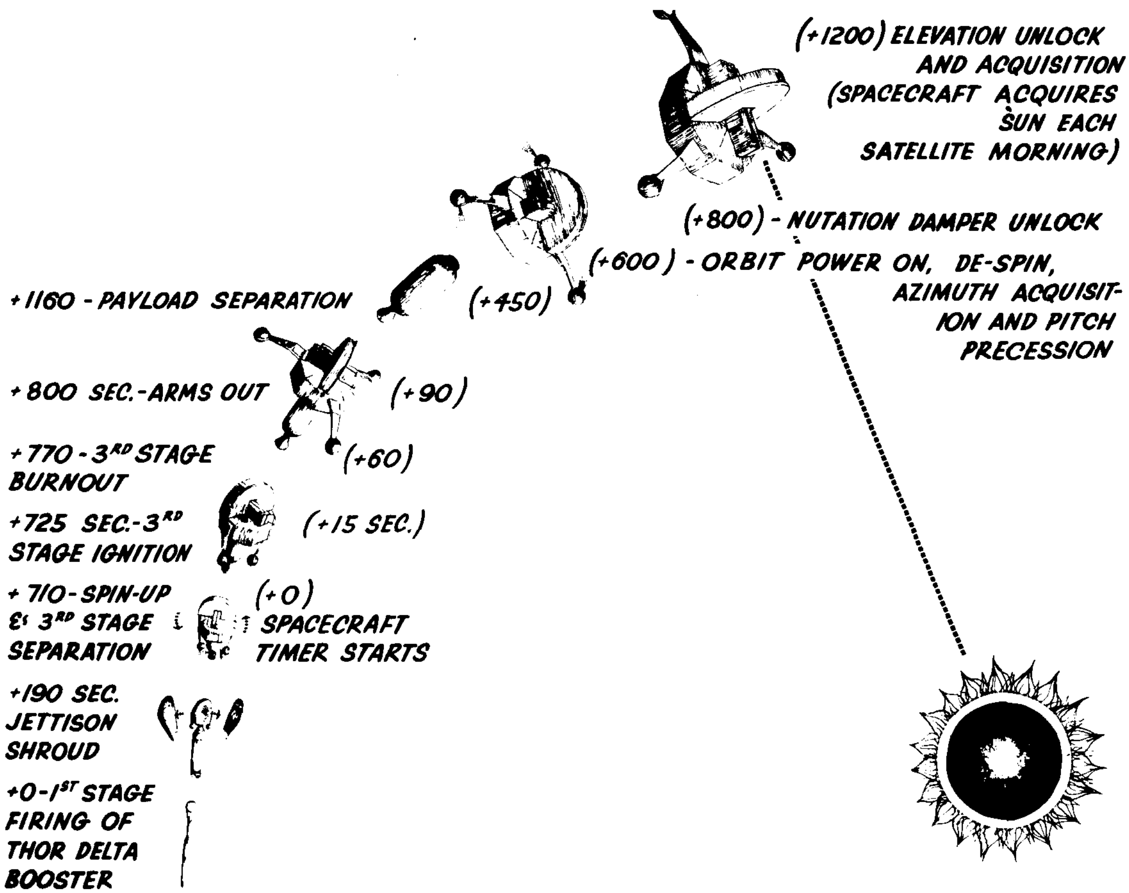


Figure 5-OSO-B2 Flight Sequence

Real-time data (400 bits per second) are transmitted and simultaneously recorded onboard on a continuous-loop tape recorder. Real-time recording and transmission cease upon execution of the playback command and begin again, automatically, at the end of playback. For the transmission of stored data, onboard tape-recorder speed in increased to 18 times the recording speed and is transmitted, therefore, at a rate of 7200 bits per second. Data transmitted throughout the remainder of the orbit at 400 bits per second will not be recorded or processed on a regular basis by the Data Processing Branch.

DATA FLOW

Figure 7, contained at the end of this document, shows the OSO-B2 data flow.

1 NRL-RT	2 WHEEL SUBCOM	3 HARVARD COLLEGE OBSERVATORY	4
5 NRL-RT	6 NRL-TAC	7 UNIV. OF NEW MEXICO	8 SAIL SUBCOM
9 NRL-RT	10 NRL-TAC	11 HARVARD COLLEGE OBSERVATORY	12
13 NRL-RT	14 UNIV. OF MINNESOTA	15 UNIV. OF MINNESOTA	16 SAIL SUBCOM
17 NRL-RT	18 WHEEL SUBCOM	19 HARVARD COLLEGE OBSERVATORY	20
21 NRL-RT	22 GSFC FROST	23 UNIV. OF NEW MEXICO	24 SAIL SUBCOM
25 NRL-RT	26 GSFC HALLAM	27 HARVARD COLLEGE OBSERVATORY	28
29 NRL-RT	30 UNIV. OF MINNESOTA	31 FRAME SYNC	32

Figure 6-Main-Frame Telemetry Format

Table I

OSO-B2 Wheel and Sail Commutators Channel Assignments

Channel	Wheel Commutator	Channel	Sail Commutator
1	Ames Commutator	1	Elevation Position Readout
2	Univ. of New Mexico Point #1	2	Elevation Scan Monitor
3	Univ. of New Mexico Point #2	3	Elevation PWM Input Signal
4	Univ. of New Mexico Point #3	4	Azimuth PWM Input Signal
5	Univ. of Minnesota Point #1	5	Azimuth Position Readout
6	Univ. of Minnesota Point #2	6	Azimuth Scan Monitor
7	Univ. of Minnesota Point #3	7	Azimuth Current Monitor
8	Univ. of Minnesota Point #4	8	Elevation Current Monitor
9	Univ. of Minnesota Point #5	9	Elevation Position Readout
10	Univ. of Minnesota Point #6	10	On Target Signal
11	GSFC Point #1	11	+15 volt Reg. (Linear Amplifier)
12	GSFC Point #2	12	Azimuth Preamplifier Monitor
13	GSFC Point #3	13	Azimuth Position Readout
14	GSFC Point #4	14	+15 PWM Monitor
15	GSFC Point #5	15	Elevation Preamplifier Amplifier
16	Sub-Commutator 1 I.D.	16	Sub-Commutator 2 I.D.
17	Battery #3 Temperature	17	Elevation Position Readout
18	Battery #5 Temperature	18	+19 volt Day Pointed Experiment Power
19	Ames Commutator	19	+19 volt (Cont. Sys.)/+15 volt (Aux.)
20	Top Skin Temperature	20	+15 volt Reg. (Scan Circuits)
21	Bottom Skin Temperature	21	Azimuth Position Readout
22	Rim Skin Temperature	22	Target Intensity
23	Transmitter #1 Temperature	23	Harvard Voltage Monitor
24	Battery #1 Temperature	24	Power Amplifier Box Temperature
25	Slip Ring Temperature	25	Elevation Position Readout
26	Hub Temperature	26	Elevation Scan Monitor
27	Spin Box Temperature	27	Linear Amplifier Box Temperature
28	+19 volt (Battery)	28	Azimuth Casting Temperatures
29	+19 volt Day Power: +19 volt Night Power	29	Azimuth Position Readout
30	Despin and Spin Backup Arming Monitor	30	Azimuth Scan Monitor
31	Arm Release and Lock Monitor	31	Solar Cell Panel Temperature
32	Transmitter Select	32	Solar Cell Panel Temperature
33	+15 volt Reg. (Spin Circuits)	33	Elevation Position Readout
34	+19 volt Orbit Power: UVS By-Pass Open	34	Azimuth Power Transistor Temperature
35	Charge Rate Monitor	35	Solar Cell Panel Temperature
36	Spin Rate Monitor	36	Solar Cell Panel Temperature
37	Spin Gas Pressure	37	Azimuth Position Readout
38	Auto Spin in Monitor	38	Sail Commutator Temperature
39	Arm Temperature	39	Pitch Readout
40	Playback Off; Modulation On	40	Harvard Temperature Monitor
41	Spin Gas Bottle Temperature	41	Elevation Position Readout
42	Pointed Experiments on One Year Timer Bypass	42	NRL Voltage Monitor
43	Magnetometer	43	P.B.U. Reg. On/Off
44	Encoder Select	44	Pitch-Man and B. U. Arming
45	+15 volt Reg. (Aux.)	45	Azimuth Position Readout
46	Tape Recorder Select	46	Pitch Gas Pressure
47	Wheel Experiment Monitor	47	Radiation and Albedo Eye Experiment
48	Sync Word	48	Sync Word

GROUND STATION OPERATIONS

Data-Acquisition Stations

Acquisition and recording of telemetered data from the OSO-B2 will be the responsibility of the GSFC STADAN stations listed in Table II. Secondary telemetry-acquisition stations will be used only during the early orbit phase or during those occasions where conflicts develop and no primary station is available to command playback and to record the telemetered data.

Table II
Telemetry Data-Acquisition Stations

Number Code	Letter Code	Three-Letter Code	Six-Letter Code	Station and Location	Tape Speed (In/Sec)
				PRIMARY STATIONS	
3	D	FTM	FTMYRS	Fort Myers, Florida	15*/30**
5	F	QUI	QUITOE	Quito, Ecuador	15
6	G	LIM	LIMAPU	Lima, Peru	15
8	J	SNT	SNTAGO	Santiago, Chile	15
				SECONDARY STATIONS	
1	A	BPO	BPOINT	Blossom Point, Maryland	15
16	Q	JOB	JOBURG	Johannesburg, S. Africa	15
17	R	MOJ	MOJAVE	Goldstone Lake, California	15
18	S	OOM	OOMERA	Woomera, Australia	15

*Tape speed to be used after the first two weeks.

**Tape speed to be used for the first two weeks after launch.

Analog Tape Track Assignments

The standard analog tape reel to be used is 10-1/2 inches in diameter and holds 2400 feet of 1/2-inch wide magnetic tape.

Normal tape track assignments are listed in Table III. Alternate assignments are to be used if no diversity combiner is available, or if the diversity-combined data is found to be unsatisfactory. The output of the MOD-I Receiver

A will be recorded on track 3, and the output from the MOD-I Receiver B will be recorded on track 5 when alternate assignments are necessary.

Table III
Analog Tape Track Assignments

Track	Record Amplifier	Source	Signal
1	Direct	Multiplexed AGC and signal-conditioner clock signal from summary amplifier	dc and 14,400 square wave
2	Direct	Minitrack time-standard control track generator	60 cps, BCD 18.24-kc carrier
3	Direct	Output of signal conditioner	Conditioned PCM data
4	Direct	Minitrack time standard (SD)	10-kc reference frequency
5	Direct	Output from diversity combiner	PCM data
6	FM	Minitrack time standard	Serial decimal time
7	Direct	Audio amplifier or WWV, voice, commands	WWV, audio, code

Recording Procedure

In order that the analog tapes may be processed most efficiently and the highest accuracy may be assigned to the time computed and inserted with the data for experimenters, it is imperative that certain recording procedures be followed:

- Record two complete passes on each reel. These passes shall be separated by approximately 60 seconds running time to simplify later processing at GSFC.

- Record 2 minutes of low-speed (400 bits per second) data before sending the playback command. (More than 2 minutes is desirable, but the playback command shall not be delayed in an attempt to obtain so much low-speed data as to risk losing any of the 5 minutes of playback or the return of the low-speed signal.)

Mailing Instructions

All tapes and accompanying station log sheets shall be sent by airmail to:

Analog Tape Librarian, Code 545
Goddard Space Flight Center
Greenbelt, Maryland 20771

These tapes are to be received by GSFC within 10 days after recording at the station.

ANALOG TAPE HANDLING

Tape Receipt

Upon receipt, the magnetic tapes from the ground stations will be placed in the analog tape library. The information contained on the station log sheet will be punched into an analog card (see Figure 8). A chronological listing based on both analog and digital cards will be produced monthly to indicate the status of processing of data received. These lists will be sent to the OSO-B2 project manager and to Production Control. In addition to the monthly listing, Production Control will receive a weekly progress report.

Tape Evaluation

In each shipment, the last tape recorded by each station will be evaluated for recording technique and conformity to standards by the Tape Evaluation Group. The Network Operations Branch of the Network Engineering and Operations Division will be notified immediately of any gross anomalies detected. All stations will be rated weekly in a report sent to the head of the Operations Branch, Operations and Support Division.

Tape Storage

Analog tapes will be stored in the Central Processing Facility, GSFC, until the data contained on them have been processed. One month after the processed data are released to the experimenters, the analog tapes will be sent to the Federal Archives for dead storage.

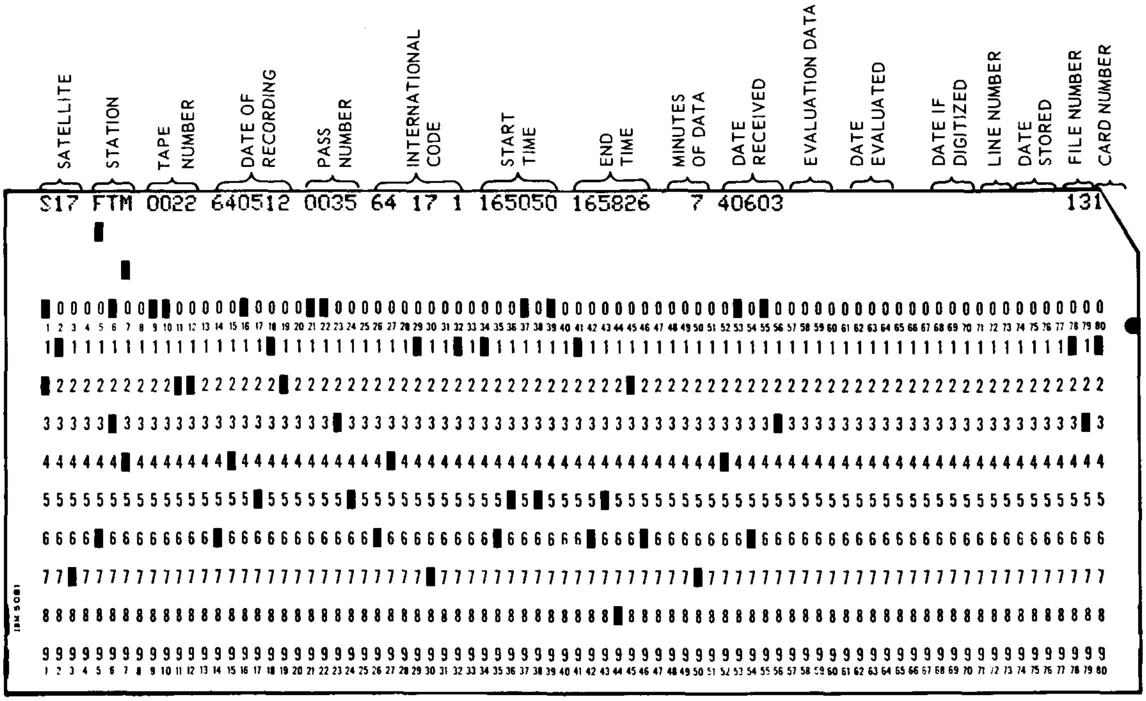


Figure 8-Analog Card

PRODUCTION CONTROL FUNCTIONS

Scheduling

Production Control (PC) is responsible for ensuring that data are processed in chronological order in three phases of the data-processing operation: analog-to-digital conversion, quality control and edit, and decommutation.

The only exception to the chronological processing will be the first 20 passes recorded at Fort Myers, Florida. These passes will be processed as received and sent as soon as possible to the experimenters.

After the satellite has been in orbit one month, the chronological processing of all passes will begin. Those original files from Fort Myers will be processed again starting with the editing. Attitude computation also will be repeated using the orbital data available at the time the attitude determination program is run.

Analog-to-Digital Conversion – Buffer tapes produced by the analog-to-digital conversion processing line must be chronological by station. To meet this requirement, Production Control will prepare for the processing-line operators a list of analog tapes to be processed on a particular day. To assure that all passes recorded have been received, Production Control will compare the station-by-station chronological file maintained by the analog tape library with the cumulative telemetry reports. All buffer tapes will be numbered consecutively throughout the life of the satellite.

Quality Control and Edit – The buffer tapes, each being chronological by station, should next be scheduled by PC to undergo computer quality-control checking and editing. The edit tapes are to be chronological by time. A regular number of files constitutes a computer run for quality-control checking and editing; one run of approximately 225 files shall be made every 2 weeks, requiring about 4 hours on the UNIVAC 1107 computer. In this phase of the data processing, PC must assure that, starting with the oldest unedited file and continuing through the number of files desired in each run, all files recorded at the ground stations have been digitized. The computer program requires a deck of cards (run deck) in addition to the buffer tapes as input, as shown in Figure 7. Electronic Accounting Machines (EAM) personnel shall prepare for PC a duplicate of the analog card with the buffer file number punched in columns 53 and 54. The buffer file number will be found on the buffer log sheet kept by the operators at the processing line. These buffer cards (Figure 9) are sent to PC and later are to be sorted on pass number (columns 21-24) by an IBM 81 card sorting machine and included in the run deck behind the subcommutator positions card (Figure 10).

The next-tape-number card (Figure 11) will be used to initiate the consecutive numbering of edit tapes when the next run is made. If at the beginning of a quality control and edit run, a rerun card (Figure 12) rather than a next-tape-number card is encountered, the output is changed to one file per tape and the tape is given the number found on the rerun buffer card. This tape number was punched into the rejected-edit file card (Figure 13) by the computer when the file was rejected.

Decommutation – Production Control will schedule decommutation runs on the computer. The decommutation runs, each requiring about 4 hours, will be scheduled every 2 weeks. The edit tapes must be in chronological order by time for input to the decommutation program. Those edit tapes made from redigitized files (i.e., files rejected by the quality control program in an earlier run but later edited successfully) must be placed in proper sequence. The decommutation output card is shown in Figure 14.

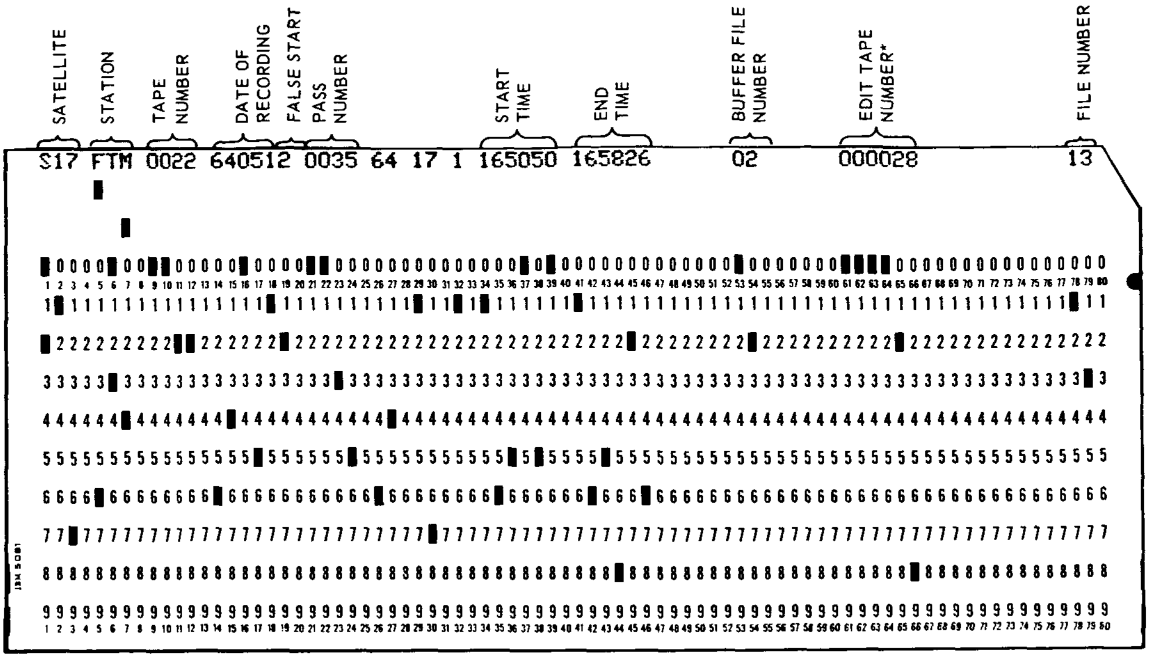


Figure 9-Buffer Card

*This field is used only after a file has been rejected and redigitized.

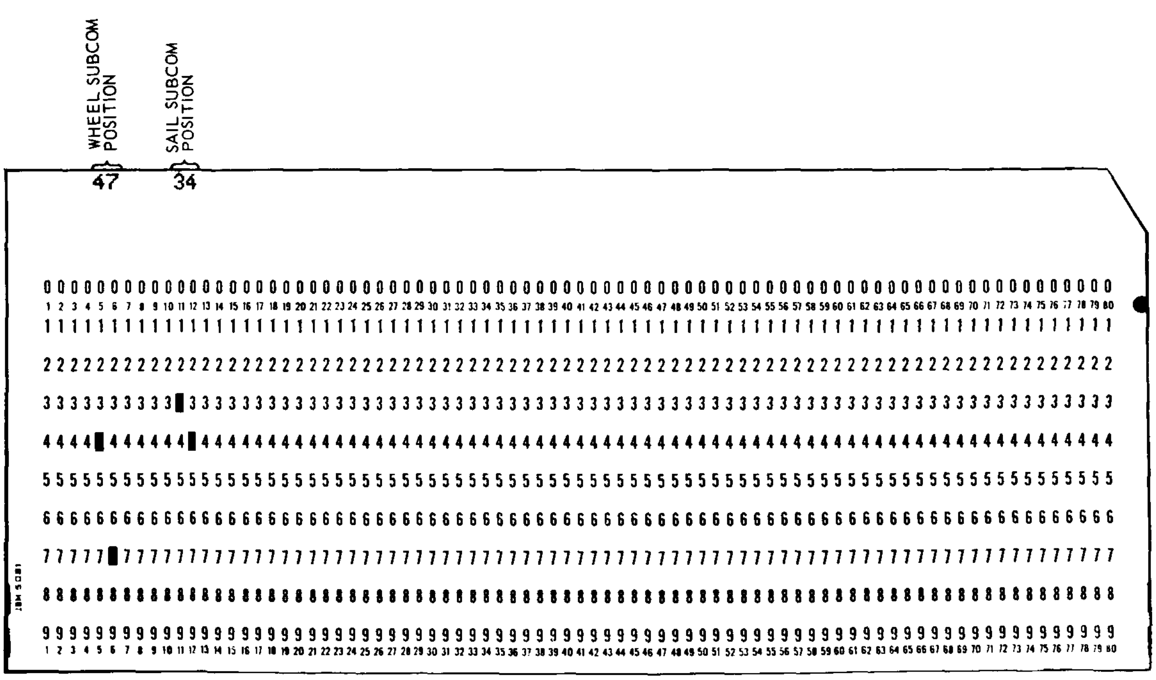


Figure 10-Subcommutator Positions Card

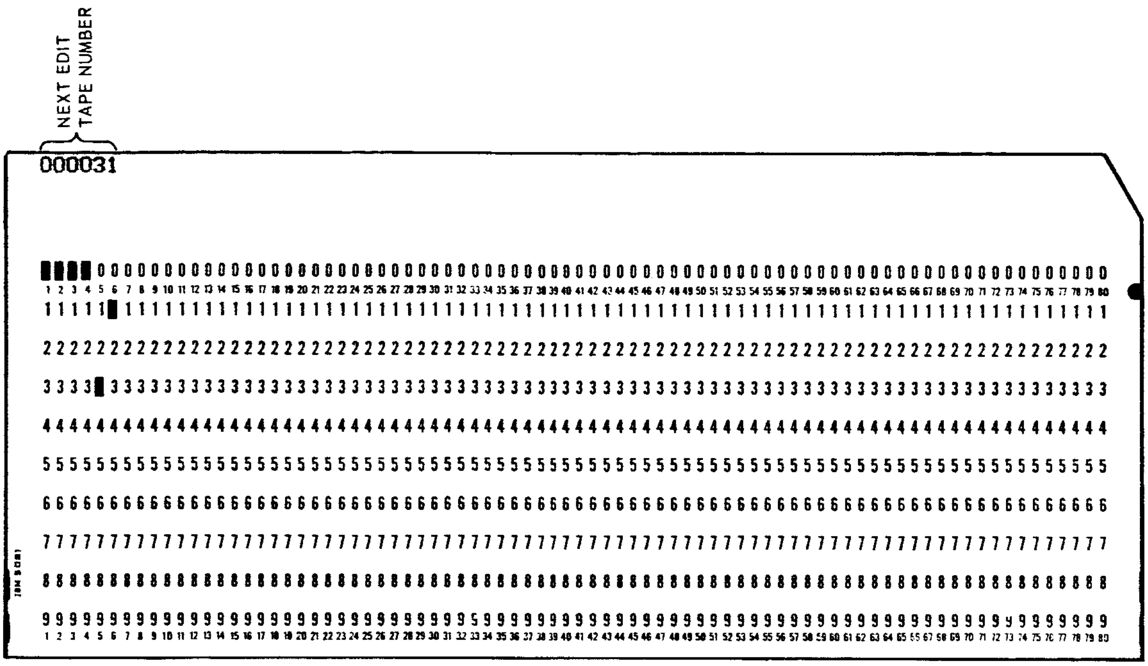


Figure 11-Next-Tape-Number Card

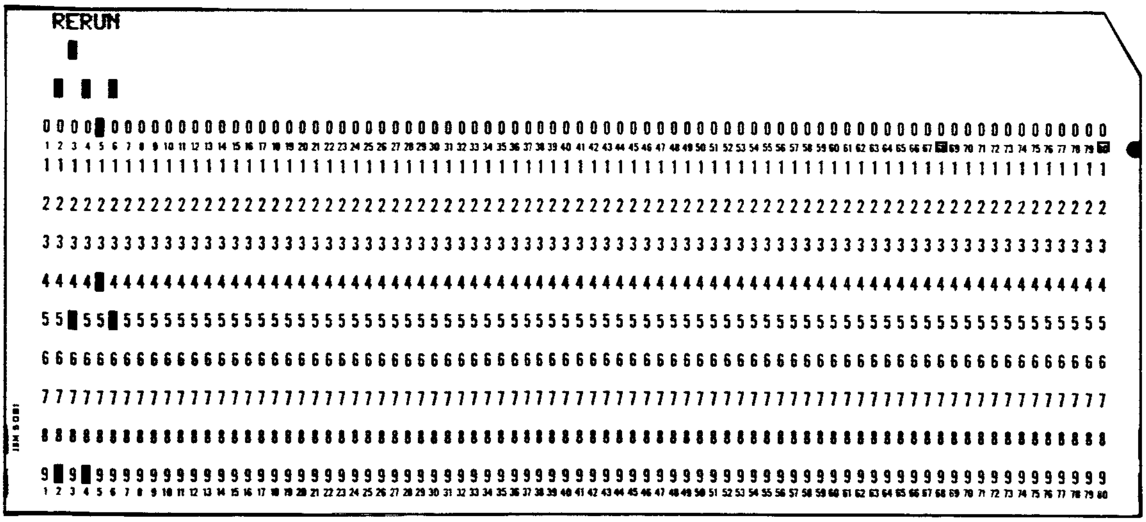


Figure 12-Rerun Card

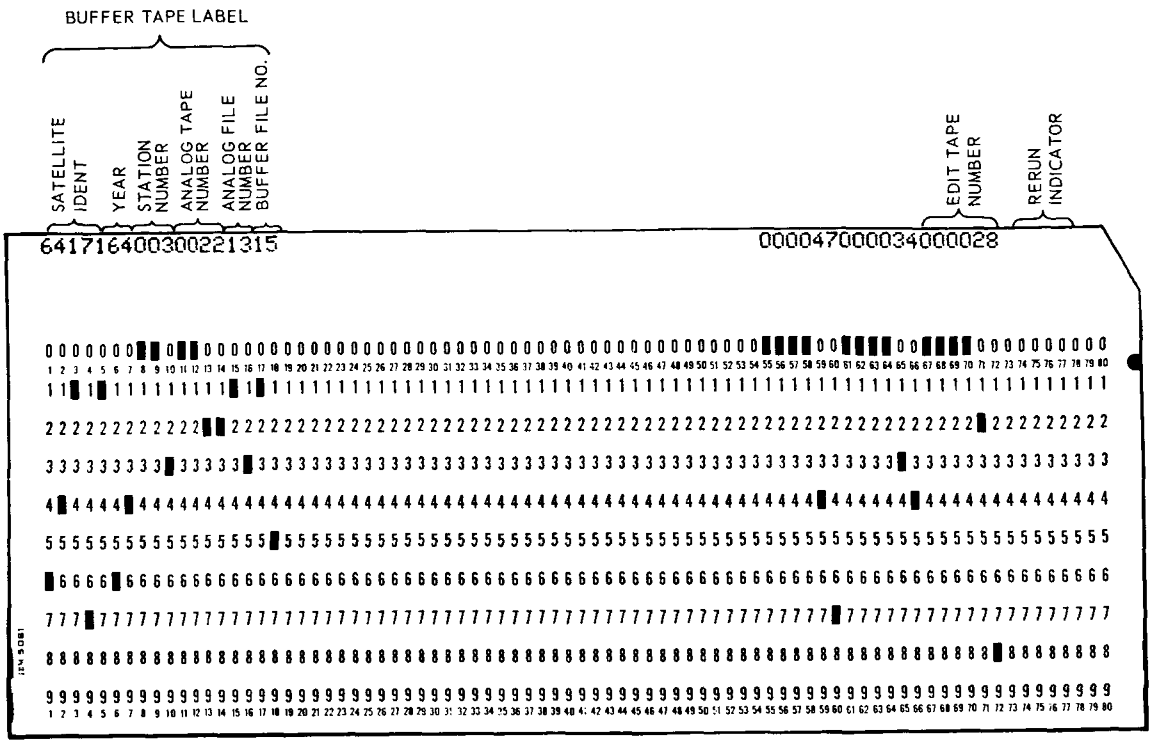


Figure 13-Rejected-Edit-File Card

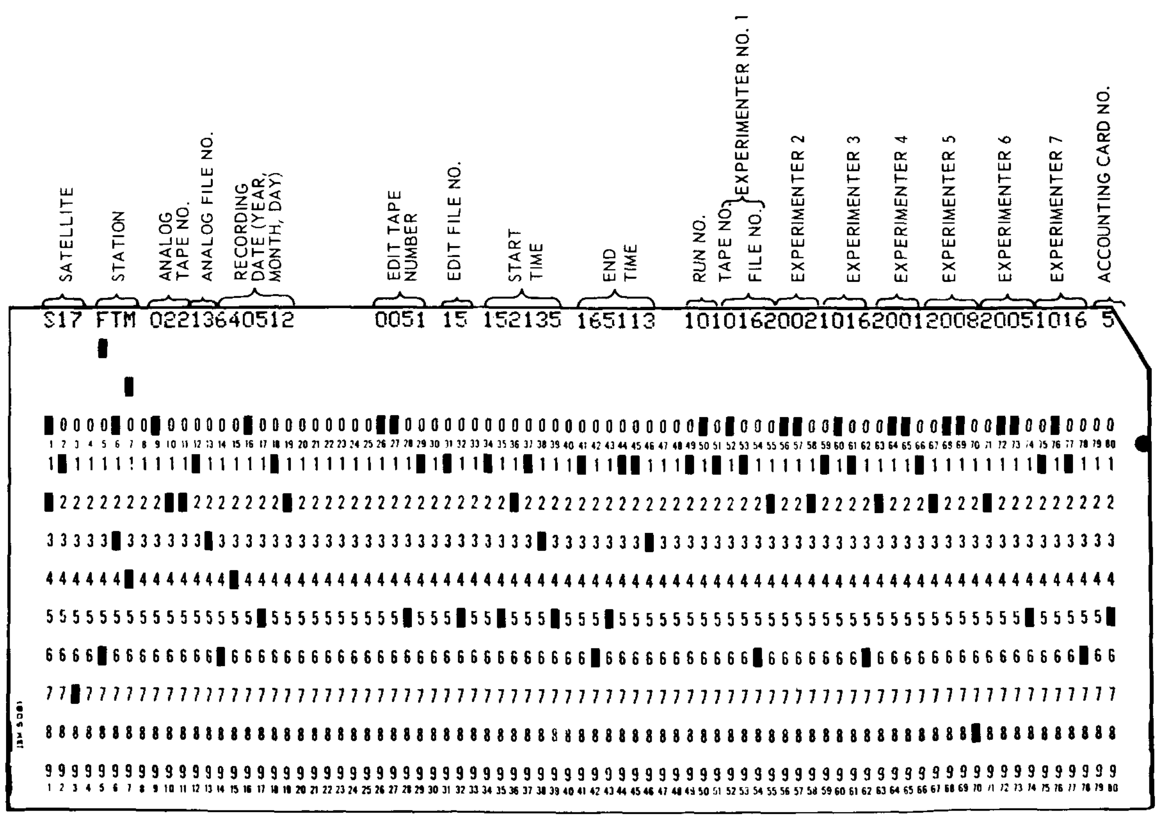


Figure 14-Decommutator Card

Records

Production Control will store in the digital library all cards punched for and by the computer, including edit cards (Figure 15), next-tape-number cards, and rejected-edit file cards, duplicated analog cards, and the buffer cards.

ANALOG-TO-DIGITAL CONVERSION

Description of the Processing Line

Analog tapes with tracks as described in "Analog Tape Track Assignments" must be converted into digital format for digital computer processing (Figure 16). The signal from a data track is fed into the PCM signal processor where the waveform is reconditioned. After bit synchronization is established in the bit synchronizer, the search is begun for the 16-bit frame-sync word. After a 16-bit word conforming to the expected sync word is found, it must be verified by appearing five consecutive times in the proper location with no more than one

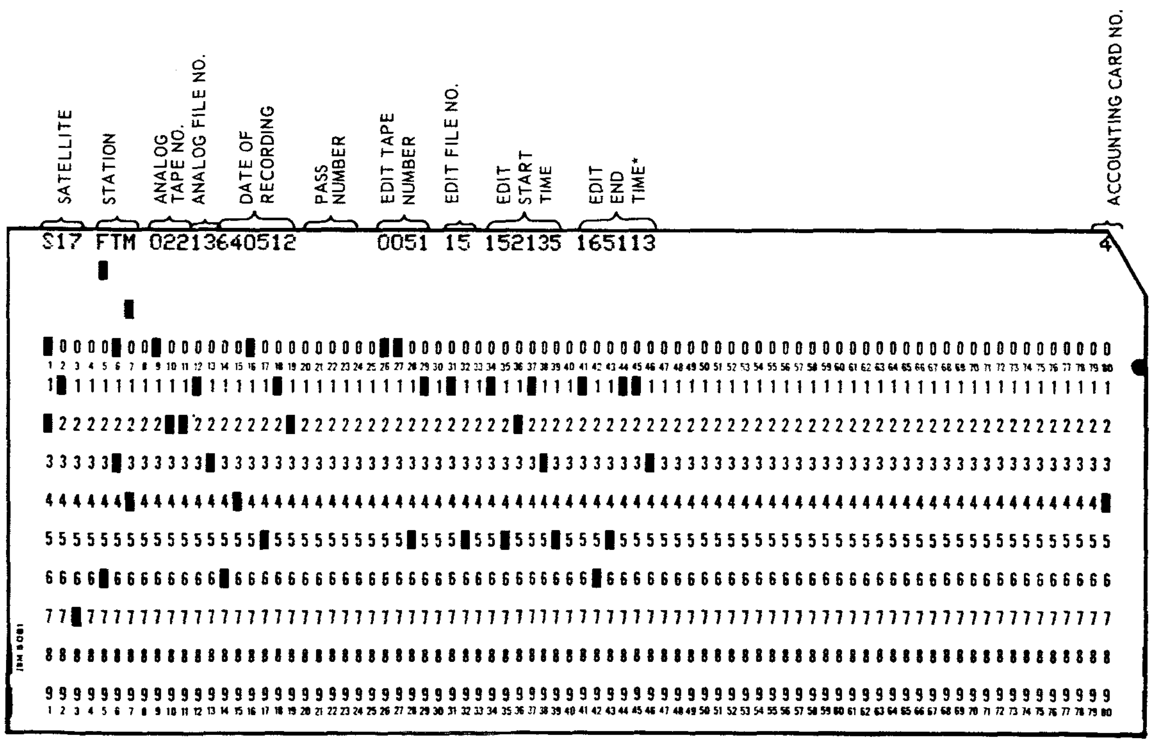


Figure 15-Edit File Card

*Columns 1-46 are output from quality control program.

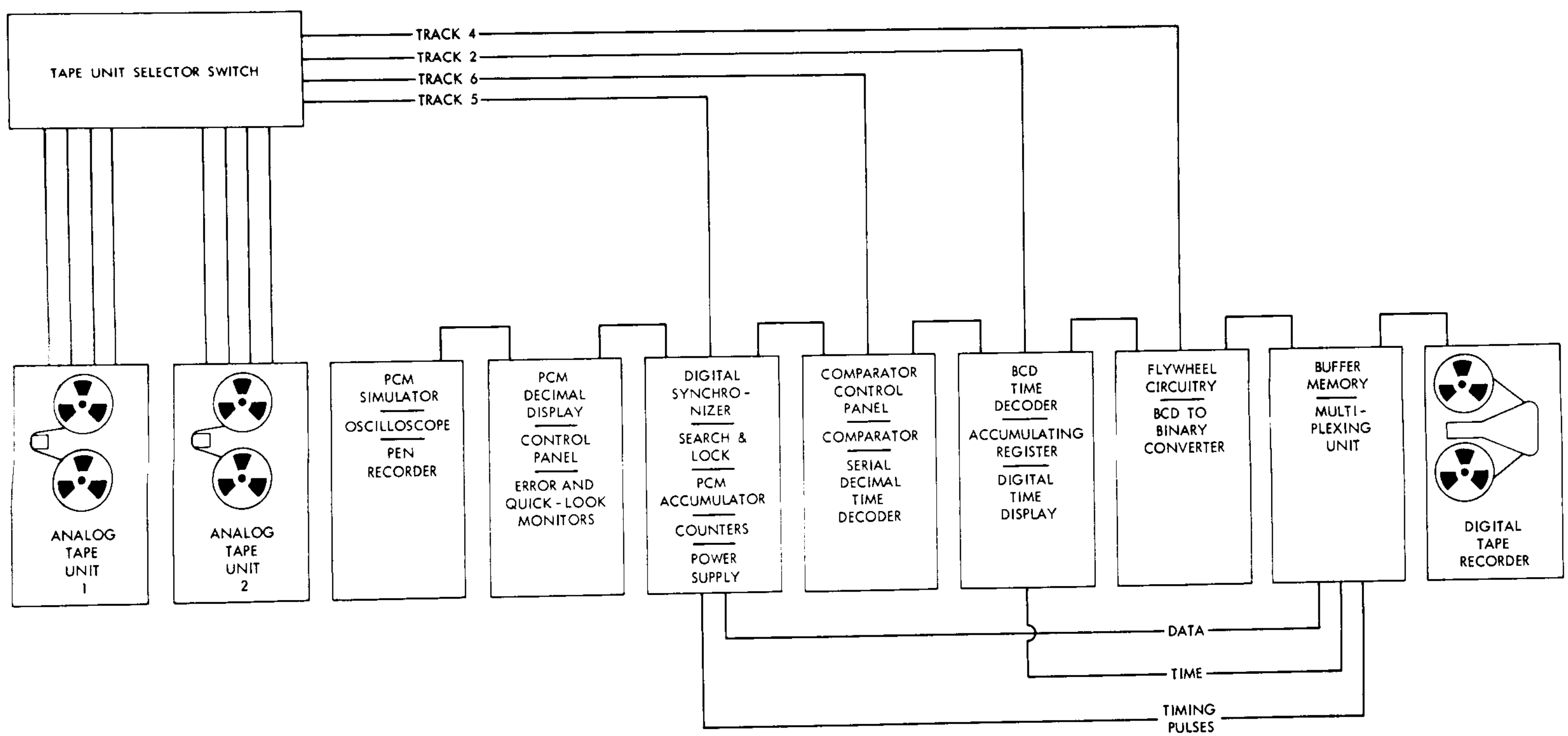


Figure 16–Analog-to-Digital Processing Line

bit error per sync pattern. The proper location within the frame is decided by starting the word counter assuming the first appearance of the sync word to be correct. If the 16-bit word is found at some location other than the expected one, the process is repeated using the most recently located 16-bit word as the starting point. Once frame sync is established, 3744-character buffer records are written. Both time codes (binary-coded decimal and serial decimal, tracks 2 and 6 respectively) are decoded. A calibrated tracking oscillator is used to update the accumulator which in turn is compared periodically against both time standards. The input to this oscillator is a 10-kc reference frequency recorded on track 4. An elaborate system of flags is generated by the line which, if properly analyzed, indicates the quality of the time recorded on the buffer tape. (These flags are used in the quality control and edit program to facilitate the time computation.)

Special Operating Procedures

Operating instructions for the general operations of the processing line are found in the instruction manual, but the following instructions are emphasized:

- Special care shall be given to digitize a maximum amount of the real-time (low speed) data preceeding the playback (high speed) portion of each file. Low-speed data which may follow the high-speed data are not to be digitized.

- The DATA PRESET/DELETE switch should be used only at the beginning of a file except as indicated below. Using this switch within a file will result in an undetectable error in the time computation.

- Any files terminated by the operator for the purpose of beginning again must be followed by an end-of-file mark and be indicated on the buffer log sheet as a false-start file.

- Special care should be taken that only one end-of-file mark is written following a file, since two end-of-file marks are interpreted by the computer programs to mean the end of the data on the reel.

- In order to make use of the speedup capabilities of the processing line without loss of data due to operator reaction time, real-time data should be digitized at the most desirable speed. When playback data appear, the bit synchronizer will go into search. Before the bit synchronizer is adjusted to accept the high-speed data, the DATA PRESET/DELETE button should be set to DATA DELETE and then the bit synchronizer adjusted to the high-speed data. Next the analog tape deck must be stopped and the tape rewound into the real-time data. Restart the analog tape forward at the speed desired for the high-speed data and press DATA PRESET while the low-speed signal is coming through.

Buffer Tape Format

Each buffer tape may have up to 18 files. Each file is made up of approximately 200 records; each record contains 48 frames. There are three types of buffer records, as follows:

The first type of buffer record is the first written following verification of the frame-sync pattern. In this record (which does not differ from the other types as far as buffer-frame format is concerned), the subcommutator positions are not known. When the subcommutator positions are found, this initial record is filled to its full length with zeros and the second type of record will follow.

The second type of record is the most common. This is written starting with wheel subcommutator position No. 48 (subcom sync word) in the first frame of the record.

The third type of buffer record occurs when the processor loses bit synchronization and data flow to the buffer stops. These records will be filled with binary 16's in every character from the last of the data to the end of the record.

In all records, the buffer frame is built by multiplexing: (a) the ground-station recording time, (b) the first 30 channels from the telemetry main frame, (c) a special flag word, and (d) the satellite frame-sync word, in that order. The special flag word, formed and inserted by the processing line, speeds up the computer processing which follows analog-to-digital conversion.

DIGITAL COMPUTER OPERATIONS

Edit and Quality Control Program

The edit and quality control program will divide the processing of data into two major phases as shown in Figure 17. In Phase I, the proper file for input is selected, data and buffer-record formats are verified, and the calculations are made which are necessary for determining the actual time of word one in each telemetry frame. In Phase II, the data are formatted into 96-frame edit records, the sync word is inspected for bit errors, universal time is inserted, and the edit tapes are written.

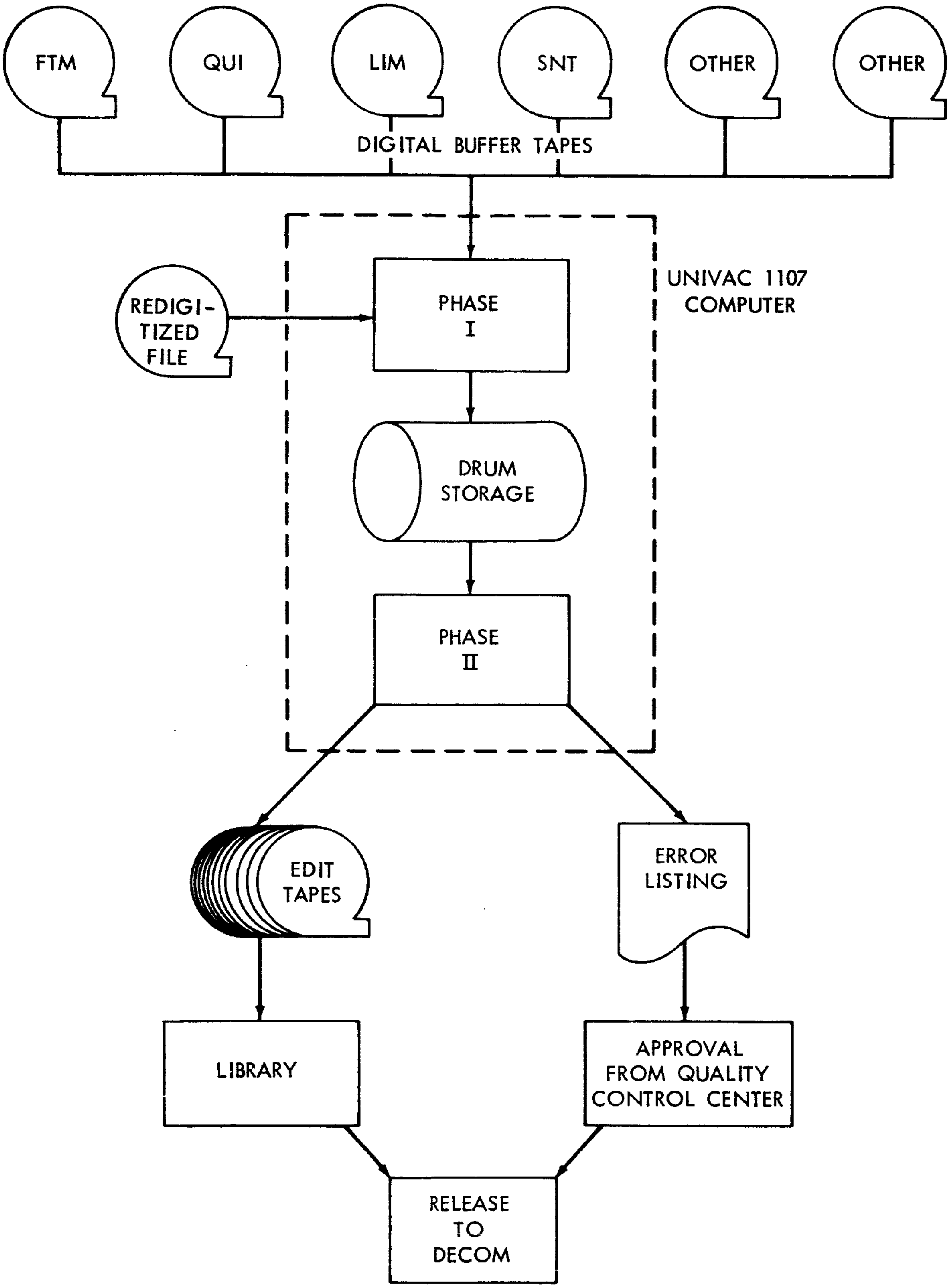


Figure 17-Quality Control Program

Phase I – The analog-to-digital processing line produces buffer tapes containing files in chronological order by station, each file representing the data collected during one pass of the satellite over that station. To produce edit tapes with files in chronological sequence, the buffer files must be called for in their proper order. The computer compares the chronologically arranged buffer cards with the internal file labels on the buffer tape, thereby selecting the files for input in chronological order. (See Figure 9 and Figure 18 for formats of the buffer cards and the buffer tape file labels.)

SATELLITE IDENTIFICATION NUMBER	YEAR	STATION NUMBER	STATION TAPE NUMBER	ANALOG FILE NUMBER	BUFFER FILE NUMBER
1 5	6 7	8 10	11 14	15 16	17 18

Figure 18-Buffer Tape Label Format

Each buffer record of each file will be inspected for format errors. This includes verifying the flags as well as the proper word, frame, and record lengths. Each buffer file will also be tested for possible sticking bits. If a zero or one bit remains unchanged in every telemetry data point of a record, the file will be rejected and redigitized.

When a file is rejected, a special-format edit card (Figure 13) will be punched by the program to give the rejected file a tape number. This number must later be included on the buffer card when the redigitized file is to be reprocessed. Production Control personnel shall schedule this process.

In Phase I, the preliminary calculations are made for determining the universal time of the data. The "one's" generator in the OSO-B2 spacecraft produces a burst of one's, referred to as a benchmark, followed by the execution of playback command. Two time benchmarks are expected to appear in each buffer file, the first at the end of real-time data and the second at the end of playback data. If either or both of these benchmarks are missing, an alternate method of time computation must be used; only one time computation method shall be used throughout the file. Since there are different uncertainties associated with different methods of time computation, a code indicating the uncertainty will be placed in the file label and a letter containing a description of these accuracy codes will accompany the first experimenter tapes mailed.

<u>Phase II</u> – Every sync word will be inspected for bit errors. If more than one bit error is found within the sync pattern, every data word in the frame will be flagged as questionable data (see Figure 19). The questionable data flag consists of a one bit in the 29 bit of data word. The sum of all sync bit errors per 96 frames and the sum of all sync bit errors accompanying questionable data

1	2	3	4	5	6	7	8	9	10	11	12	1 (DATA)	2 (DATA)
P	P	P	P	P	P	P	P	P	P	P	P*		
E	2^5	F	2^5	0	2^5	0	0	2^{23}	2^{17}	2^{11}	2^5		
G	2^4	0	2^4	0	2^4	0	0	2^{22}	2^{16}	2^{10}	2^4		
2^9	2^3	2^9	2^3	0	2^3	0	0	2^{21}	2^{15}	2^9	2^3		
2^8	2^2	2^8	2^2	2^8	2^2	0	2^{26}	2^{20}	2^{14}	2^8	2^2		
2^7	2^1	2^7	2^1	2^7	2^1	0	2^{25}	2^{19}	2^{13}	2^7	2^1		
2^6	2^0	2^6	2^0	2^6	2^0	0	2^{24}	2^{18}	2^{12}	2^6	2^0		

←TAPE MOTION—

CHARACTER	DESCRIPTION
1	(E) = 1, Time discontinuous between this 96 frame record and the next. (G) = 1, This is the flag-time field indicator and is always a one bit.
1 - 2	Total sync word bit errors in this 96 frame record.
3	(F) = 1, Dummy data in this 96 frame record.
3 - 4	Count of sync bit errors from the frames with more than one bit error in the sync word. (Totaled for 96 frames)
5 - 6	Day count of year.
7 - 12	Milliseconds of day.

*P = Lateral Parity

Figure 19- Twelve-Character Flag and Time Field

will be repeated in each of the ninety-six 12-character time-flag fields of the edit record. Also included in this field will be a flag to indicate if dummy data was inserted in the edit record and another flag to indicate any time discontinuity between the end of the current record and the beginning of the next output record. Figure 19 shows the location of these flags within the flag field.

The time (in universal time) the first data word of each frame began will be inserted into each of the edit records. Errors due to the delay in transmission of universal time from WWV to the respective stations will be corrected. See Table IV for a list of the corrections to be applied by the program.

Table IV
WWV Time Transmission Delay

Three-Letter Code	Location	Milliseconds Correction
BPO	Blossom Point, Maryland	1
FTM	Fort Myers, Florida	6
QUI	Quito, Ecuador	16
LIM	Lima, Peru	20
SNT	Santiago, Chile	29
JOB	Johannesburg, South Africa	46
MOJ	Goldstone Lake, California	13
OOM	Woomera, Australia	59

To preserve data format and to maintain time consistency throughout an edit record, dummy data will be inserted where the data signal recorded at the ground station was obscured by noise. The dummy data is described under "Experimenter's Data Tape."

Each edit record contains four cycles of the wheel subcommutator and six cycles of the sail subcommutator. The relative position of the subcommutators within the edit record will remain fixed throughout the life of the satellite, unless the telemetry is turned off, in which case a new relationship is established between the wheel and sail subcommutators; the experimenters may recognize this change by inspecting the file label (characters 39-42).

Edit tapes will be numbered by the program in consecutive order throughout the life of the satellite. The program also will instruct the computer operator, by way of the console typewriter, to identify the completed edit tape with an external label. This label will show the OSO-B2 edit-tape number, the number of files included, the date of editing, and the density and parity of the tape. Rejected files later found capable of being processed will be inserted in their proper position in the chronological sequence before decommutation. The format of cards to be used for input to and output from the edit and quality control program are shown in Figures 9 through 14. Limiting the number of files per tape to 20 assures that all files will be completed on the original tape.

After each edit file is completed, a quality and housekeeping listing is printed, including: percent of frames lost; beginning time of playback data, end time of playback data, and elapsed time (all in hours, minutes, and seconds); total number of sync bit errors; and total number of sync bit errors in flywheel frames (questionable data).

Also associated with each edit file output is an edit card, formatted to Production Control's specifications. (See Figure 11).

A concise summary listing will be printed at the end of each computer run, as shown in Figure 20. The listing will include action taken on every buffer file interrogated. For every file edited, the edit file label and percent of data out of sync are formatted for readability. When files are rejected by the program, a brief message stating the reason will be given in the portion of the listing usually devoted to edit information.

Decommutation Program

The decommutation process produces experimenter tapes from the edit tapes. The basic output is one data record for each experimenter from each 96-frame edit record. The experimenter may request any arrangement of both experimenter data and necessary subcommutated data from that 96-frame edit record. In most cases, more than one of these experimenter records are written without the usual intervening gaps, thus producing longer tape records and achieving higher tape utilization.

The number of files included on each experimenter tape is given in Table V, page 28. Since the unit of importance is a file and not a tape, summary labels will not be written on experimenter tapes. Each file will be labeled as shown in Figure 21. Each reel of tape mailed to the experimenter will be labeled with the following information: satellite name, experimenter's name, decommutation run number, experimenter's tape-sequence number from this run, and the number

THE NEXT EDIT TAPE NUMBER TO BE USED IS - 3

S-17 QUALITY CONTROL AND EDIT SUMMARY
25 JAN 65

SATELLITE IDENT	YEAR	BUFFER LABEL STATION NUMBER	BUFFER LABEL STATION TAPE NUMBER	BUFFER LABEL ANALOG FILE NUMBER	BUFFER LABEL BUFFER FILE NUMBER	EDIT LABEL DAY COUNT YEAR	EDIT LABEL FRAME PERIOD	EDIT LABEL TIME COMP FLAG	EDIT LABEL START TIME (SEC)	EDIT LABEL END TIME (SEC)	EDIT LABEL SUBCOM ITEM IN WORD 2	EDIT LABEL SUBCOM ITEM IN WORD 8	EDIT LABEL EDIT FILE NO	EDIT LABEL EDIT TAPE NO	PERCNT DATA LOST
65171	65	003	0021		01	122	943	1	38112	43327	47	17	01	0001	02.9
65171	65	003	0021		02	122	929	1	45269	46702	47	17	02	0001	02.1
65171	65	008	0016		01	122	896	1	48942	54126	47	17	03	0001	02.1
65171	65	006	0036		01	122	935	1	54311	59530	47	17	04	0001	02.2
65171	65	005	0003		01	122	940	1	59705	64927	47	17	05	0001	02.3
65171	65	006	0036		02	122	933	1	66870	7030[illegible]	47	10	01	0002	02.1
65171	65	008	0016		02	122	896	1	70506	75705	47	10	02	0002	56.4
65171	65	008	17		03	122	913	1	77694	81126	47	10	03	0002	02.1
65171	65	005	0003		02	122	927	1	81272	00092	47	10	04	0002	02.3
65171	65	006	0037		03	123	927	2	[illegible]	00000	47	10	05	0002	02.0
65171	65	003	0023		03	123	927	2	16540	00000	47	10	06	0002	02.4
65171	65	003	0023		04	123	927	2	21894	00000	47	10	07	0002	04.4
65171	65	006	0037		04	123	931	1	27274	32494	47	10	08	0002	02.1
65171	65	008	0017		0	124	9[illegible]2	1	48997	54098	47	10	09	0002	21.3

Figure 20-Quality Control and Edit Summary List

BINARY CODED DECIMAL TAPE CHARACTERS

SATELLITE IDENT. NUMBER	YEAR	STATION NUMBER	STATION TAPE NUMBER	ANALOG FILE NUMBER	BUFFER FILE NUMBER	DAY COUNT OF YEAR	REAL-TIME FRAME PERIOD	TIME ACCURACY CODE	START TIME (Sec.)	END TIME (Sec.)	EXPERIMENTER'S	WHEEL SUBCOM POSITION IN WORD 2	SAIL SUBCOM POSITION IN WORD 8	EDIT FILE	EDIT TAPE NUMBER
1 … 5	6 7	8 … 10	11 … 14	15 16	17 18	19 … 21	22 … 24	25	26 … 30	31 … 36	37 38	39 40	41 42	43 44	45 … 48

THIS 48-CHARACTER FORMAT SHALL BE FOLLOWED BY BINARY ZEROS REPEATED UNTIL THE FILE LABEL RECORD IS THE SAME LENGTH AS THE CORRESPONDING EXPERIMENTER'S DATA RECORD.

Figure 21—Format of Experimenter's File Label Record

of files written on the experimenter's tape. The computer operator will be instructed by the console typewriter to write this information on a label and to attach the label to the tape on the particular channel and unit assigned to the experimenter.

Analysis Programs for Goddard Experimenters

In addition to the data processing discussed throughout the remainder of this document, data from two GSFC experiments will be analyzed using programs designed and written under the supervision of Data Processing Branch personnel. These programs will provide the experimenters with a display of the data acquired by their respective experiments in such a manner that their study of the data and final conclusions may be accomplished readily.

Attitude-Determination Program

In order that attitude information be as accurate as possible, the initial computations will be delayed to at least one month after launch. This will permit an accumulation of a large sample of magnetometer data to be used in the attitude computation. Since the hour-by-hour variations in the spin-axis orientation solution are large and range from a couple of degrees to no solution at all when the sun vector and the local magnetic field vector are nearly parallel, the roll-angle error is computed and included in the tape. The computed attitude will be merged

Table V
Attitude Orbit Tape Summary Label

Word No.	Symbol	Function	Units
1.	–	Identification (Satellite)	–
2.	–	Year	–
3.	–	(Beginning of First	Day Count
4.	–	(Orbit on This Tape	Milliseconds of Day
5.	–	(End of Last Orbit on	Day Count
6.	–	(This Tape	Milliseconds of Day
7.	–	Number of Records/Tape	–
8.	–	First Orbit Number	–
9.	–	Last Orbit Number	–
10-500	–	Spares	–

NOTE: All data is represented in floating point form.

with an orbit provided by the Systems and Analysis Section yielding a tape consisting of a tape label, orbit label, and data records. The contents of the OSO-B2 attitude-orbit tape is given in Tables V, VI, and VII. The attitude-orbit tapes (like the data tapes) will be binary and either high or low density.

FUNCTIONS OF THE QUALITY CONTROL GROUP

The Liability Control Group shall have the responsibility of assuring that the tapes produced for the experimenters by the Data Processing Branch contain the proper information. To do this, Quality Control must check and approve the edit tapes before they are decommutated as well as check the output of the decommutation run. The duties of Quality Control are:

Quality Control and Edit Program Output Check

- To verify that the files processed were in chronological order without any skips other than file rejections listed in the summary list.

Table VI
Orbit Label

Word No.	Symbol	Function	Units
1.	–	Orbit Number	–
2.	–	Orbit Start Time	Day Count
3.	–		Milliseconds of Day
4.	–	Orbit End Time	Day Count
5.	–		Milliseconds of Day
6.	Δt	Sampling Rate	Milliseconds
7.	–	Identification (Satellite)	–
8.	–	Year	–
9.	–	Eclipse Start[1]	Day Count
10.	–	Time	Milliseconds of Day
11.	–	Eclipse End[1]	Day Count
12.	–	Time	Milliseconds of Day
13.	–	Next Orbit Eclipse[1]	Day Count
14.	–	Start Time	Milliseconds of Day
15.	–	Next Orbit Eclipse[1]	Day Count
16.	–	End Time	Milliseconds of Day
17.	–	Time of Minimum Pointing	Day Count
18.	–	Error	Milliseconds of Day
19.	Xx		
20.	Xy	Rollaxis (Min. Pointing Vector)	Unit Vector
21.	Xz		
22.	Yx		
23.	Yy	Pitch Axis (Min. Pointing Vector)	Unit Vector
24.	Yz		
25.	Zx		
26.	Zy	Yaw/Spin	Unit Vector
27.	Zz	Axis (Min. Pointing Vector)	
50.	–	Label Flag	
28-500	–	Spares	

NOTE: All data is represented in floating point form.
[1]Geometric shadow of an oblate earth (no atmosphere) with a point source sun.

Table VII
Attitude Data Record

Word No.	Symbol	Function	Units
1	t_i	Time	Day Count
2			Milliseconds of Day
3	p_x	Position Vector	Kilometers
4	p_y		
5	p_z		
6	v_x	Velocity Vector	Kilometers/Second
7	v_y		
8	v_z		
9	ϕ	Geocentric Coord. Latitude	Degrees
10	λ	Geocentric Coord. Longitude	Degrees
11	h	Ht above Spheroid	Kilometers
12	s_x	Solar Vector	Kilometers
13	s_y		
14	s_z		
15	L	McIllwains Parameter (Mag Coord.)	Earth Radii
16	B	Field Strength (Mag Coord.)	Gamma
17	RA	Right Ascension (Mag Coord.)	Degrees
18	DEC	Deliniation (Mag Coord.)	Degrees
19	SR	Spin Rate (Channel 36 Wheel Subcommutator Readout	RPS
20	α	Pitch Angle	Radians
21	ρ	Roll Angle	Radians
22	$\Delta\rho$	Roll Angle Error	Radians
23	x_x	Roll Axis	Unit Vector
24	x_y		
25	x_z		
26	y_x	Pitch Axis	Unit Vector
27	y_y		
28	y_z		
29	z_x	Yaw/Spin Axis	Unit Vector
30	z_y		
31	z_z		
32-49		Spares	
50		End of Record Flag (Last Item of Record Only)	
51-500		Nine Additional 50-word Items	

- To verify that each time a new subcommutator relationship is found, the file containing the new relationship is written on a new edit tape – (This new edit tape will be the first tape of a decommutation run.)

- To record the speedup ratio-vs-day count – (This count is given in the edit output list.)

Decommutation Program Output Check

- A decommutation run is to be made with any new decommutation format requested by the experimenter. The input should be a special edit tape which will be a computer-program generated tape with characters such that when it is decommutated, the output can be readily checked by Quality Control against a listing of each experimenter's data tape format to ensure agreement.

EXPERIMENTER DATA TAPES

Each decommutated tape provides the experimenter with the data acquired by his experiment plus any necessary subcommutated data. Experimenter data will be on one-half inch wide magnetic tape written in binary tape characters (odd parity) with either 200 or 556 six-bit characters to the inch, as requested by each experimenter. Each eight-bit telemetered word shall be represented by two six-bit characters. Four zeros shall preceed the first (2^7) and second (2^6) highest order bits in the first character and the six low-order bits go in the second character.

0	2^5
0	2^4
0	2^3
0	2^2
2^7	2^1
2^6	2^0

Where the four zeros preceed the high order bit (2^7).

Each ground-station readout period will constitute a file. The experimenter's file label will have the same number of characters as the corresponding experimenter's data record. The format for the experimenter's file label is shown in Figure 21 as it will appear on the data output tapes. The field labeled "experimenter number" (characters 37 and 38) will identify the experiment data on the particular tape according to the following numbers:

01 - NRL-TAC	06 - Minnesota
02 - GSFC-Frost	07 - NRL-RT
03 - Harvard	08 - NASA-Ames
04 - GSFC-Hallam	09 - GSFC-Attitude
05 - New Mexico	10 - Ball Brothers Research Corp.

The other 46 characters of the label will be the same for all experiments.

For the purpose of illustration, it is assumed that an experimenter receives data records containing the data from only 96 main telemetry frames. The experimenter's 96-frame data tape record is subdivided into four parts: Part 1 contains universal time. Part 2 contains the main-frame data from 96 main telemetry frames. Part 3 contains wheel subcommutator words. Part 4 contains sail subcommutator words. In Parts 3 and 4, requested subcommutator words are from the same time period covered in Part 2. Obviously, if subcommutator words are not requested from one of the subcommutators, there would be only three parts to the record. These parts may be re-arranged within the tape record if requested by the experimenter.

Part 1	Part 2	Part 3	Part 4	
Flags and Universal Time	Data from the 96 Main Telemetry Frames	Wheel Subcommutator Words	Sail Subcommutator Words	3/4-inch Tape Gap

The main-frame data words from 96 telemetry frames will be written following the time field, and may be arranged in any format desired. Parts 3 and 4 (containing the wheel and sail words) may also be arranged to suit the experimenter, but sequential readout is required if the times of occurrence are important.

The experimenter will receive fixed-length records even when a data dropout occurs. The length will be fixed by filling the data portion of the record with unique two-character dummy data words consisting of ones in the 2^0 to the 2^8 bit positions. (The good data words use only the 2^0 to 2^7 bit positions.) Because GSFC is guaranteeing fixed length records and continuous time throughout these records, the remainder of a record will have time and dummy data when data is missing for short periods of time. It will be possible to give the experimenters records in which time will be continuous from one record to the next for a very high percentage of the time, and to put dummy data in blocks as large as 191 frames. Should the data dropout be greater than 191 frames, there will be a time discontinuity between the two 96-frame records with some good data and the experimenters will not receive records containing only dummy data.

Along with the main-frame data will be the time field (universal time of the first word of the telemetry frame) and included flags (Figure 19). The subcommutator words hold permanent positions within the framework of each of the 96 telemetry main frames. Although the relative positions of these words in each subcommutator are known before launch, the timing of one subcommutator with reference to the other will not be known until after launch. After launch (when the subcommutator readout positions will be observed), the computation of the time for any subcommutator data words can be done by each experimenter. To compute this, the experimenter only need know which words from both of the subcommutators will be read out in the first frame of a record. This information will be included in the file label.

Since the end of a pass and the end of a data-tape record will probably never coincide, the last experimenter data record will have two kinds of dummy data in it. Should an experimenter desire multiples of the 96-frame records (six, for instance) and the end of pass occurs in the middle of the third 96-frame group, the third 96-frame group will be filled with the previously described dummy data and the fourth through sixth groups will have a second kind of dummy data. This end-of-pass dummy data shall have all ones in the 2^0 to 2^9 bit positions. These two-character dummy data words will be repeated to the end of the experimenter's record.

The experimenter may verify the presence of the flag time field in his data record by searching for the flag time field indicator. This indicator will be a one bit in the 2^4 bit position of the first character of the field. The end-of-pass dummy data always has a zero in this bit position distinguishing it from time which ordinarily occupies the same position of the record.

One end-of-file mark shall follow each file on the tapes. The last file on each experimentar tape is followed by two end of file marks signifying the end of the data on the reel.

Table VIII gives the maximum number of files to be written on the experimenter tapes.

Table VIII
Experimenter Tapes

Experimenter Name	No.	Maximum Number of Files	Density (Characters Inch)
NRL-TAC	01	150	556
GSFC-FROST	02	300	556
HARVARD	03	60	556
GSFC-HALLAM	04	300	556
LEAVITT	05	320	556
NEY	06	95	200
NRL-RT	07	90	556
NASA-AMES	08	2000	556
ATTITUDE	09	2000	556
BBRC	10	70	556

PUNCHED CARD SUMMARY

A. Analog Card – punched from ground station log sheet by EAM personnel (Figure 8).

B. Quality Control and Edit Run Cards

1. The proper order for run deck cards for normal run is:

   (a) Load Deck – independent of the data

   (b) Next-Tape-Number Card – produced by the previous run

   (c) Subcommutator Positions Card — produced by the previous run

   (d) Buffer Cards – duplicates of portions of the analog cards with the buffer file numbers based upon the buffer log sheets. One card is produced for each buffer file written on the buffer tape including any incomplete (false start) files (Figure 9). Buffer cards for false start files shall have a one punched in column 20 in addition to the usual information.

2. The output cards from quality control and edit program are:

(a) Edit Cards – One card is produced by the computer for each file edited (Figure 15). These become part of the records of PC.

(b) Rejected-Edit File Card – One card is produced by the computer for each file rejected in the quality control and edit program (Figure 13). This card is not used as input, but information from this card is added to a normal buffer card for a run after the file has been redigitized.

(c) Subcommutator Positions Card – One card is produced by the computer at the end of a run (Figure 10). This card is to be saved by PC and put behind next-tape-number card in the input deck for the next normal run.

(d) Next-Tape-Number Card – One card is produced by the computer at the end of a run (Figure 11). This card is to be saved by PC and inserted into the run deck as the first data card.

3. The proper order of run deck cards to process redigitized files is:

(a) Load Deck

(b) Rerun Card – Special card format to indicate a rerun rather than a normal quality control and edit run (Figure 12).

(c) Subcommutator Positions Card – Punched by EAM. One subcommutator positions card will preceed each deck of rerun buffer cards with identical subcommutator positions as found in columns 59, 60 and 65, 66 of the rejected-edit file cards.

(d) Rerun Buffer Cards – The edit tape number is added to a buffer card which is a duplicate of the original analog card (columns 61 to 66). The buffer file number in columns 53 and 54 is based upon the new buffer log sheet; the edit tape number is taken from the rejected-edit file card punched by the computer at the time the original buffer file was rejected.

C. Decommutation Run

1. The experimenter formats are included in the decommutation program and therefore do not require any input cards even though the

experimenter's format may change because of a change in telemetry. Should, however, the experimenter request a change in the contents of his tapes, the program will have to be changed.

The decommutation run will generate experimenter tapes for those experiments for which an assignment card (ASG) is included in the decom run deck.

2. Decommutator Output Cards – These cards are produced by the computer after each file is processed (Figure 14). The information contained on them identifies the source of the file and where the file may be found on each of the experimenter's data tapes. The decommutator run numbers will also be included.

TAPE DISPOSITION

One month after the experimenter tapes have been released by Production Control, the analog station tapes and the edit tapes will be transferred to Federal Archives and the buffer tapes will be erased.

The experimenter tapes will be mailed to the following addressees:

Dr. T. A. Chubb, Code 7120
Atmosphere and Astrophysics Division
U.S. Naval Research Laboratory
Washington 25, D.C.

Mr. K. J. Frost, Code 614
Building 2, Room 215
Goddard Space Flight Center
Greenbelt, Maryland 20771

Dr. Leo Goldberg
60 Garden Street
Harvard College Observatory
Cambridge, Massachusetts

Dr. K. L. Hallam, Code 614
Building 2, Room 215
Goddard Space Flight Center
Greenbelt, Maryland 20771

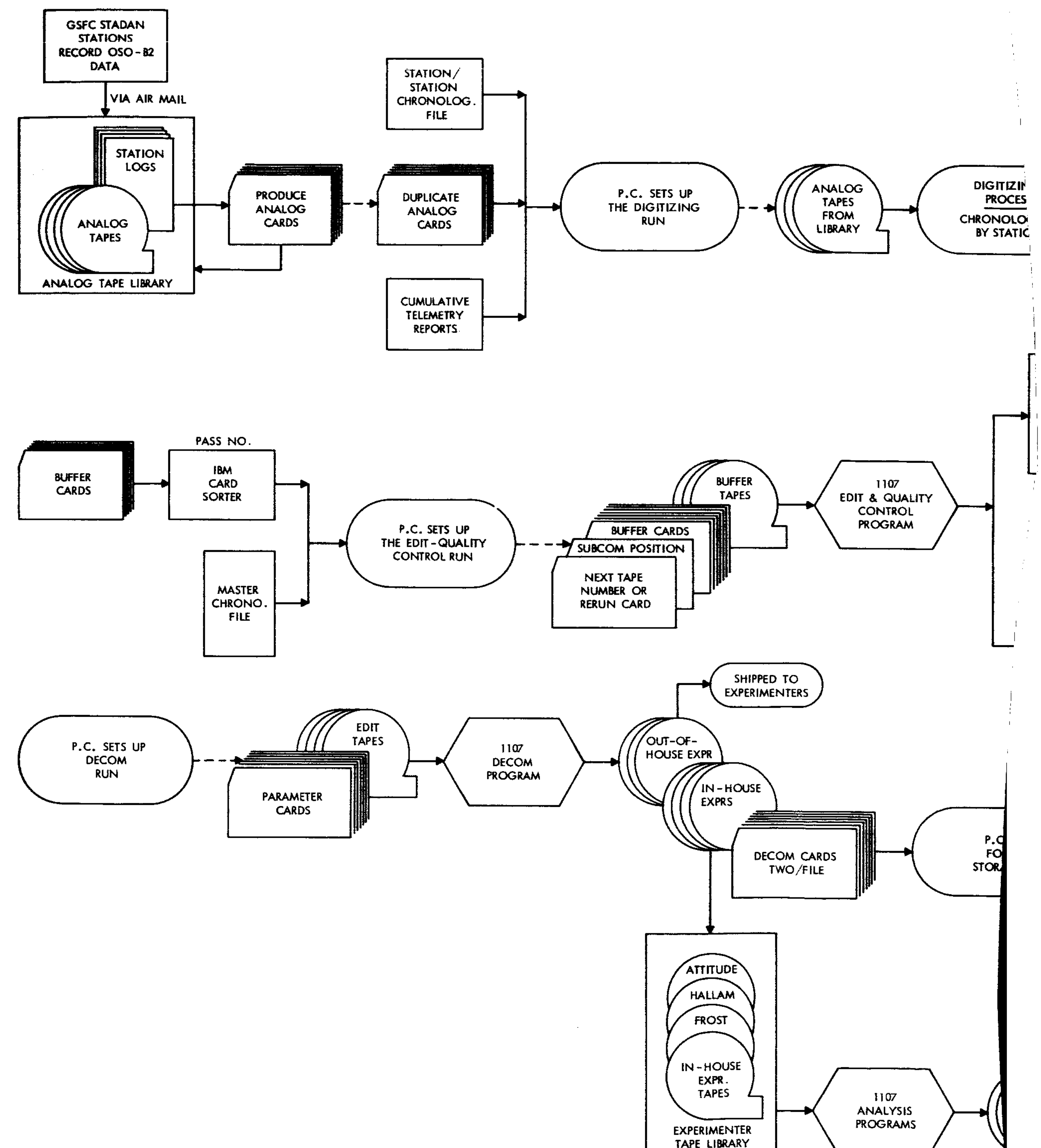
Dr. C. P. Leavitt
Department of Physics
University of New Mexico
Albuquerque, New Mexico

Dr. E. P. Ney
School of Physics
University of Minnesota
Institute of Technology
Minneapolis, Minnesota

Dr. Richard Tousey, Code 7140
Atmosphere and Astrophysics Division
U.S. Naval Research Laboratory
Washington 25, D.C.

Mr. Carr Neel
Ames Research Center
Moffett Field, California 94035

Mr. Tim Ostwald
Ball Brothers Research Corp.
Boulder Industrial Park
Boulder, Colorado



PRECEDING PAGE BLANK NOT FILMED.

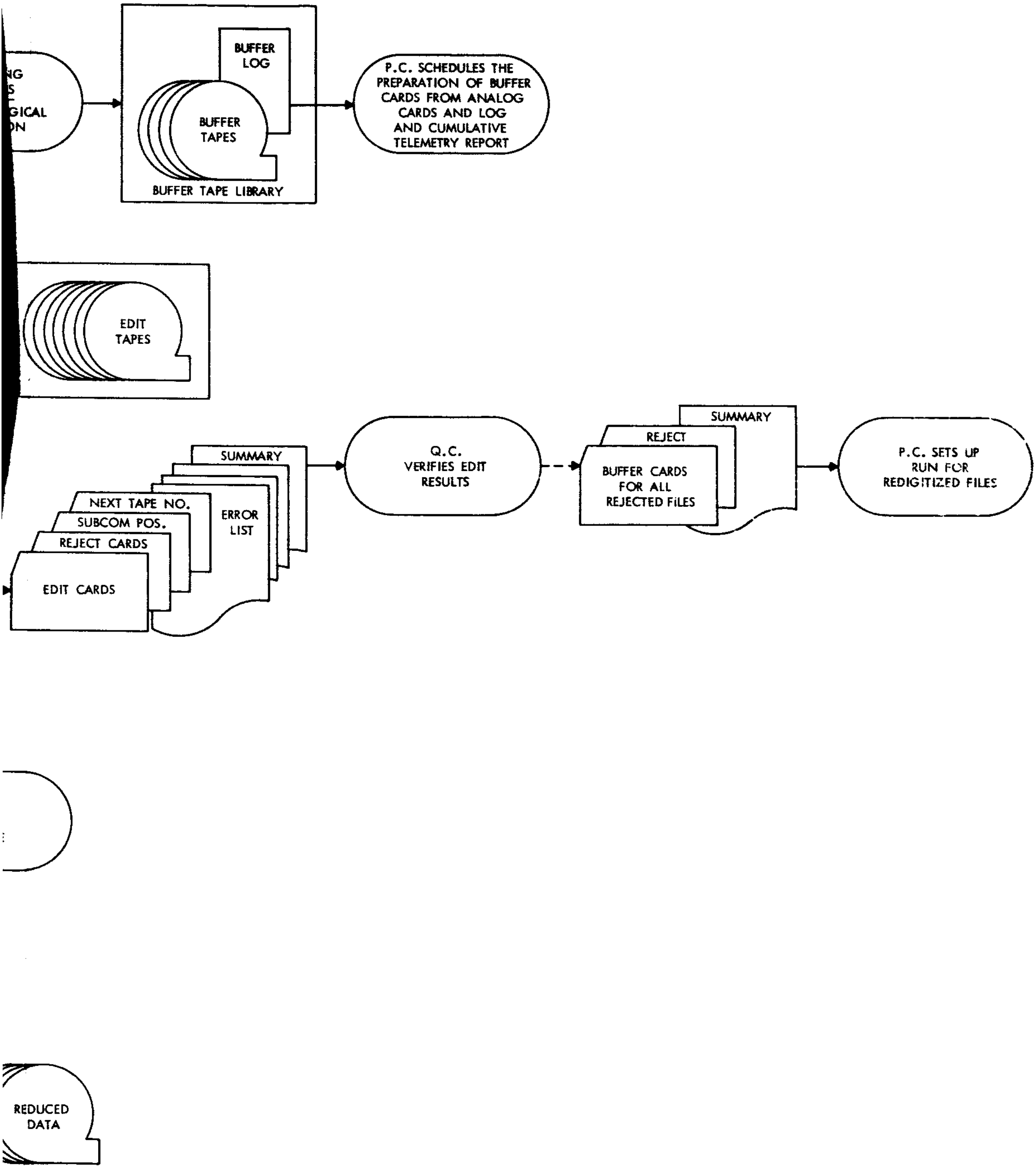


Figure 7-OSO-B2 Data Flow Chart [redacted]