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VEHICLE 2355 SYSTEM REPORT (U)

VOLUME III – FLIGHT PERFORMANCE

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LOCKHEED MISSILES & SPACE COMPANY

AC-04306
Volume III
31 March 1965

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VEHICLE 2355 SYSTEM REPORT (U)

Volume III - Flight Performance

Contract [redacted]
Supplemental Agreement Number 13

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FOREWORD

This report covers the span of time from the inception of the first satellite borne radar system through the final evaluation of the on orbit performance of the first flight. An objective review is attempted, of the complete scope of activities associated with bringing a new system into being and of the system performance during an essentially nominal and troublefree mission.

From this review, it is hoped that the systems management and program control parameters which were found to be effective may be properly recognized and thereby enhance the organization and conduct of similar future activities.

The system definition and resulting configuration is reviewed in retrospect, together with the problems associated with this Program development and testing.

The engineering management concept and the test philosophy which were applied are outlined and restated, with the objectives of first recording these, and then attempting to objectively analyze them for areas susceptible to improvement. The Air Force - LMSC - Associate Contractor team is defined, as it existed during the development, testing and operation of Vehicle 2355.

The system performance from launch through recovery and thence to battery depletion is evaluated from the primary aspect of payload operation.

System performance is compared against predictions, and the performance accomplishments and achievements are enumerated.

The report is therefore, in addition to a flight report, a total summary of the composite effort associated with the preparation and operation of this system. From the system evaluation certain conclusions and recommendations are formulated which are intended to be useful for later work on similar systems.

Through the medium of the detailed information contained in this report, it is intended to properly acknowledge the efforts of all those who were instrumental in managing and conducting a program which produced a completely successful mission with the first flight of a new payload vehicle system.

PART III

Table of Contents

PART III (Cont.)

Table of Contents

Report Numbering and Organization

The complete 2355 System Report is contained in three volumes.

Volume I - (PART I) - Summary

Volume II - (PART II) - Engineering

Volume III - (PART III) - Flight Performance

The report paragraph numbering is in accordance with the following convention:

First number indicates volume number

Second number indicates main paragraph number

Third number indicates a subparagraph

Fourth number indicates a further subdivision of a subparagraph

Figures are numbered consecutively within main paragraphs.

<u>Reports By Participating Contractors</u>

The complete system description and performance evaluation is contained in reports issued by the three contractors. These are listed here for reference by the reader:

Lockheed Missiles and Space Company:

Title: 2355 System Report, dated 31 March 1965.

Volume I - Summary

Volume II - Engineering

Volume III - Flight Performance

Goodyear Aerospace Corporation:

Title: Program Report, KP-II Orbital Doppler Radar, Thor/ Agena Satellite Program, dated 1 March 1965.

[redacted]

Title: [redacted]

PART III

System Performance During Orbital Operations

Introduction

This section of the report - Part III - is designed to contain a maximum of orbital performance data. The subsystems, the thermodynamic conditions which prevailed, the vacuum gage responses and the performance of the Satellite Control Facility are each discussed.

The payload subsystem operation, as recorded in Para. 3.4, was evaluated by Engineering personnel relatively inexperienced in evaluation of photographs or of radar imagery. The basis of the evaluation was:

- All telemetry data considered pertinent.
- The recorded video data transparency.
- The correlated radar imagery for the full length of all operating passes. (An unrefined copy)

The resulting observations and comments provide a total evaluation of the payload data and radar imagery accumulated in 32.91 minutes of operation throughout the 14 orbits of payload operation - with the qualifications indicated above.

The entries made for each pass may form a basis for further evaluation - if required - without recourse to extensive research through retired data records.

3.1 Electrical Power Subsystem

3.1.1 Summary

The 2355 Electrical Power System performed flawlessly throughout the entire mission. Ascent, orbit, recovery, and post-recovery orbital performance of all components was normal until the rated capacity of the three Type 1-D batteries had been exhausted, at Orbit 73. Abnormal loads on the output of the High Voltage Power Supply occurred during payload operation on Orbits 8 and 9; however, no interruptions or excessive degradation in output from the power supply was present. The abnormal high voltage loads at Orbits 8 and 9 were of two types, each identical in all respects to similar disturbances experienced during payload testing in the TASC Chamber, 30 November 1964.

3.1.2 Battery Performance

Battery performance was exceptional for the duration of the mission. Average current division throughout the life of the vehicle was 2:1 as anticipated, within the tolerance of the Ampere Hour Meters (+0, -10 ampere-hours). Projected versus actual AHM readings are shown in Fig. 3.1.1. Actual values are slightly lower than predicted because of: a) the AHM tolerance, b) relatively early recovery, and c) the fact that actual average payload operation was conducted at PRF Step 8 or 9, rather than at PRF Step zero (worst case) for which the projections were made.

Battery temperatures increased slowly throughout the mission. All three Type 1-D batteries were between 65° and 75° from launch to recovery, and from 73° to 85°F from recovery to Orbit 73.

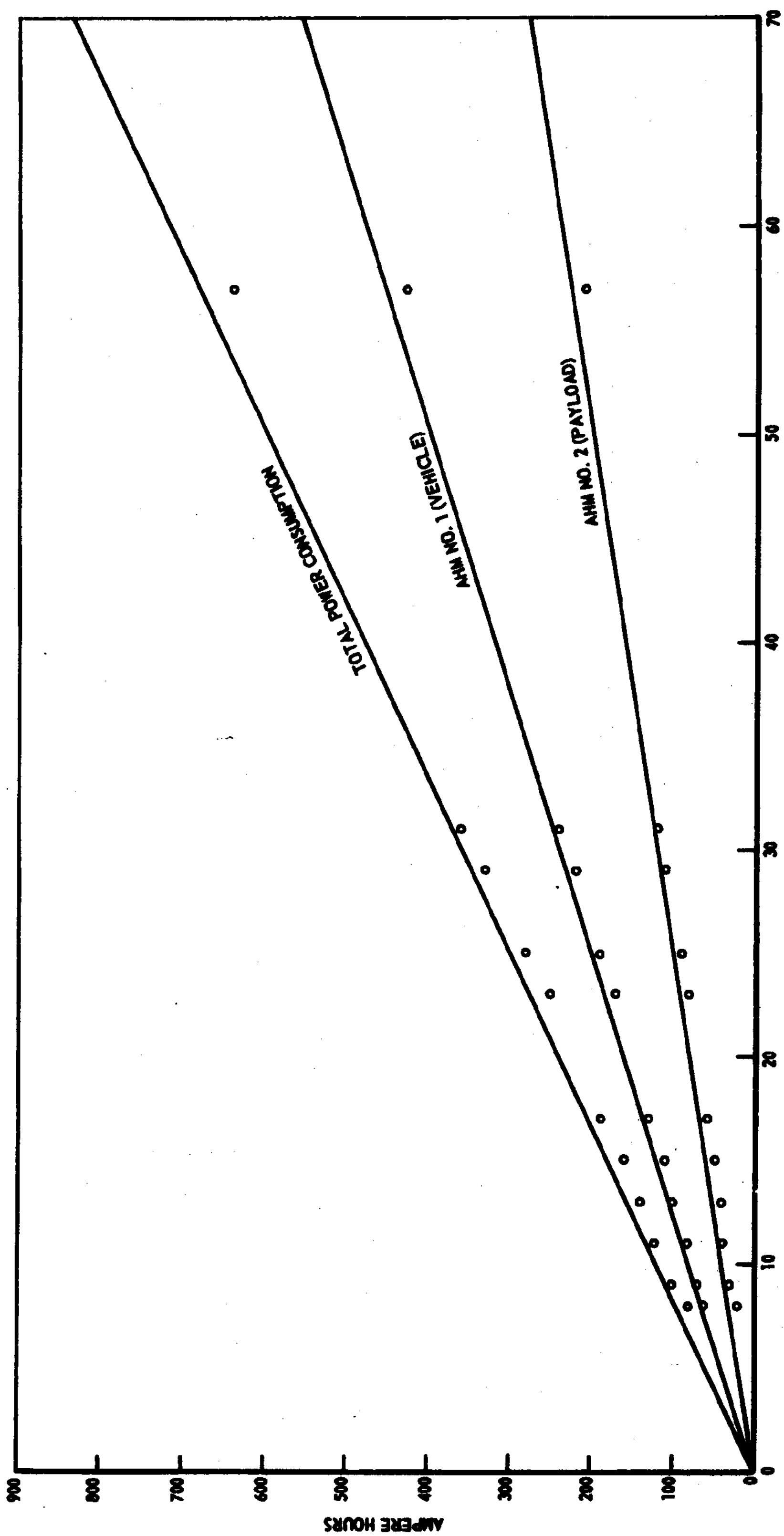

Figure 3.1.1 Predicted Ampere Hour Meter Readings - Vehicle 2355 Actual Values are Shown (o)

3.1.3 Power Conversion Equipment Performance

Vehicle and Payload Power Conversion Equipment performance was normal throughout the flight. The switching of the payload conversion equipment was executed as programmed. All output voltages were within specification except during payload operation on the last payload operating pass, Orbit 72. During this pass, the batteries were nearly expended and the internal resistance was relatively high. For this reason, the battery voltage dropped below 22 volts during the high-current payload operating period causing the Power Conversion Equipment to fail to regulate properly. The low buss voltage effect upon the 2 KC inverter was most severe as shown in Table 3.1.1. Payload read-in data was satisfactory during the pass, however, until 22653 seconds System Time when an Attenuator 7 command was sent. As a result of this command, it is impossible to evaluate payload data subsequent to this time. The buss voltage at 22653 seconds when data was lost was 18.6 volts.

3.1.4 Discussion of Abnormal High Voltage Loads at Orbits 8 and 9

Analysis of 2355 flight data indicates a series of high voltage disturbances during the first two payload operating orbits, NHS Pass 8 and VTS Pass 9. The disturbances are of two types: Type I is a brief pulse of excessive high voltage supply output current coincident with a slight decrease in high voltage; Type II is a sustained disturbance, lasting 12 seconds at Orbit 8 (refer to Figures 3.1.2 - 3.1.5). These indications are noticeable by virtue of the amplification and delayed decay characteristics of the peak reading monitors, C-283, and C-284.

TABLE 3.1.1

System Time	22609	22610	22653	22686	22687	22696
Payload Mode	Pre-operate	Operate	Operate	Operate	Warmup	Warmup
Battery Voltage	23.0	20.5	18.6	18.3	20.9	23.0
+28 Reg. (VDC)	28.0	28.0	25.7	25.3	28.3	28.3
2 KC (VAC)	110	100	90	88	105	111
ØAB (VAC)	115	114	105	103	115	115
ØCB (VAC)	115	109	100	98	115	115
ØAC (VAC)	115	115	109	107	115	115

Power Conversion Equipment temperatures were between 61° and 90°F from launch to Orbit 73.

The Type I disturbance occurred 7 times during Orbit 8 and 4 times during Orbit 9. The Type II disturbance occurred only once, at Orbit 8.

The Type II disturbance started at 24268 seconds and stopped at 24280 seconds System Time. The Type II disturbance is characterized by: a) a slight decrease in high voltage; b) a slight decrease in high voltage supply input current; c) essentially constant high voltage supply output current until the end of the disturbance when the current momentarily increases; d) an oscillatory noise burst causing the high voltage peak-reading monitors to repsond. The slight decrease in high voltage is considered to be caused by the effect of the abnormal oscillatory nature of the load at the time of the disturbance on the regulator circuit of the Lear-Siegler unit.

Both types of disturbance discussed here were also encountered during payload altitude testing in the TASC Chamber 30 November 1964, and were present only during the first four simulated orbits.

The source of the disturbances is the transmitter or the power supply. A conclusive finding as to cause cannot be established.

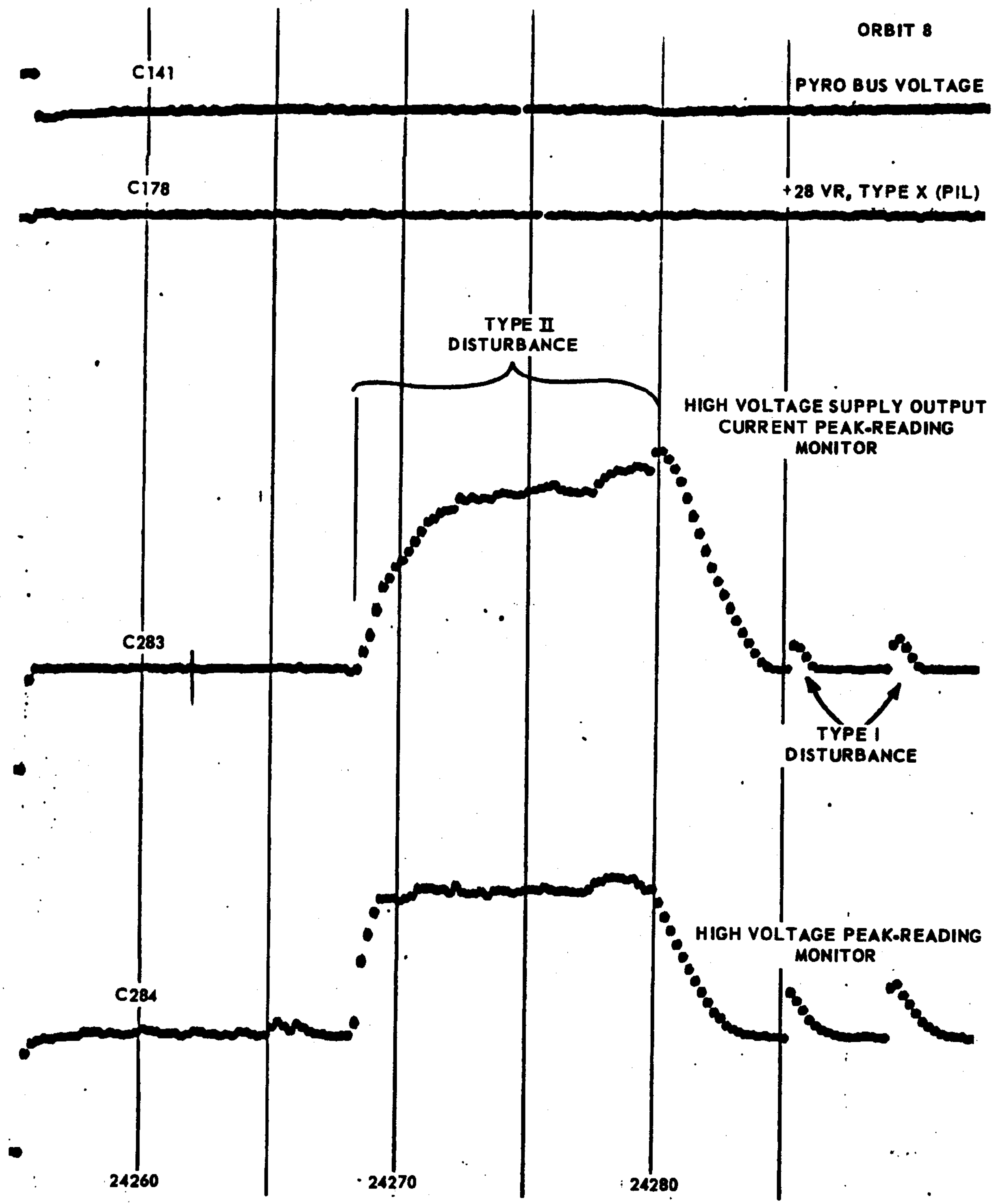
ORBIT 8
C141
PYRO BUS VOLTAGE
C178
+28 VR, TYPE X (PIL)
TYPE II
DISTURBANCE
HIGH VOLTAGE SUPPLY OUTPUT
CURRENT PEAK-READING
MONITOR
C283
TYPE I
DISTURBANCE
HIGH VOLTAGE PEAK-READING
MONITOR
C284
24260
24270
24280

Figure 3.1.2

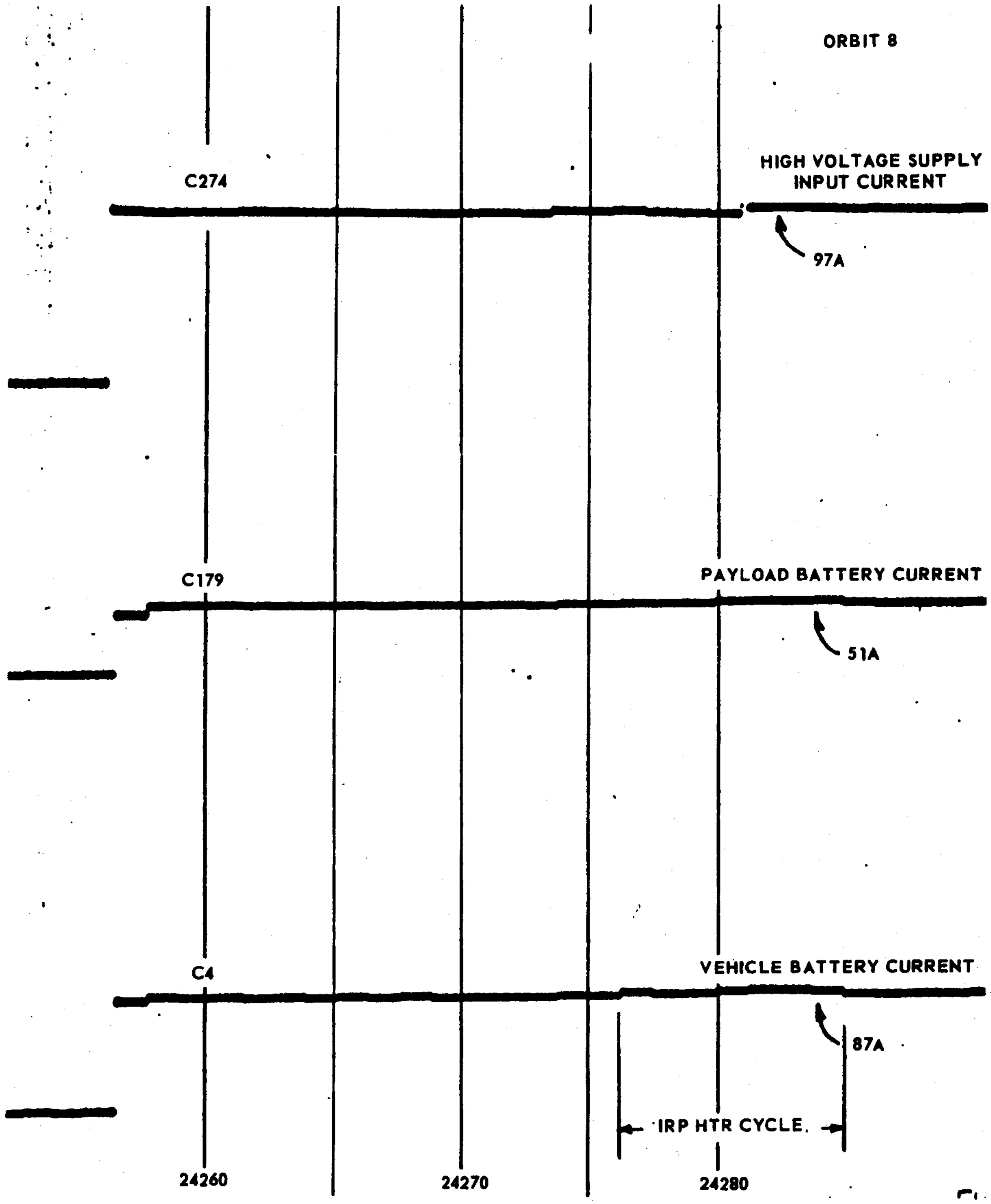
ORBIT 8
C274
HIGH VOLTAGE SUPPLY INPUT CURRENT
97A
C179
PAYLOAD BATTERY CURRENT
51A
C4
VEHICLE BATTERY CURRENT
87A
IRP HTR CYCLE
24260
24270
24280

Figure 3.1.3

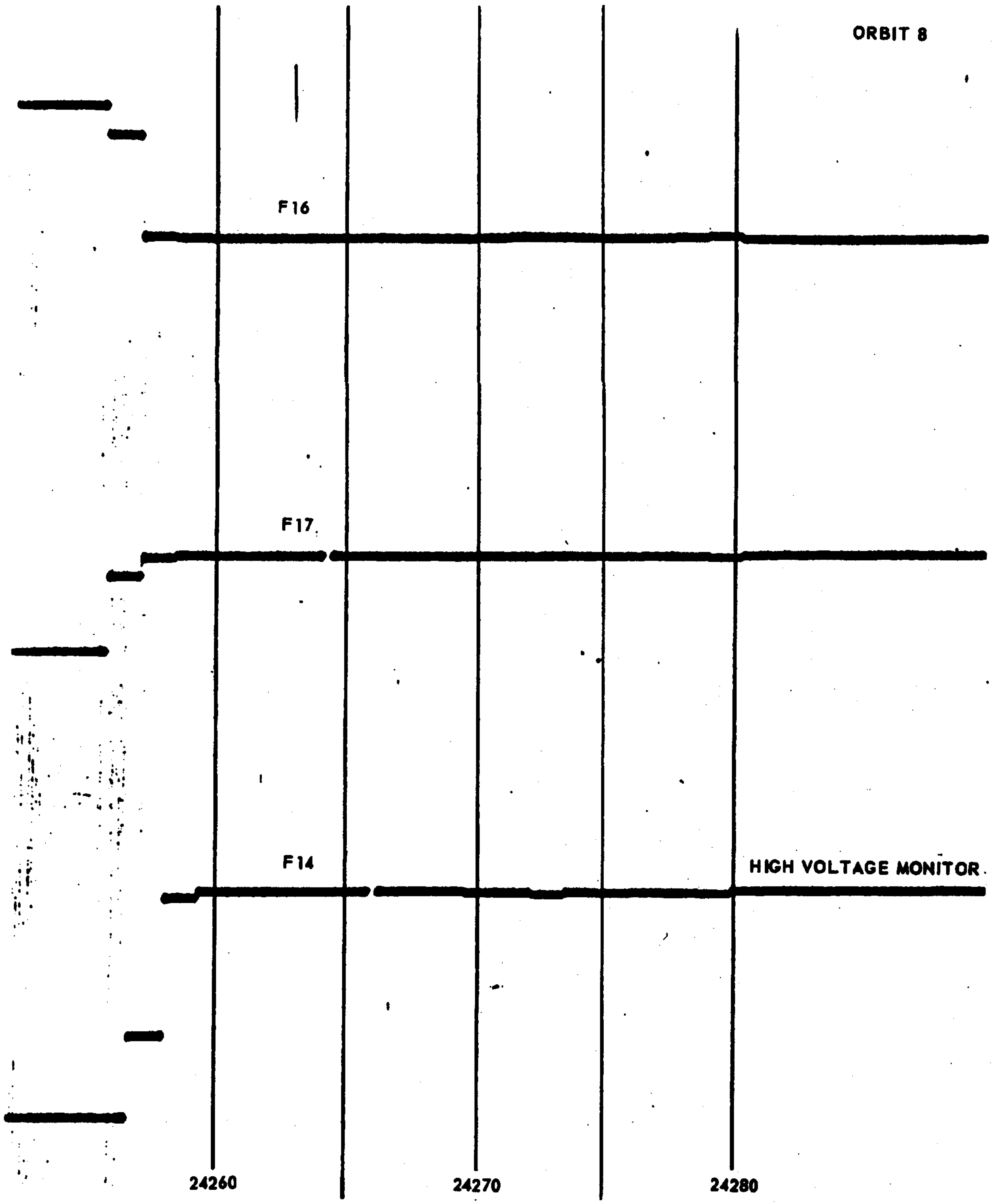

Figure 3.1.4

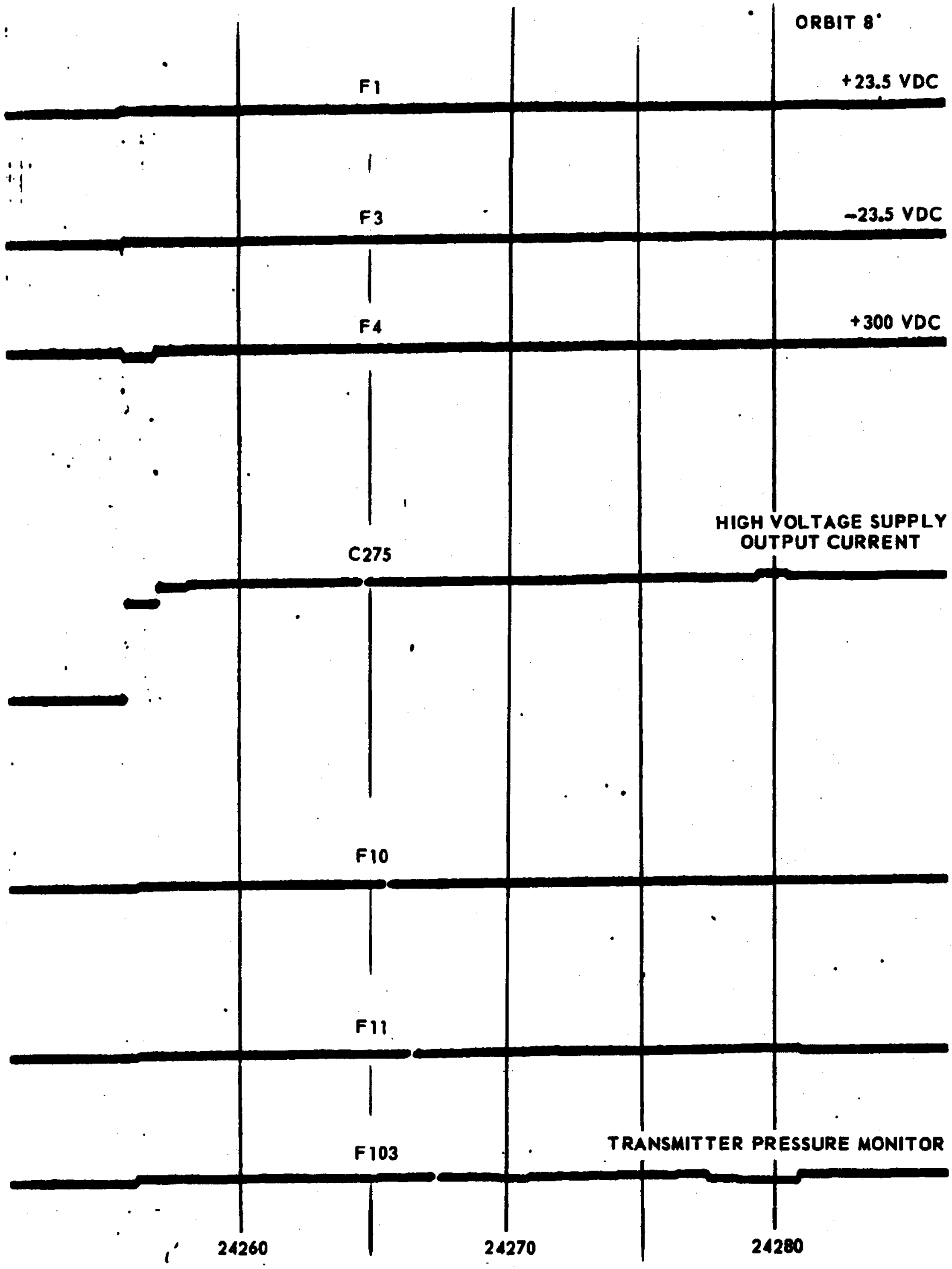
ORBIT 8
F1
+23.5 VDC
F3
-23.5 VDC
F4
+300 VDC
C275
HIGH VOLTAGE SUPPLY
OUTPUT CURRENT
F10
F11
F103
TRANSMITTER PRESSURE MONITOR
24260
24270
24280

Figure 3.1.5

3.2 Attitude Control Subsystem

3.2.1 System Performance Summary

The two most significant aspects of the vehicle flight performance and subsequent evaluation were the extremely noisy horizon sensor signal outputs and the difficulty of extracting vehicle attitude pointing information from the payload data. The horizon sensor outputs exhibited noise to some extent on every active pass. In a few cases the anomalous sensor signals appeared to exceed 2° peak-to-peak. It should be noted that an anomalous horizon sensor output will not result in a corresponding vehicle attitude error. The relatively low horizon sensor to gyro torquing gains reduce the effect of the sensor signals and the error signal deadbands (about 0.35 average peak-to-peak) block out a large portion of the anomalous signal. One factor which tended to accentuate the anomalous horizon sensor performance on this flight was the improved telemetry resolution. Prior to the flight it had been thought that vehicle attitude could be extracted directly from the payload (radar map) data. This can (and has) been done for roll attitude but it now appears that this approach is impractical for pitch and yaw attitude data. This subject will be discussed in a subsequent section. Some attitude information apparently can be obtained through analysis of the payload system performance. It is expected that the Goodyear report will contain information on this subject.

In all other respects the control system performance was consistent with that predicted for the conditions of this flight. Items of particular interest are discussed in subsequent sections.

3.2.2 Derived Data-Vehicle

The Horizon Sensor output normally defines the vehicle's pitch and roll attitude. Unfortunately the Horizon Sensor output for this particular vehicle was anomalous. Part, if not all, of the cause for the erroneous Sensor output was the vast cold cloud cover at the time of the flight. At any rate, because of the loss of vehicle attitude data, some other means of determining vehicle attitude was necessary.

A number of methods were used. The initial attack was to approach the solution from a grossly approximate standpoint with the intent to refine the method as the results pointed to the most likely solution.

It was felt that the key to the solution lay in evaluating the impulse contained in each gas valve firing. In pursuit of this, the following method was used:

$$T = I\alpha \qquad (1)$$

$$FR = I\frac{\Delta W}{\Delta t} \qquad (2)$$

$$F\ t = \frac{I}{R}\Delta W \qquad (3)$$

$$\text{Impulse per pulse} = \frac{F\Delta t}{N} = i\ ;\ i_2;\ \ldots i_6 \qquad (4)$$

and it follows that

$$i_1 \propto W_1;\ i_2 \propto W_2;\ \text{etc.}$$

(see Figure 3.2.1 for gas valve location and vehicle axis description).

Vehicle body rates were obtained in the following manner:

$$W_y = \dot{\theta}_g - \dot{\theta}_d + \dot{\theta}_c - W_o - K_\theta\,(H_\theta - \theta_g) \qquad (5)$$

$$W_x = \dot{\phi}_g - \dot{\phi}_d + \psi\dot{\theta} \mp \dot{\phi}_c \pm \psi_c W_o - K_\phi H_\phi \qquad (6)$$

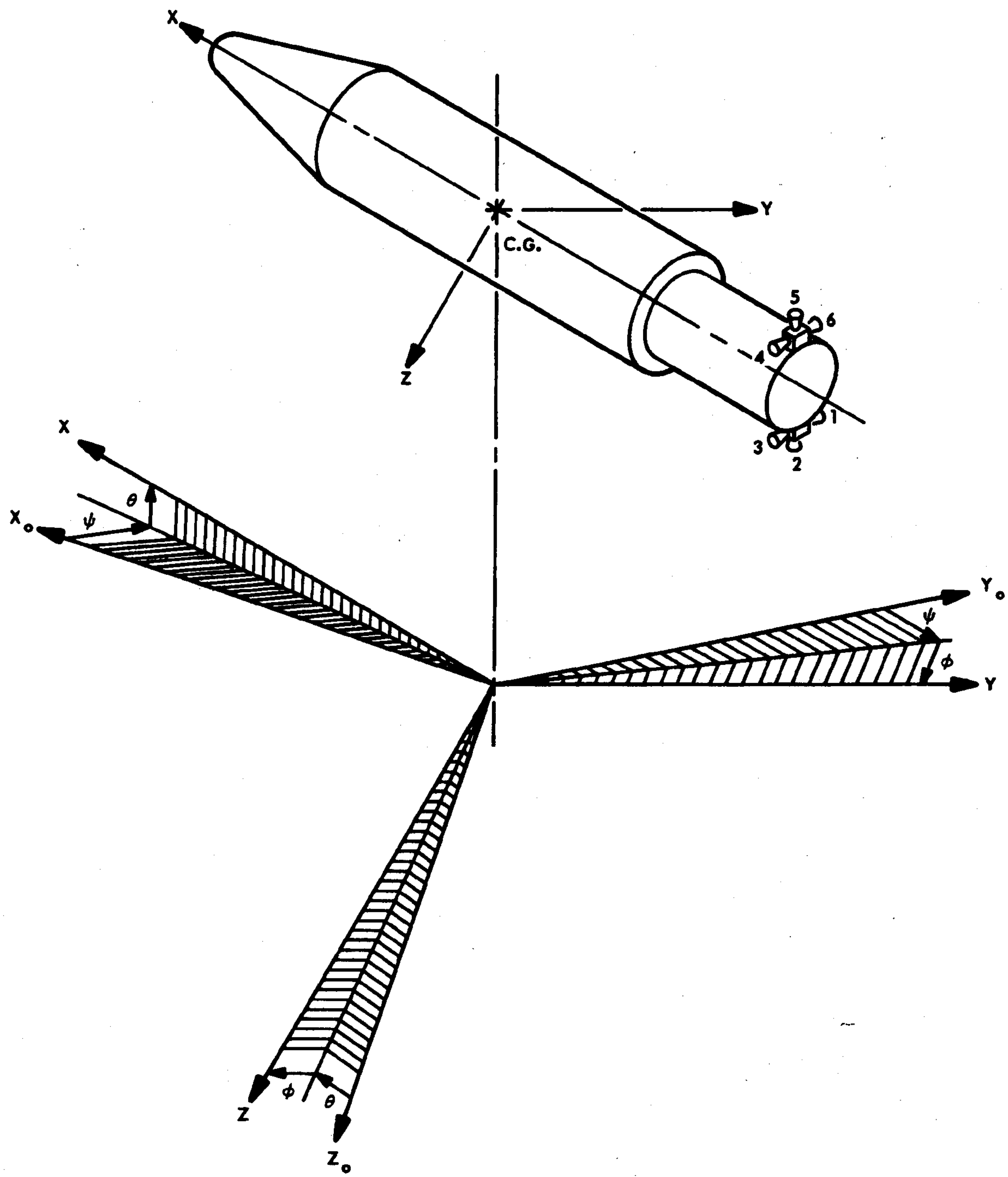

FIGURE 3.2.1 GAS VALVE LOCATION AND VEHICLE AXES

$$W_z = \dot{\psi}_g - \dot{\psi}_d - \phi \dot{\theta} + K_\psi \ H \phi \qquad (7)$$

Assuming:

1. Gyro drift rates are zero
2. $W_o = \dot{\theta}_c$
3. $\psi = \phi = 0$
4. $\mp \dot{\phi}_c = \pm \psi_c W_o$

The body rate equations become:

$$W_y = \dot{\theta}_g - K_\theta (H_\theta - \theta_g) \qquad (8)$$

$$W_x = \dot{\phi}_g - K_\phi H_\phi \qquad (9)$$

$$W_z = \dot{\psi}_g + K_\psi H_\phi \qquad (10)$$

The use of these equations also neglects such potential error sources as:

1. Horizon Sensor torquing gain tolerance
2. External torques
3. Telemetry linearity and bias uncertainty
4. Component alignment to body axis errors

and assumes:

1. Gyro rate thresholds are zero deg/sec.
2. Each gas valve command produces a valve firing

The first attempt using the above method produced rates per gas valve firing of 0.0006 deg/sec for the pitch and yaw axes. (For convenience, from now on in this report, rates will be stated in milli-degrees per second (m °/s): 0.0006 °/s = 0.6 m °/s).

While these rates per gas valve firing produced reasonable pitch and yaw rates and attitude changes, the roll rates and displacement were not reasonable. For this reason, rate calculations were performed for another pass. (By this time better data records were available.) The results were as follows:

$W_{z1} = W_{z6} = 0.62$ and 0.55 m °/s

$W_{z3} = W_{z4} = 0.46$ m °/s

$W_{y2} = 0.82$ and 0.64 m °/s

$W_{y5} = 0.85$ m °/s

These results indicated a greater dispersion in the rate produced per gas valve firing (W/VF) than had been anticipated. For this reason it was decided to concentrate on the non-coupled pitch axis W/VF for all of the thirteen passes available. The results produced the following range in the data:

$W_{y2} = 0.64$ to 1.14 m °/s

$W_{y5} = 0.75$ to 1.40 m °/s

The weighted average of the W/VF was:

$\overline{W_{y2}} = 0.80$ m °/s

$\overline{W_{y5}} = 0.92$ m °/s

The difference between the impulse from gas valve #2 and gas valve #5 could be real, or it could be caused by an external torque which tended to produce a positive rate. Sources of external torque would be:

1. Vehicle's magnetic moment interacting with the earth's magnetic field
2. Gravity gradient

3. Aerodynamic

4. Rotating machinery on board

The data were examined for the presence of an external torque. During times when the Horizon Sensor output was disconnected from the gyro, it was noted that in the absence of gas valve firings, rate changes occasionally appeared on the gyro outputs. The required torque to produce the rate change was calculated. Its value was found to be 0.0018 foot-pound. The gravity gradient moment would be of a magnitude of 0.00045 foot-pound per degree, and the aerodynamic moment would be 0.0028 foot-pound per degree. These are small values compared with the observed moment. Therefore the magnetic moment was assumed to be the major contributor to the apparent torque. In light of this, four passes, one day apart, were analyzed and evaluated. The reason for selecting them one day apart was to place each pass in essentially the same earth's magnet field, therefore the same magnetic moment.

Further, because of the wide variance in W/VF, that method of evaluation was temporarily abandoned. Pitch body rates were determined, and a steady state torque was superimposed upon these calculated rates. The rates were numerically integrated, and the curves shown in Figures 3.2.2 thru 3.2.5 were produced. The curves do exhibit similarities, but they do not suggest the possible vehicle attitude.

It was next decided to perform the same type of operation on the roll and yaw parameters for the same passes. It was felt that the pitch and roll sensor errors together might suggest a solution for vehicle attitude.

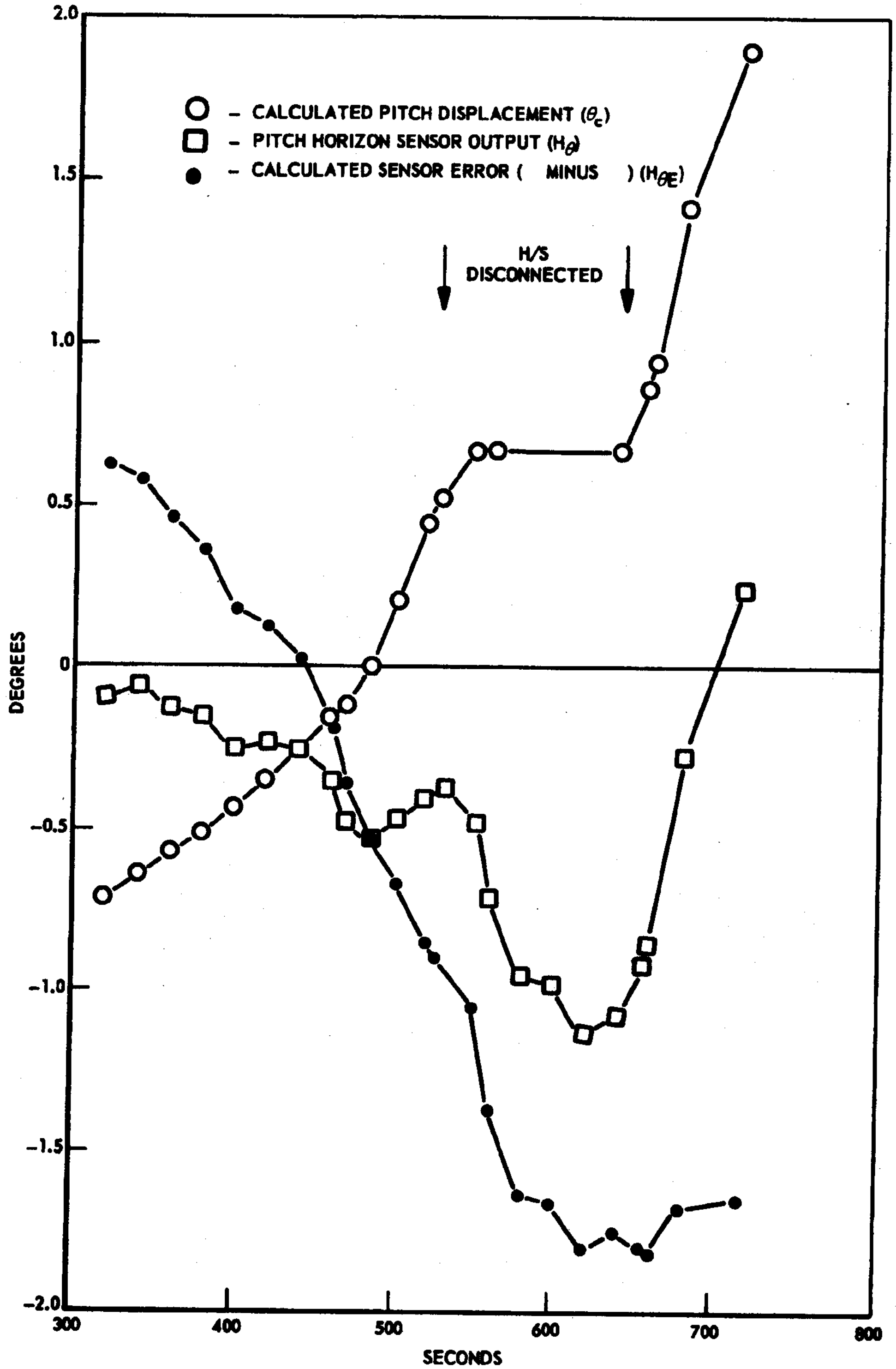

FIGURE 3.2.2 PITCH ATTITUDE VS. SYSTEM TIME (PASS 9)

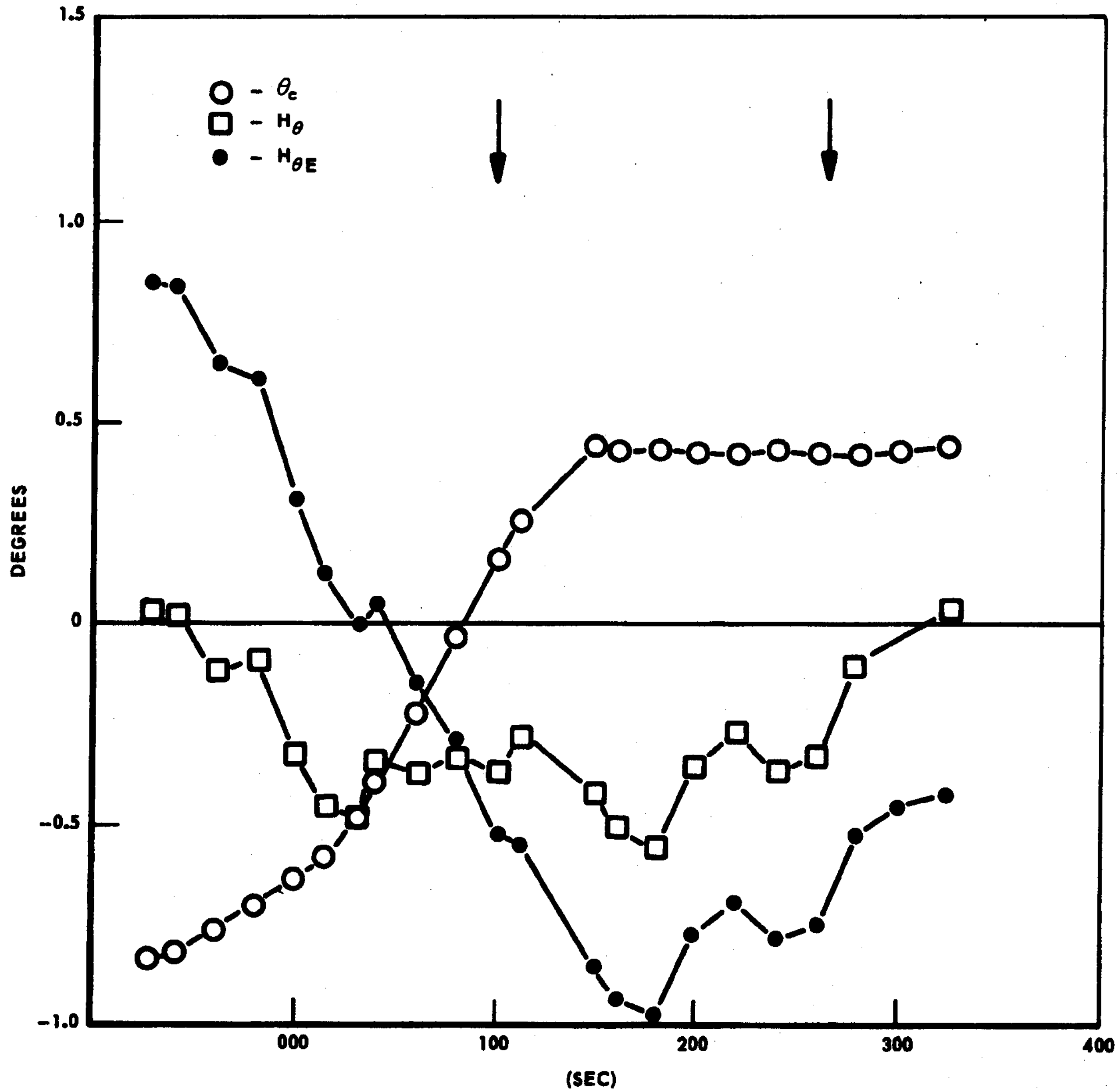

FIGURE 3.2.3 PITCH ATTITUDE VS. SYSTEM TIME (PASS 25)

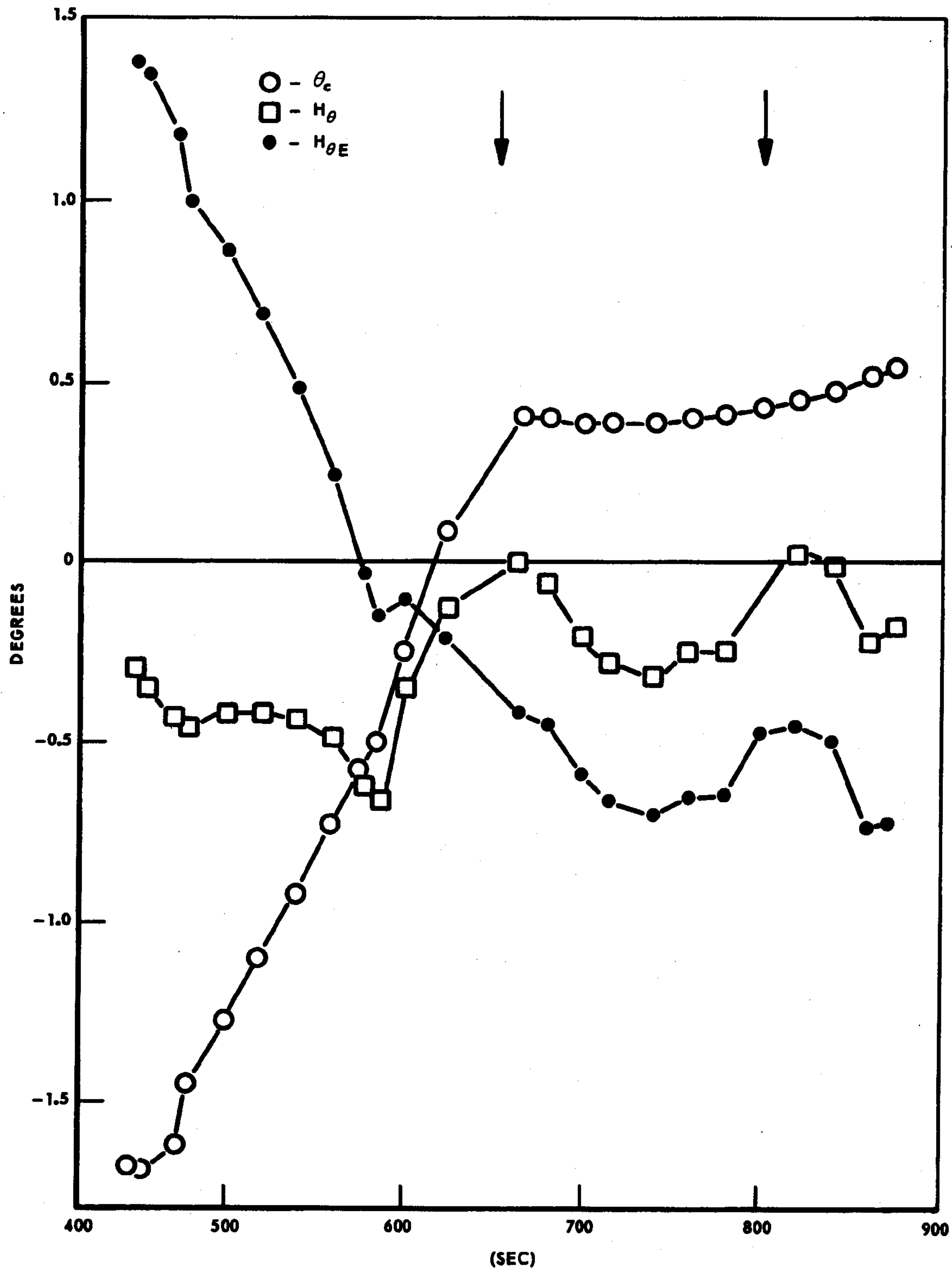

FIGURE 3.2.4 PITCH ATTITUDE VS. SYSTEM TIME (PASS 41)

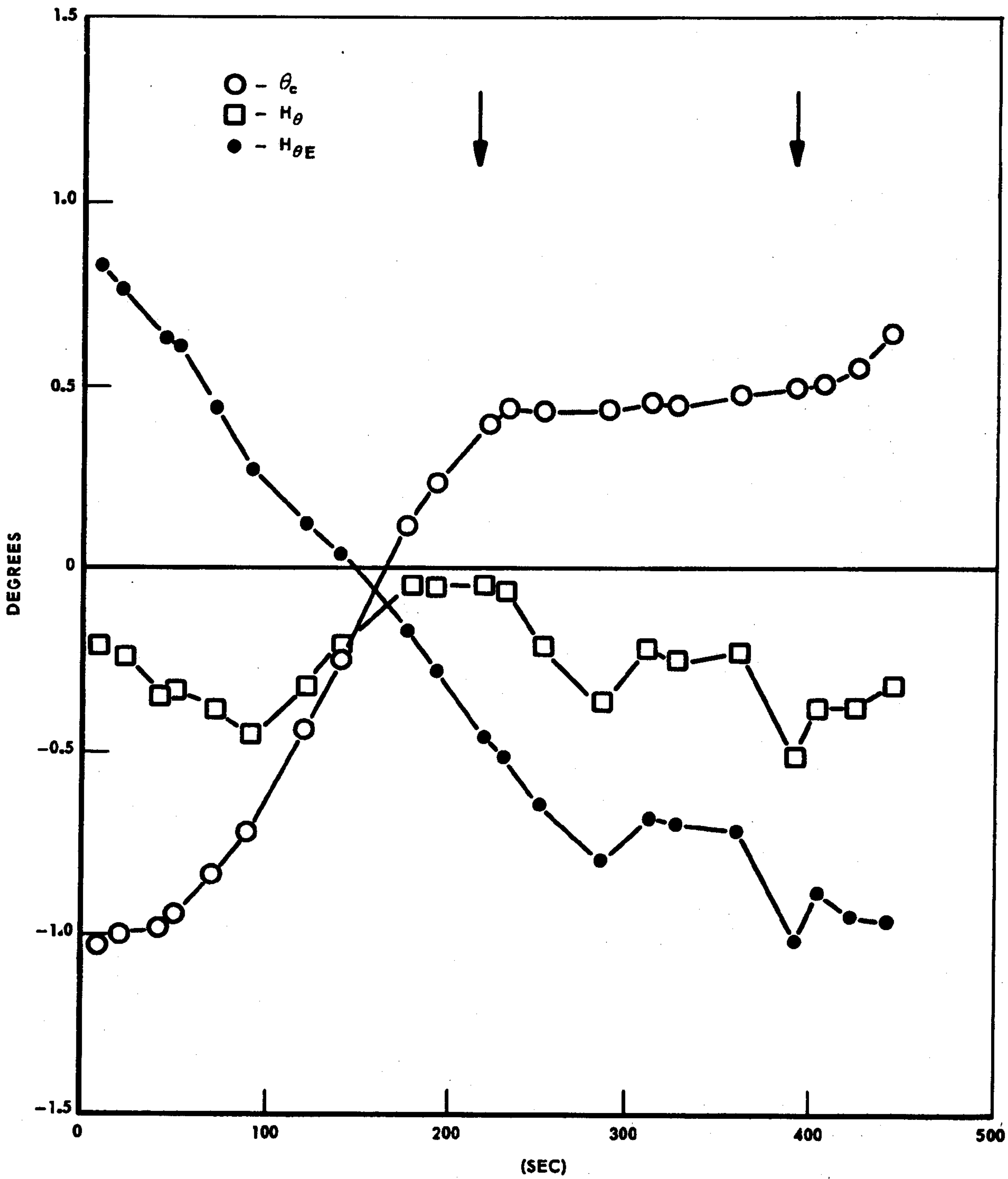

FIGURE 3.2.5 PITCH ATTITUDE VS. SYSTEM TIME (PASS 57)

Because roll rates (W_x) always appeared low, and thus more greatly affected by the absence of the ψW_o and $\dot{\phi}_d$ terms in the approximate eq. (9), it was decided to attempt again to evaluate W/VF.

The method used was:

$$N_1 W_{z1} + N_2 W_{z6} = (\Delta W_z)_1$$

$$N_3 W_{z1} + N_4 W_{z6} = (\Delta W_z)_2$$

Solving equations (11) and (12) simultaneously results in a solution for W_{z1} and W_{z6}. Similar solutions may be obtained for W_{z3} and W_{z4}. Rates produced about the yaw axis are related to the rates produced about the roll axis by the ratio of their respective inertias and lever arms.

Therefore:

$$W_x = 3.1 W_z$$

and roll rate changes are:

$$(\Delta W_x)_1 = N_1 W_{x1} - N_2 W_{x6}$$

$$(\Delta W_x)_2 = N_5 W_{x3} - N_6 W_{x4}$$

The results obtained again indicated large variations in the W/VF value. The final attempt to arrive at a reasonable W/VF value utilized the following set of equations:

$$N_1 W_{z1} + N_2 W_{z6} = (\Delta W_z)_1$$

$$N_1 W_{x1} - N_2 W_{x6} = (\Delta W_x)_1$$

These equations were solved simultaneously. The results again were inconsistent. At this point the attempt to evaluate W/VF was abandoned.

Yaw displacements were calculated in the same manner as the pitch displacements had been. (Yaw rates are higher than roll rates so it was reasonable to exclude the ϕW_o and the $\dot{\psi}_d$ terms.) There was reason to believe that an external torque existed in yaw also. For this reason a steady state rate was superimposed on the calculated body rates. The curves produced are shown in Figures 3.2.6, 3.2.7, and 3.2.8. The yaw displacement did not exhibit the consistency from pass to pass observed on the pitch curves. It may be observed that the average yaw rates during Horizon Sensor disconnect are lower than the average yaw rates while the Horizon Sensor is connected. The average yaw displacement during these three passes was 0.84 degree. Using:

$$W_x = \psi W_o$$

The average change in roll rate due to this changing yaw attitude may be calculated. This average change was found to be 1.0 m °/s. This is too small a change to be useful in evaluating roll attitude.

The next approach, in an effort to obtain roll attitude, was to request from another subsystem a point in time when a yaw error was suspected. This data was then used in the following expression:

$$\dot{\phi} = \dot{\phi}_g + \psi \dot{\theta} - K_\phi H_\phi$$

This is essentially eq. (6). Data for Figure 3.2.9 were calculated. The plot without the "$\psi \dot{\theta}$" correction was also included on the figure. Neither plot exhibited good correlation with the roll output of the Horizon Sensor.

The last attempt to establish absolute attitude data was based upon the

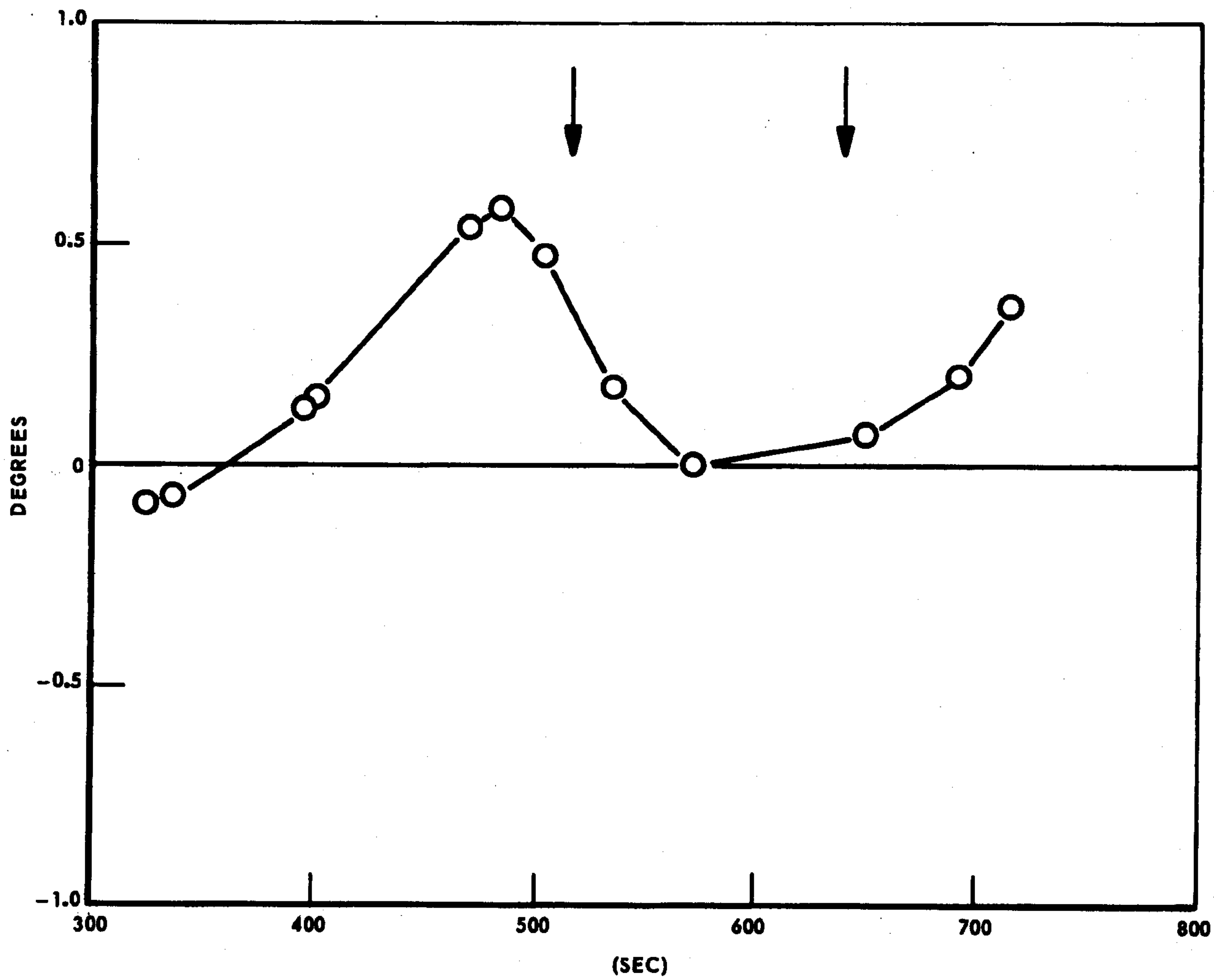

FIGURE 3.2.6 YAW DISPLACEMENT VS. SYSTEM TIME (PASS 9)

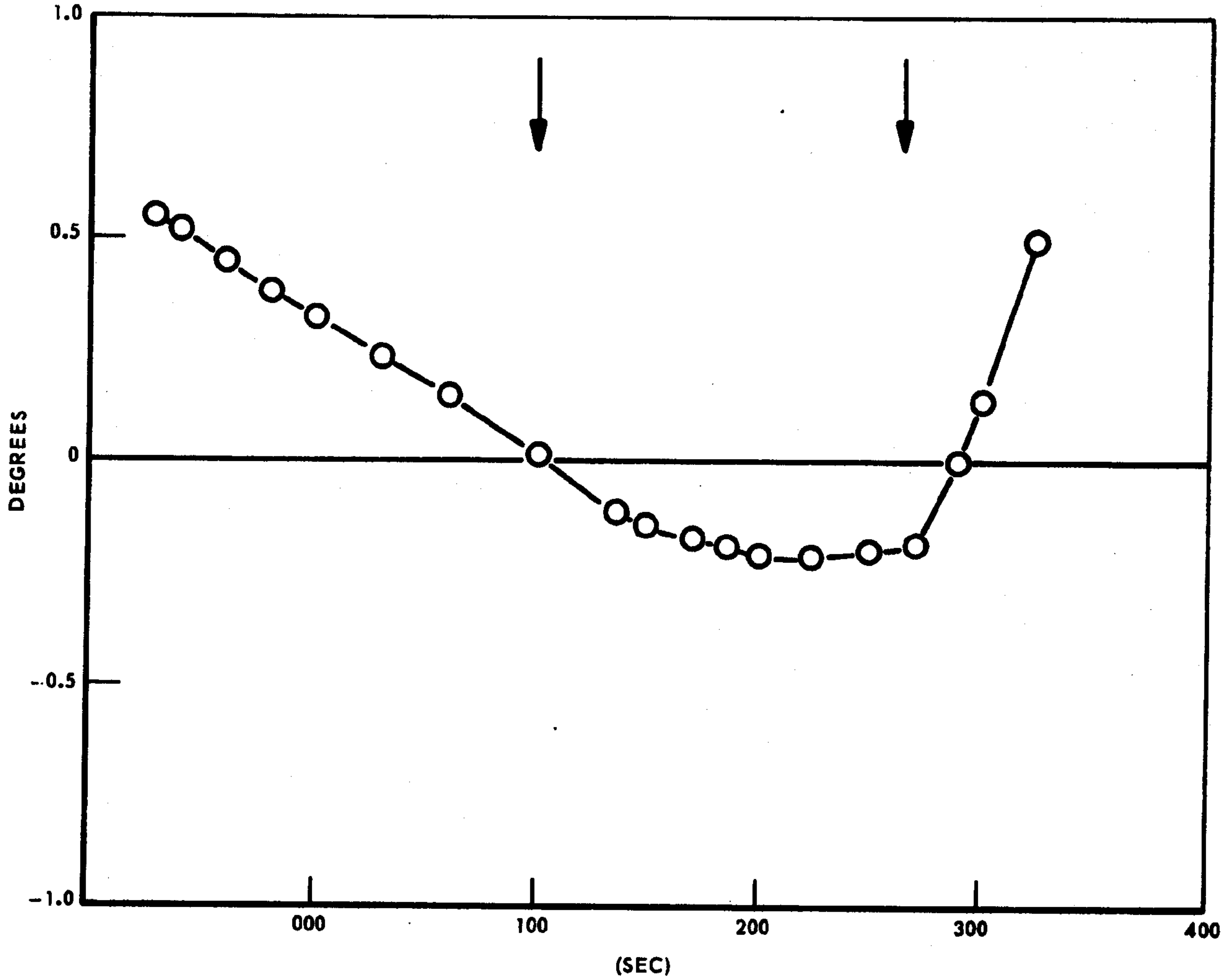

FIGURE 3.2.7 YAW DISPLACEMENT VS. SYSTEM TIME (PASS 25)

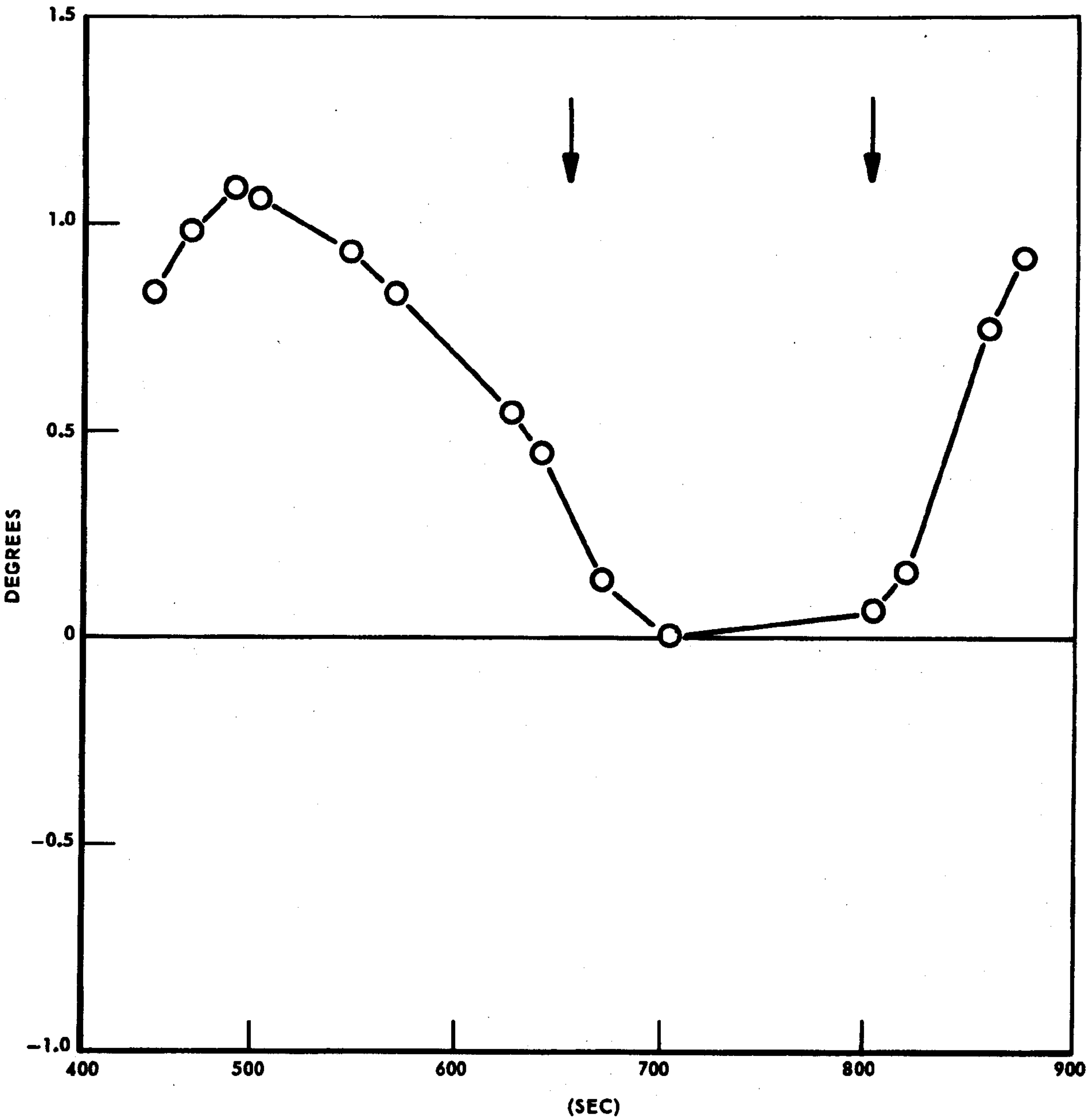

FIGURE 3.2.8 YAW DISPLACEMENT VS. SYSTEM TIME (PASS 41)

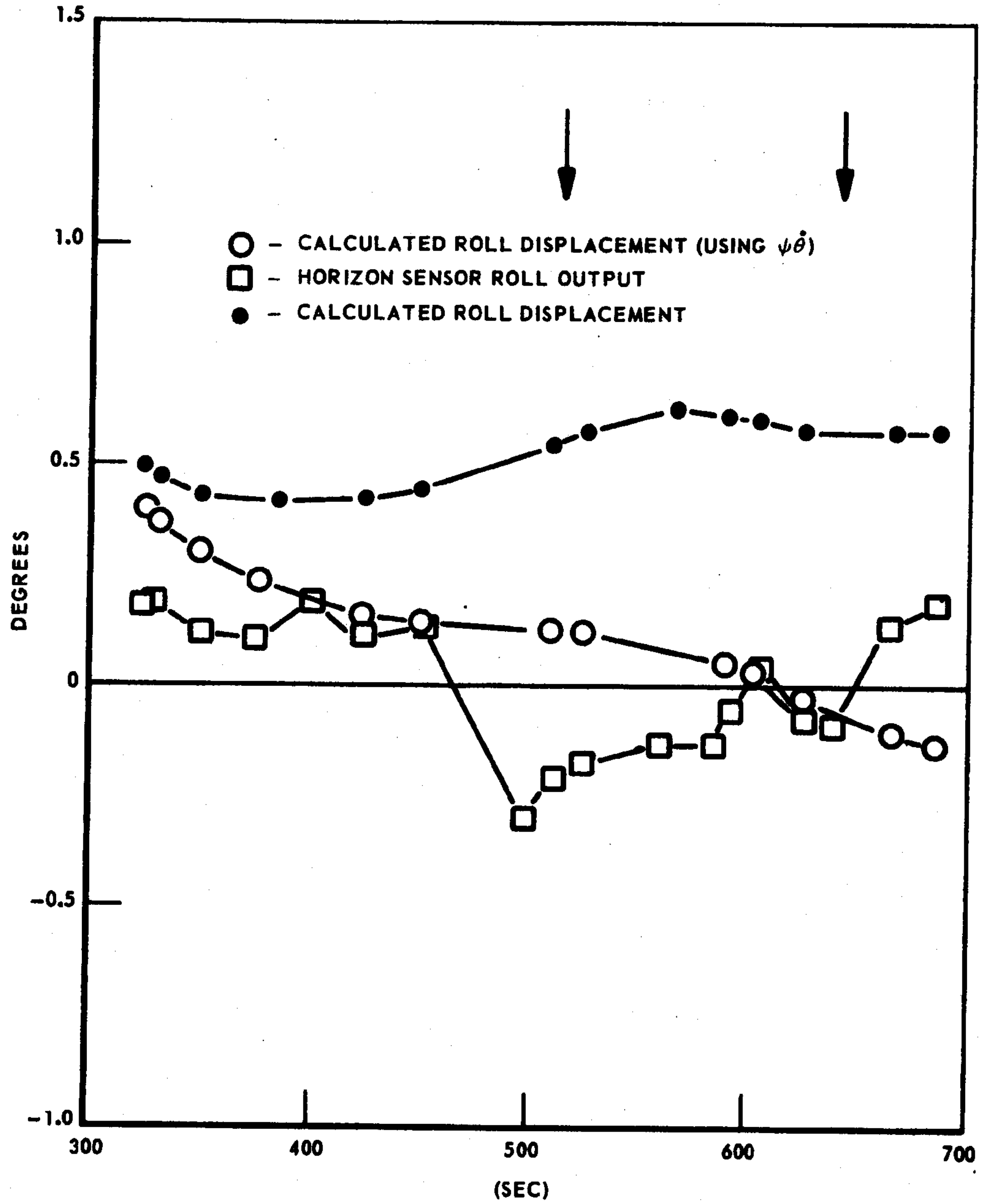

FIGURE 3.2.9 ROLL PARAMETERS VS. SYSTEM TIME (PASS 9)

premise that at sometime the Horizon Sensor output must be exhibiting true vehicle attitude. The data from all 13 passes were reviewed, and a pass which seemed to offer the best possibilities was chosen. Yaw displacement was backed out of eq. (18). The correlation with the yaw displacement which was calculated using eq. (10) was poor. It was at this point in time that further effort to obtain absolute roll and yaw attitude information was discontinued. The possibility of determining absolute pitch attitude using the latter method has promise. However, the value of this quantity is not as great as the roll - yaw parameters. Therefore this method was not pursued.

Pitch and yaw body rates have been evaluated. They are tabulated in Table 3.2.2. The confidence in this data is good. The pitch rate tabulated is body rate minus orbital rate. It should be noted that in almost every case the pitch and yaw body rates were quite high immediately following the horizon sensor disconnect. These rates resulted from the anomalous Horizon Sensor signals. When the corresponding attitudes attained an amplitude sufficient to actuate the pneumatic system these rates were damped to much lower levels. Thus if the first twenty seconds of each pass were ignored the average rates would be approximately one half of the values tabulated.

No attempt to evaluate roll rates was made for two reasons:

1. The magnitude of the roll rates were so low that the $\dot{\phi}d$ and the ψw_o terms became significant.
2. The threshold rate of the roll gyro was unknown.

The observed roll rates were well below the required limits in all cases.

TABLE 3.2.1

Definition of Symbols

Symbol	Description	Units
F	Thrust at the gas valve	lb
H_ϕ, H_θ	Horizon Sensor output	deg
i_1; i_2; ... i_6	Gas valve #1, #2, ... #6 impulse per pulse	lb-sec/ pulse
I_x, I_y, I_z	Components of vehicle inertia	ft-lb-sec^2
K_ϕ, K_θ, K_ψ	Horizon Sensor to gyro torquing gains	deg/sec/ deg
N_1; N_2; ... N_3	Number of gas valve firings	
R_x, R_y, R_z	Gas valve moment arm	ft
t	time	sec
x, y, z	components of body axes	
α	angular acceleration	rad/sec^2
ϕ, θ, ψ	Euler angles	deg
$\dot{\phi}$, $\dot{\theta}$, $\dot{\psi}$	Euler angle rates	deg/sec
ϕg, θg, ψg	Gyro angles	deg
$\dot{\phi} g$, $\dot{\theta} g$, $\dot{\psi} g$	Gyro angular rates	deg/sec
ϕc, θc, ψc	Commanded vehicle attitude	deg
$\dot{\phi} c$, $\dot{\theta} c$, $\dot{\psi} c$	Commanded vehicle rate	deg/sec
$\dot{\phi} d$, $\dot{\theta} d$, $\dot{\psi} d$	Gyro drift rate	deg/sec
W_o	Orbital pitch over rate	deg/sec
W_x, W_y, W_z	Vehicle body rates	deg/sec

TABLE 3.2.1 (Cont.)

Symbol	Description	Units
$\Delta W_x, \Delta W_y, \Delta W_z$	Change in vehicle body rates	deg/sec
$W_1; W_2; \ldots W_6$	Body rate produced per gas valve firing	deg/sec/ pulse
$W/_{VF}$	Body rate produced per gas valve firing	
↓ ↓	Start and End of payload operation	

TABLE 3.2.2

Pitch and Yaw Body Rates
During Horizon Sensor Disconnect

Pass	$\dot{\theta} - W_o$	W_z	Δt
8	0.0	2.89	120
9	1.97	2.98	124
14	1.68	2.92	124
16	0.49	4.05	96
24	3.03	2.74	130
25	1.55	1.50	166
30	1.59	2.36	223
40	0.14	2.98	109
41	0.21	2.50	146
46	1.81	0.62	194
47	1.92	2.62	179
56	3.20	1.22	105
57	0.41	2.47	172

3.2.3 Derived Data - Payload

As discussed in Section 3.2.1 it had been anticipated that three axis vehicle pointing attitude information could be extracted from the final radar map. This can be done to a degree for roll attitude. An explanation of the method and a tabulation of the results follow. A discussion of the situation with respect to pitch and yaw data is also presented.

Derived Roll Attitude The basis of the method used to obtain the vehicle roll attitude depends upon the validity of the assumption that the A-Scope operator was able to select the correct PRF (Pulse Repetition Frequency) setting for each pass. A simplified explanation of the payload characteristics is presented to aid in understanding the method.

For each specific PRF the data from a specific slant range will be recorded. This results from the time phasing of the data recording interval (range gate) with respect to the time of pulse transmission. Another way of expressing this is to say that when the PRF is changed the ground swath which will be recorded will step to a different range. The best data will be obtained when the PRF is set such that the range is equal to the actual range measured along the antenna boresight axis. For this condition the STC (Sensitivity Time Control) gain curve is set to compensate for the power distribution across the main lobe of the antenna and the resulting map will be evenly illuminated across the entire swath. This subject is discussed in detail in Section 2.2, Volume II and Section 3.4.5, Volume III. Goodyear personnel have stated that they believe the A-Scope operator is capable of setting the PRF to within ± 1 step of the ideal setting. Each PRF step corresponds to a range change of about 0.65 nautical miles which is equivalent to a ground range of 1.13 nautical miles.

Figure 3.2.10 illustrates the method used to determine roll attitude. Initially, the post-flight best fit S-Look is used to plot the centerline of the ground range. This plotted line would correspond to the ground intercept of the antenna boresight axis for perfect attitude control (no bias uncertainity and no limit cycle). The observed roll gyro attitude at the time in question is then converted to the equivalent change in ground range. The S-Look plot is then moved to the new position and the bias uncertainty allowance is plotted. The $\pm 0.4^{\circ}$ bias uncertainty is equivalent to ±1.28 nautical miles. The radar map is examined to find the center of the actual swath. This line is then plotted along with the ±1.13 nautical mile accuracy assumed.

The manner of evaluating the resulting data could take many forms. Considering the limitations of the method used and the fact that there is no compelling reason to go beyond an approximate analysis, it was decided to present two simple comparisons. These are tabulated in Table 3.2.3. The column titled Swath Center Offset gives the roll bias uncertainty equivalent to the difference between the adjusted S-Look swath and the actual swath center. These figures are correct if it is assumed that the PRF was set correctly. The column titled % Overlap gives the percentage of the actual swath tolerance band which overlaps the adjusted S-Look tolerance band. They may be thought of as a degree of probability that the roll bias uncertainty was within ±0.4 degree.

For either method of evaluation it appears that with the exception of Pass 9 the roll attitude was within the required limits. The data for passes 41 a and 56 were not suitable for analysis.

TABLE 3.2.3

Pass No.	Swath Center Offset Deg.	% Overlap
8	+ 0.01	100
9	- 0.55	29
14	- 0.17	82
16	+ 0.17	82
24	+ 0.03	100
25	+ 0.27	69
30	- 0.25	71
40	+ 0.25	100
41	-	-
46	- 0.12	89
47	- 0.12	90
56	-	-
57	+ 0.26	69
72	+ 0.09	94

<u>Derived Pitch and Yaw Attitude</u> - As stated previously, it had been thought prior to the flight that the radar map data could be used to determine the azimuthal pointing accuracy of the vehicle. The azimuthal pointing is a function of both pitch and yaw pointing accuracy. The method which had

been envisioned was simply to find two easily identified points on the radar map (one near range and one far range) which should lie on a line perpendicular to the swath. The angular difference between the actual line joining the points and a perpendicular would then be measured. Unfortunately the method will not work. Both [redacted] and Goodyear personnel came to this conclusion after some deliberation. The complete explanation of the impossibility of the method is beyond the scope of this discussion. Briefly stated, the near and far range targets have different doppler histories and their positions are effectively shifted in an undeterminable manner by the clutterlock action.

Goodyear is analyzing the clutterlock performance and may have some comments on vehicle attitude control performance.

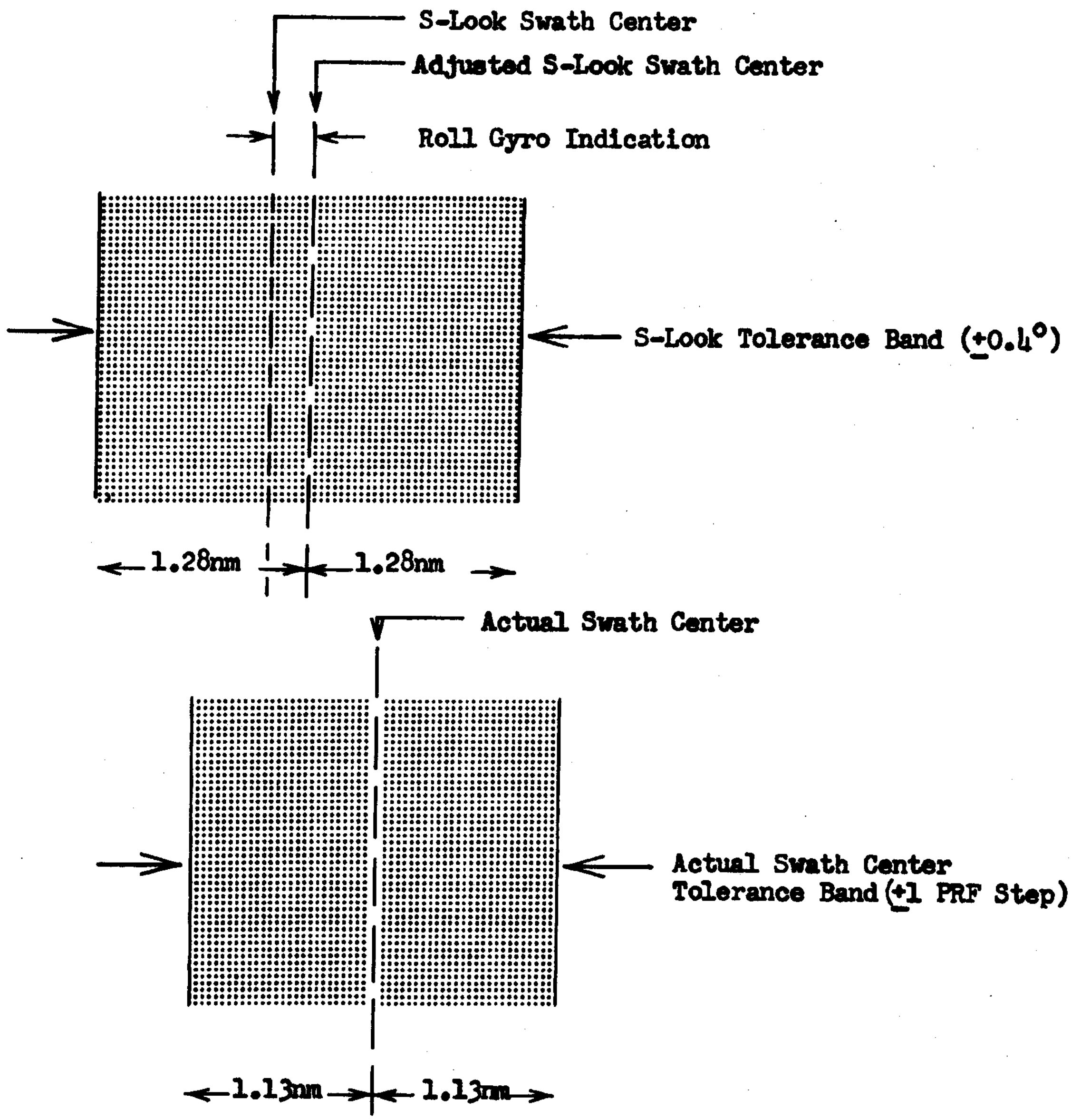

FIGURE 3.2.10 SWATH CENTERLINE COMPARISON

3.3 Command and Control Subsystem

3.3.1 Data Links (VHF)

Quality of Data - All of the telemeter data links performed as specified. Signal strength of all links were adequate for good data quality. No failures or malfunctions have been reported.

3.3.2 Command System

S-band signal strength fluctuations and dropouts during three passes - (NHS 13, KTS 32, KTS 33)

Investigation of S-band Transponder performance revealed that it was activated throughout each of the 44 passes, and a total of approximately 200 S-band commands were transmitted to it and verified. In addition, it was continuously interrogated during each pass to provide the S-band tracking signal.

C&C has reviewed telemetry data from the transponder monitors during the three passes where dropouts occurred (NHS 13, KTS 32, and KTS 33) and three of the passes where large fluctuations occurred (KTS 16, HTS 18, and KTS 31). It is significant that although the receiver interrogation rate monitor (H47) and the modulator interrogation rate monitor (H48) were not affected by even large fluctuations, they both dropped to zero during the periods of signal strength dropout. It is also significant that the transponder temperature monitor (H49) remained steady throughout the passes and the dropouts. (It showed a consistent temperature increase of 4° F during each pass.) Since the receiver level dropped to zero during each dropout, unusual or excessive interference at the receiver input cannot be blamed for the dropout since such interference would have caused this receiver level to increase. Furthermore, a review of the tracking error signals from the ground radar (VERLORT at KTS and PRELORT at NHS) at each tracking station has shown that the radar antenna was locked on at time dropout occurred. Therefore radar antenna misorientation cannot be blamed for the dropout, since if the radar had lost track and caused the dropout by shifting out of the S-band radiation pattern, a large error signal would have appeared just before the dropout when the radar antenna was moving out of the pattern.

With no evidence of malfunction in the transponder, the difficulty must be in the ground radar or an unusual propagation condition which caused a large attenuation of the radar signal.

3.3.3 Wide-band Data Link

Flight Data vs. Calculated Data - Signal strength records from VTS and NHS have been compared with calculated values and found to be in good agreement. Signal strength records from both stations are the best that have been obtained to date. In general, NHS records show signal strengths 4 to 6 db higher than VTS. Calculated values for the passes checked lie between the values of recorded signal strengths. Calculations are shown in Table 3.3.1. Figure 3.3.1 shows recorded signal strengths for three typical passes and the calculated values.

A possible variation of 3 db in transmitting antenna pattern, calibration errors, and differences in propagation losses can easily account for the observed differences and between stations calculated values.

WBDL Temperature and Frequency Response - Wide band data link frequency response is influenced to some extent by temperature. Frequency response curves for room temperature and 100° F are shown in Figure 3.3.2 and 3.3.3. WBDL Exciter temperature ranged from 69° to 77° so that the curve of Figure 3.3.2 is valid for this flight.

3.3.4 Tracking and Acquisition Subsystems

Tracking - The S-band Beacon and 400 mc acquisition transmitter both performed properly throughout the operation.

Acquisition - Apparent out-of-spec center frequency drift by the 400 mc acquisition transmitter occurred.

This problem was reported by NHS, but upon investigation, the station found that the local oscillator crystal in the ground receiver was off frequency.

TABLE 3.3.1

LINK CALCULATION
UHF WIDE BAND DATA LINK

GAIN

Transmitter Power	10 dbw
Transmit Antenna	3 db
Receive Antenna	48 db
	61 dbw

LOSS

Receive Antenna Feed Line	0.9 db
Vehicle Line Loss	1.5 db
Space Loss, 770 n.m. slant range, 5° Elevation	162.5 db
Polarization Loss	3.0 db
Propagation	1.0 db
	168.9 db

Received Signal = -108 dbw
or = - 78 dbm
Receiver Noise Power = - 99 dbm

IF S/N = 21 db

$$\frac{SO}{NO}\frac{(PK)}{(RMS)} = 10 \log \quad 3 \frac{(fd)^2}{(fm)} \frac{Bif}{fm} + \frac{C}{N} \text{ (db)}$$

fm = noise bandwidth of output low pass filter = 9.5 mc

fd = transmitter deviation = 6 mc

Bif = receiver IF bandwidth = 28 mc

$$\frac{SO}{\ }\frac{(PK)}{(RMS)} = 10 \log \quad 3 \frac{(6)^2}{(9.5)} \frac{28}{9.5} + \frac{C}{N} \text{ (db)}$$

$$= 5.5 \text{ db} + 21 \text{ db} = \underline{26.5 \text{ db}}$$

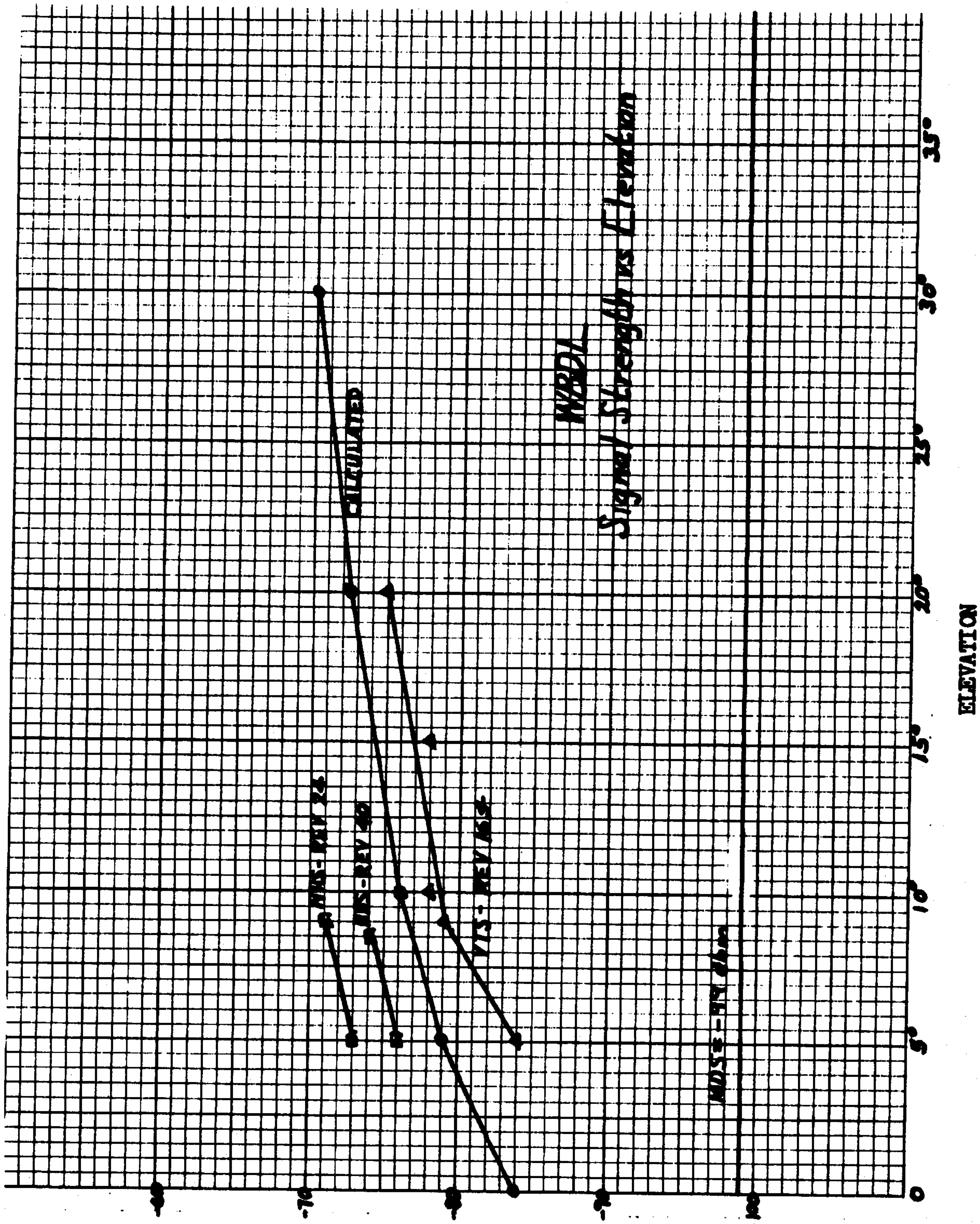

FIGURE 3.3.1 SIGNAL STRENGTH (dbm)

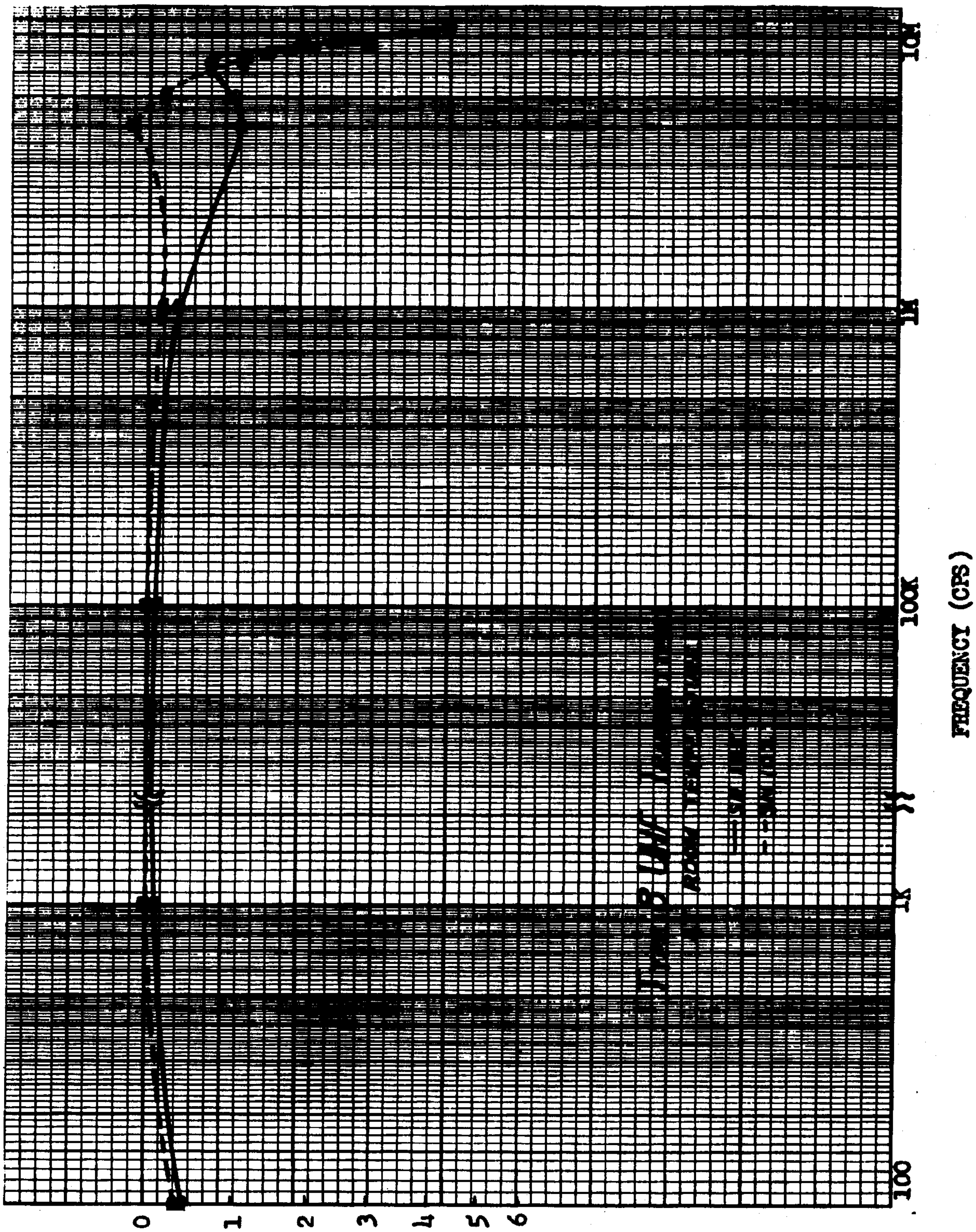

FIGURE 3.3.2 LOSS FROM MID-RANGE (db)

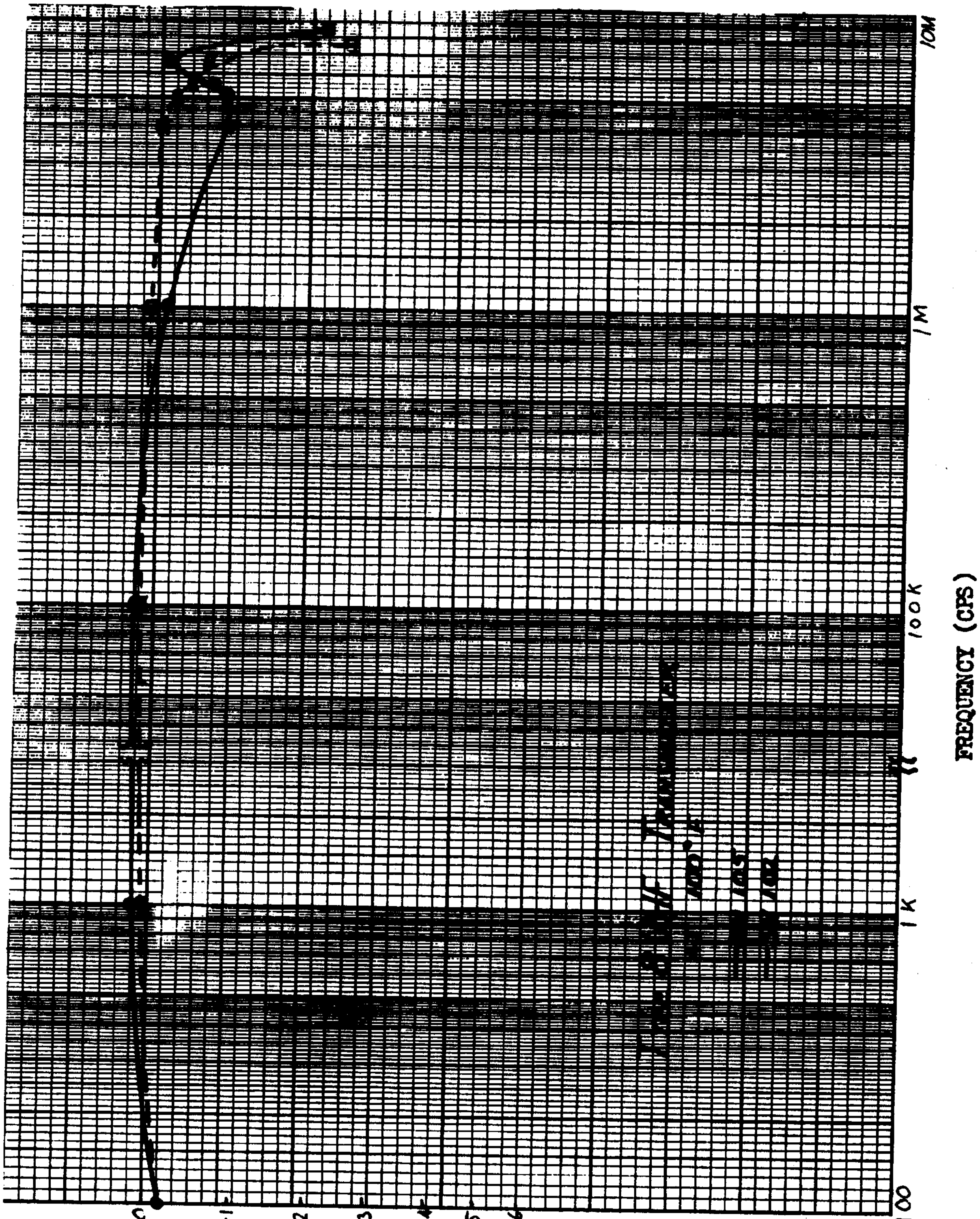

FIGURE 3.3.3 LOSS FROM MID-RANGE OF FIGURE 3.3.2 (db)

3.4 Radar Payload Subsystem

General The satellite vehicle was programmed by means of the orbital programmer to operate for 80 orbits. The payload was programmed to operate through a warmup and a preoperate cycle whenever the satellite was in sight of the Vandenberg AFB or the New Hampshire tracking stations, and when the ground mapping swath was within the Continental United States. The recovery was originally planned for Rev 65. Due to interference with other operations a decision was made to effect recovery on Rev 33. The seven payload operating passes prior to Rev 33 were utilized to acquire a maximum of recovered film data of highest quality. Accordingly, the only payload control which was conducted during these Operate periods consisted of adjusting the PRF. Automatic gain control was used for all passes prior to recovery, as was Clutterlock Integrator (In) and Time Constant #1. Engineering experiments as indicated herein, were conducted during the seven passes following recovery. The objective of this section of the report is the recording of a maximum of payload operating data and performance parameters which would permit subsequent and more detailed evaluation of the system -- as desired.

This section consists of the following paragraphs:

3.4.1 Pass Summary Log (Verbal Reports to STC During Operation) This log contains a quick reference source of all payload operations during this mission, by pass, with operating times per event and cumulative. (Not complete.) Refer to Para. 3.4.2 for specific event details.

3.4.2 Pass Analysis

This paragraph contains the basic data taken from telemetry records, doppler data film and correlated radar imagery, arranged in a time sequenced format for each of the fourteen active payload passes.

3.4.3 Telemetry Schedule

This paragraph contains a basic telemetry listing.

3.4.4 Telemetry Data

This paragraph contains basic telemetry data.

3.4.5 Positioning of the Return Pulse in the Range Gate.

3.4.6 Terrain Reflectivity.

3.4.7 Direct Monitoring of Payload Radiation.

3.4.1

PASS SUMMARY LOG Day 1, 2, 3

Pass	Sta.	Dir.	Payload ON Pass	Payload ON Total	Veh T/R T/O	Significant Events
8	NHS	S-N	120	120		Started pass in PRF Step 14, PAC then stepped to PRF 13, to PRF 12, to PRF 11, and finally to PRF Step 10.
9	VTS	S-N	124	244		Started pass in PRF Step 10. PAC then stepped to PRF 5, then to PRF 6, to PRF 7, to PRF 8, and then to PRF Step 9.
14	NHS	N-S	124	368		Went to PRF Step 10 before payload operate. PAC then went to PRF Step 9 and then to PRF Step 8.
16	VTS	N-S	96	464		Went to PRF Step 10 before payload operate. Did NOT turn control over to PAC.
24	NHS	S-N	130	594		Went to PRF Step 11 on Pass 23. PAC went to PRF Step 10.
25	VTS	S-N	166	760		Went to PRF Step 11 before payload operate. PAC went to PRF Step 10 and then to PRF 9.
30	NHS	N-S	223	983		Went to PRF Step 8 before payload operate. PAC went to PRF Step 9, then back to PRF Step 8. Total of 16.4 min. operation up to recovery.
33	KTS HTS	N-S	----	----		RECOVERY PASS
40	NHS	S-N	109	1092		Went to Attenuator Step 2, then to Attenuator 3.
41	VTS	S-N	146	1238		Went to PRF Step 9 and Attenuator Step 4 before payload operate. Then went thru attenuator Steps 5 and 0 during payload operate.

PASS SUMMARY LOG (Continued) Day 1, 2, 3

Pass	Sta.	Dir.	Payload ON Pass	Payload ON Total	Veh T/R T/O	Significant Events
46	NHS	N-S	194	1432		Went to Attenuator Position #1 and PRF Step 8 before payload operate. PAC went to PRF Step 7, then to PRF 6 during payload operate.
47	VTS	N-S	179	1611		Stepped thru all PRF Steps. (Was on Timer Subcycle 48.)
56	NHS	S-N	105	1716		1. Bypassed Integrater T/C. 2. Went from PRF Step 6 to 7, to 8.
57	VTS	S-N	172	1888		1. Selected T/C #2 and WBDL #2. 2. Went to PRF Step 9, then to 8. 3. Let Brush 4 turn Payload OFF.
72	NHS	S-N	87	1975 (32.91 min.)		1. To PRF Step 7, then to 6. 2. Had very poor Decom Sync.
73	VTS	S-N	---	---		Last pass that was seen by SCF did not operate payload.

PASS LOG

PASS # 8 STATION NHS S-N TIME 2243 (PDT) DATE: 12-21-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
23767		Brush 7 and 8 - Payload Warm-up ON
24097		Brush 9 and 10 - Payload Pre-Operate
24166		NHS Acquire Delta 1 and Delta 2
178		NHS Acquire Delta 3
24247	BCD - 16	Payload Operate ON
24271	" 4	To PRF Step 13 (by PAC)
279	" 3	To PRF Step 12 (by PAC)
300	" 6	To PRF Step 11 (by PAC)
360	" 2	To PRF Step 10 (by PAC)
24367	" 24	Payload Operate OFF
24397	BCD - 39	Reset Enable
438	" 40	RESET
526		Brush 4 Payload OFF
24602		Brush 2 - ALL OFF

TOTAL ON TIME: 120 sec.

GENERAL COMMENTS:

1. Started pass with PRF Step 14 and PAC stepped down to PRF Step 10.

PASS LOG

PASS # 9 STATION VTS S-N TIME 0009 (PDT) DATE: 12-22-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
29021		Brush 7 and 8 - Warm-up ON
29290		Brush 9 and 10 - Payload Pre-Operate
29320		VTS Acq. Delta 1, Delta 2 and Delta 3
375		Tape Index (TPI)
29516	BCD - 16	Payload Operate ON
559	" 9	To PRF Step 5 (by PAC)
583	" 5	To PRF Step 6 (by PAC)
592	" 3	To PRF Step 7 (by PAC)
614	" 8	To PRF Step 8 (by PAC)
619	" 2	To PRF Step 9 (by PAC)
29640	" 24	Payload Operate OFF
29657		Brush 4 - Payload OFF
29716		Brush 2 - ALL OFF

TOTAL ON TIME: 124 sec.

GENERAL COMMENTS:

1. Went into pass on PRF Step 10, PAC then went to Step 5, then 6, to 7, to 8, and finally to 9.

PASS LOG

PASS # 14 STATION KTS, NHS TIME 0751-KTS(PDT) DATE: 12-22-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
57400		Brush 7 and 8 - Payload Warm-up
57669		Brush 9 and 10 - Payload Pre-Operate
57703		NHS Acquire Delta 1, Delta 2 and Delta 3
57779	BCD - 4	PRF to Step 10
57888	" 16	Payload Operate ON
57915	" 5	To PRF Step 9 (by PAC)
57934	" 3	To PRF Step 8 (by PAC)
58012	" 24	Payload Operate OFF
58037		Brush 4 - Payload OFF
58048		Brush 2 - Payload OFF

TOTAL ON TIME: 124 sec.

GENERAL COMMENTS:

1. Went to Payload Step 10 prior to Payload Operate ON.
2. PAC went to Step 9 and then to Step 8.

PASS LOG

PASS # 16 STATION KTS, VTS N-S TIME 1054/1102(PDT) DATE: 12-22-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
68232		Brush 7 and 8 - Payload Warm-up ON
502		Brush 9 and 10 - Payload Pre-Operate ON
68520		VTS Acquire Delta 1, Delta 2 and Delta 3
68584	BCD - 2	PRF to Step 9
594	" 4	PRF to Step 10
68645	" 16	Payload Operate ON
741	" 24	Payload Operate OFF
68978		Brush 4 - Payload OFF
990		Brush 2 - ALL OFF

TOTAL ON TIME: 96 sec.

GENERAL COMMENTS:

1. Did NOT turn control over to PAC.

PASS LOG

PASS # 24 STATION NHS S-N TIME 2236 (PDT) DATE: 12-22-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
23474		Brush 7 and 8 - Payload Warm-up ON
744		Brush 9 and 10 - Payload Pre-Operate ON
23765		NHS Acq. (on Acq. Bcn)
744		Delta 1, Delta 2 and Delta 3 turn ON
23825	BCD - 16	Payload Operate ON
855	" 2	To PRF Step 10 (by PAC)
23955	" 24	Payload Operate OFF
24128		Brush 4 - Payload OFF
198		NHS Fade
24206		Brush 2 - ALL OFF

TOTAL ON TIME: 130 sec.

GENERAL COMMENTS:

1. Went to PRF Step 11 on Pass 23. PAC went to Step 10.

PASS LOG

PASS # 25 STATION VTS S-N TIME 0001 (PDT) DATE: 12-23-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND		REMARKS
28625			Brush 7 and 8 - Payload Warm-up ON
894			Brush 9 and 10 - Payload Pre-Operate
28925			VTS Acquire Delta 1 and Delta 2
969			VTS Acquire Delta 3
29002	BCD -	3	To PRF Step 11
29098	"	16	Payload Operate ON
149	"	2	To PRF Step 10
198	"	5	To PRF Step 9
29264	BCD	24	Payload Operate OFF
29289			Brush 4 - Payload OFF
29333			Brush 2 - ALL OFF

TOTAL ON TIME: 166 sec.

GENERAL COMMENTS:

1. Went to PRF Step 11 before payload operate.
2. PAC went to Step 10 and then to Step 9.

PASS LOG

PASS # 30 STATION KTS,NHS N-6 TIME 0743/0754 (PDT) DATE: 12-23-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
56965		Brush 7 and 8 - Payload Warm-up ON
57234		Brush 9 and 10 - Payload Pre-Operate ON
57293	BCD - 3	To PRF Step 8
57366	BCD - 16	Payload Operate ON
394	" 2	To PRF Step 9 (by PAC)
518	" 3	To PRF Step 8 (by PAC)
589	BCD -24	Payload Operate OFF
604		Brush 4 - Payload OFF
57616		Brush 2 - ALL OFF

TOTAL ON TIME: 223 sec.

GENERAL COMMENTS:

1. Went to payload Step 8 before payload operate.
2. PAC went to Step 9, then back to Step 8.
3. KIK ZORRO 36 was sent on Pass 29. This commits us to Recovery on Pass 33.

PASS LOG

PASS # 33 STATION KTS,HTS N-S TIME 1218-KTS (PDT) DATE: 12-23-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
72143		KTS Acq. Delta 1 and Delta 2
72201.4		Pitch Down
355.8		Elect. Disconnect
357		Separation
359		Spin-up
366.4		Retro-fire
377		De-Spin
378		T/C Eject
72451.6		VM Closed
		First sighting by A/C #5
75153		#5 Making Look-See Pass
153		#5 Reports Capsule OK
255		#5 Lined up in position for Pick-Up
355		Capsule in Trail
75804		Capsule aboard aircraft [redacted] - Pilot)

PASS LOG

PASS # 40 STATION NHS S-N TIME 2229 (PDT) DATE: 12-23-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
22998		Brush 7 and 8 - Payload Warm-up ON
23266		Brush 9 and 10 - Payload Pre-Operate ON
23349		NHS Acq. Delta 1 and Delta 2
367		Acq. Delta 3
23410	BCD - 16	Payload Operate ON
422	" 12	To Attenuator Step 2
484	" 15	To Attenuator Step 3
23519	" 24	Payload Operate OFF
23651		Brush 4 Payload OFF
743		Brush 2 ALL OFF

TOTAL ON TIME: 109 sec.

PASS LOG

PASS # 41 STATION VTS TIME 2354 (PDT) DATE: 12-23-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND		REMARKS
28146			Brush 7 and 8 - Payload Warm-Up ON
415			Brush 9 and 10 - Payload Pre-Operate ON
28436			VTS Acquire Acq. Bcn.
446			Delta 1, Delta 2 and Delta 3
28497	BCD -	2	To PRF Step 9
524	"	10	To Attenuator Position 4
28654	"	16	Payload Operate ON
692	"	14	To Attenuator Position 5
727	"	15	
735	"	11	To Attenuator Position 0
741	"	13	
28800	"	24	Payload Operate OFF
28817			Brush 4 - Payload OFF
872			Brush 2 - ALL OFF

TOTAL ON TIME: 146 sec.

GENERAL COMMENTS:

1. Was on Step 9 throughout Payload Operate.
2. Went to Attenuator Position 4 before Payload Operate and to Position 5, and then 0 during Payload Operate.

PASS LOG

PASS # 46 STATION NHS N-S TIME 0748 (PDT) DATE: 12-24-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND		REMARKS
56529			Brush 7 and 8 - Payload Warm-up ON
796			Brush 9 and 10 - Payload Pre-Operate ON
56879			NHS Acquire Delta 1, Delta 2 and Delta 3
56923	BCD -	14	Attenuator to Position 1
940	"	3	To PRF Step 8
56956	"	16	Payload Operate ON
57074	"	9	To PRF Step 7 (by PAC)
116	"	2	To PRF Step 6 (by PAC)
57150	"	24	Payload Operate OFF
57164			Brush 4 - Payload OFF
57179			Brush 2 - ALL OFF

TOTAL ON TIME: 194 sec.

GENERAL COMMENTS:

1. Went to Attenuator Position 1 and PRF Step 8 before Payload Operate.
2. PAC went to PRF Step 7 and then 6 during Payload Operate.
3. Sent a "Subcycle Skip" - to have Timer on Subcycle 48 for Pass 47.

PASS LOG

PASS # 47 STATION VTS N-S TIME 0918 (PDT) DATE: 12-24-64
(Sheet 1 of 2)

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
62022		Brush 7 and 8 - Payload Warm-up ON
257		VTS Acq. Delta 1 and Delta 2
62330	BCD - 17	Payload Pre-Operate ON
62343	BCD - 16	Payload Operate ON
360	" 3	To PRF Step 7
370	" 8	To PRF Step 8
380	" 2	To PRF Step 9
390	" 4	To PRF Step 10
400	" 3	To PRF Step 11
410	" 7	To PRF Step 12
420	" 2	To PRF Step 13
430	" 5	To PRF Step 14
440	" 3	To PRF Step 15
450	" 9	To PRF Step 0
460	" 2	To PRF Step 1
470	" 4	To PRF Step 2
480	" 3	To PRF Step 3
490	" 6	To PRF Step 4

PASS LOG

PASS # 47 STATION VTS TIME 0918 (PDT) DATE: 12-24-64
(Sheet 2 of 2) N-S

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
62500	BCD - 6	To PRF Step 5
510	" 2	To PRF Step 6
62522	" 24	Payload Operate OFF
62729		Brush 4 - Payload OFF
744		Brush 2 - ALL OFF

TOTAL ON TIME: 179 sec.

GENERAL COMMENTS:

1. Stepped thru all PRF Steps.
2. Was on Timer Subcycle 48 - and also sent a REPEAT to get timer back to Subcycles.

PASS LOG

PASS # 56 STATION NHS S-N TIME 2222 (PDT) DATE: 12-24-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
22574		Brush 7 and 8 - Payload Warm-up ON
842		Brush 9 and 10 - Payload Pre-Operate ON
940		NHS Acquire
22981	BCD - 16	Payload Operate ON
995	" 20	Bypass Integrator T/C
23014	" 3	To PRF Step 7 (by PAC)
018	" 8	To PRF Step 8 (by PAC)
23086	" 24	Payload Operate OFF
208		Brush 4 - Payload OFF
23286		Brush 2 - ALL OFF

TOTAL ON TIME: 105 sec.

PASS LOG

PASS # 57 STATION VTS S-N TIME 2347 (PDT) DATE: 12-24-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
27704		Brush 7 and 8 - Payload Warm-up ON
972		Brush 9 and 10 - Pre-Operate ON
28004		VTS Acquire
28049	BCD - 19	Selected T/C #2
077	" 43	Selected WBDL #2
28104	" 2 =	To PRF Step 9
28217	" 16	Payload Operate ON
352	" 3	To PRF Step 8
28389		Brush 4 - Payload OFF
28442		Brush 2 - ALL OFF

TOTAL ON TIME: 172 sec.

GENERAL COMMENTS:

1. Selected T/C 2 and WBDL #2.
2. Started pass on PRF Step 9 then PAC went to Step 8.
3. Did not send Payload Operate OFF - Brush 4 turned Payload OFF.

PASS LOG

PASS # 72 STATION NHS S-N TIME 2214 (PDT) DATE: 12-25-64

EVENT SEQUENCE

SYSTEM TIME	EVENT OR COMMAND	REMARKS
22130		Brush 7 and 8 - Payload Warm-up
22400		Brush 9 and 10 - Payload Pre-Operate ON
22502		NHS Acquire
22601	BCD - 16	Payload Operate ON
624	" 9	To PRF Step 7
630	" 2	To PRF Step 6
22688	" 24	Payload Operate OFF
22764		Brush 4 - Payload OFF
22843		Brush 2 - ALL OFF

TOTAL ON TIME: 87 sec.

3.4.2 Pass Analysis

This section contains data pertaining to payload operation throughout each of the fourteen active passes. The data utilized for preparation of these operating summaries for each pass consisted of the S-Look tabulations, all the telemetry records, the doppler history film negative and the correlated radar imagery. The ephemeris data associated with the payload on times for each pass is given here, as is a summary of Radar Map Scale Factors. The vehicle velocity over the ground was approximately 3.99 NM/second - depending upon altitude. The copy of the radar imagery which was used was an early copy and was admittedly not equivalent to the final quality map prints, but was sufficient for this general evaluation. A large number of striated markings were noted on the doppler film, which are termed "Rabbits" in the evaluation comments. These markings displayed distinctive patterns, which, when measured in frequency and length, appear to be caused by other X-band radars, the received pulses of which are causing brief abnormalities of CRT sweep modulation. Two examples; one on Pass 8 calculated to be at 1163 cps repetition rate with 4.8 microsecond pulse width, and Pass 9 of 842 cps repetition rate with .77 microsecond pulse width.

The radar imagery utilized in making the following observations was a 2.6:1 enlargement copy, of an early correlator run, not necessarily controlled for optimum data. These fourteen pass images will become a part of the archival material from this mission, therefore the scale factors, dimensions and comments result from the particular observation pertaining to these image copies.

This end to end record of the events and imagery resulting is included in this system report in the interests of completeness, since a similar total evaluation summary is not available elsewhere. This section, together with the individual pass imagery and the other data contained in this report, will permit fuller evaluation at a later date - if required.

3.4.2.1 Orbit 8 North to South Pass - NHS

Recovery capsule data film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	24255.3	24369.5
o Vehicle flight path location:	38.37°N 84.97°W	45.21°N 80.76°W
o Vehicle altitude:	138.367 NM	137.834 NM
o Radar look point:	38.93°N 86.90°W	45.91°N 82.84°W
o Radar target slant range:	170.615 NM	169.951 NM
o Radar map swath length:	Approximately 456.8 NM	

Radar Map Scale Factors

- Measured radar map length = 213.5 inches
- Measured data track film length = 571 inches
- Elapsed payload on time = 114.2 seconds
- Radar map azimuth scale = 1.86 inches/second

$$\frac{213.5}{114.2} = 1.86 \text{ inches/second}$$

Radar Map Evaluation

The first 32.5 inches of map has poor detail visible in the far range. PRF Step 14 is probably too low in repetition rate.

From 32.5 to 44.7 inches the map far range detail still is poor due to low PRF.

Map detail from 44.7 to 83.8 inches is improved and was recorded with PRF Step 12.

From 83.8 inches to 213.5 inches the map was produced with the PRF on Step 11. The illumination and detail is generally good.

Over the bay by Alpena and North Point, Michigan, shore and lake ice formations were recorded.

Major land marks such as roads, rivers and communities can be identified without difficulty.

Operating Chronology in Telemeter Time:

System Time	Function and Effect
	Payload Warm-up ON - PRF on Step 14.
	Payload Pre-Operate ON.
	NHS acquired telemetry.
	NHS acquired Wide Band telemetry.
24249.4	Payload Operate ON - Film Drive ON.
24255.3	Payload High Voltage ON. The radar map begins with the near range dark and changing to light in the far range. From approximately 1.8 inches to the end of the far range detail is obscured.

System Time	Function and Effect
	At 24266 seconds there is a gradual building of noise on the data track film corresponding closely to a glitch (anomaly) noted on telemeter points C283 and C284. No apparent effect on the radar map.
	"Rabbits" are on the data track film are noted in increasing numbers and intensity until sudden drop-off when the PRF is changed to Step 12 at 24279.7 seconds.
24273.3	PRF changed to Step 13.
	Map illumination improves but the far range is still light with loss of detail.
	The radar map information appears to have moved about 0.1 inches to the far range and about 0.2 inches to the left in azimuth.
24279.9	PRF changed to Step 12.
	The map illumination improves but still with a light streak in the far range. Detail is generally good.
	The radar map information appears to have moved about 0.3 inches to the far range and about 0.15 inches to the right in azimuth.
24300.7	PRF changed to Step 11.
	The radar map information moved about 0.3 inches

System Time	Function and Effect
	to the far range.
	Illumination of the map is good but still with a very light streak in the far range which disappears in 16 inches of map, corresponding to approximately 8.6 seconds.
	At about 196.7 inches of radar map there is a strip of fog 2.8 inches long corresponding to 10 inches of fog on the data track film, starting at 24359.8 seconds. This section is over Lake Huron.
24369.5	Payload Operate OFF - Film Drive OFF.
	Payload Warm-Up OFF.
	Telemetry OFF.

3.4.2.2 Orbit 9 South to North Pass - VTS

Recovery capsule data film analyzed.

Vehicle Target Geometry (S-Look)	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	29524.1	29641.8
o Vehicle flight path location:	31.00°N 110.73°W	39.22°N 107.17°W
o Vehicle altitude:	138.891 NM	138.249 NM
o Radar look point:	32.56°N 112.54°W	39.81°N 109.11°W
o Radar target slant range:	171.265 NM	170.467 NM
o Radar map swath length:	Approximately 470 NM	

Radar Map Scale Factors

- o Measured radar map length = 221.3 inches
- o Measured data track film length = 588.5 inches
- o Elapsed payload on time = 117.7 seconds
- o Radar map azimuth scale = 1.88 inches/second

$$\frac{221.3}{117.7} = 1.88 \text{ inches/second}$$

Radar Map Evaluation

The radar map begins about 53 nautical miles south of Phoenix, Arizona.

On the map the near range is lighter than the far range.

At 70 inches of recorded imagery the PRF is changed to Step 5 where detail is lost in the center of the map.

A reversal of data recorded, i.e., far range information in the near range, which was caused by improper PRF, as discussed elsewhere in this report. (See Part I, Para. 1.6.)

As the PRF was changed toward Step 9 the far range information moved toward the near range, and in Step 9 the range data appears in the correct order.

On the imagery produced with PRF Step 10, 8 and 9, major land marks such as rivers, roads and communities can be identified without difficulty.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	Payload Warm-Up ON - PRF on Step 10.
	Payload Pre-Operate ON.
29518.0	Payload Operate ON - Film Drive ON.
29524.1	Payload High Voltage ON. The radar map begins south of Phoenix, Arizona. The near 1/3 of near range is light with detail washed out and the 2/3 of far range is dark with detail obscured. At about 8 inches of map, the far range details appears to improve and a darker strip on the extreme far range disappears.

System Time	Function and Effect
	Details of Phoenix appears generally good except for the near 1/3 of range which appears lighter than optimum. At 36 inches of map the overall illumination becomes more even.
29561.5	PRF changed to Step 5.
	"Rabbits" recorded on the data track film for one second not observable on the radar map.
	A radical change occurred in the radar map. Far range imagery is recorded in the near range. There is a very light streak centered 1.3 inches from the near range edge with an apparent loss of continuity (see Para. 3.4.5, Positioning of Reflected Energy in the Range Gate).
29853.4	PRF changed to Step 6.
	At 111 inches the far range detail moved toward the near range but the amount of movement is difficult to measure due to a lack of detail. It still appears that the extreme near range information belongs in the far range.
29592.6	PRF changed to Step 7.
	At 128.5 inches of map the information moved approximately 0.3 inch toward the near range. The first 1/4 of near range information appears to belong in the far range.

System Time	Function and Effect
29614.6	PRF changed to Step 8. "Rabbits" appear on the data track film for the entire PRF Step period but are not recognizable on the radar map. At 169.5 inches the radar map information appeared to shift about 0.3 inch toward the near range. The near 1/3 of range still appears to be washed out. The Colorado River detail is good.
29620.5	PRF changed to Step 9. "Rabbits" appear on the data track film for 0.7 seconds with no observable effect on the radar map. The radar map information shifted 0.3 inches to the near range and the image is properly reconstructed. Detail of the swath is good except for the first 0.2 to 0.3 inches of the near range where detail appears washed out for a length of approximately 6 inches. Fog appears on the radar map at 204.5 inches for a length of 3.6 inches, corresponding to 10 inches of fog on the data track film. The remainder of the map is evenly illuminated and ends at 221.3 inches.

3.4.2.3 Orbit 14 North to South Pass - NHS

Recovery capsule data film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	57896.7	58014.2
o Vehicle flight path location:	41.37°N 81.72°W	34.20°N 77.89°W
o Vehicle altitude:	128.460 NM	127.876 NM
o Radar look point:	41.98°N 79.87°W	34.75°N 76.19°W
o Radar target slant range:	158.283 NM	157.557 NM
o Radar map swath length:	Approximately 471 NM	

Radar Map Scale Factors

- Measured radar map length = 221.5 inches
- Measured data track film length = 614 inches
- Elapsed payload on time = 117.5 seconds
- Radar map azimuth scale = 1.89 inches/second

$$\frac{221.5}{117.5} = 1.89 \text{ inches/second}$$

Radar Map Evaluation

The radar map starts over Lake Erie with the PRF on Step 10. The first 8 inches from the point identified as high voltage on is light with poor detail. At about 8 inches the detail is good with a very light streak in the far range which disappears at approximately 18 inches.

PRF Step 9 begins at 39.5 inches on the radar map, the detail is good and the illumination is good. This PRF produced the best portion of the imagery for Pass 14.

At 72.5 inches PRF Step 8 begins and the map has the same general appearance as with PRF Step 9 except for a dark strip in the extreme far range. The same general appearance is maintained for the remainder of the map which ends over the Atlantic Ocean near Pamlico Sound, North Carolina.

Major land marks such as roads, rivers, and communities can be identified without difficulty.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	Payload Warm-up ON - PRF on Step 10.
	Payload Pre-Operate ON.
	NHS acquired VHF and Wide Band Telemetry.
57889.7	Payload Operate ON.
	"Rabbits" recorded on the data track film with no apparent effect on the radar image.
57896.7	Payload High Voltage ON.
	"Rabbits" on the data track film disappear.
57917.6	PRF changed to Step 9.
	The radar map information moved approximately 0.25 inches to the far range and to the

System Time	Function and Effect
	right in azimuth (direction of flight) at the extreme far range.
57935.2	PRF changed to Step 8.
	"Rabbits" on the data track film increasing in strength to end of pass. No apparent effect on radar map.
	The effect of PRF change from Step 9 to 8 is difficult to identify on the imagery.
	Ten inches of fog appears on the data track film at about 58003 seconds which corresponds to a fogged portion of the radar map at 205 inches. This area includes a small amount of land in Pamlico Sound, North Carolina.

3.4.2.4 Orbit 16 North to South Pass - VTS

Recovery capsule data analysed.

Vehicle Target Geometry

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	68653.0	68745.0
o Vehicle flight path location:	40.76 N 126.62 W	35.15 123.62
o Vehicle altitude:	128.494 NM	128.040 NM
o Radar look point:	41.37 N 124.79 W	37.71 N 121.90 W
o Radar target slant range:	158.325 NM	157.760 NM
o Radar map swath length:	Approximately 358.8 NM	

Radar Map Scale Factors

- o Measured radar map length = 172.8 inches
- o Measured data track film length = 448.5 inches
- o Elapsed payload on time = 89.7 seconds.
- o Radar map azimuth scale = 1.92 inches/second

$$\frac{172.8}{89.7} = 1.92 \text{ inches per second.}$$

Radar Map Evaluation

- o The radar image begins on the Pacific Ocean west of Crescent City, California, with the PRF on Step 10. Water fills the first 23.8 inches. About 0.7 inches of the near range is very dark, the next inch of range is lighter and the remainder of range is lighter. (PRF not optimum.)

- At 23.8 inches land begins to fill the range swath just north of the Eel and Salt Rivers. This corresponds to appr ximately 68666 seconds where the AGC monitored on F53 abruptly increases 7 db. The radar map continues over land to 39 inches where water begins to partially fill the range swath. The near-half in range is darker than the far-half of range which shows a loss of detail.
- At 39 inches the terrain becomes a combination of land and water and the AGC monitored on F53 abruptly drops 5 db. The far-half of range becomes darker with good detail but the near-half of range is still darker.
- Land covers the range swath at 60 inches where the AGC monitored on F53 increases, the near range is dark with poor detail and the map becomes lighter in range.
- A vertical smudge appears on the radar map at 83 inches apparently due to processing of the data track film.
- From 85 to 106 inches the radar map is a combination of land and water which includes the Russian River, Boedga Bay and Point Reyes, California. A number of dark areas appear on the radar map, over the water, which are rain cloud returns.
- From 106 to 172.8 inches the map covers water only ending southwest of Point Sur, California. At 151.5 inches 3.7 inches of fog appears corresponding to 10 inches of fog on the data track film.

- o Quantitative comparisons of the radar map were not made with USGS maps for the purpose of measuring distance or speed.
- o Identification of major land marks such as rivers and roads can be made without difficulty. Terrain changes corresponding to AGC changes shown on F53 can be easily identified by terrain and telemetry time.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	Payload Warm-Up ON - PRF on Step 8.
	Payload Pre-Operate ON.
	VTS acquired VHF and Wide Band telemetry.
68586.7	PRF changed to Step 9.
68595.0	PRF changed to Step 10.
	Payload Operate ON - Film Drive ON
	o "Rabbits" on the data track film increased in signal strength until high voltage ON.
68653.5	Payload High Voltage ON.
	o There were no anomalies noted on the data track film except for 10 inches of fog starting at approximately 68733.7 seconds.
68743.0	Payload Operate OFF - Film Drive OFF.
	Payload Warm-up OFF.
	Telemetry OFF.

3.4.2.5 Orbit 24 South to North Pass - NHS

Recovery capsule data film analyzed.

Vehicle Target Geometry (S-Look)	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	23833.7	23956.1
o Vehicle flight path location:	38.90°N 86.82°W	46.19°N 84.29°W
o Vehicle altitude:	137.543 NM	136.982 NM
o Radar look point:	39.53°N 88.74°W	47.15°N 82.19°W
o Radar target slant range:	169.592 NM	168.893 NM
o Radar map swath length:	Approximately 500 NM	

Radar Map Scale Factors

- Measured radar map length = 231.7 inches.
- Measured data track film length = 612 inches.
- Elapsed payload on time = 122.4 seconds.
- Radar map azimuth scale = 1.89 inches/second.

$$\frac{231.7}{122.4} = 1.89 \text{ inches/second.}$$

Radar Map Evaluation

The first 44.4 inches of radar map covering land only with the PRF on Step 11 generally has good detail. The PRF appears to be one (1) step too high (repetition rate too low).

The remaining 187.3 inches of radar map covering land and water, and combination of land and water, with the PRF on Step 10 appears to have good detail except for a) an area of increased reflectivity on the south shore of Lake Michigan, b) land areas adjacent to water and c) 2.8 inches of fog on the data track film.

Quantitative comparisons of the radar map and USGS maps were not made. Points can be located on the radar map without difficulty. Major land marks such as roads, rivers, communities, and airports can be identified without difficulty.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	Payload warm-up ON - PRF on Step 11
	Payload Pre-operate ON
	NHS acquired acquisition beacon
	VHF-TM and Wide Band telemetry ON
	Payload Operate ON - Film Drive ON
	"Rabbits" on data track film, until high voltage on, in varying strengths depending upon doppler history strength - no apparent effect on radar map.
23833.7	Payload High Voltage ON
	The first 44.4 inches of radar map covering land only was produced with the PRF on Step 11 and is calculated to be approximately 94 nautical miles in length. The detail is generally good. There is a light streak in the middle of the far-half

System Time	Function and Effect
	in range apparently due to the PRF being one (1) step too high (the repetition rate too low). The clutterlock output monitored on F60 started from +1.3 volts at 23833.7 seconds to +0.5 volt at 23845.0 seconds and remained there until about 23857 seconds.
23857.0	PRF changed to Step 10 Map information shifted about 0.33 inches to the far range (1.27 nautical miles) at the PRF change. "Rabbits" on the data track film in varying strengths depending on doppler signal strength. These apparently have no effect on the radar map. The first 27.5 inches of radar map produced with the PRF on Step 10 covers land only and is calculated to be 58.5 nautical miles in length. The light streak in the middle of the far-half in range (from PRF Step 11) disappears in about 3.25 seconds and the map is evely illuminated with good detail to about 14 nautical miles from the Lake Michigan shoreline. Within this 14 miles, the AGC monitored on F53 increased 2.5 db until water made up about one-half of the target in range.

System Time	Function and Effect
	Lake Michigan takes about 52.5 inches of the radar map starting about 23871 seconds, which is calculated to be 111 nautical miles in length as displayed on the map.
	At 124 inches of map Lake Michigan shoreline is reached (going north). The land terrain is dark until the land itself almost fills the radar map in range. The far-half of range is then lighter than the near-half of range and continues this way for about 27 inches which is calculated to be approximately 14.3 seconds. The map continues with even illumination and good detail for 17 inches where the terrain contains a large amount of water. At 23908.8 seconds a 0.02 second loss of data occurs - cause unknown - with no apparent effect on the radar map.
	From 168 to 203 inches the radar map is a combination of land and water which is calculated to be about 74 nautical miles. The first 5 inches this portion appears to be evenly illuminated then

System Time	Function and Effect
	the land area becomes dark with loss of detail. AGC monitored on F53 follows the terrain. At 23929.7 seconds a 0.02 second loss of data occurred on the data track film without any apparent effect on the radar map.
	From 203 to 218.5 inches the radar map covers land terrain with the far-half of range lighter than the near-half of range. At 215 inches on the radar fog covers 2.8 inches corresponding to 10 inches of fog on the data track film at 23956.3 seconds - map details are obscured.
	From 218.5 inches to the map end at 231.7 inches the radar map terrain is a combination of land and water and appears evenly illuminated except land adjacent to water which is dark. Land detail is good except near water. AGC monitored on F53 follows the terrain.
	The clutterlock goes from +0.5 volt to +0.1, at the PRF change and start up at 23867 seconds and reaches +0.5 volt at about 23897 seconds. It remains between +0.5 and +0.8 volts for the remainder of the operate period.
23956.1	Payload Operate OFF
	Payload warm-up OFF

System Time	Function and Effect
	Station Fade
	Telemetry OFF

3.4.2.6 Orbit 25 South to North Pass - VTS

Recovery capsule data film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	29106.2	29266.0
o Vehicle flight path location:	32.77°N 112.52°W	42.42°N 107.36°W
o Vehicle altitude:	138.018 NM	137.209 NM
o Radar look point:	33.31°N 114.27°W	43.13°N 109.36°W
o Radar target slant range:	170.159 NM	169.166 NM
o Radar map swath length:	Approximately 639.2 nautical miles.	

Radar Map Scale Factors

- Measured radar map length = 301 inches.
- Measured data track film length = 799 inches.
- Elapsed payload on time = 159.8 seconds.
- Radar map azimuth scale = 1.885 inches/seconds

$$\frac{301}{159.8} = 1.885 \text{ inches/second.}$$

Radar Map Evaluation

The first 3.5 inches of radar map lacks detail in light returns. AGC monitored on F53 follows this pattern.

From 3.5 inches to 52 inches the radar map detail and illumination is good. From 52 inches to 84.3 inches the far-half of range is lighter than the near-half of range due to the PRF not being on an optimum setting.

At 174.5 inches the PRF was changed to Step 9 where the illumination appears to improve. Step 9 appears to be the best PRF. Between 222 and 234 inches the terrain reflectivity seemed to increase which corresponds to a momentary increase in AGC voltage monitored on F53. From 234 to 252 inches the map detail and illumination is good.

From 252 to 285 inches the map is generally lighter in the far-half of range. The map is fogged 3.7 inches due to fog on the data track film.

At about 293 to 301 inches the details are washed out in the far range. AGC voltage monitored on F53 shows an increase of 2 db for this period.

Two (2) areas on the radar map were selected for quantitative comparisons with USGS maps. The first area is south of Big Sandy River, Arizona, and close to "S" Look parameters 34.21°N - 113.95°W which indicates a ground speed of 4.01 nautical miles per second, as expected, and a range swath of 9.5 nautical miles. The second area is north of Urie, Utah, close to "S" Look parameters 41.56°N - 110.27°W which indicates a ground speed close to 3.94 nautical miles per second and a range swath of 9.35 nautical miles. Points can be located on the map without major difficulty. Major land marks such as roads, rivers, communities, and airports can be identified without difficulty.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	Payload Warm-Up ON - PRF on Step 10.
	Payload Pre-Operate ON.
	VTS acquired VHF telemetry.
	VTS acquired Wide Band telemetry.
29004.0	PRF changed to Step 11.
	"Rabbits" recorded on the data track film which were strong with no apparent effect on the radar map.
29106.2	Payload High Voltage ON.
	"Rabbits" on data track film decreased in strength with apparent change in repetition rate - no apparent effect on radar map.
	The radar map begins with the first 3.5 inches of detail light. The near-half of range is darker than the far-half of range with a slightly darker strip in the middle. The AGC voltage monitored on F53 is 2 db below the average for this period of time.
	At approximately 20 inches from the start the radar map appears to be evenly illuminated and the detail appears good.

System Time	Function and Effect
	At about 25 inches from the start the AGC monitored on F53 shows a momentary drop of approximately one (1) db. This corresponds to about 29120 seconds and where the Arizona Cactus Plain Sand Dunes fills the entire radar map in range.
	From about 20 inches to 30 inches of radar map the terrain elevation changes from 200 feet to 3137 feet - the illumination and detail appears good. This 20 inches closely corresponds to the integrator output, monitored on F60, going from -2.0 volts to -0.5 volt.
	At approximately 39 inches on the image the far-half of range becomes lighter than the near-half of range. This corresponds to the approach to the Hualapai Mountains just south of the Big Sandy River crossing.
29151.3	PRF changed to Step 10.
	"Rabbits" on the data track film decreased in strength with no apparent effect on the radar map.
	At 84.3 inches the radar map information moved 0.35 inches (approximately 1.23 nautical miles) to the far range, the near-half of range became abruptly lighter than with PRF Step 11 and the

System Time	Function and Effect
	far-half of range became darker. As the Grand Canyon is crossed the map becomes lighter, more evenly illuminated and the AGC monitored on F53 goes up (just over the canyon) approximately 5 db. After crossing the Grand Canyon the far-half of range remains light and the near-half of range dark with an overall loss of detail. At about 158 inches the near-half range becomes darker for approximately 0.8 inches from the leading edge (this is 3 shades in contrast). From 29151.3 to 29199.5 the integrator output monitored on F60 varied between -0.8 and 0.0 volts.
29199.5	PRF changed to Step 9.
	At about 174.5 inches, corresponding to 29199.5 seconds, the radar map information moved 0.35 inches (approximately 1.23 nautical miles) to the far range. The near-half of range becomes evenly illuminated and the far-half of range remains light. At about 182 inches the radar map illumination becomes even and is generally good to about 221 inches. From 221 to 235 inches the far-half in range is lighter. Just south of Urie, Utah, at 235 inches which corresponds to 29232 seconds the map terrain is

System Time	Function and Effect
	evenly illuminated with good detail. This continues to 252 inches, just north of Urie, where the far-half in range becomes lighter. Horizontal streaks appear in the center of the radar map from 260 to 272 inches apparently due to processing.
	At 285 inches on the radar map a strip of fog 3.7 inches long obscures data which corresponds to 10 inches of fog on the data track film starting at 29256 seconds. Fog appears to continue to about 293 inches, where the map continues to 301 inches, with the far-half of range lighter than the near-half of range.
	From 29199.5 to 29266.0 seconds the integrator output monitored on F60 varies between -0.8 and 0.0 volts.
29266.0	Payload Operate OFF - Film Drive OFF
	Payload Warm-Up OFF
	Telemetry OFF

3.4.2.7 Orbit 30 North to South Pass - NHS

Recovery capsule data film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	57374.4	57591.1
o Vehicle flight path location:	46.64°N 87.39°W	33.34°N 79.62°W
o Vehicle altitude:	128.941 NM	127.847 NM
o Radar look point:	47.32°N 85.40°W	34.10°N 78.02°W
o Radar target slant range:	158.882 NM	157.521 NM
o Radar map swath length:	861 NM	

Radar Map Scale Factors

- Measured radar map length = 406 inches
- Measured data track film length = 1082 inches
- Elapsed payload on time = 216.7 seconds
- Radar map azimuth scale = 1.87 inches/second

$$\frac{406}{216.7} = 1.87 \text{ inches/second}$$

Radar Map Evaluation

The Radar Map quality was good and little data was lost due to improper PRF settings. Some areas of special interest are the following:

- Divider strip US Highway 2 in Michigan at 57395 seconds.
- Parked aircraft at Wurtsmith AFB, Michigan, at 57423 seconds.
- Side lobe ghosts at Cleveland, Ohio, at 57471 seconds.
- Ships near Wilmington, North Carolina at 57590.5 seconds.

The PRF was never more than one step from optimum and the two corrections made during the pass were in the proper direction (steps 8 and 9 utilized).

When the PRF was set at optimum a dark streak, approximately 20% of the swath width, appeared in the center of the Radar Map. More attenuation was needed at the center of the STC curve to match the radar antenna pattern.

The Radar Map has six (6) sections each approximately one half (.5) second wide where the data is blurred (Ref. Operating Chronology). The blurred sections appear to be processing problems.

Glitches and Rabbits observed on the Data Track Film did not appear on the Radar Map.

AGC was used for the entire pass. The range of the AGC during the pass was from -96.8 to -74.4 dbm. The largest abrupt change was 18.4 db at the water-land interface at Albert E. Sleeper State Park, Michigan: Time 57430 seconds.

Ghost images of strong Cleveland, Ohio, targets appeared .68 seconds before the main lobe targets appeared at 57471.5 seconds. The AGC change at the Cleveland land-water interface was 15.6 db. The ghost targets appeared before the AGC reduced the receiver gain.

Roll gyro output varied from -.1° to +.05°, pitch gyro varied from -1.7° to +1.1° and yaw gyro varied from -.15° to +.2° during the pass. From 57400 seconds to the end of the pass the pitch gyro varied from +.1 to +15°; the yaw gyro from 0° to +.2° and the Clutterlock Integrator output from -1.3 to -2.6 VDC.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	PRF in Step 9.
56965	WARM-UP ON
57234	PRE-OPERATE ON
57293	NHS acquired VHF-TM Links 1 and 2 and the WIDE BAND DATA LINK.
57334.7	PRF to Step 8.
	OPERATE ON, FILM DRIVE ON.
	The Data Track Film has rabbits present, changing frequency slightly at HIGH VOLTAGE ON, gradually lowering in strength to end of pass. The Radar Map doesn't have any evidence of rabbits.
57374.4	HIGH VOLTAGE ON
	Turn on over water (Lake Superior). Near range was lighter than far range indicating that the PRF was not optimum.

System Time	Function and Effect
57396.5	PRF to Step 9. Mapped data moved in toward the near range approximately 1.1 nm. Near range and far range approximately same density indicating PRF was correct.
57397.5	Radar Map blurred for approximately .5 second centered on the time indicated.
57398.7	Glitch of unknown origin appeared on Data Track Film, it did not appear on the Radar Map.
57408 57420	Radar Map blurred for approximately .5 second centered on the times indicated.
57420.9	End of first piece of Data Track Film. Approximately one (1) second of Data Track Film lost at this point.
57422	Start of second piece of Data Track Film.
57452	Data map blurred for approximately one half (.5) second centered on the time indicated.
57458.8	Glitch causing data dropout on Data Track Film, did not appear in Radar Map. Cause unknown.
57471.5	Cleveland, Ohio Targets. Ghost images of strong Cleveland area targets appeared .68 seconds (approx. 2.7 nm) early on

System Time	Function and Effect
	the Radar Map before the AGC reduced the IF gain. F53 IF GAIN CONTROL changed from -90 dbm over Lake Erie to -74.4 dbm over Cleveland.
57519	PRF to Step 8. Mapped data moved out toward far range approximately .8 nm. Far range slightly darker and resolution better after PRF change to Step 8.
57550 & 57572	Radar Map blurred for approximately one half (.5) second centered on the times indicated.
57582 to 57584	Radar Map is washed out during this period appears to be processing problem.
57591.1	OPERATE OFF (Film Drive OFF) 34.13°N, 78.04°W (Geodetic Map).
57604	BRUSH 4 PAYLOAD OFF
57616	BRUSH 2 ALL OFF.

3.4.2.8 Orbit 40 South to North - NHS

Wide Band Data Link film analyzed.

Vehicle Target Geometry (S-Look)	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	23418.7	23521.2
o Vehicle flight path location:	40.23°N 88.17°W	46.32°N 84.19°W
o Vehicle altitude:	136.881 NM	136.433 NM
o Radar map look:	40.87°N 90.11°W	47.03°N 86.28°W
o Radar target slant range:	168.764 NM	168.207 NM
o Radar map swath length:	406 NM	

Radar Map Scale Factors

- Measured radar map length = 191.65 inches
- Measured data track film length = 509.5 inches
- Elapsed payload on time = 102.5 seconds
- Radar map azimuth scale = 1.869 inches/second

$$\frac{191.65}{102.5} = 1.869 \text{ inches/second}$$

Radar Map Evaluation

In general the quality of the radar map was poor. Targets could not be detected for the first 3 seconds after High Voltage ON and were very poor for the first 7 seconds. The data was very light during the AGC operation which was the first 3.8 seconds after High Voltage ON. The clutterlock integrator output moved from 0 to +4 VDC during this first 7 second interval.

The PRF was in Step 8 during the entire pass. The near range data was lighter than the far range data. A comparison of the S-look data, Geodetic Map and Radar Map, at 23459 seconds, revealed that the PRF was approximately 2 steps higher than optimum at that time.

Rabbits observed on the Data Track Film did not appear on the Radar Map. The Glitches (loss of data) that appeared on the Data Track Film after 23443.8 seconds appeared as a light streak approximately .2 second wide across the Radar Map.

The Radar Map has 3 sections approximately .5 seconds wide where the data is blurred. These blurred sections appear to be processing problems, on this copy of the imagery.

AGC (position 1) and Attenuator positions 2 and 3 were used during the pass. Position 3 yielded the best data.

Roll gyro output varied from $-.05^\circ$ to $-.01^\circ$, pitch gyro output varied from $+.15^\circ$ to $+.1^\circ$ and yaw gyro output varied from -0.5° to $+.2^\circ$ during the pass. After 23430 seconds the Clutterlock Integrator output was +2.0 to +3.33 VDC.

Operating Chronology in Telemeter Time

System Time	Function and Effect
	PRF in Step 8, Attenuation in Position 1 (AGC)
22998	Brushes 7 and 8. WARM-UP ON.
23266	Brushes 9 and 10. PRE-OPERATE ON.

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System Time	Function and Effect
23349	Telemeter Links 1 and 2 acquired.
23367	Wide Band Data Link acquired.
23381.2	Ground based recorder ON
	Rabbits until High Voltage ON
23418.7	High Voltage ON
	Radar map data very dim and blurred unable to detect targets until 23422 seconds. Very poor targets until 23426 seconds.
23422.5	Changed Attenuation to Position 2.
	Radar map data became darker - resolution of targets very poor.
23425.3	Blurred section approximately one-half (.5) second wide on the Radar Map.
23427.3 23427.5 23436.3	Sharp glitches were present on the Data Track Film at the times indicated, but did not appear on the Radar Map.
23440.6	Blurred section approximately one-half (.5) second wide on the Radar Map.
23443.8	Sharp glitch was present on the Data Track Film at the time indicated, but did not appear on the Radar Map.
23463.4 23465.3 23478.4	Sharp glitches were present on the Data Track Film at the times indicated. A light section approximately .2 second wide is present on the

System Time	Function and Effect
	Radar Map at the times indicated.
23487	Changed Attenuation to Position 3. Data lighter and detail better after the change.
23494.1 23496.6	Sharp glitches were present on the Data Track Film at the times indicated. A light section approximately .2 second wide is present on the Radar Map at the times indicated.
23506.4	Blurred section approximately one-half (.5) second wide on the Radar Map.
23509.2	Sharp glitches were present on the Data Track Film at the times indicated. A light section approximately .2 second wide is present on the Radar Map at the times indicated.
23510.2	
23521.2	Operate OFF
23528.3	Ground Based Recorder OFF
23651	Brush 4 PAYLOAD OFF
23743	Brush 2 ALL OFF

3.4.2.9 Orbit 41 South to North Pass - VTS

Wide Band Data Analyzed

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	28660.7	28801.9
o Vehicle flight path location:	32.23 N 114.87 W	40.76 N 110.50 W
o Vehicle altitude:	137.506 n.m.	136.781 n.m.
o Radar map look:	32.80 N 116.66 W	41.40 N 112.45 W
o Radar target slant range:	116.952	116.8639
o Radar map swath length	558n.m.	

Radar Map Scale Factors:

- o Measured radar map length = 263.8 inches
- o Measured data track film = 705 inches
- o Elapsed payload on time = 141.2 seconds
- o Radar map azimuth scale $= \frac{263.8}{141.2} = 1.86$ inches/second

Radar Map Evaluation:

PRF Position 9 was selected prior to payload OPERATE command and was unchanged during the active portion of the pass.

The radar map has two sections approximately 0.75 sec. in width, that are blurred in azimuth centered at 28760.2 sec. and 28801.5 respectively. These blurred sections were believed due to processing.

The attenuation was commanded through Position 5, 4, 3, and 0 respectively. All changes in attenuation were clearly visible.

In attenuator Steps 3 and 0, terrain features and highway routes were clearly visible.

In attenuator Step 4 only major terrain features were visible. Railroads, highways, etc. were not resolvable.

In attenuator Step 5 data detail is eliminated.

Some areas of interest:

Union Pacific Railroad through Delamar Mountains around Caliente. System time 28736 through 28744.

The most dramatic area with land and water interface is the Great Salt Lake area, at system time 28796 through 28803.

Operating Chronology in Telemeter Time:

System Time	Function and Effect
28148	Brushes 7 and 8 Payload Warm-up ON.
28417	Brush 9 and 10 Pre-OPERATE ON.
28438	VTS acquires acquisition beacon.
28448	Telemeter links 2, 3 and wide band data link ON.
28499.5	Change to PRF Step 9.
28526.0	Change to attenuation 4.
28656	Payload OPERATE ON
28660.7	HIGH VOLTAGE ON: Video monitor F70 indicates 4.1 ± .4 VDC CRT light mon.F71 indicates 3.6 ± .05 VDC

System Time	Function and Effect
28693.5	Change to attenuation Position 5:
	Video monitor F70 indicated 3.0 ± 0.5 VDC
	CRT light monitor F71 indicated 3.6 VDC.
28728.4	Change to attenuation Position 4:
	CRT light increased 0.7 VDC then decayed to 3.6 VDC
	Map appears slightly darker for the first 2 seconds in Position 4.
28735.9	Change to attenuation Position 3:
	CRT light monitor increased to 3.8 VDC then decayed to 3.78 VDC
	Map again appears to be slightly darker for the first 2 seconds in Position 3.
28742.1	Change to attenuation Position 0 followed in 0.25 seconds by 0.07 data dropout.
	Video monitor F70 increased to 4.8 ± 0.1 VDC while in Position 0.
	CRT light monitor F71 increased to 4.2 $^{+0.1}_{-0.2}$ VDC through most of the remainder of the pass. Over the Great Salt Lake the level decreased to 3.7 VDC.
	Data dropout appears as a light streak ½ inch from the change in attenuation and 0.20 inches in width. There was no apparent loss of data due to dropout, on the correlated image.
28801.9	Payload OPERATE OFF.

3.4.2.10 Orbit 46 North to South Pass - NHS Wide Band Data Link film analyzed.

Vehicle Target Geometry (S-Look)	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	56964.8	57152.2
o Vehicle flight path location:	44.88°N 88.21°W	33.5 in. 81.78 W
o Vehicle altitude:	128.645 n.m.	127.836 n.m.
o Radar map look:	45.53°N 86.27°W	34.06N 80.10W
o Radar target slant range:	158.514	157.506 n.m.
o Radar map swath length:	746 n.m.	

Radar Map Scale Factors

- o Measured radar map length = 351 inches
- o Measured data track film length = 930 inches
- o Elapsed payload on time = 187.4 seconds
- o Radar map azimuth scale = 1.873 in/sec.

$\frac{351}{187.4}$ = 1.873 in/sec.

Radar Map Evaluation - The radar map quality was excellent, from wide band data link film. Two areas of good resolution are: Columbus, Ohio at 57058 seconds and Lockbourne AFB at 57060 seconds.

The PRF was never more than one step from optimum during the pass. The 3 corrections made during the pass were in the proper direction (Steps 6 and 7 were used during High Voltage ON). Rabbits observed on the Data Track Film did not appear on the radar map. The "Glitches" (loss of data) that appeared on the Data Track Film, during High Voltage ON, appeared as light streaks 0.11 to 0.16 seconds wide across the radar map. Black streaks, which appear to be due to processing, are scattered throughout the radar map. AGC (Position 1) was used during the pass. The AGC range (F-53), during the pass varied from -90.4 dbm, over Lake Michigan, to -76.8 dbm over land targets. Mixed water and land targets caused the AGC to call for too much gain resulting in land returns over-driving. This is especially apparent at North Monitou Island, Michigan, at 56972 to 56974 seconds, when the AGC was set for -86.4 dbm.

Roll gyro output varied from $-.02^{\circ}$ to $+.1^{\circ}$, pitch gyro output varied from $-.13^{\circ}$ to $+.15^{\circ}$ and yaw gyro output varied from $-.15^{\circ}$ to 0° during the pass. The clutterlock integrator output changed from $-.04^{\circ}$ to +4.0 VDC in the first 17 seconds after High Voltage ON and then changed approximately linearly to +2.0 VDC at High Voltage OFF.

Operating Chronology in Telemeter Time

System Time	Function and Effort
	PRF in Step 9, Attenuation in Position 0.
56529	Brushes 7 and 8 Warm-up ON.
56796	Brushes 9 and 10 Pre-operate ON.
56879	Tracking Station acquired Telemeter Links 1 and 2 and the Wide Band Data Link.
56907	Ground-based Recorder ON. Rabbits were present on the Data Track Film but did not appear on the Radar Mp.
56923.5	Glitch on the Data Track Film which caused a .3 second noise burst in the Radar Map.
56925.5	Attenuation changed to Position 1 (AGC). Telemeter point F-53 indicates the change but the Radar Map density does not change.
56925.5	Noise level drops for 0.3 seconds on the Data Track Film, which caused a light strip on the Radar Map for .37 seconds.
56942.5	PRF to Step 8.
56942.5	Glitch appeared and Rabbits change frequency on the Data Track Film; Radar Map not affected.
56956.5	Glitch on Data Track Film of 0.2 second duration which caused a 0.21 noise burst on the Radar Map.
56958	OPERATE ON.
56964.8	HIGH VOLTAGE ON - Rabbits change frequency on the Data Track Film. Radar Map gets darker but no evidence of rabbits. Turn-on was over water (Lake Michigan) the AGC level was -90.4 dbm after High Voltage ON.
56971.3 to 56973.1	Passing over North Manitou Island, Michigan the AGC changed from -90.4 dbm to 86.4 dbm then back to -90.4 dbm. The Radar Map of Manitou Island is very poor (dark).

System Time	Function and Effort
56974.5	Water-Land interface at Pyramid Point, Michigan. The AGC changed from -90.4 dbm to -80.4 dbm.
57055.0	Glitch on Data Track Film of 0.15 second duration which caused a 0.16 second light streak on the Radar Map.
57076.2	PRF to Step 7 - Mapped data moved out toward far range approximately 1.1 n.m. Prior to PRF change the far range Radar Map data was lighter than the near range; after the change the far range data is darker than the near range. Detail slightly improved after PRF change.
57100.2	Glitch on Data Track Film of 0.05 second duration (data loss) which caused a 0.16 second light streak on the Radar Map.
57116.7	PRF to Step 6
57147.9 to 57151	Glitches on Data Track Film of 0.05 seconds duration (loss of data) at the times indicated. Radar Map has a light streak .11 seconds wide at the times indicated.
57152.2	OPERATE OFF.
57152.6	Ground-based Recorder OFF.
57164	Brush 4 - Payload OFF.
57179	Brush 2 - ALL OFF.

3.4.2.11 Orbit 47 North to South Pass - VTS

Wide Band Data Link film analyzed.

Vehicle Target Geometry (S-Look)	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	62350.3	62524.2
o Vehicle flight path location:	43.91°N 110.17°W	33.34°N 104.32°W
o Vehicle altitude:	128.540 NM	127.813 NM
o Radar look point:	44.55°N 108.25°W	33.88°N 102.64°W
o Radar target slant range:	158.383 NM	157.478 NM
o Radar map swath length:	690 NM	

Radar Map Scale Factors

- Measured radar map length = 322 inches
- Measured data track film length = 870 inches
- Elapsed payload on time = 174 seconds
- Radar map azimuth scale = 1.89 inches/second

$$\frac{324^*}{174} = 1.89 \text{ inches/second.}$$

* Corrected for premature shutdown of ground recorder.

Radar Map Evaluation

The principle objective of the Pass 47 operations were to collect data associated with PRF vs slant range relationships in support of a post-flight study of their effects on the geometry and quality of the resulting correlated radar map.

S-Look readout data were used to establish an initial coordinate grid describing the approximate look path on U.S. Geological Survey maps. These coordinate values were then refined whenever possible by measurements from known target locations so as to optimize the scaling accuracy used in time/function/position determinations.

S-look values are computed from orbit ephemeris data which assume a smooth, ellipsoidal earth model and do not consider the actual terrain irregularities which, during Pass 47, presented variations in elevation above mean sea level of from 4400 ft at HV ON, through a maximum of 14,000 ft to 3800 ft at HV OFF.

Study of the effect of PRF changes was facilitated by a complete display of all the PRF steps on a single pass during which other payload conditions were held constant and the terrain maintained approximately similar characteristics.

During the active part of the pass (from northern Wyoming to western Texas) commands were sent by VTS which systematically stepped the PRF through all of the 16 values (ranging from 8215 CPS to 8735 CPS). The general quality of the radar map was good. As expected, the wrong PRF settings had a pronounced result in image ambiguities, causing a maximum data loss of approximately 50%. Dimensional instability of the print paper used for the map was responsible for fairly large discrepancies so that scaling accuracy was limited. A discontinuity of data appeared very near the end of the pass due to a premature shutdown and subsequent restart of the GBOE recorder just prior to Payload Operate OFF. There were no excursions in AGC greater than 10 db as there were no great changes in the terrain, i.e., from land to water, etc. There were no known targets suitable for a reliable resolution measurement.

Due to the major portion of the map being made at intentionally incorrect PRF settings, the point by point correlation with the USGS maps was necessarily low. However, Pass 47 provided an opportunity to study in detail the effect of PRF changes and the associated swath shifts in the range direction and to trace the progress of the "washed out" area completely across the map. Transposition of near- and far-range data was well illustrated. For the orbital altitudes and terrain elevations encountered, the most nearly correct PRF would have been between Steps 7 and 8 (about 8467 CPS). This value, obtained from visual inspection of the radar map, incidentally corresponds to the PRF setting which would provide a swath whose center would coincide with the S-look path. Position 14 exhibited the maximum loss of data due to ambiguity transposition although this phenomenon was not confined to PRF 14.

A detailed study of the Pass 47 map would not be required to conclude that the correct PRF setting is a definite requirement for the production of useable maps. Throughout this experiment the main source of data loss was an incorrect PRF value.

Operating Chronology in Telemeter Time

System Time	Function and Effect
62350.3	High Voltage ON. (PRF setting on Position 6, Attenuation Position 1, AGC.) Terrain data require about 0.2 inch to exhibit full detail. Near range lighter than far range.
62361.9	Change to PRF Step 7. 1.2 inch data loss. This appears to be the best PRF setting for this slant range (S-look = 158.3 NM) with terrain averaging about 5000 ft above sea level. Near range somewhat lighter than far range.
62370.4	Change to PRF Step 8. Two data losses, 0.2 inch and 0.4 inch separated 1 inch apart. Data faded slightly at far range.
62380.5	Change to PRF Step 9. 1.6 inch data loss. Far range data showing wash out of all but prominent targets.
62390.2	Change to PRF Step 10. No data loss. Far range data nearly gone.
62400.5	Change to PRF Step 11. Two data losses 0.2 inch wide, 0.6 inch apart. Washed out area shifted toward near range with a few far range targets reappearing. Transposition of near- and far-range data probably starts here.

System Time	Function and Effect
62410.7	Change to PRF Step 12. Washed out data shifted further toward near range. Targets visible almost continuously at extreme far range. Near- and far-range data transposed.
62420.5	Change to PRF Step 13. 1.1 inch data loss.
62430.3	Change to PRF Step 14. Two data losses of 0.4 inch and 1.0 inch separated by 0.3 inch data.
62440.4	Change to PRF Step 15. 0.4 inch data loss. Near range has started to fade. Washed out area of swath passes over Colorado Springs but only a few prominent targets are recorded.
62450.4	Change to PRF Step 0. 2.7 inch data loss. Near range further washed out, however, western portion of Pueblo is clearly discernable.
62460.5	Change to PRF Step 1. 1.5 inch data loss. Only prominent targets visible at near range.
62470.4	Change to PRF Step 2. 0.9 inch data loss. Almost no data at near range.
62480.4	Change to PRF Step 3. 0.9 inch data loss.
62487.5	Glitch. 0.3 seconds on doppler film, varies from 0.4 to 0.7 inch on map. Cause unknown.
62490.5	Change to PRF Step 4. 1.5 inch data loss. Data continuous across map in the range direction but lighter and lower quality at near range.

System Time	Function and Effect
62497.6	Glitch. 0.13 seconds on doppler film, 0.2 inch on map. Cause unknown.
62500.2	Change to PRF Step 5. Estimated data loss 0.9 inch. Amount questionable due to nature of terrain which was nearly devoid of targets in this area. Data quality higher at far range.
62506.3	Glitch. 0.07 seconds on doppler film, 0.1 inch on map. Cause unknown.
62510.2	Change to PRF Step 6. 0.6 inch data loss. Data legible across entire swath but lighter at near range.
62515.5	Glitch. 0.05 seconds on doppler film, 0.2 inch on map. Data usable through glitch. Cause unknown.
62517.0	Glitch. 0.08 seconds on doppler film, 0.2 inch on map. Data useable through glitch. Cause unknown.
62520.0	Glitch. 0.01 seconds on doppler film, barely discernable faint line on map. Cause unknown.
62520.1	Glitch. 1.2 seconds on doppler film. Data lost for 2.0 inches on map. Cause unknown.
62521.3	Ground based recorder shutoff.
62523.6	Ground based recorder turned on. Map data resumed for 1.1 inches.

System Time	Function and Effect
62524.2	High Voltage OFF.

3.4.2.12 Orbit 56 North to South Pass - NHS

Wide Band Data Link film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	22989.5	23088.2
o Vehicle flight path location:	41.84°N 91.60°W	47.75°N 87.67°W
o Vehicle altitude:	136.286 NM	135.874 NM
o Radar look point:	41.84°N 91.60°W	47.75°N 87.67°W
o Radar target slant range:	168.023 NM	167.510 NM
o Radar map swath length:	391 NM	

Radar Map Scale Factors

- Measured radar map length = 187 inches
- Measured data track film length = 494 inches
- Elapsed payload on time = 98.7 seconds
- Radar map azimuth scale = 1.90 inches/second

$$\frac{187}{98.7} = 1.90 \text{ inches/second}$$

Radar Map Evaluation

The overall quality of the Pass 56 map was fair. The terrain was relatively uniform in nature (from Southeastern Iowa across Wisconsin to the Northern tip of Michigan). Absence of mountains, canyons, coast lines, etc., together with extensive snow coverage tended to prevent fine detail resolution. Targets assoicated with communities and thoroughfares were easily discernable, indicating that

PRF and gain were approximately correct. There were no known targets suitable for a reliable resolution measurement.

A study of the AGC telemetry record, F-61, indicated that radar returns varied in signal strength over a range of less than 10 db, further confirming the relative uniformity of the terrain and lack of strong targets. Attenuation Step 1 (AGC) was used for the entire pass. Comparisons of radar maps with the corresponding doppler data from earlier passes had indicated that most minor interferences recorded on the doppler film would not "correlate", thus leaving the map relatively unaffected. On Pass 56 doppler film, however, there were large amounts of strong rabbit patterns recorded in the GBOE before the start of signals from the payload. This section of film was fortunately processed through the correlator and was searched for any trace of the rabbits. This search resulted in locating the entire rabbit pattern, equivalent to about 30 seconds of recording time, reproduced through the correlator, on the radar map. The individual pulses were not present but the paths taken by the pulses were clearly defined.

Study of data quality and illumination indicated that PRF step 8 was the most nearly correct value although the near range edge of the map was slightly lighter than the far edge. Extrapolation of the trend in data quality indicated that the ideal PRF setting would probably lie between PRF steps 8 and 9.

Operating Chronology in Telemeter Time

System Time	Function and Effect
22956.8	Ground Based Recorder ON - Strong rabbit pattern on both doppler and radar map.
22984.4	Glitch on doppler, unknown cause - map unaffected.
22985.3	35 cps modulation in density of doppler data lasting for 17 seconds (to 23002) - map unaffected.
22986.5	Rabbits fading on map.
22989.2	Interference on doppler film lasting 3.3 seconds, unknown cause - not on map.
22989.5	High Voltage ON (PRF setting on Step 6, Attenuation Position 1, AGC). Unable to determine exact location, either on doppler film or on map.
22991.3	Glitch on doppler, 0.1 second data loss, very faint trace on map.
22992.2	Glitch on doppler, 0.1 second data loss, rabbits until end of pass - very faint trace of glitch

System Time	Function and Effect
	on map but no evidence of rabbits.
22994.0	First legible terrain data on map - near edge of range washed out.
22997.8	Clutterlock grounded - no positive identification of effect on map.
23016.8	Change to PRF step 7 - identification on map questionable but illumination becomes more uniform. Near range still lighter than far range.
23019.5	Change to PRF step 8 - 0.65 second data loss on both doppler film and map. Illumination more uniform but near range still lighter than far range.
23088.2	High Voltage OFF - rabbits stop on doppler.

3.4.2.13 Orbit 57 South to North Pass - VTS

Wide Band Data Link film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	28225.6	28390.8
o Vehicle flight path location:	32.94°N 116.61°W	42.96°N 111.22°W
o Vehicle attitude:	136.909 NM	136.103 NM
o Radar look point:	33.52°N 118.41°W	43.62°N 113.22°W
o Radar target slant range:	168.780 NM	167.796 NM
o Radar map swath length:	650 NM	

Radar Map Scale Factors

- Measured radar map length = 310 inches
- Measured data track film length = 826 inches
- Elapsed payload on time = 165 seconds
- Radar map azimuth scale = 1.88 inches/second

$$\frac{310}{165} = 1.88 \text{ inches/second}$$

Radar Map Evaluation

Pass 57 operations had two main objectives, a) to determine effects of increasing the clutterlock time constant and, b) to operate the redundant WBDL transmitter. Commands to accomplish these changes were given before the payload was commanded ON so that any effects due to the changed conditions could be studied throughout the entire operation from high voltage ON to OFF.

At high voltage ON, the vehicle was in a fairly stable condition, the telemeter record indicating a yaw error of plus 0.1°. The increased clutterlock time constant was from 2.5 seconds to 5 seconds. Turn on occurred while the swath was over Catalina Island off the coast of Southern California.

Good may detail was present from the coastline of Catalina until a PRF change (from Step 9 to Step 8) 128.5 seconds after high voltage ON. The second WBDL operated nominally during this period.

Simultaneously with the above PRF change (the only one made during the mapping portion of the pass) the radar map deteriorated in quality due to an apparent jitter in the range direction. This displacement and duplication of all major targets continued until high voltage OFF. The amount of displacement was approximately 0.03 inch on the map. An examination of the corresponding doppler film showed a 0.01 inch displacement in range of prominent targets. This value agrees with the enlargement ratio (1:2.60) between the doppler film and the radar map. The jitter in the doppler data was approximately square wave in form although considerable raggedness in the pattern was evident.

The displacement in range between a typical doppler history and its duplicate was about 0.67 microsecond. The frequency of the jitter varied widely between 46 and 120 cycles per second. The cause of the jitter is not known and since it appeared in only one isolated instance, a further study is not recommended.

Operating Chronology in Telemeter Time

System Time	Function and Effect
* 28077	Select WBDL No. 2
* 28104	Change to PRF Step 9 (had been in Step 8).
* 28217	Payload Operate ON (in Attenuation Position #1, AGC)
**28224.8	Ground Based Recorder ON
28225.6	High Voltage ON. Map lacks detail for 0.8 second, followed by generally blurred condition for an indeterminate time, approximately 3 or 4 seconds.
28230.0	Swells in ocean indicating north-westerly wind.
28231.8	Swath crosses California coastline near Long Beach. Targets typical of large populated areas. Swath lighter than optimum but legible over entire width.
28254.8	Glitch - 0.20 second data loss on doppler, corresponding light streak on map.

* Taken from VTS Pass Log entries.
** From measurement of doppler film.

System Time	Function and Effect
28259.8	Glitch - 0.02 second data loss on doppler, not on map.
28261.1	Glitch - 0.05 second data loss on doppler, not on map.
28261.5	Glitch - 0.10 second data loss on doppler, not on map.
28262.3	Glitch - 0.05 second data loss on doppler, faintly visible on map.
28264.3	Glitch - 0.02 second data loss on doppler, not on map.
28290.0	Far range edge of swath becoming lighter very gradually.
28340.0	Far range edge of swath considerably lighter. Only prominent targets recorded.
28354.1	Change to PRF Step 8. Nearly all detail lost on map for about 2 seconds, followed by an apparent doubling of all prominent targets with components separated about 0.03 inch. Same effect found on doppler film. Cause unknown.
28363.9	Glitch - 0.02 second data loss on doppler, not on map.
28390.8	High Voltage OFF.

3.4.2.14 Orbit 72 South to North Pass - NHS

Wide Band Data Link film analyzed.

Vehicle Target Geometry (S-Look)

	HIGH VOLTAGE ON	HIGH VOLTAGE OFF
o System time in seconds:	22610.0	22687.3
o Vehicle flight path location:	45.74°N 88.72°W	55.76°N 79.20°W
o Vehicle altitude:	135.228 NM	134.560 NM
o Radar look point:	46.44°N 90.77°W	56.63°N 81.58°W
o Radar target slant range:	166.725 NM	165.876 NM
o Radar map swath length:	172 NM*	

Radar Map Scale Factors

- Measured radar map length = 82.2 inches*
- Measured data track film length = 217 inches*
- Elapsed payload on time = 43.5 seconds*
- Radar map azimuth scale = 1.89 inches/second

$$\frac{82.2}{43.5} = 1.89 \text{ inches/second}$$

* Lengths and times measured between High Voltage ON and the change to Attenuator position 7 as no discernable doppler or map data were obtained thereafter.

Radar Map Evaluation

The objective of the Pass 72 operations was to provide comparitive data on extreme gain settings of the payload radar receiver. Attenuation Position 1 (AGC), Position 0 (highest gain) and Position 7 (lowest gain) were commanded in close sequence so as to minimize effects of terrain changes. PRF setting (Step 6) was not changed during the series of attenuation changes although PRF steps 8 and 7 had been selected earlier in the pass. No gain adjustments were made on the WBDL or GBOE at the tracking station during the payload gain changes.

The map quality was good with clear definition and high contrast. PRF selection (from step 8 to step 6) appeared to degrade the uniformity of illumination somewhat although no data was lost on this account. It appears that a PRF setting between steps 7 and 8 would have produced optimum illumination across the map.

The gain shift from maximum to minimum gain settings had, as expected, a pronounced effect on the map. Attenuation 0 produced overdriven signals on the doppler film which resulted in a correspondingly dense, low quality map. An improved map could have been obtained in this area if correlator and processing controls were adjusted for the differences produced by the high gain setting, as described in Part I, Para. 1.6. Attenuation 7 apparently lowered the signal below the noise level and the resulting map in this area contained no data. There was also an absence of data on the corresponding doppler film. Because of the extreme over- and under-optimum signal strengths resulting from

Attenuations 0 and 7, respectively, the only useable map data was produced during Attenuation 1. The AGC varied within rather narrow limits (6 db) although the swath crossed land/water boundaries at least twice.

Although the maximum look angle (elevation of satellite above the tracking station horizon) was less than 5 , the resulting marginal WBDL parameters apparently did not decrease the quality of the map.

Operating Chronology in Telemeter Time

System Time	Function and Effect
22562.7	Ground Based Recorder ON - rabbits on doppler, not on map.
22582.4	Glitch on doppler, 0.15 second data loss, unknown cause, dark streak across map.
22610.0	High Voltage ON - map data starts slightly washed out and gradually develops good detail in 2 or 3 seconds. Look angle from tracking station is 3.8 above horizon. PRF in Step 8, Attenuation in position 1 (AGC). Map symmetrically illuminated about center of swath. Slightly darker at each edge. Swath 9.6 NM wide, mapping flat terrain of Bad River Indian Reservation of

System Time	Function and Effect
	Northern Wisconsin. Sharp contrasts and good detail as swath moves into Lake Superior and over several islands.
22625.1	Change to PRF Step 7 - 0.2 second data loss in doppler and map. Illumination symmetry decreased slightly. Far range edge of map noticeably darker. No prominent targets in water but surface appears to have a definitely mottled texture such as might be caused by hummocks of ice and snow.
22630.3	Change to PRF Step 6 - Sharp glitch in doppler, very faint trace on map. Far range edge of map much darker than near range. Swath crosses over water/land interface. Good detail except for far range.
22646.8	Change to Attenuation Position 0. Map detail very dense and blocked out except for weak target areas. Near range contains more useable data but still of low quality. Correlator/processor adjustments would probably produce higher quality map.
22653.5	Change to Attenuation Position 7. All data ceases abruptly on doppler film and on map.
22688	Payload Operate OFF - Film Drive OFF

3.4.3 Telemetry Schedule

This listing of telemetry point numbers and titles is provided as reference for use with the telemetry data contained in the report.

TABLE

POINT	NOMENCLATURE
F-1	+23.5 VDC Monitor
F-3	-23.5 VDC Monitor
F-4	300 VDC Monitor
F-5	+28.3 VDC Regulated
F-7	400 CPS 3∅ ∅AB Volts
F-8	400 CPS 3∅ ∅CB Volts
F-9	2KC Voltage Monitor
F-10	10KV Voltage Monitor
F-11	2KV - RF-IF
F-13	Klystron Filament Volt
F-14	4.5 KV Monitor
F-16	Inverse - Current Mon.
F-17	Klystron Waveform
F-18	Deflection Current
F-20	Temp - 300 VDC Power Sup
F-21	Temp - Control Unit Case
F-22	Temp - Video Amp
F-23	Temp - Gate Sequencer
F-24	Temp - $\frac{\sin x}{x}$ Pulser

TABLE

POINT	NOMENCLATURE
F-25	Temp - Timer A
F-26	Temp - Audio Sync. Demod.
F-27	Temp - Ref. Computer Gate
F-28	Temp - Deflect Amp.
F-29	Temp - 10KV Pwr. Sup.
F-30	Temp - Recorder Case
F-31	Temp - TWT
F-32	Temp - Stalo
F-33	Temp - RF-IF Case
F-34	Temp - Klyst. Collect.
F-35	Temp - Klystron Body
F-36	Temp - Trans-Mod Case
F-37	Temp - Resistor Block
F-41	Pre-Operate ON
F-42	PRF Select #1
F-43	PRF Select #2
F-44	PRF Select #3
F-45	PRF Select #4
F-46	Bypass Integrator
F-47	Internal Test Mode
F-48	Integrator T/C Select
F-49	Film Motion Monitor
F-51	Operate Recorder

TABLE

POINT	NOMENCLATURE
F-52	Isolation Roller
F-53	Gain Control
F-55	Ramp Monitor
F-56	Payload Operate
F-60	Integrator Output
F-61	AGC Monitor
F-62	70 MC Reference
F-63	70 MC Offset
F-64	70 MC SSB
F-65	Sweep Trigger Monitor
F-66	0.06 u sec. 70 MC Pulse
F-67	140 mc pulse
F-68	ON-GATE Monitor
F-70	Video Monitor
F-71	Cathode Ray Tube Light
F-72	R.F. Pwr to Xmtr
F-73	R.F. Pwr from Xmtr
F-74	TWT Grid Pulse
F-75	100 mc output level
F-76	PRF/4
F-83	Acceleration - Recorder
F-84	Acceleration - RF-IF
F-86	Acceleration - Trans. Mod

TABLE

POINT	NOMENCLATURE
F-91	Capsule Footage Pot
F-92	Temp Capsule Retro
F-93	Water-seal & Cont.-Loop
F-94	Temp. Thrust Cone
F-95	Capsule Battery #2 Volt
F-96	Capsule Battery #1 Volt
F-97	Temp - Cassette
F-98	Temp - Capsule Forebody
F-99	Cassette - Commutator
F-100	Pressure - Near +Y Axis
F-101	Pressure - Near -Y Axis
F-102	Pressure - Recorder
F-103	Pressure - Transmitter
F-104	Pressure - Wave Guide

PRF Step position is indicated by binary code step functions displayed on four telemetry points. F-42 is a binary one, F-43 a binary 2, F-44 a binary 4, and F-45 a binary 8. PRF step position at any point in time can be verified by reviewing the status level of the four telemeter points. TM voltage level of 0.35 indicates a binary zero. TM voltage level of 4.6 indicates the presence of that appropriate binary bit. PRF can be selected and commanded in 15 incremental steps from 8735 pps thru 8215 pps. The indicated sum of the binary code readout on the four telemeter points is the PRF step position.

3.4.4 Telemetry Data

This paragraph contains tabulations and analog records of basic telemetry data:

Table 1	Voltages	F-1 thru F-11
Table 2	Voltages	F-13 thru F-46
Table 3	Voltages	F-47 thru F-62
Table 4	Voltages	F-63 thru F-68
Table 5	Voltages	F-70 thru F-75
Table 6	F-53 Changes	
Table 7	F-46 and F-48 Selections	
Table 8	Battery Bus Voltages	
Table 9	Analog Displays (as follows):	

<u>Video Level/Control Data</u>

F-53

F-61

F-70

F-71

<u>Power Data</u>

F-14

C-275 (High Voltage Output Current)

F-72

F-73

<u>Attitude Data</u>

F-60

Pitch Gyro Outputs (Low)

<u>Attitude Data</u> (Cont'd)

Yaw Gyro Outputs (Low)

Roll Gyro Outputs (Low)

The voltage tabulations of Tables 1 through 5 were taken from the AUGIE data received in the STC during the mission. Minor data dropouts were experienced. Table 9 contains the analog displays of 12 significant parameters for each payload operating sequence, displayed against system time reference, grouped as indicated.

NOTE 1: Table 9 is contained in Pages 4-104 to 4-145 inclusive.

NOTE 2: F-60 ordinate values range between +5000 cps and -5000 cps. (Actual CPS x 10^{-3} gives ordinate.)

NOTE 3: Payload High Voltage ON and OFF command times are shown by arrows at top of pages in Table 9. Approximately a 6.2 second delay occurs in the High Voltage Power Supply after ON command before High Voltage is present.

TABLE 1 F-1 thru F-11 ORBITS 8 - 72

PASS	P/L Mode	DATA OBTAINED BETWEEN NOTED TIMES	F-1 VDC Regulated	F-3 VDC Regulated	F-4 VDC	F-5 VDC Regulated	F-9 VAC	F-10 KV	F-11 VDC
8 NHS	During								
	Pre-Op	24175	23.2 ± .2	-23.6 ± .2	299.5 ± 1	28.0 ± .5	117 ± .5	9.1	-2000 ± 75
	Op-ON	24255.33	23.5 ± .2	-23.3 + .2	301.5 ± 1	28.6 ± .5	116.5 ± .5	10.0	-1975 $^{+25}_{-100}$
	OP-OFF	24369.5		- .1		28.2 ± .5	117 ± .5	8.95	
9 VTS	During								
	Pre-Op	29327	23.4	-23.5	301	28.4	118 ± .5	9.45	-1997
	OP	29524.13	24.0	-23.1	309.5	29.2	116 ± 1.0	10.0	-1948
	OP-OFF	29641.78				28.4	118 ± 0.5	9.45	
14 NHS	During								
	PRE-OP	57714	23.8	-23.7	301	28.4	118 ± .5	9.45	-1997
	OP	57896.65	24.0	-23.3	309.5	28.8	117 ± .5	10.0	-1948
	OP-OFF	58014.2				28.4	118 ± .5	9.45	
16 VTS	During								
	Pre-OP	68528	23.2	-23.5	301	28.4	118 $^{+1.0}_{-0.5}$	9.45	-1997
	OP	68653.25	24.0	-23.1	307	29.2	117.5 ± .5	10.0	-1948
	OP-OFF	68743.0				28.4	118 $^{+1.0}_{-0.5}$	9.45	
24 NHS	During								
	Pre-Op	23778	23.2 ± .25	-23.7 ± .3	297.5 $^{+3.0}_{-2.5}$	27.8 ± .5	118 ± 0.5	9.1	-2000 ± 35
	OP	23833.65	23.6 ± .2	-23.4 $^{+.2}_{-.3}$	304.0 ± 5	28.7 ± .5	117.5 ± .5	10.0	-1975 ± 35
	OP-OFF	23956.1				28.2 ± .5	118 $^{+1.0}_{-0.5}$	9.1	

TABLE 1 F-1 thru F-11 ORBITS 8 - 72

PASS	P/L Mode	DATA OBTAINED BETWEEN NOTED TIMES	F-1 VDC Regulated	F-3 VDC Regulated	F-4 VDC	F-5 VDC Regulated	F-9 VAC	F-10 KV	F-11 VDC
25 VTS	During Pre-OP	28928	23.2 + .4 - .3	-23.6 + .3 - .2	298 ± 7	27.8 ± .7	118 ± 1.0	9.2	-2000 +50 -40
	OP	29106.15	23.6 .2	-23.4 + .2 - .25	304 ± 3	28.5 ± 1	117.5 + .5 - .5	10.0	-1975 +25 -30
	OP OFF	29265.95				28.2 ± .2	118 ± .5	9.45	
30 NHS	During Pre-OP	57300	23.6	-23.6	301	28.4	118	9.45	-1997
	OP	57374.4	24.3	-23.5	301	28.4	117.5	10.0	-1997
	OP OFF	57591.1				28.4	118	9.45	
40 NHS	During Pre-OP	23367	23.2	-23.9	301	27.5	118	9.45	-1997
	OP	23418.65	24.0	-23.5	307	29.2	117.25	9.6	-1970
	OP OFF	23521.2				28.4	118	9.45	
41 VTS	During Pre-OP	28454	23.2	-23.9	295	26.7	118	9.1	-2050
	OP	28660.7	23.6	-23.5	301	28.4	117	9.6	-1970
	OP OFF	28801.85				27.5	118	8.95	
46 NHS	During Pre-OP	56900	23.2	-23.9	295	27.5	118	9.45	-1997
	OP	56964.8	23.6	-23.5	301	28.4	117.5	9.45	-1997
	OP OFF	57152.2				27.5	118.2	8.95	

TABLE 1 F-1 thru F-11 ORBITS 8 - 72

PASS	P/L Mode	DATA OBTAINED BETWEEN NOTED TIMES	F-1 VDC Regulated	F-3 VDC Regulated	F-4 VDC	F-5 VDC Regulated	F-9 VAC	F-10 KV	F-11 VDC
47 VTS	During W-UP ON	62253				27.5	118.2	8.95	
	Pre-OP ON	62332	22.9	-23.9	295	27.5	118	8.95	-2050
	OP	62350.25	23.2	-23.5	301	27.95	117	9.45	-1997
	OP OFF	62524.15				27.5	118.2	8.95	
56 NHS	During Pre OP	22950	23.2	-23.9	295	27.5	118	9.45	-1997
	OP	22989.5	23.4	-23.5	301	27.95	116	9.45	-1997
	OP OFF	23088.15				27.5	118	8.95	
57 VTS	During Pre-OP	28008	22.9	-23.9	295	27.1	118 ± .5	8.95	-2050
	OP	28225.6	23.2	-23.5	301	28.4	116 ± .5	9.45	-1997
	P/L OFF	28390.8				27.5		8.95	
72 NHS	During Pre-OP	22557	23.3 ± .1	-23.6 +.2/-.1	300 +2/-4	28.0 ± .3	116.5 +.6/-.5	9.45	-2010 ± 20
	During OP	22625	22.95	-23.1 ± .1	306 +2/-2	25.5	96	10.0	-2050
	During OP	22685	23.6	-23.1 ± .1	306 ± 2	26.6	99	10.0	-1996
	AFTER P/L OFF	22690				28.75 ± .25	118 ± .5	9.45	

TABLE 2 F-13 thru F-46 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-13 FIL VOLTS	F-16 T/M VOLTS	F-17 T/M VOLTS	F-18 T/M VOLTS	F-41 T/M VOLTS	F-46 T/M VOLTS
8	During Pre-OP OP-ON OP-OFF	 24175 24255.33 24369.5	 7.085 7.085 7.085	 4.4 1.95 4.4	1.7	4.4 4.4	1.7 1.7	0.4 4.3
9	During Pre-OP OP-ON OP-OFF	 29327 29524.13 29641.7	 7.26 7.26 7.26	 4.4 1.95 4.5	1.7	4.4 4.4	1.7 1.7	4.3 4.3
25	During Pre-OP OP-ON OP-OFF	 28928 29106.15 29265.95	 7.26 7.26 7.26	 4.45 2.0 4.5	1.7	4.35 4.35	1.7 1.7	4.3 4.3
30	During Pre-OP OP-ON OP-OFF	 57300 57374.4 57591.1	 7.26 7.26 7.26	 4.45 1.98 4.5	1.7	4.35 4.39	1.7 1.7	4.3 4.3
40	During Pre-OP Op-ON OP-OFF	 23367 23418.65 23521.2	 7.26 7.26 7.26	 4.42 2.0 4.52	1.7	4.35 4.35	1.7 1.7	4.3 4.3
41	During Pre-OP OP-ON OP-OFF	 28454 28660.7 28801.85	 7.26 7.26 7.26	 4.42 2.0 4.52	1.7	4.35 4.39	1.7 1.7	4.3 4.3

TABLE 2 F-13 thru F-46 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-13 FIL VOLTAGE	F-16 T/M VOLTS	F-17 T/M VOLTS	F-18 T/M VOLTS	F-41 T/M VOLTS	F-46 T/M VOLTS
56	During							
	Pre-OP	22950	7.26	4.42		4.35	1.7	4.3
	OP-ON	22989.5	7.26	2.0	1.72	4.39	1.7	0.4
	OP-OFF	23088.1	7.26	4.52				
72	During							
	Pre-OP	22557	7.085	4.5		4.35	1.7	4.3
	OP-ON	22609.95	7.085	1.8	1.7	4.35	1.7	4.3
	OP-ON	22680	7.085	1.4	2.0	4.35	1.7	4.3
	OP-OFF	22687.2	7.087	4.52				

TABLE 3 F-47 thru F-62 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-47 T/M VOLTS	F-48 T/M VOLTS	F-51 T/M VOLTS	F-55 T/M VOLTS	F-56 T/M VOLTS	F-62 T/M VOLTS
8	During Pre-OP OP-ON OP-OFF	24175 24255.33 24369.5	0.4 0.4	4.4 4.4	3.44	.95 ± .05 .95 ± .05	1.25 3.4 1.25	1.3 1.3
9	During Pre-OP OP-ON OP-OFF	29327 29524.13 29641.7	0.4 0.4	4.4 4.4	3.75	.75 .80	1.25 3.4 1.25	1.3 1.3
25	During Pre-OP OP-ON OP-OFF	28928 29106.15 29265.95	0.4 0.4	4.4 4.4	3.65	1.13 1.19	1.25 3.4 1.25	1.3 1.3
30	During Pre-OP OP-ON OP-OFF	57300 57374.4 57591.1	0.4 0.4	4.4 4.4	3.65	1.15 1.12	1.25 3.4 1.25	1.3 1.4
40	During Pre-OP OP-ON OP-OFF	23367 23418.65 23521.2	0.4 0.4	4.4 4.4	3.6	1.12 1.2	1.25 3.4 1.25	1.3 1.3
41	During Pre-OP OP-ON OP-OFF	28454 28660.7 28801.85	0.4 0.4	4.4 4.4	3.6	1.1 1.1	1.25 3.4 1.25	1.3 1.3

TABLE 3 F-47 thru F-62 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-47 T/M VOLTS	F-48 T/M VOLTS	F-51 T/M VOLTS	F-55 T/M VOLTS	F-56 T/M VOLTS	F-62 T/M VOLTS
56	During							
	Pre-OP	22950	0.4	4.4		1.2	1.25	1.3
	OP-ON	22989.5	0.4	4.4	3.65	1.17	3.4	1.3
	OP-OFF	23088.1					1.25	
72	During							
	Pre-OP	22557	0.4	0.4		1.13	1.20	1.3
	OP-ON	22609.95	0.4	0.4	3.4	1.2	3.2	1.3
	OP-ON	22680.2	0.4	0.4	3.32	1.2	3.2	1.3
	OP-OFF	22687.2					1.20	

TABLE 4 F-63 thru F-68 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-63 T/M VOLTS	F-64 T/M VOLTS	F-65 T/M VOLTS	F-66 T/M VOLTS	F-67 T/M VOLTS	F-68 T/M VOLTS
8	During							
	Pre-OP	24175	1.4	1.0	2.9	3.2	2.6	2.9
	OP-ON	24255.33	1.4	1.0	2.9	3.2	2.6	2.9
	OP-OFF	24369.5			2.9			
9	During							
	Pre-OP	29327	1.4	1.1	2.9	3.2	2.6	2.9
	OP-ON	29524.13	1.4	1.1	2.9	3.2	2.6	2.9
	OP-OFF	29641.7			2.9			
25	During							
	Pre-Op	28928	1.4	1.1	2.95	3.2	2.6	2.9
	OP-ON	29106.15	1.4	1.1	2.95	3.2	2.6	2.9
	OP-OFF	29265.95			2.95			
30	During							
	Pre-OP	57300	1.4	1.1	2.9	3.2	2.6	2.9
	OP-ON	57374.4	1.4	1.1	2.9	3.2	2.6	2.9
	OP-OFF	57591.1			2.9			
40	During							
	Pre-OP	23367	1.4	1.1	2.9	3.2	2.6	2.9
	OP-ON	23418.65	1.4	1.1	2.94	3.2	2.6	2.9
	OP-OFF	23521.2			2.9			
41	During							
	Pre-OP	28454	1.4	1.1	2.9	3.2	2.6	2.9
	OP-ON	28660.7	1.4	1.1	2.94	3.2	2.6	2.9
	OP-OFF	28801.85			2.9			

TABLE 4 F-63 thru F-68 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-63 T/M VOLTS	F-64 T/M VOLTS	F-65 T/M VOLTS	F-66 T/M VOLTS	F-67 T/M VOLTS	F-68 T/M VOLTS
56	During							
	Pre-OP	22950	1.4	1.1	2.9	3.2	2.6	2.9
	OP-ON	22989.5	1.4	1.1	2.9	3.2	2.6	2.9
	OP-OFF	23088.1			2.9			
72	During							
	Pre-OP	22557	1.4	1.1	2.9	3.18	2.6	2.9
	OP-ON	22609.95	1.4	1.0	2.9	3.18	2.6	2.9
	OP-OFF	22687.2			2.9			

TABLE 5 F-70 thru F-75 ORBITS 8 - 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-70 T/M VOLTS	F-74 T/M VOLTS	F-75 T/M VOLTS
8	During				
	Pre-OP	24175	4.6	2.6	4.0
	OP-ON	24255.33	4.67	2.65	4.0
	OP-OFF	24369.5			
9	During				
	Pre-OP	29327	4.6	2.6	3.9
	OP-ON	29524.13	4.73	2.6	3.9
	OP-OFF	29641.7			
25	During				
	Pre-OP	28928	4.64	2.6	3.9
	OP-ON	29106.15	4.51	2.6	3.9
	OP-OFF	29265.95			
30	During				
	Pre-OP	57300	4.63	2.6	3.9
	OP-ON	57374.4	4.56	2.6	3.9
	OP-OFF	57591.4			
40	During				
	Pre-OP	23367	4.61	2.6	3.97
	OP-ON	23418.65	4.35	2.6	3.97
	OP-OFF	23521.2			
41	During				
	Pre-OP	28454	2.86		
			1.9	2.6	3.95
	OP-ON	28660.7	3.5	2.6	3.95
	OP-OFF	28801.85			

TABLE 5 F-70 thru F-75 ORBITS 8-- 72

PASS	P/L MODE	DATA OBTAINED BETWEEN NOTED TIMES	F-70 T/M VOLTS	F-74 T/M VOLTS	F-75 T/M VOLTS
56	During				
	Pre-OP	22950	4.55	2.58	3.95
	OP-ON	22989.5	4.85	2.59	3.96
	OP-OFF	23088.1			
72	During				
	Pre-OP	22557		2.52	3.9
	OP-ON	22609.95		2.50	3.8
	OP-OFF	22687.2			

TABLE 6

F-53 GAIN-SETTINGS

The following chart lists the orbit number and the system time at which gain setting changes were commanded for the entire mission.

GAIN POS.	LAUNCH	40 - NHS	41 - VTS	46 - NHS	72 NHS
OFF					
Pos. 0			28742.1		22646.8
(AGC) Pos. 1	-0-			65925.5	
Pos. 2		23422.5			
Pos. 3		23487.0	28735.9		
Pos. 4			28526.0 & 28728.4		
Pos. 5			28693.5		
Pos. 6					
Pos. 7					22653.5

TABLE 7

F-46 CLUTTERLOCK INTEGRATOR AND F-48 TIME CONSTANT SELECTION

ORBIT	F-46 POSITION	F-48 POSITION
8	IN	No. 1
9	IN	No. 1
14	IN	No. 1
16	IN	No. 1
24	IN	No. 1

ORBIT	F-46 POSITION	F-48 POSITION
25	IN	No. 1
30	IN	No. 1
40	IN	No. 1
41	IN	No. 1
46	IN	No. 1
47	IN	No. 1
56	In THEN OUT	No. 1
57	IN	No. 2
72	IN	No. 2

NOTE: 1. DATA OBTAINED FROM:
   a. C-177, P/L U28 V BUSS.
   b. C-280, P/L U28 V
   c. C-1, VEH. U28 V BUSS.
   d. C-45, VEH. U28 V

2. VEH. U28 V BUSS AT LAUNCH WAS 24.9 V DC

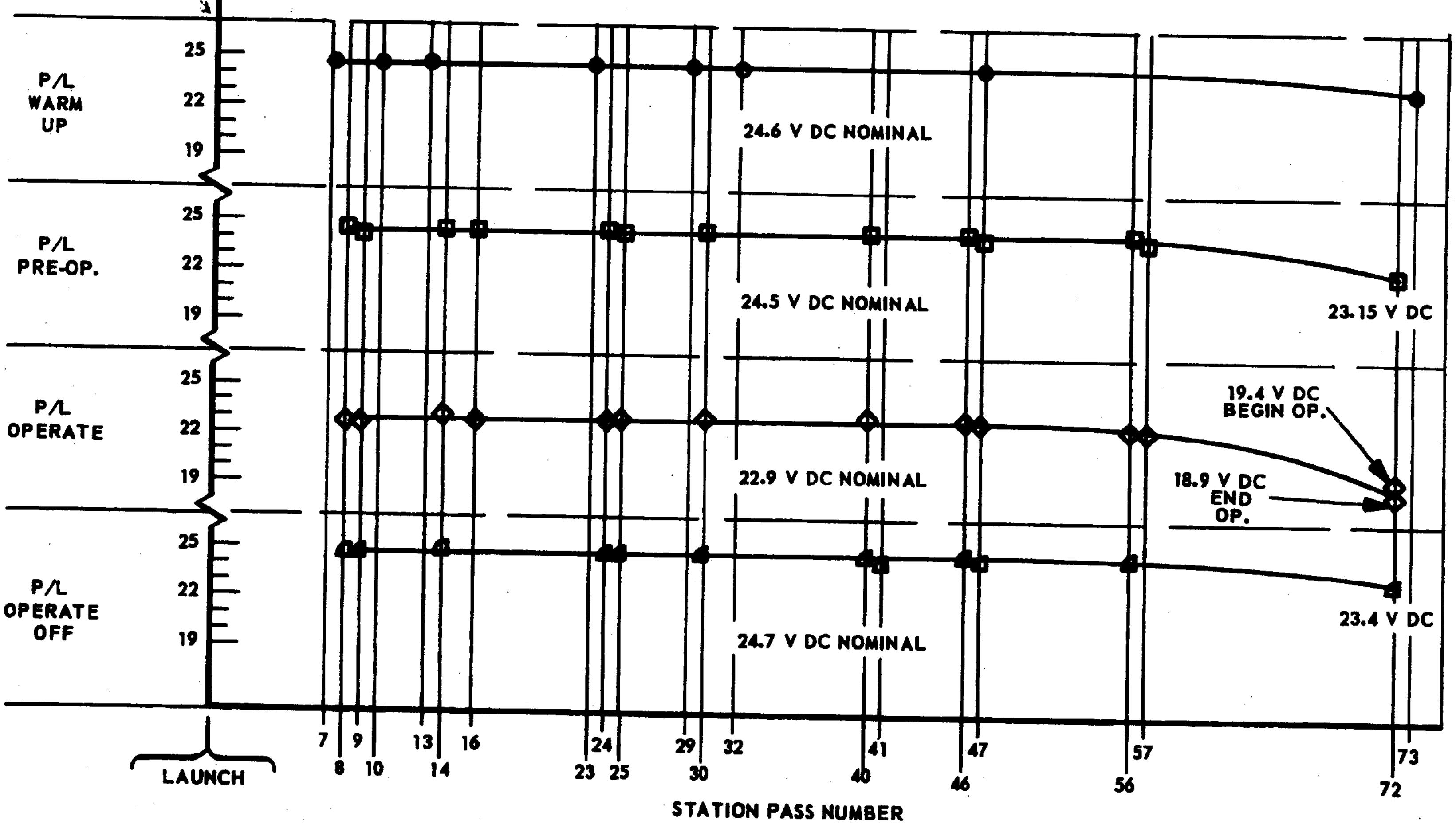
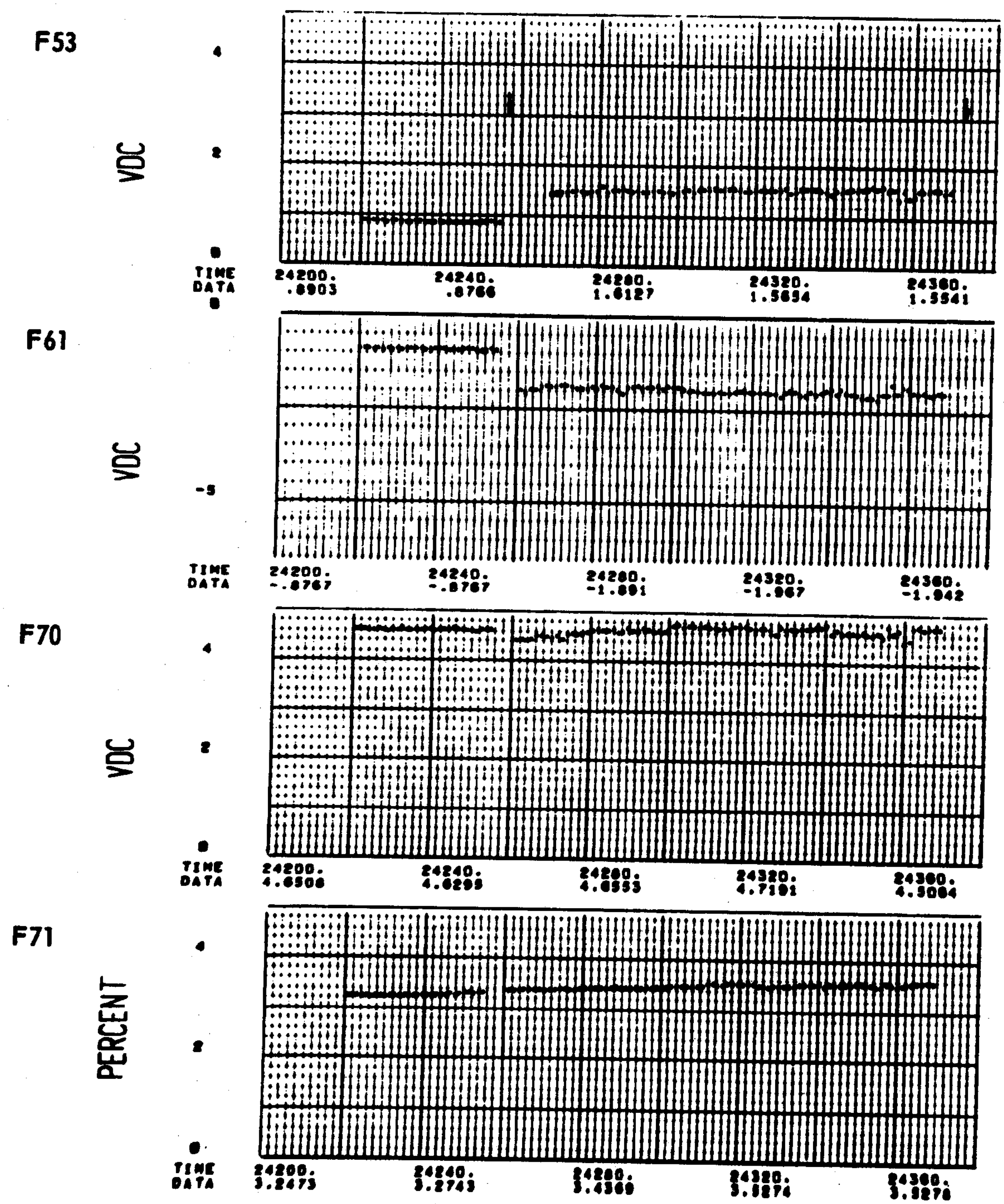
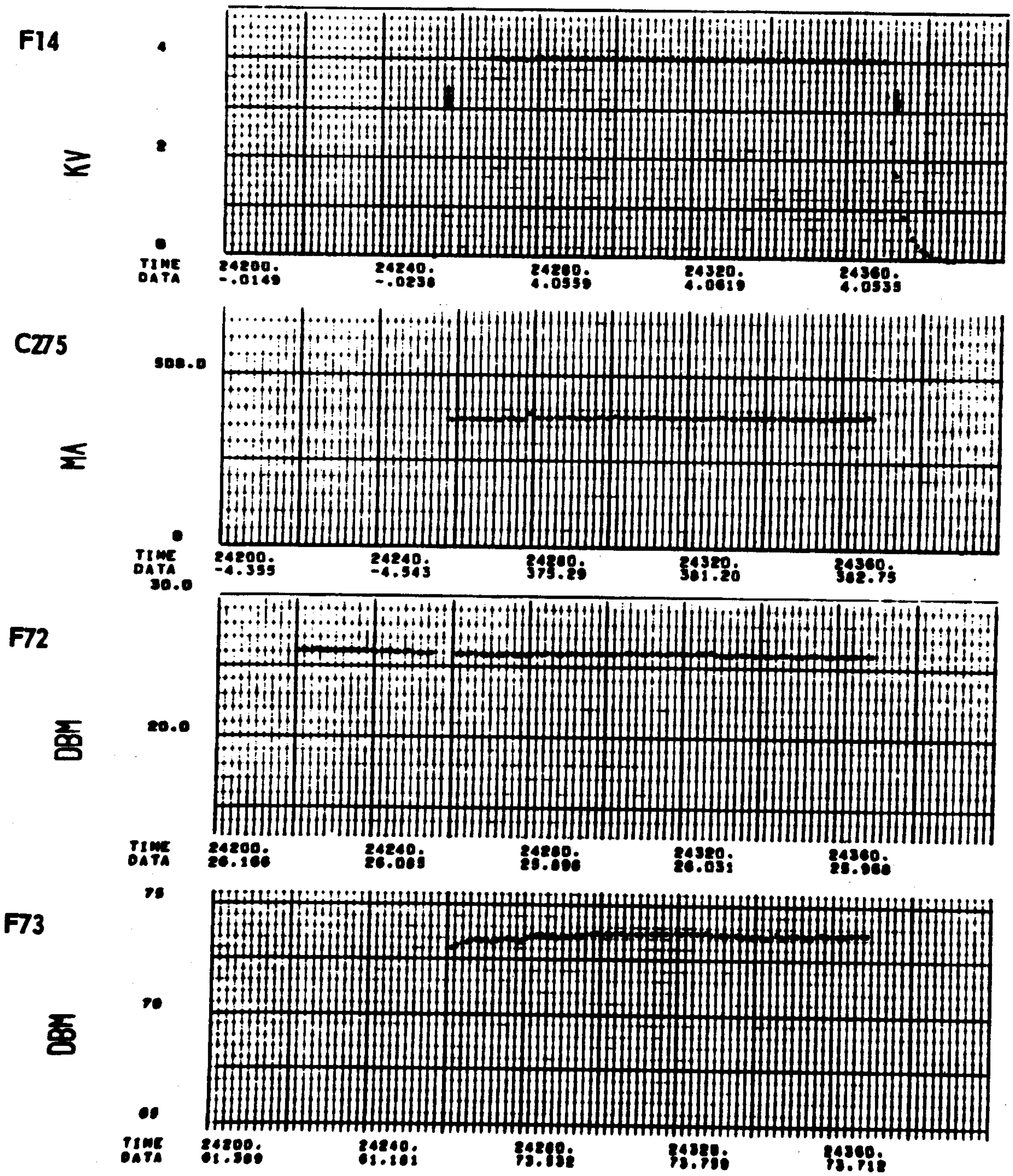


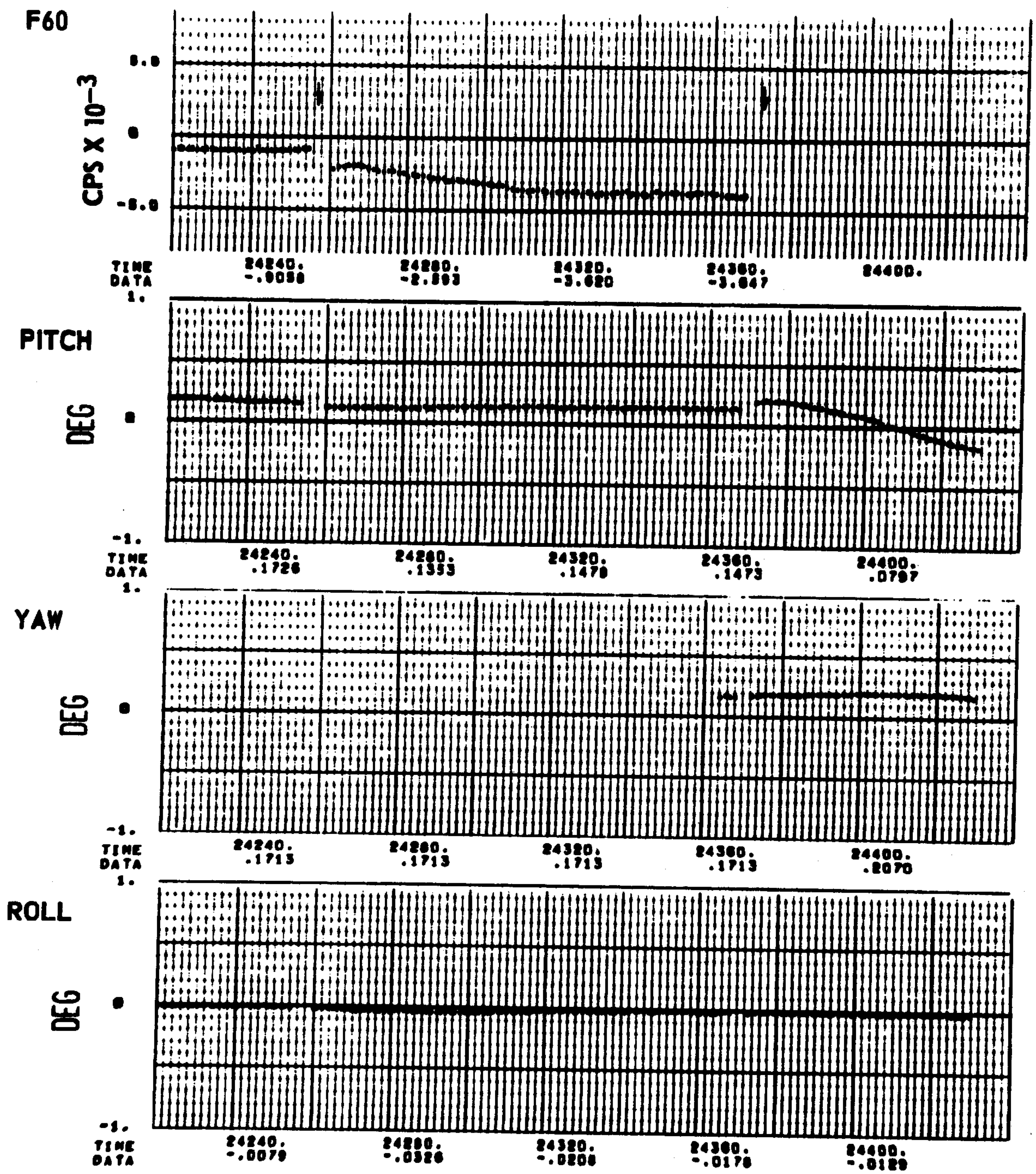
TABLE 8 BATTERY BUS VOLTAGES



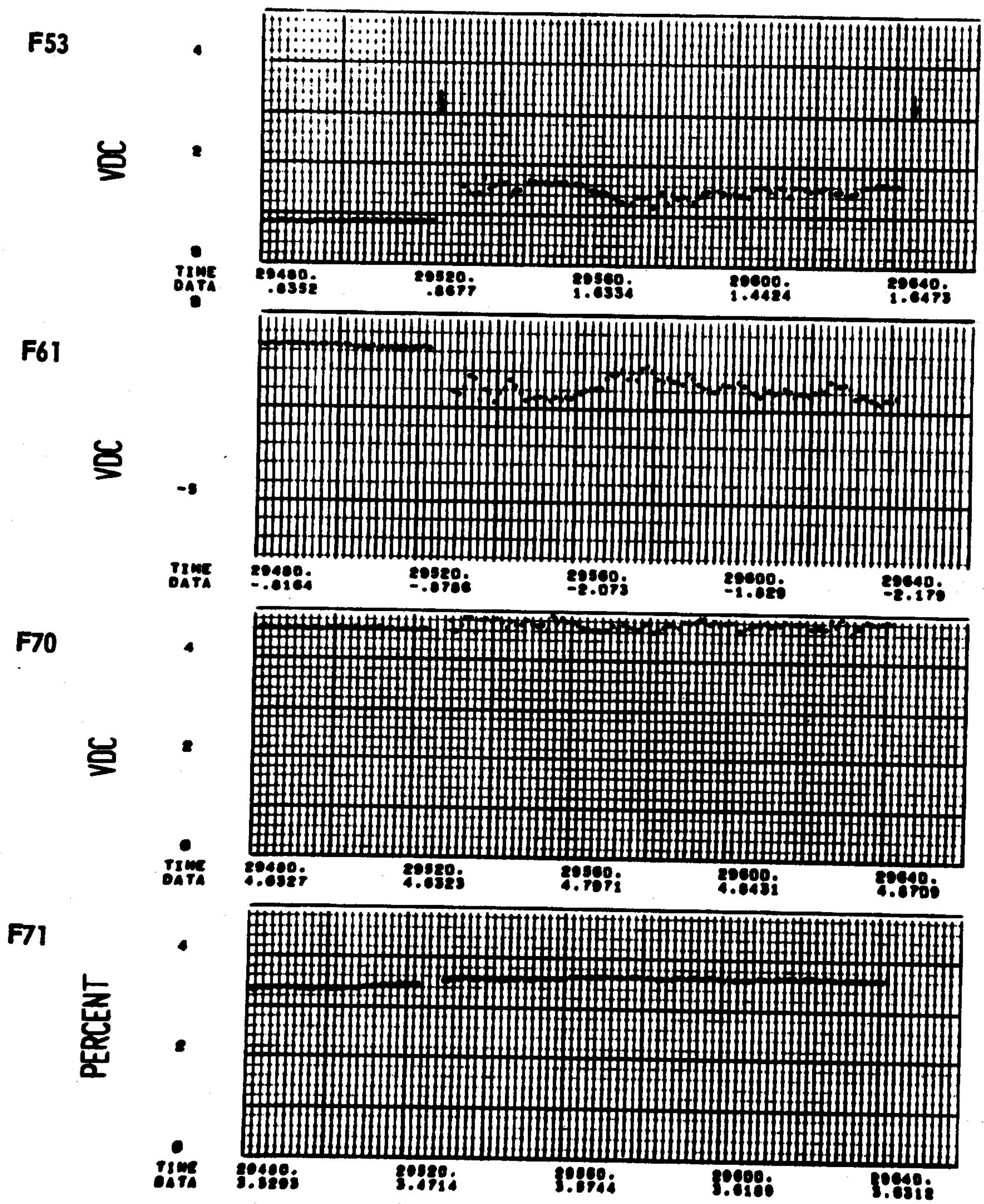
Pass 8 - Video Level and Gain Data



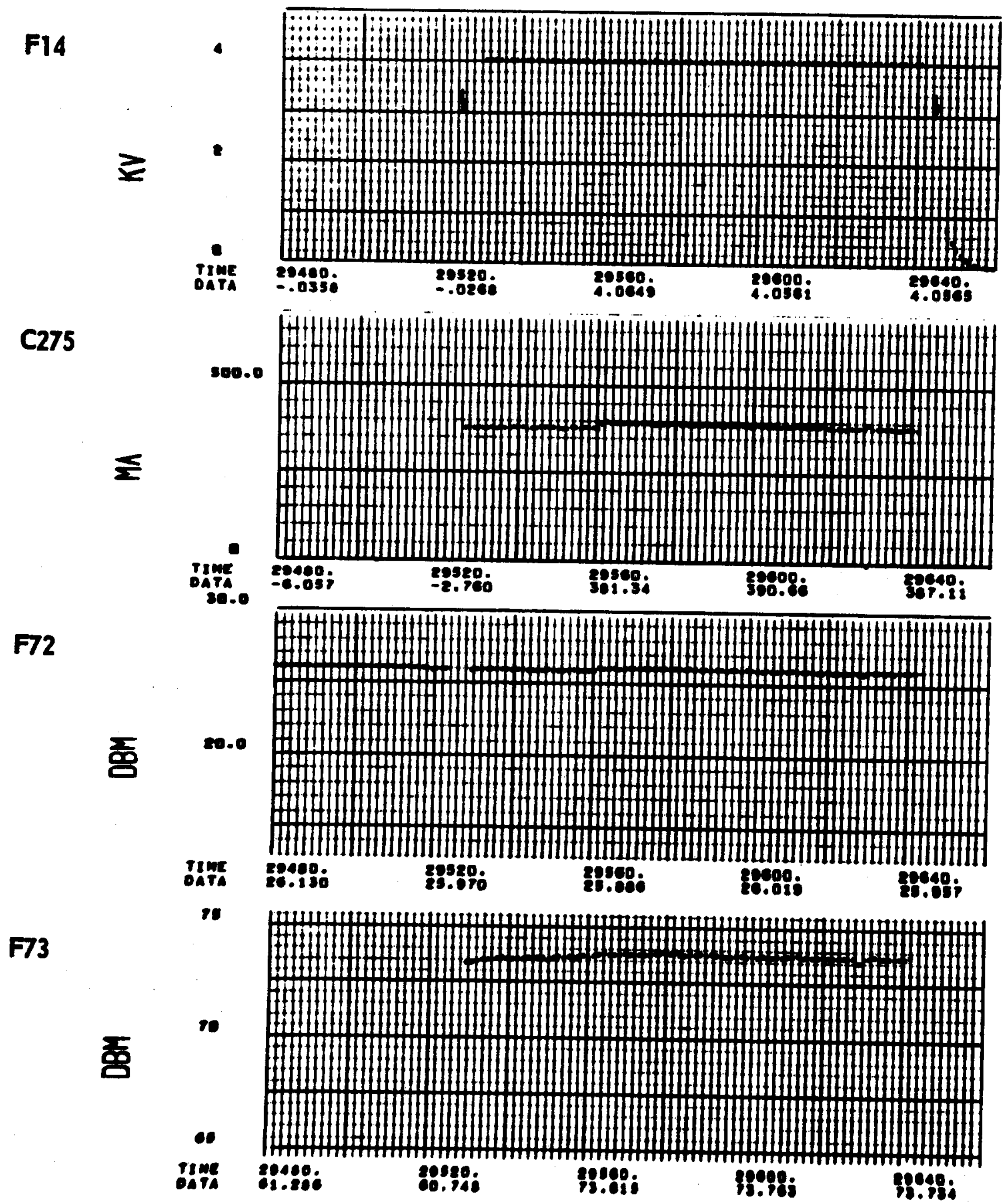
Pass 8 - Power Data



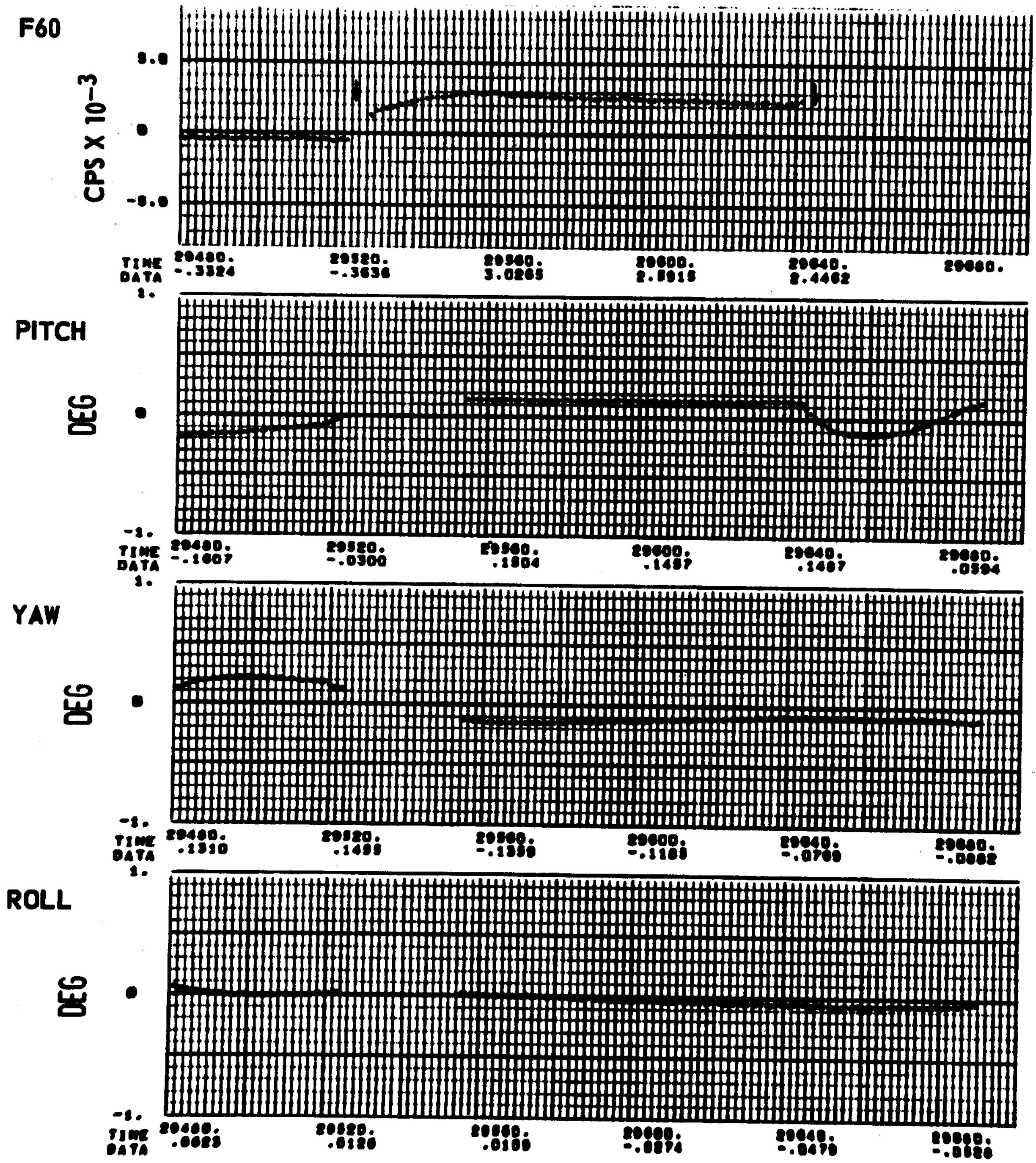
Pass 8 - Clutter Lock and Gyro Outputs



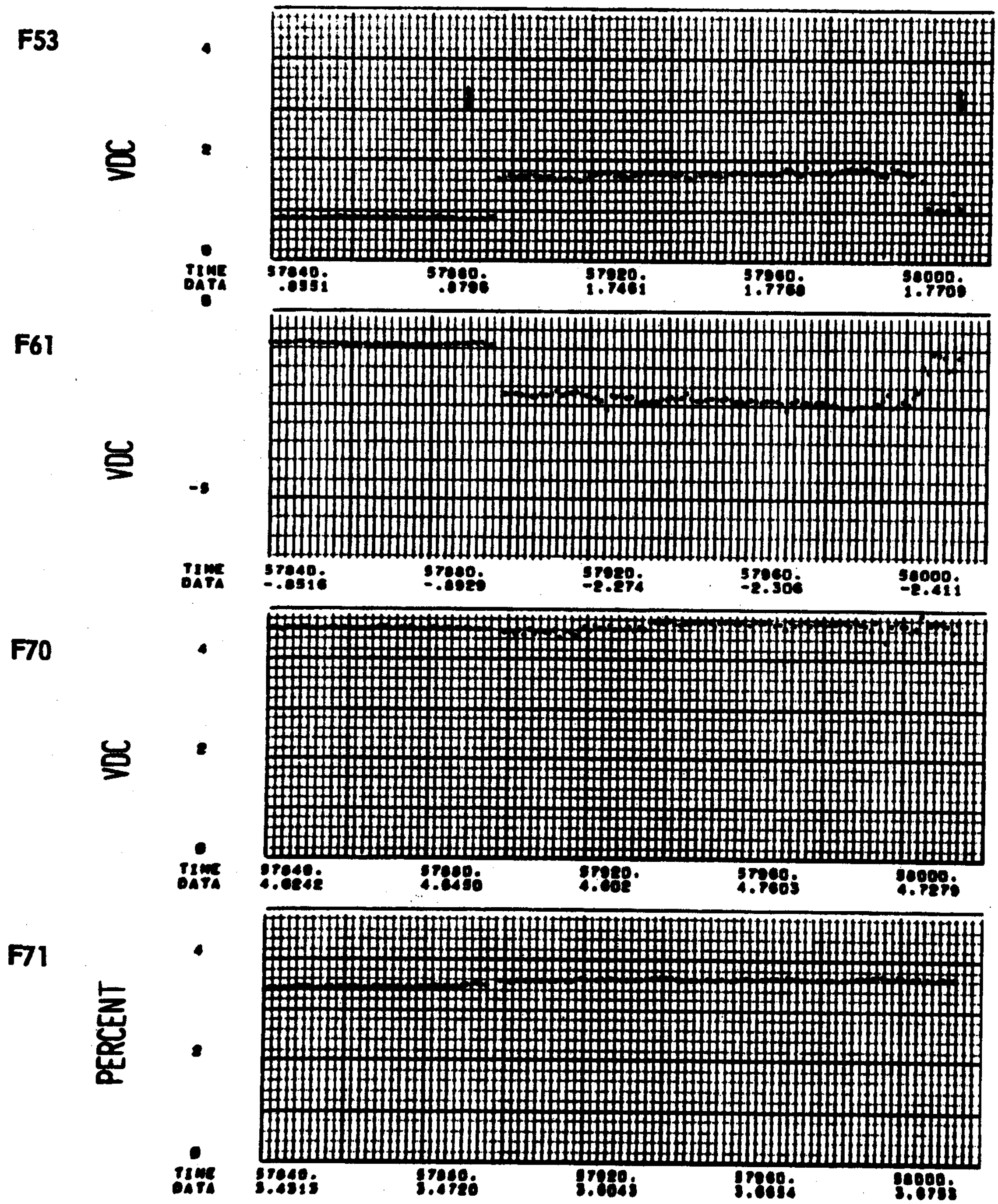
Pass 9 - Video Level and Gain Data



Pass 9 - Power Data

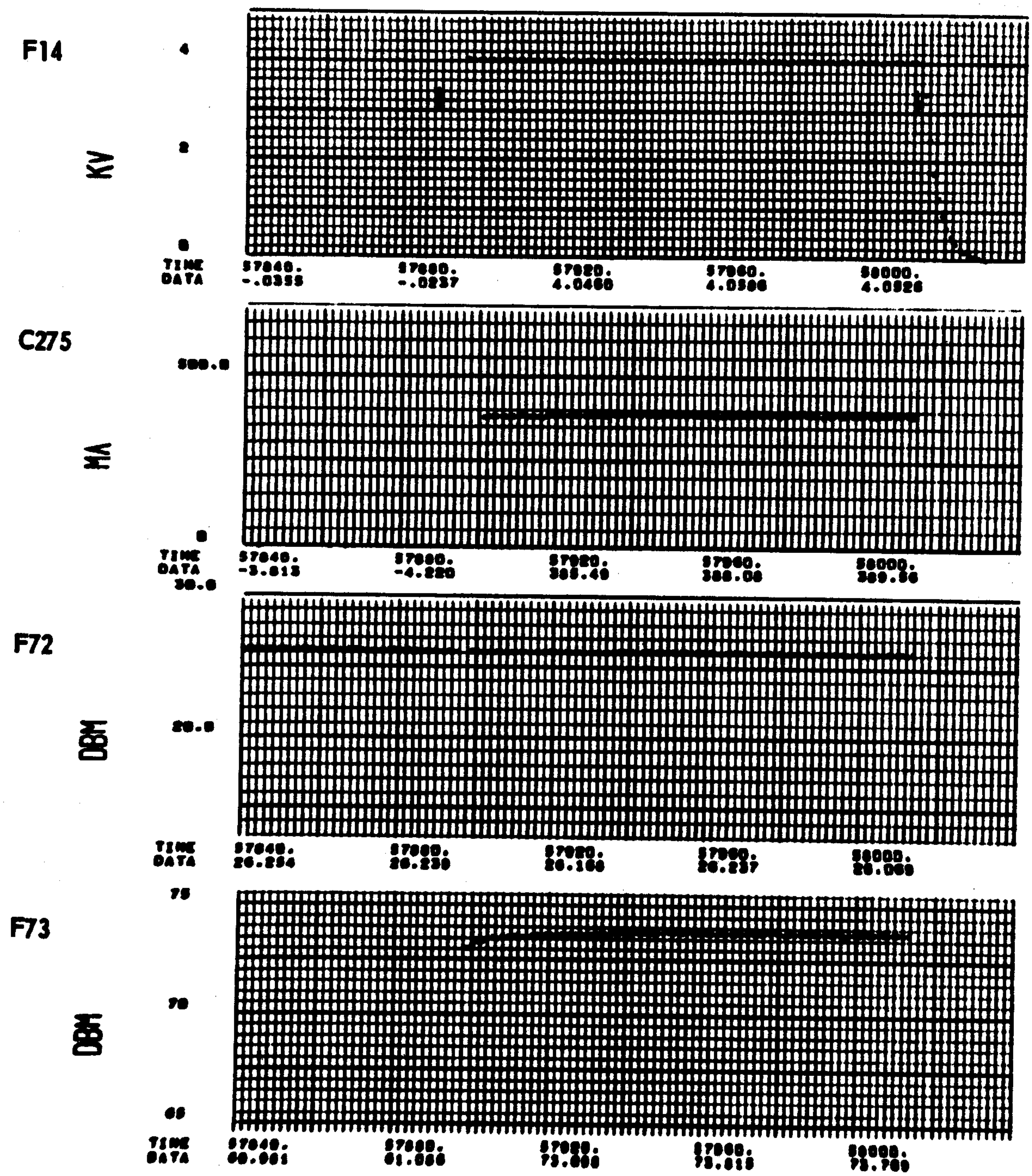


Pass 9 - Clutter Lock and Gyro Outputs

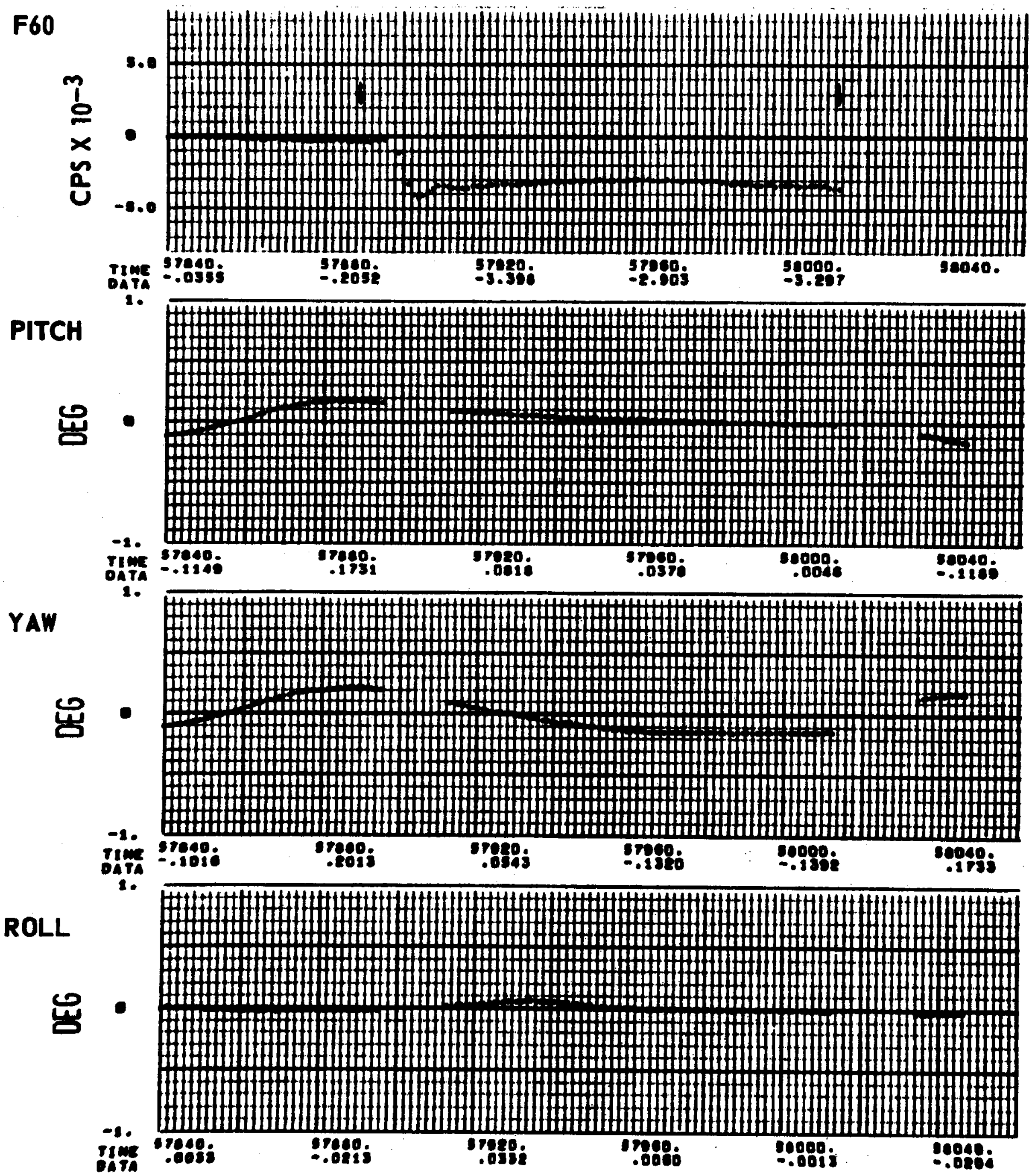


Pass 14 - Video Level and Gain Data

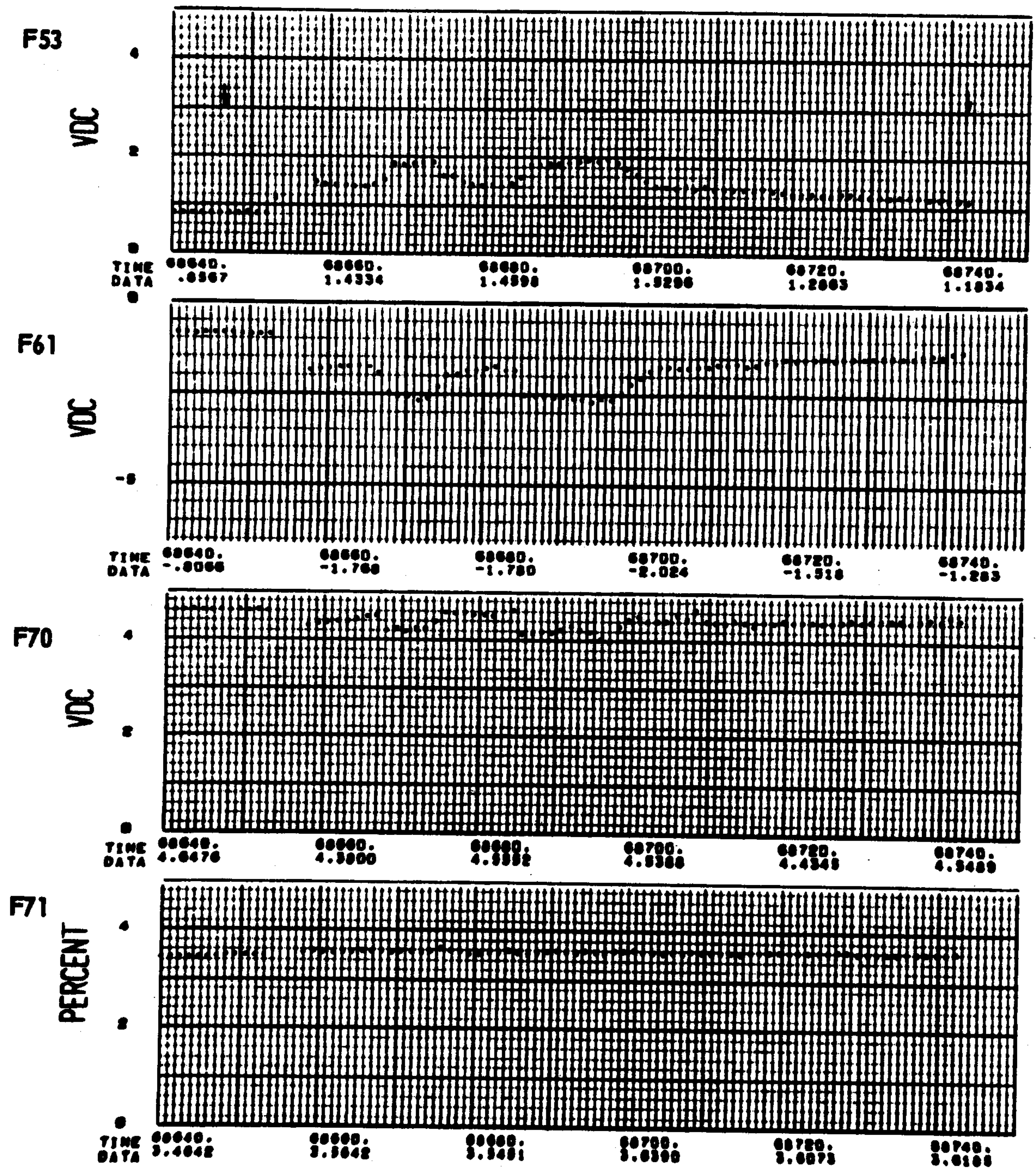
AC04306



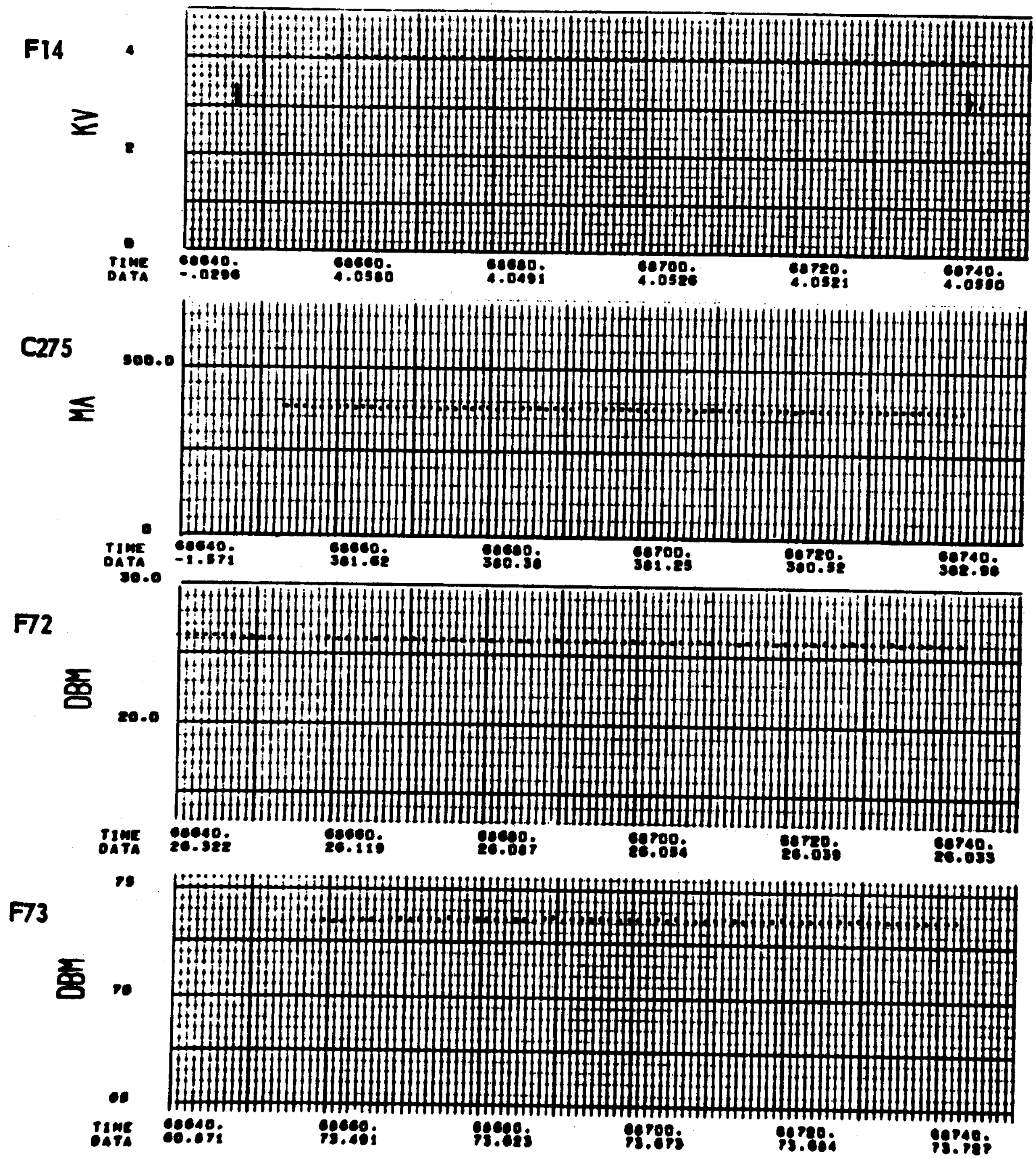
Pass 14 - Power Data



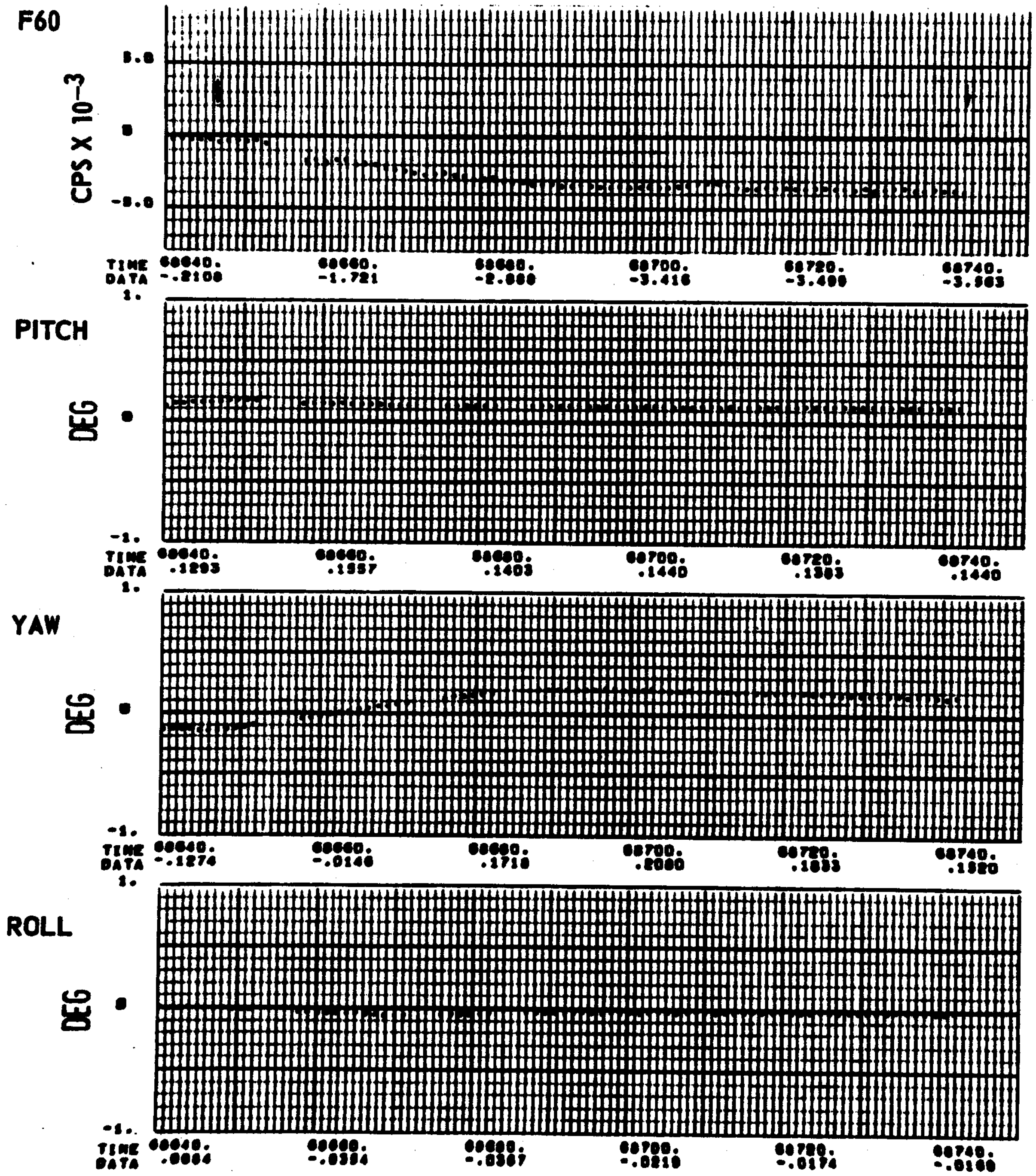
Pass 14 - Clutter Lock and Gyro Outputs



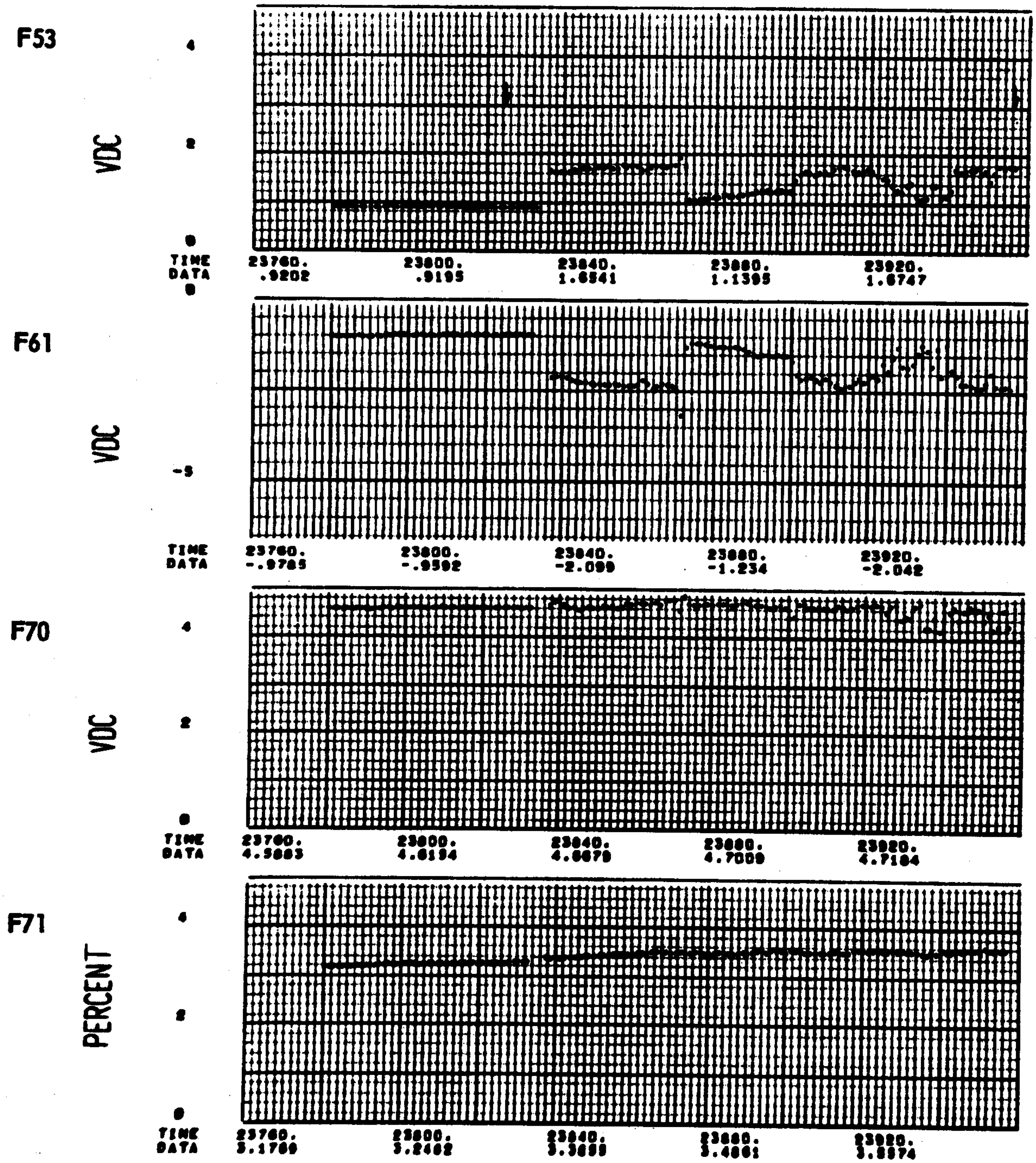
Pass 16 - Video Level and Gain Data



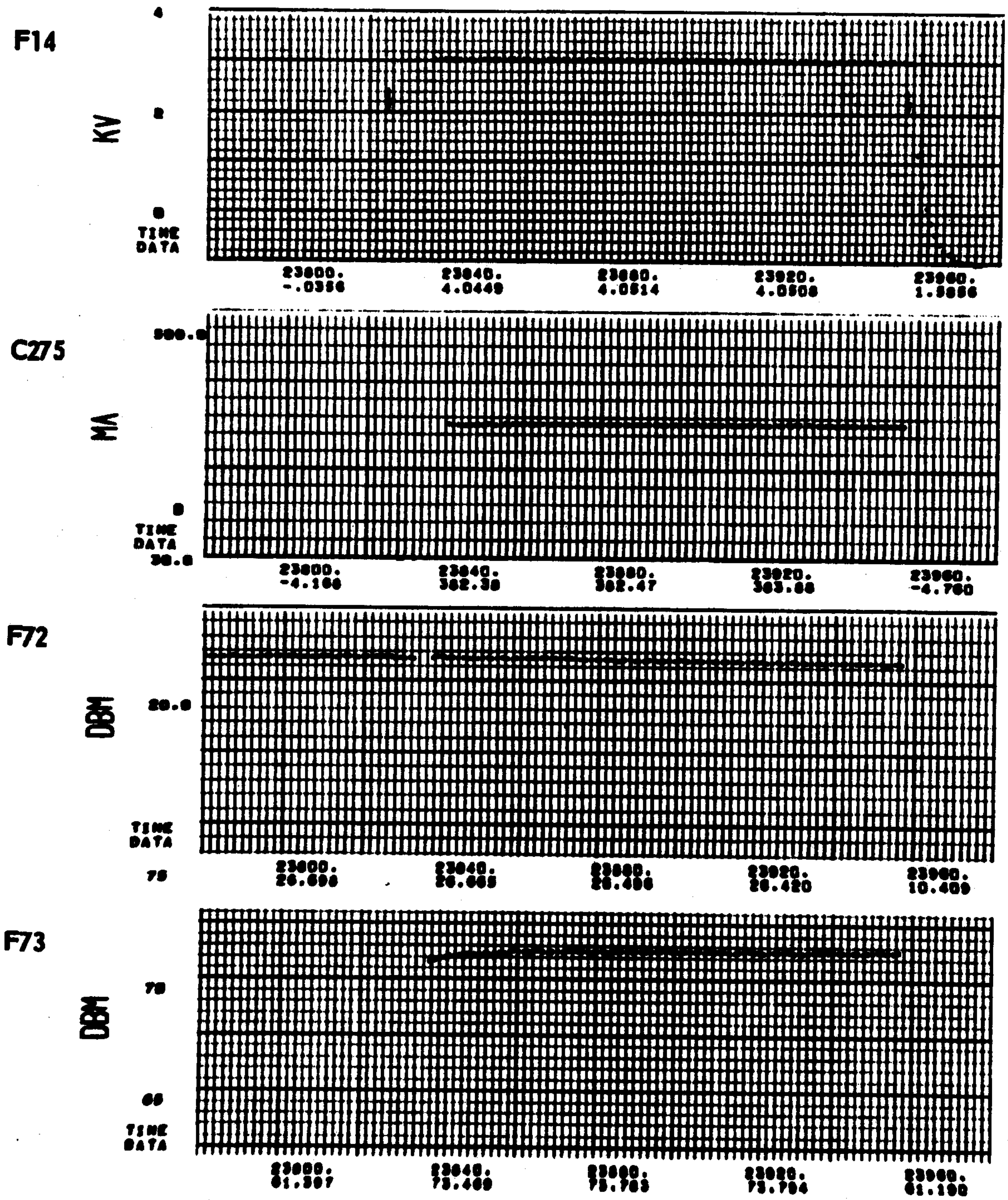
Pass 16 - Power Data



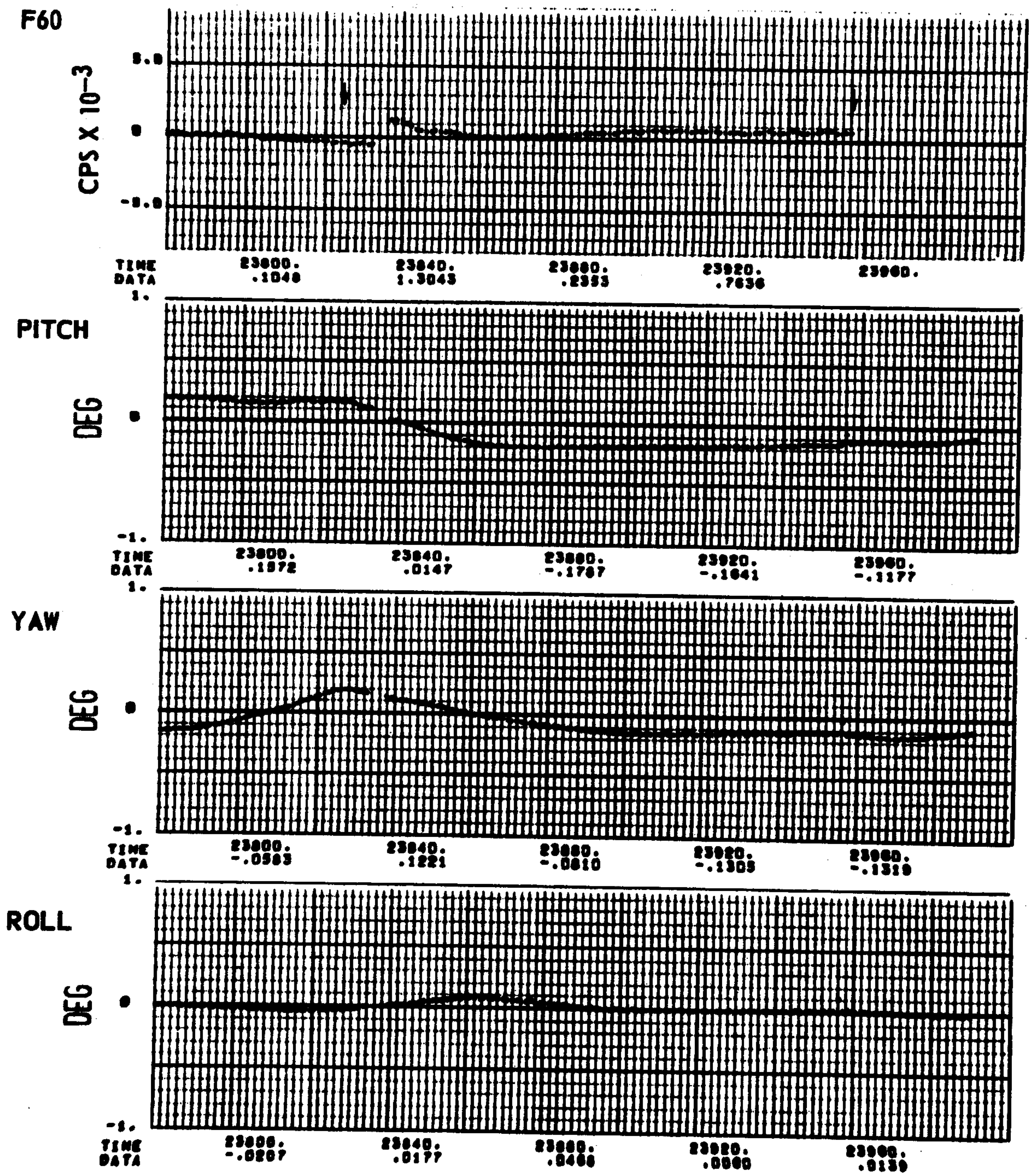
Pass 16 - Clutter Lock and Gyro Outputs



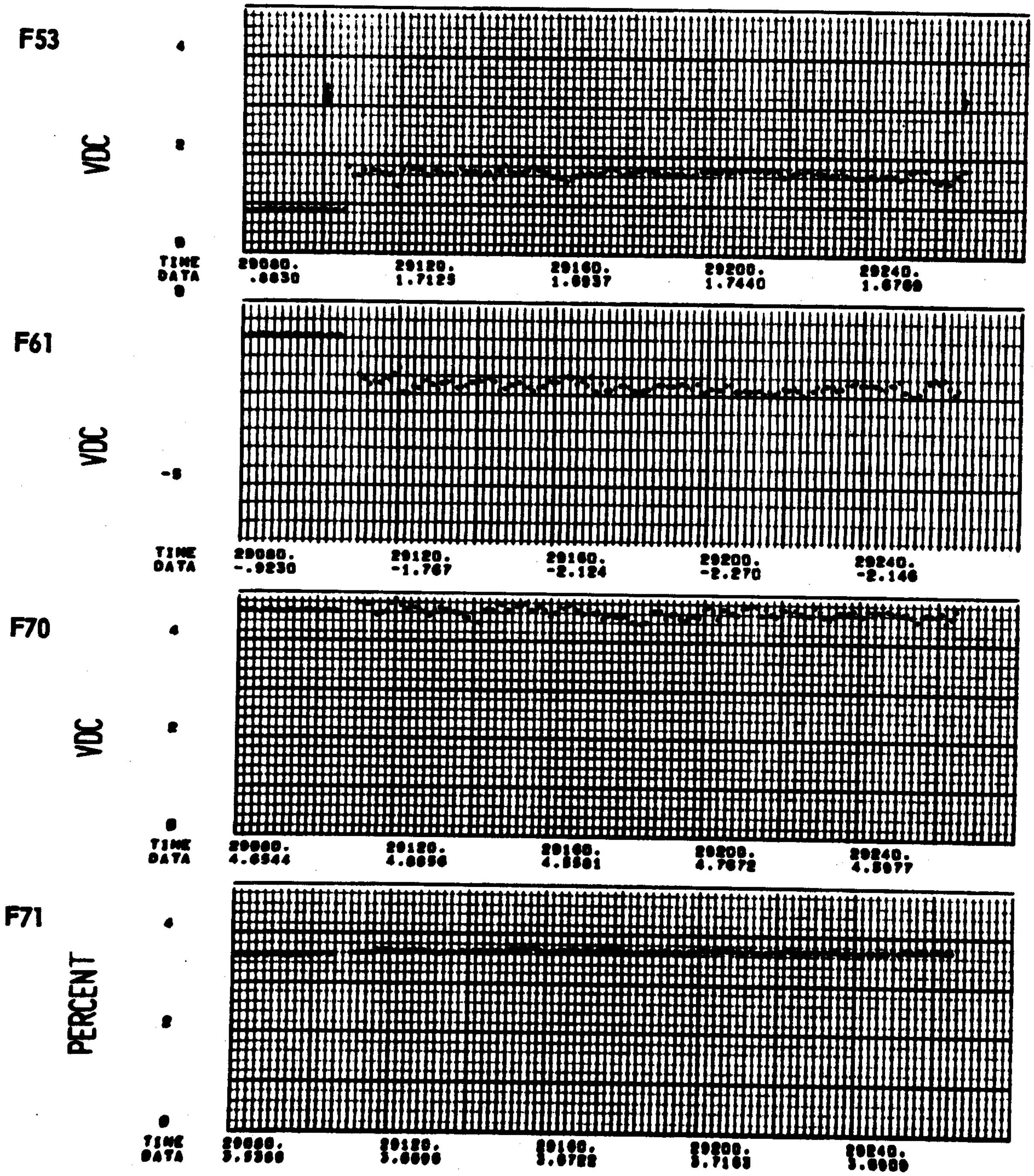
Pass 24 - Video Level and Gain Data



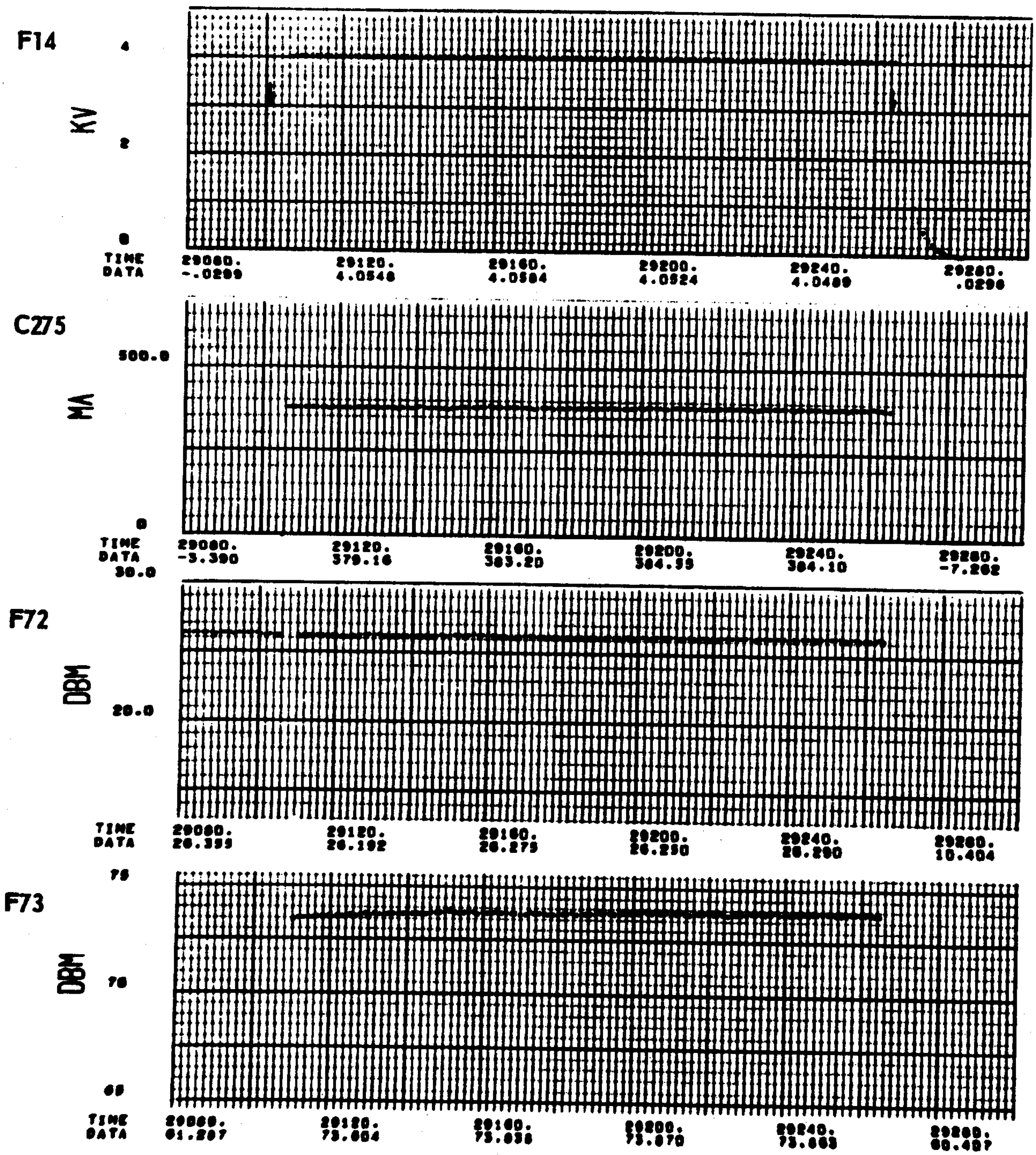
Pass 24 - Power Data



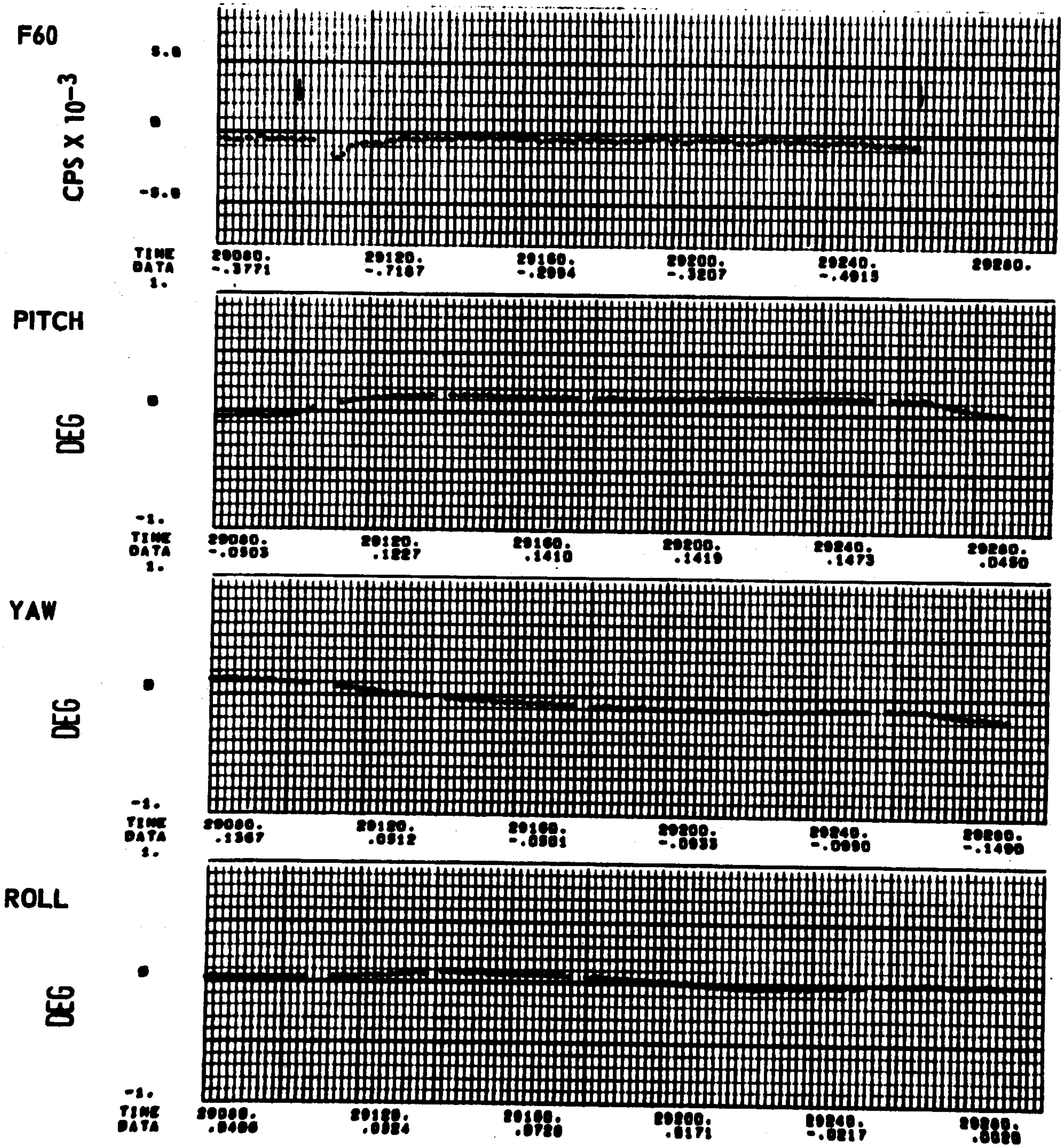
Pass 24 - Clutter Lock and Gyro Outputs



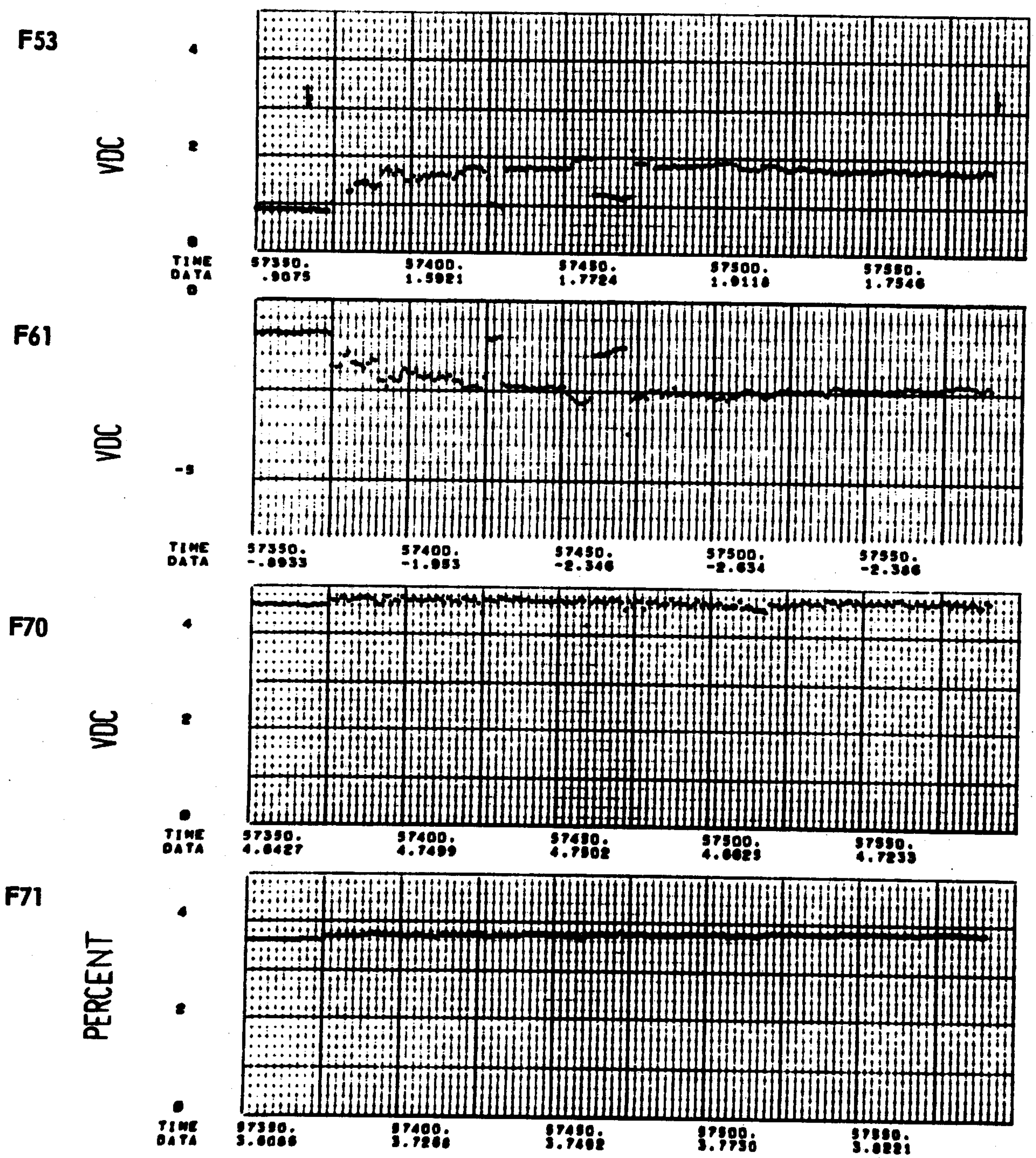
Pass 25 - Video Level and Gain Data



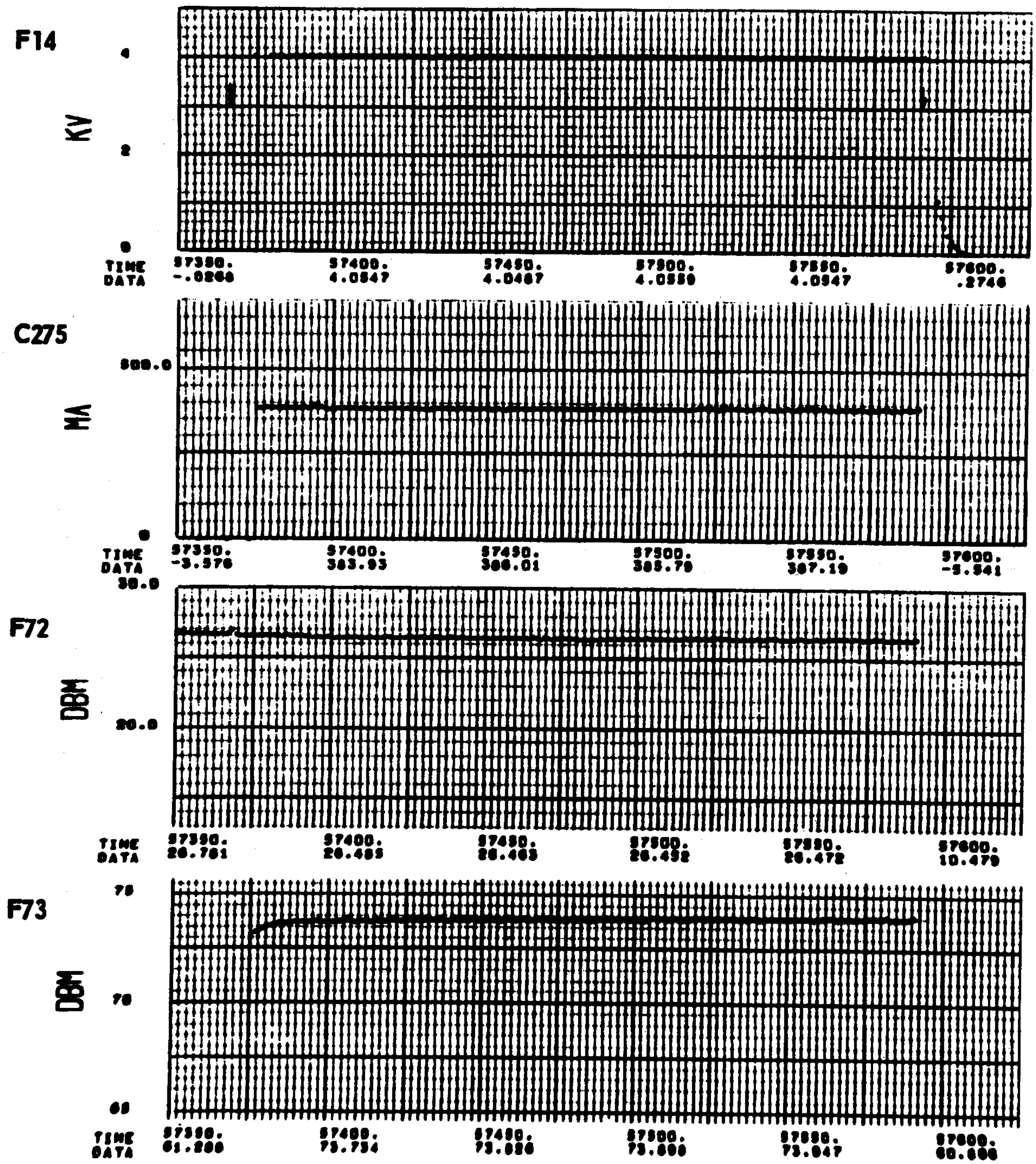
Pass 25 - Power Data



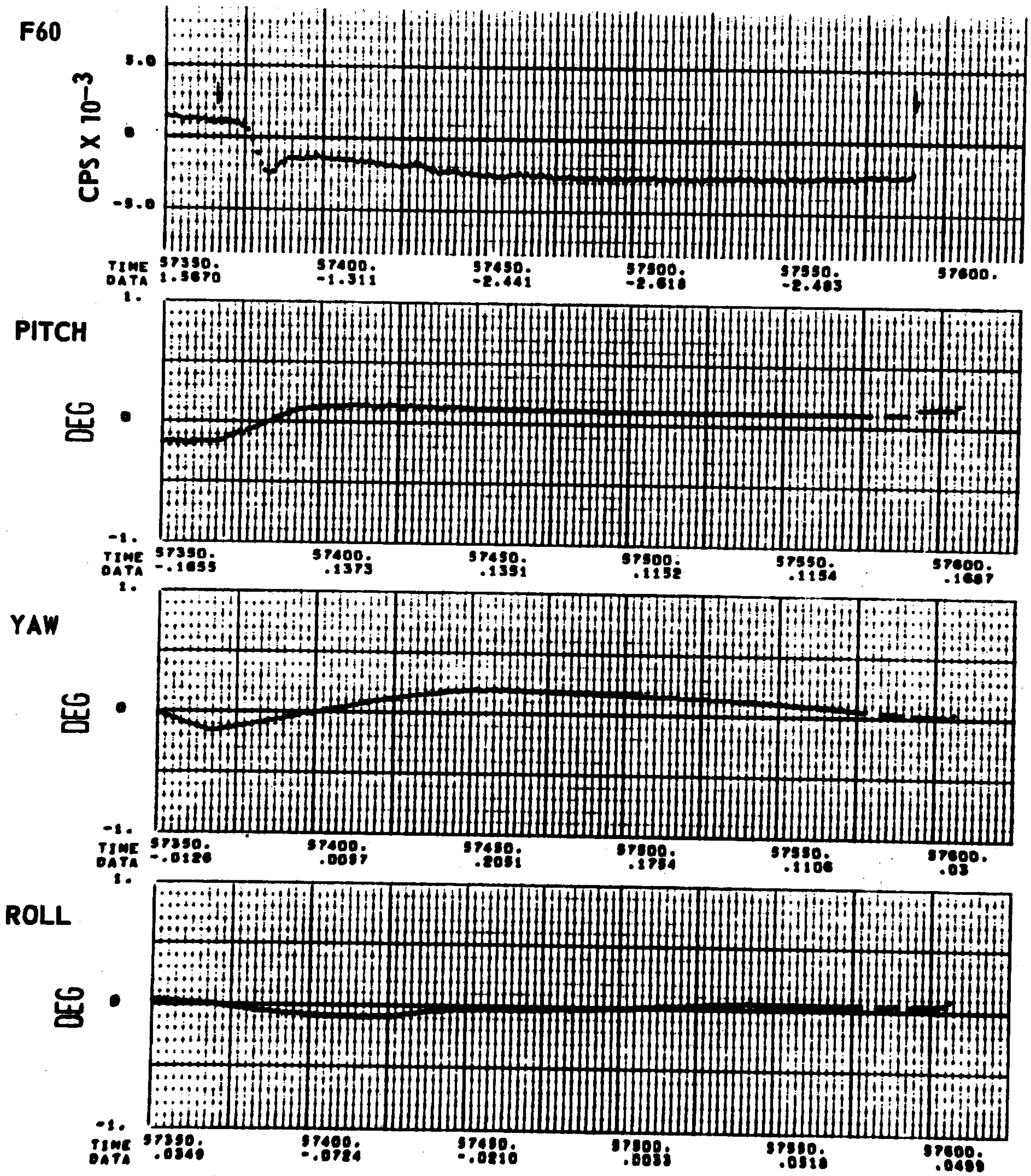
Pass 25 - Clutter Lock and Gyro Outputs



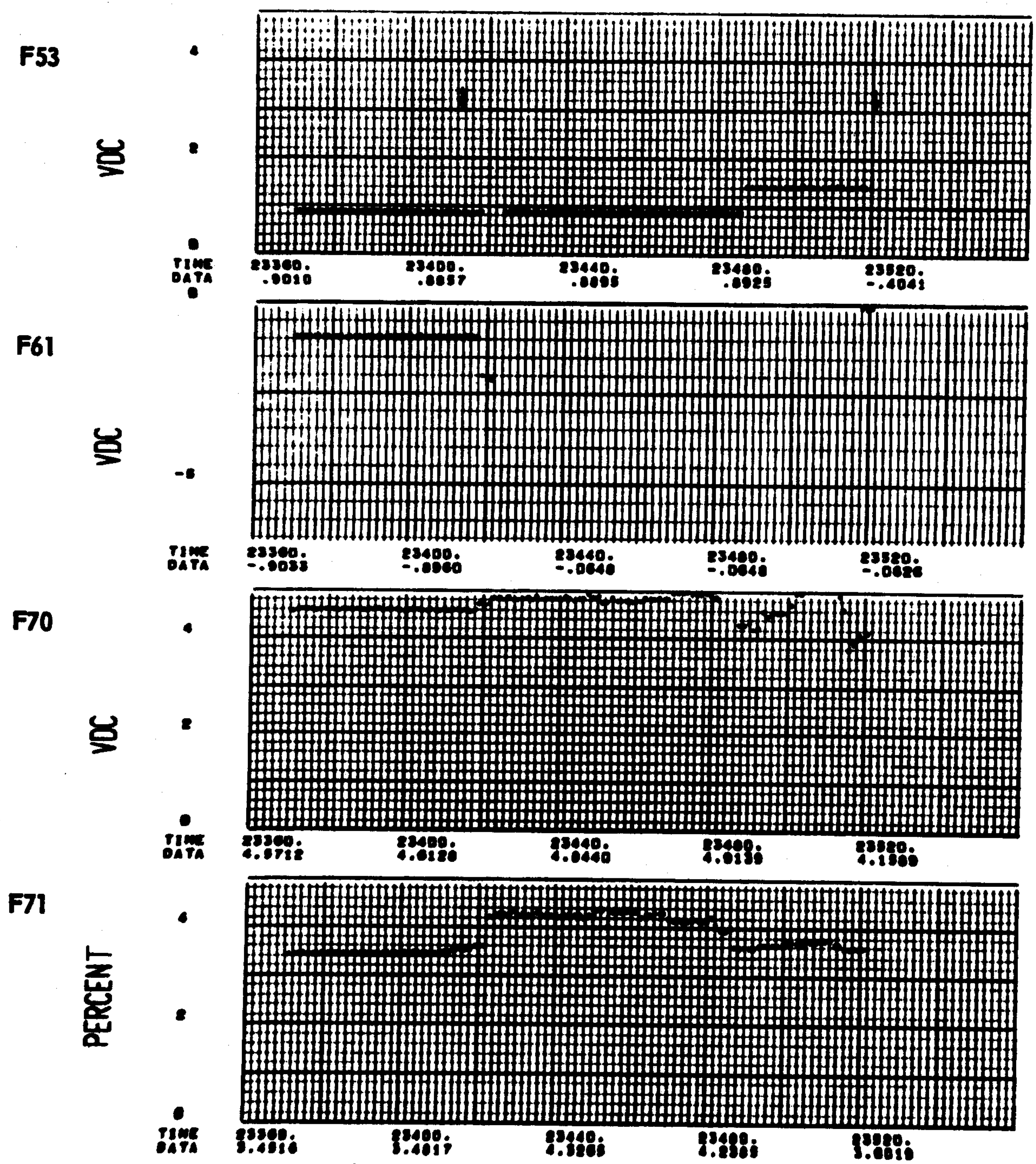
Pass 30 - Video Level and Gain Data



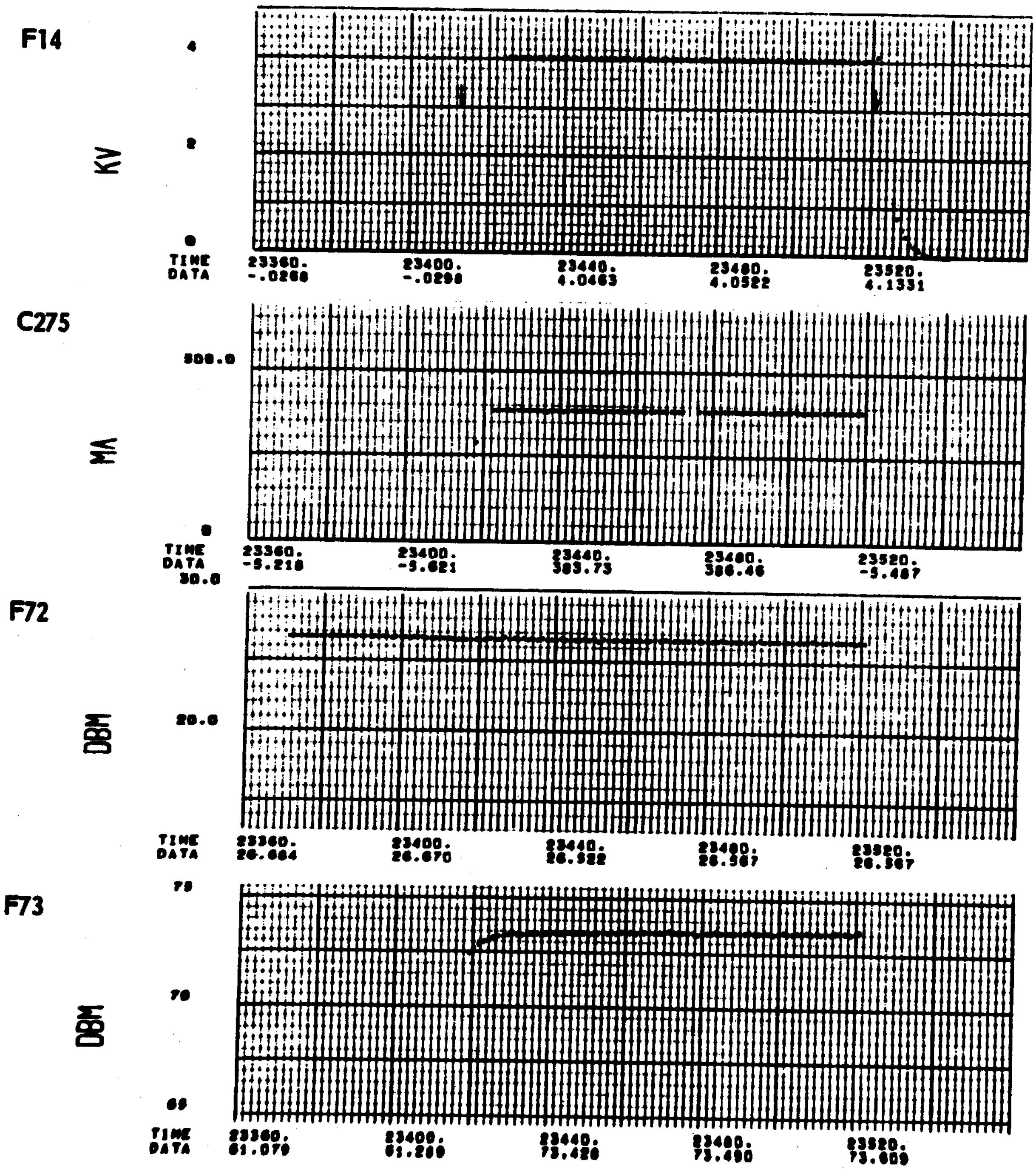
Pass 30 - Power Data



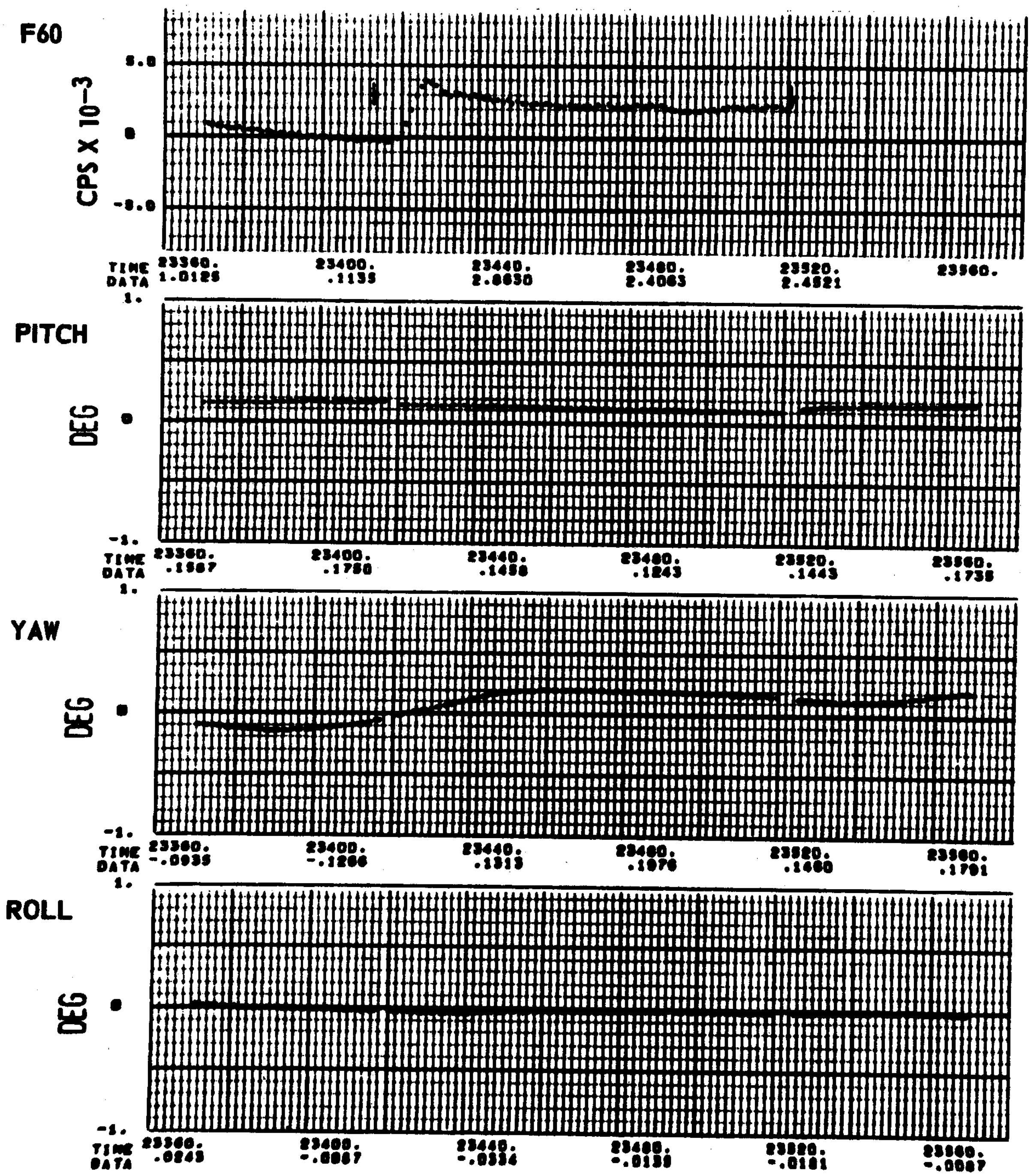
Pass 30 - Clutter Lock and Gyro Outputs



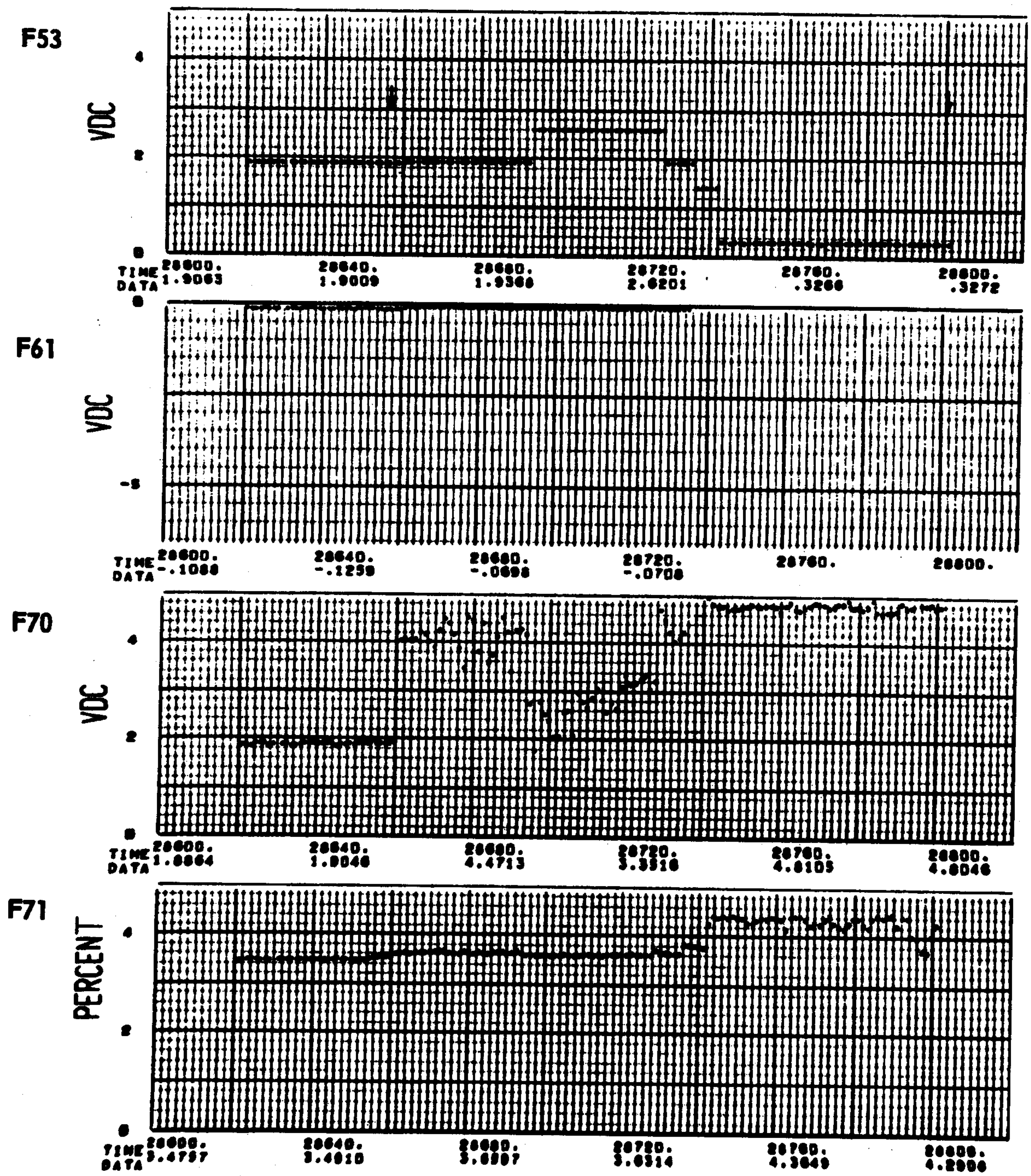
Pass 40 - Video Level and Gain Data



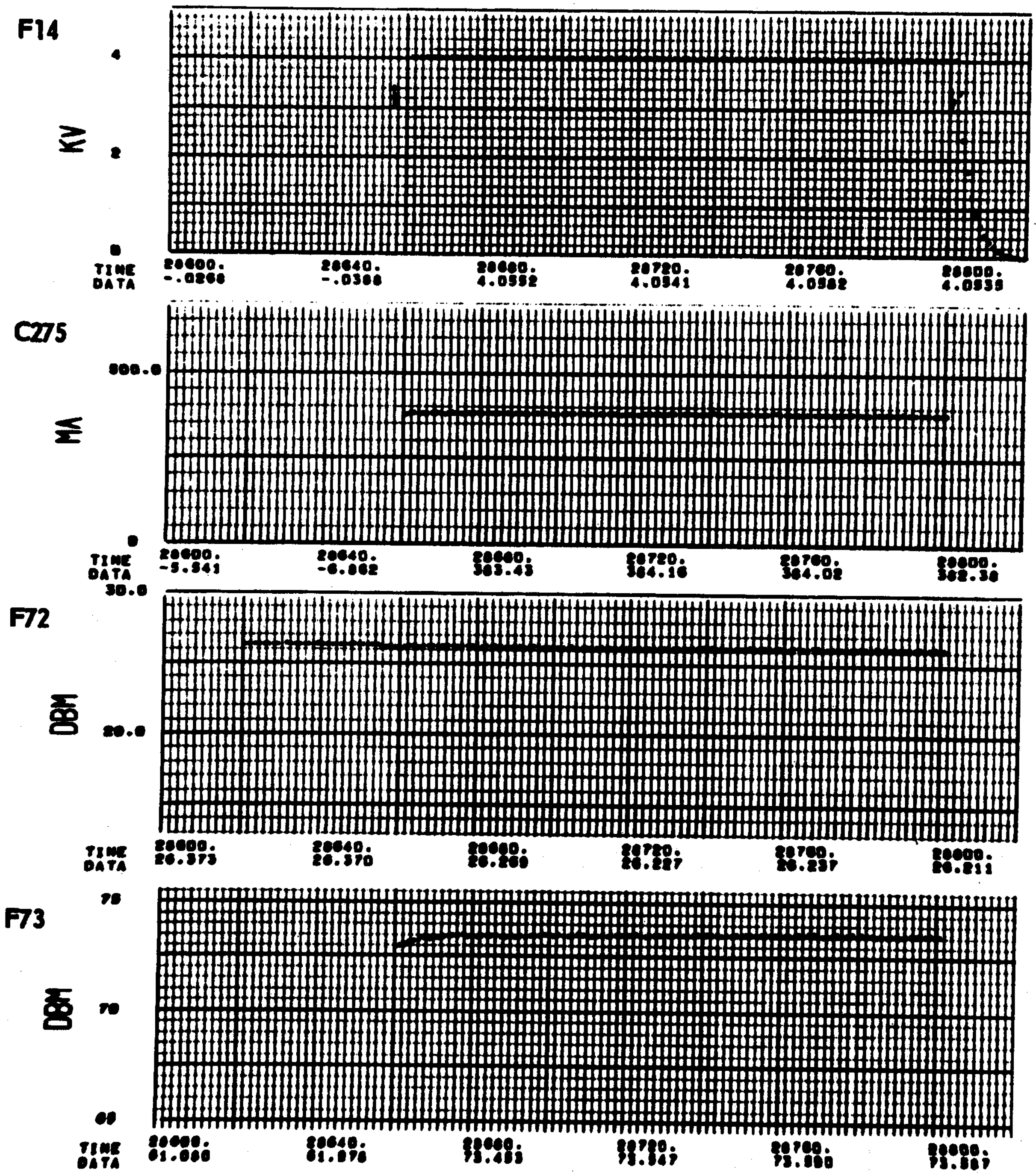
Pass 40 - Power Data



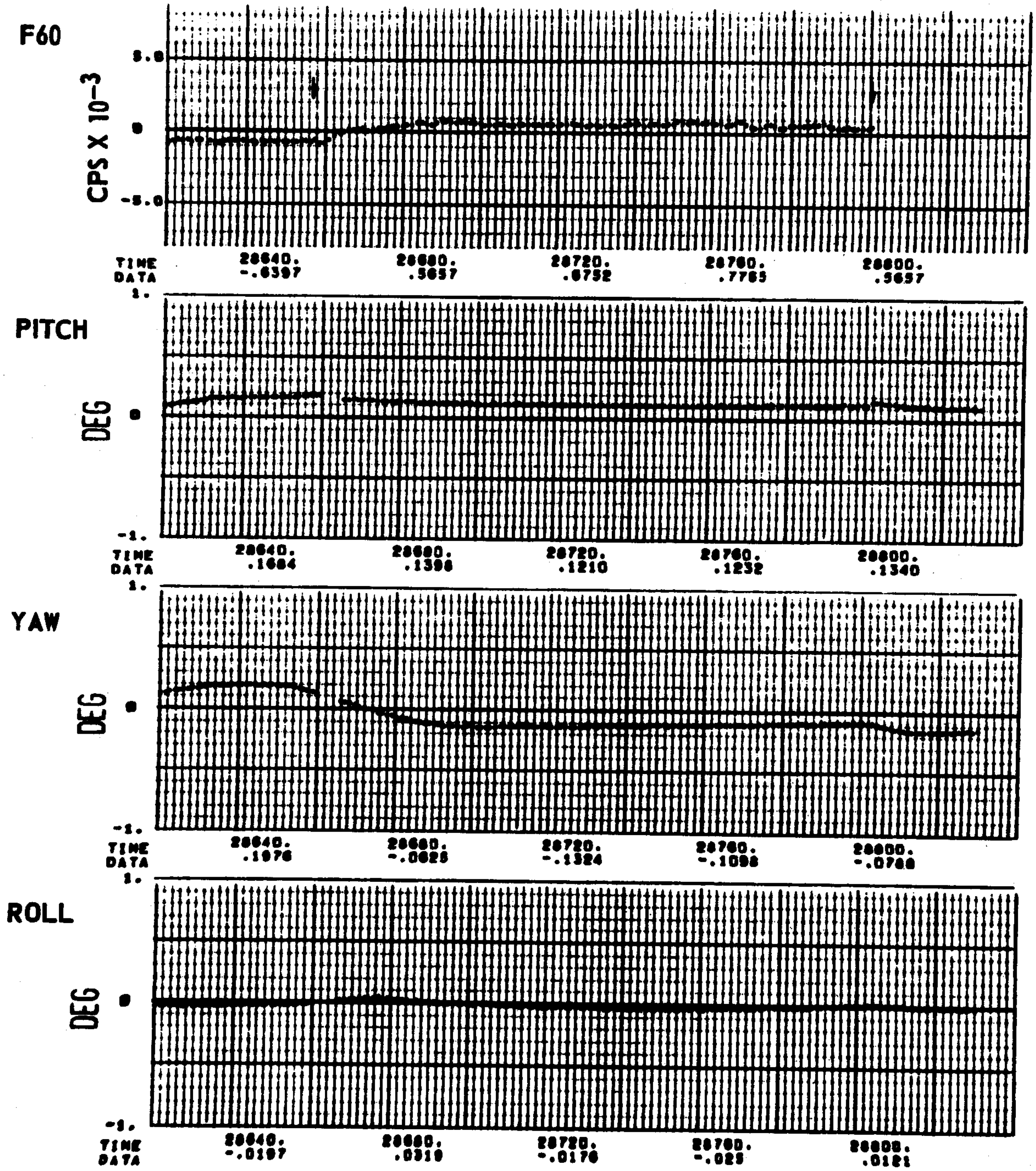
Pass 40 - Clutter Lock and Gyro Outputs



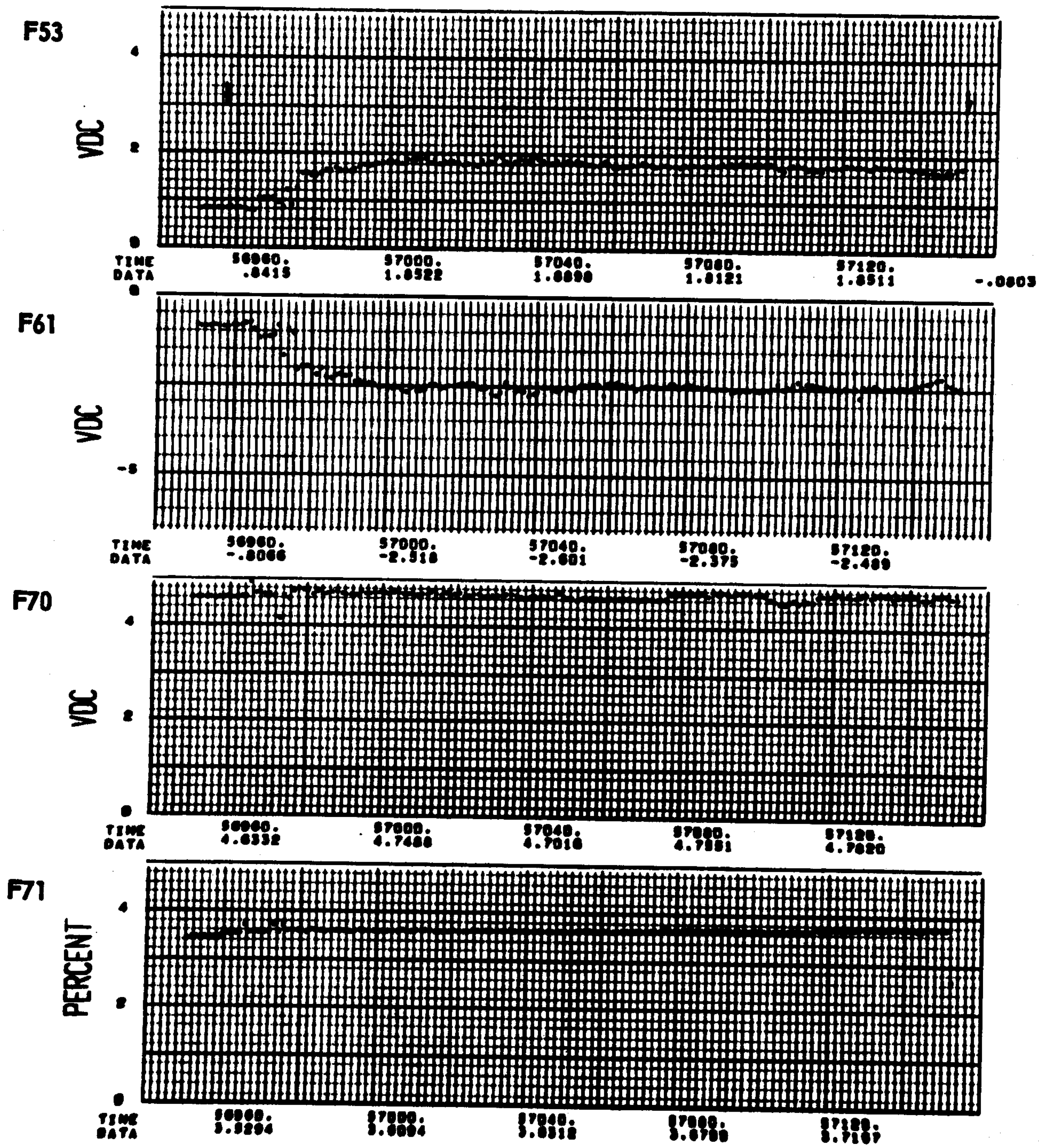
Pass 41 – Video Level and Gain Data



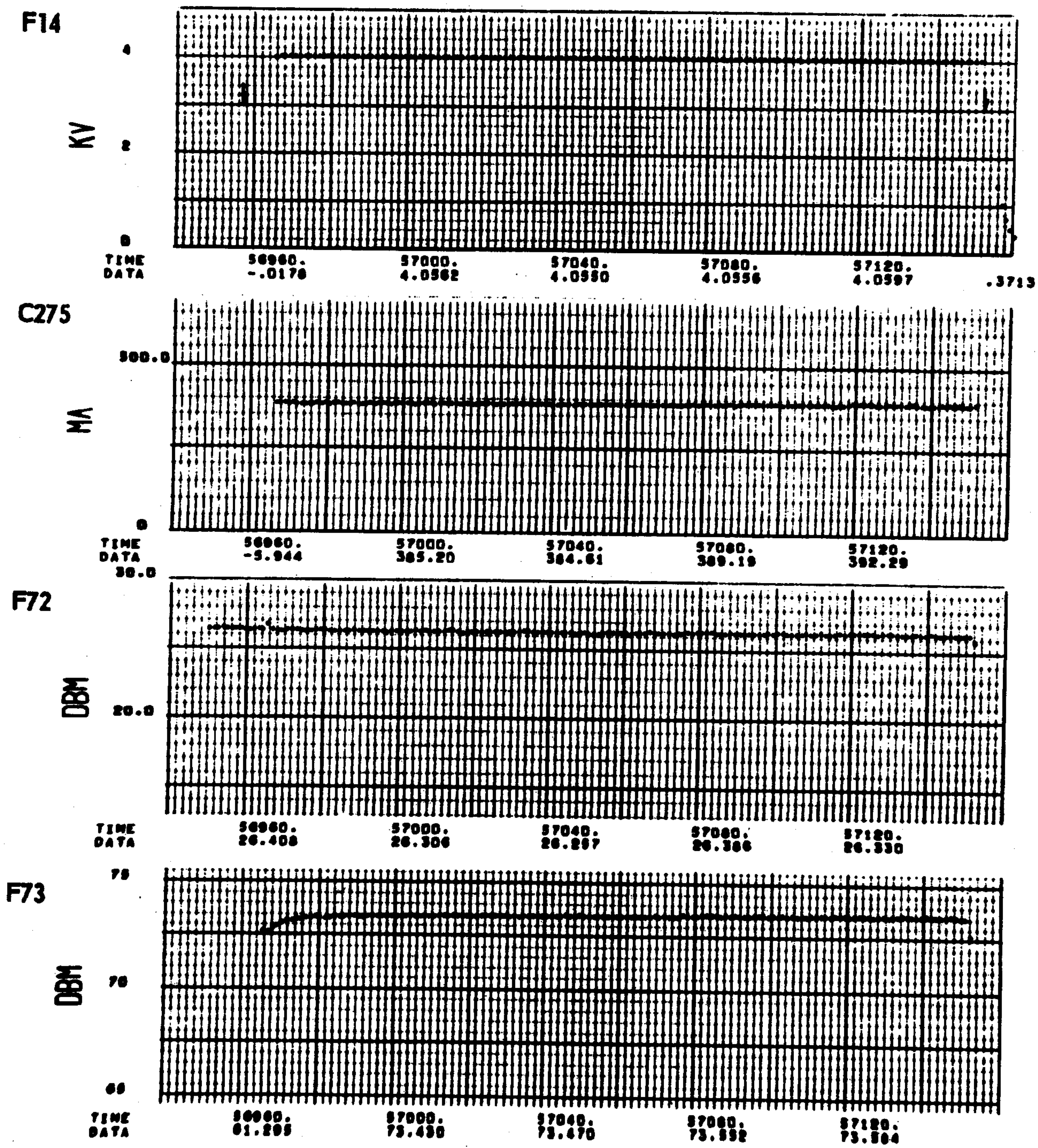
Pass 41 - Power Data



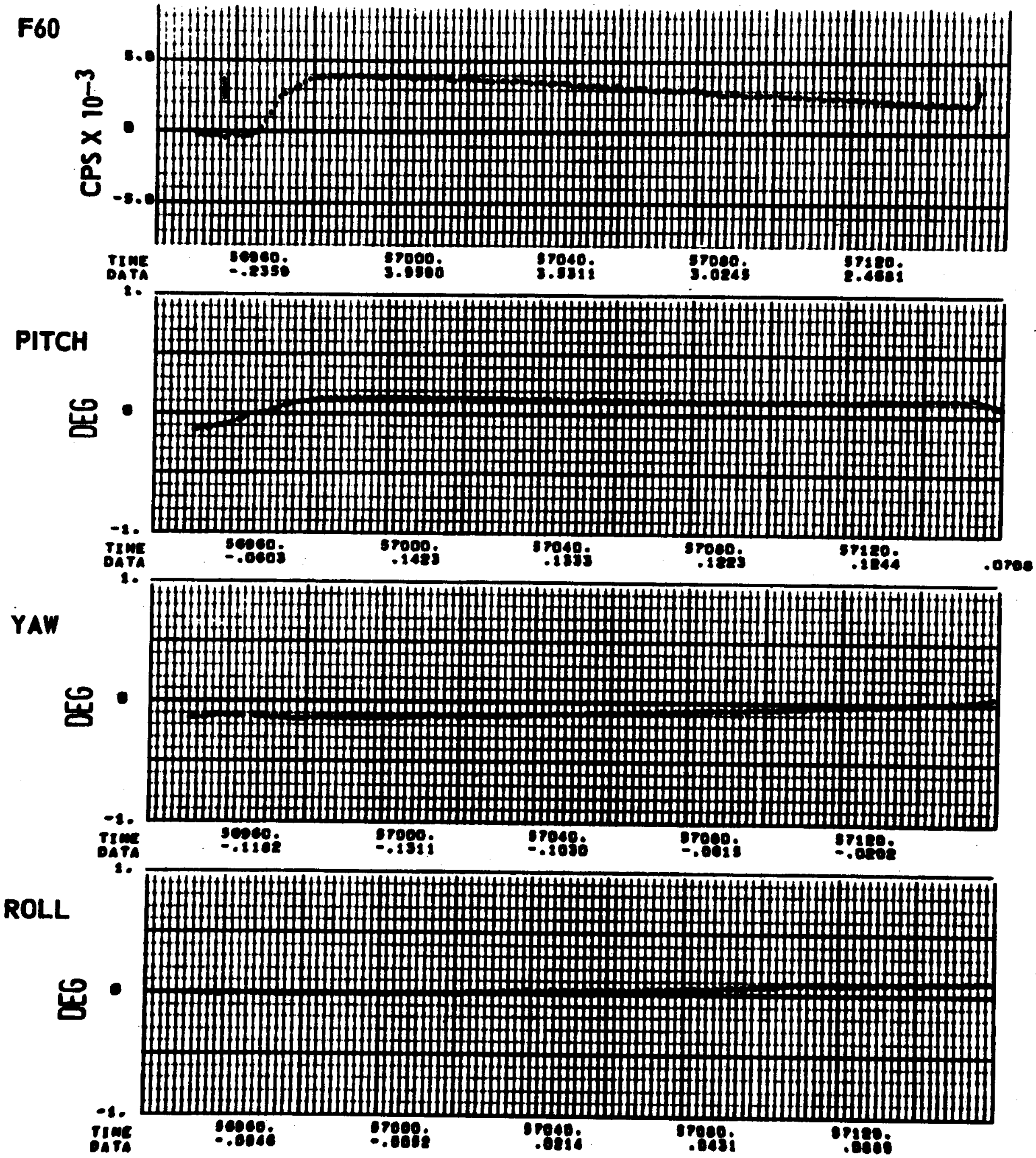
Pass 41 - Clutter Lock and Gyro Outputs



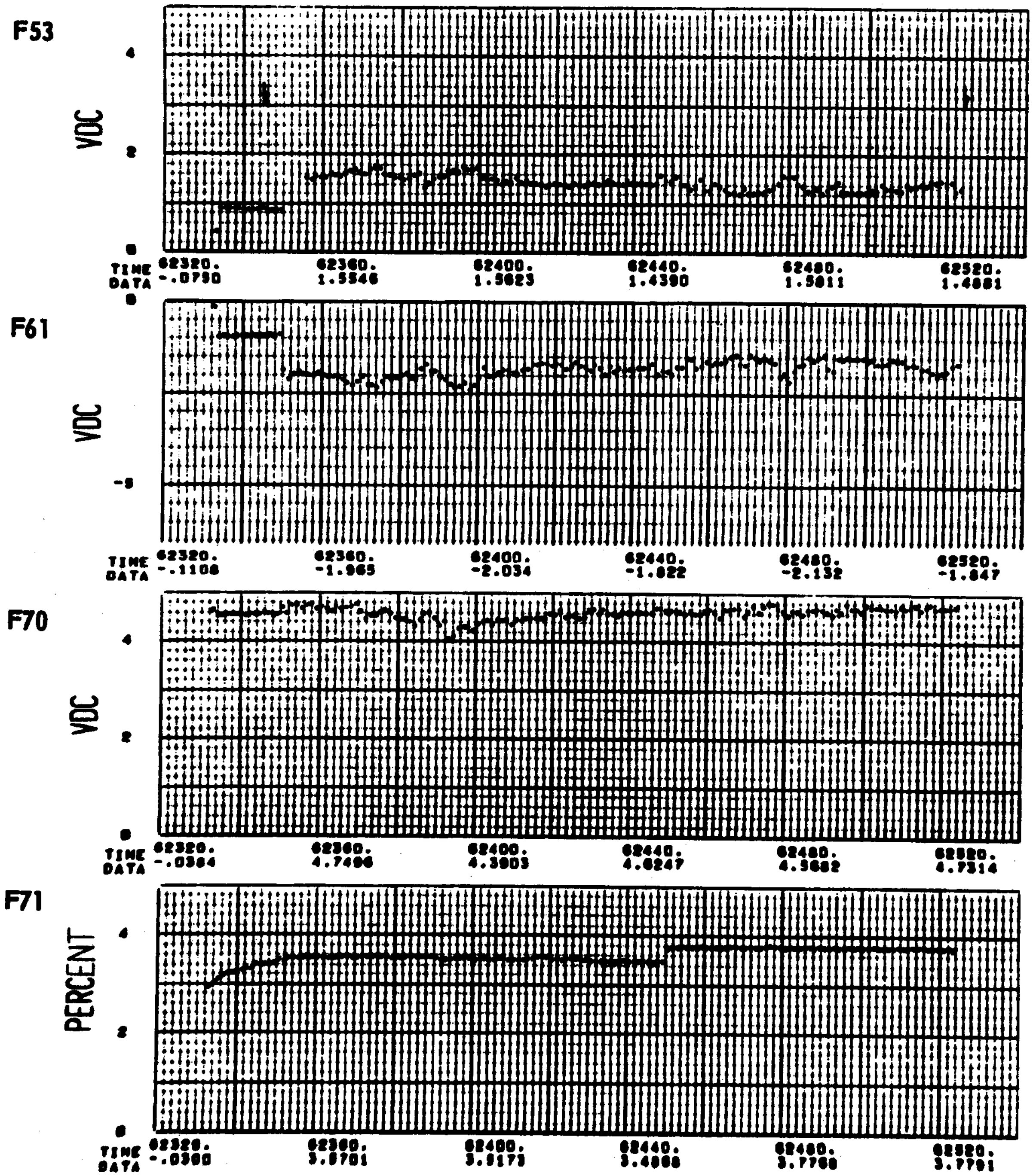
Pass 46 - Video Level and Gain Data



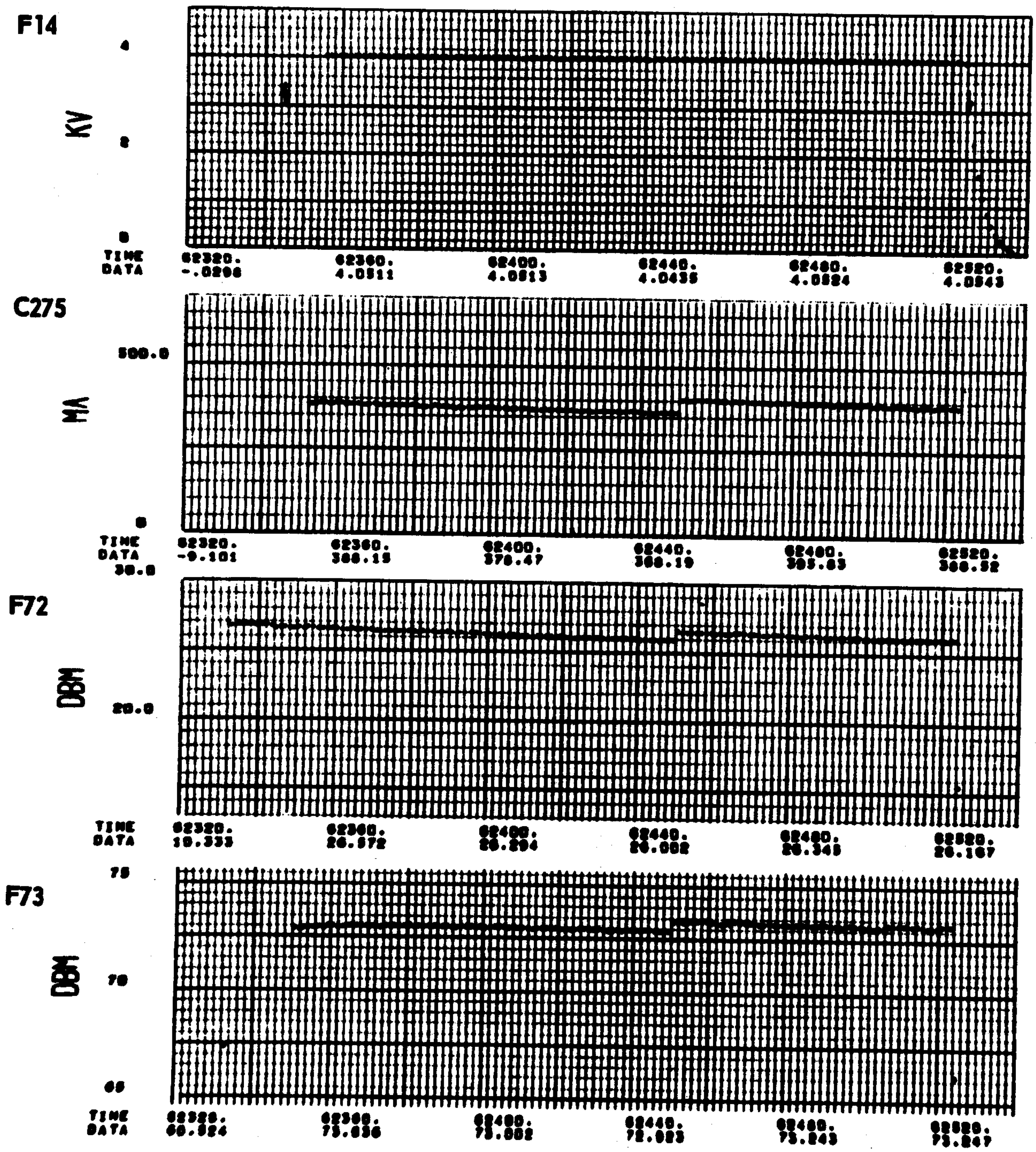
Pass 46 - Power Data



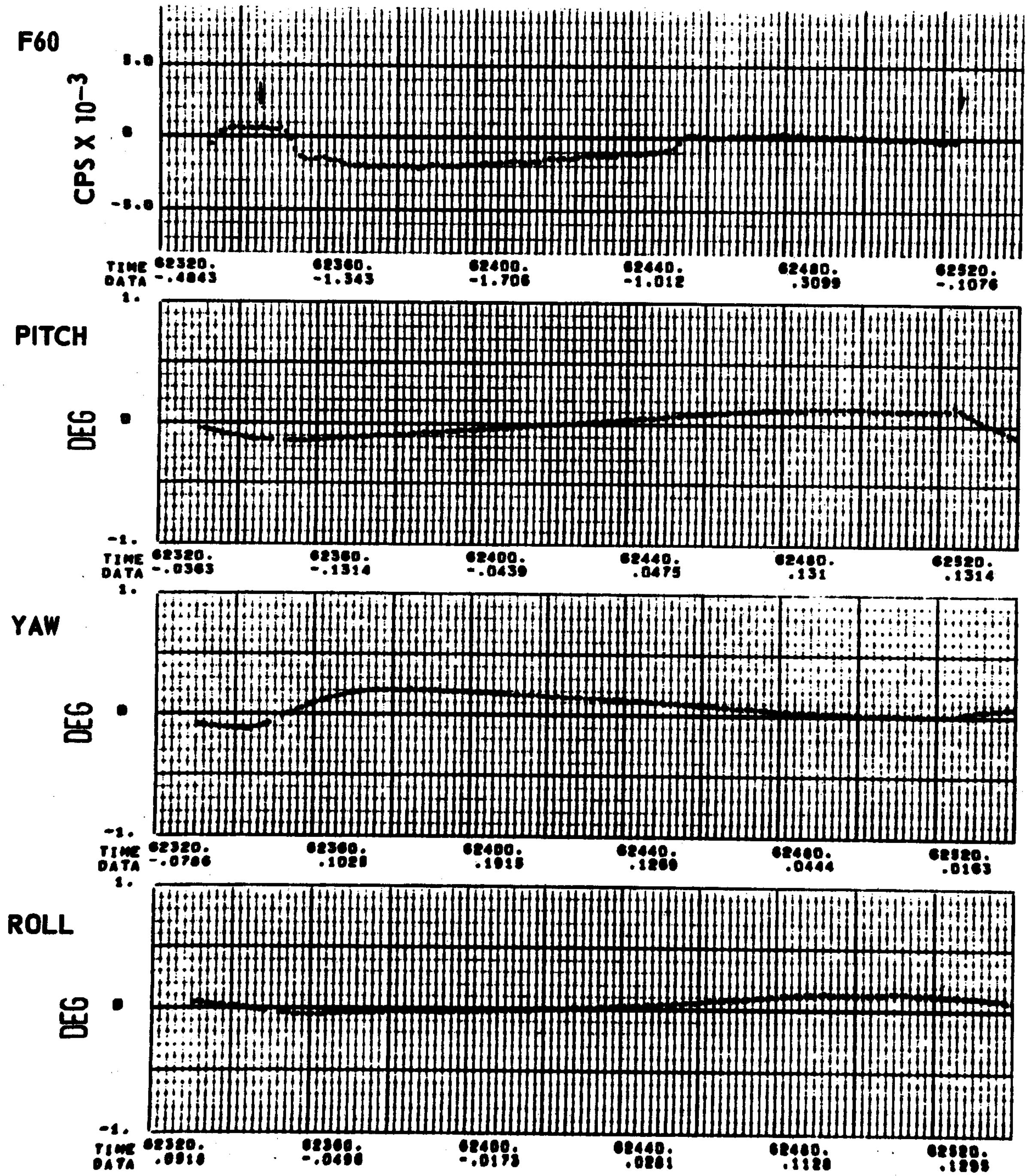
Pass 46 - Clutter Lock and Gyro Outputs



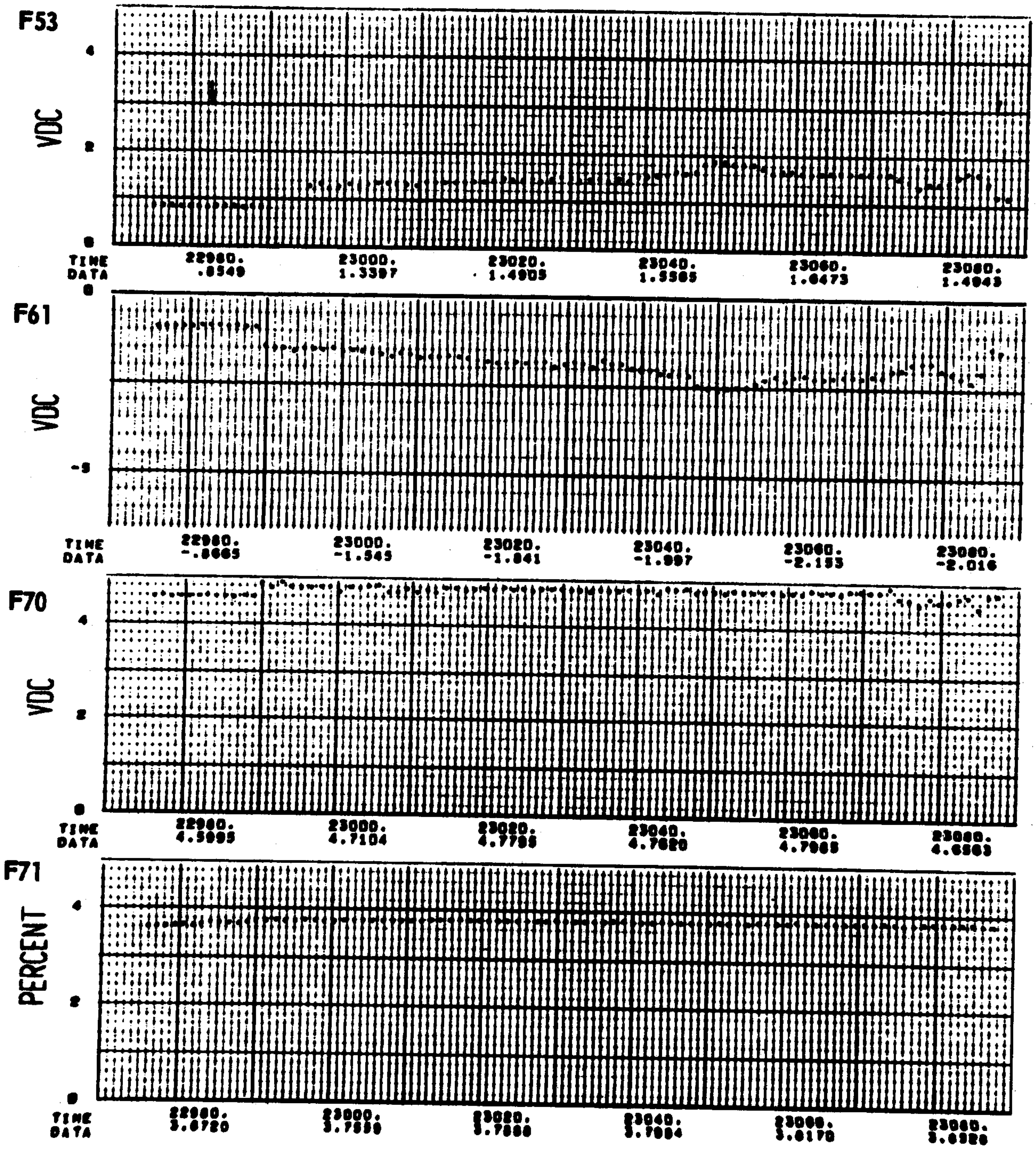
Pass 47 - Video Level and Gain Data



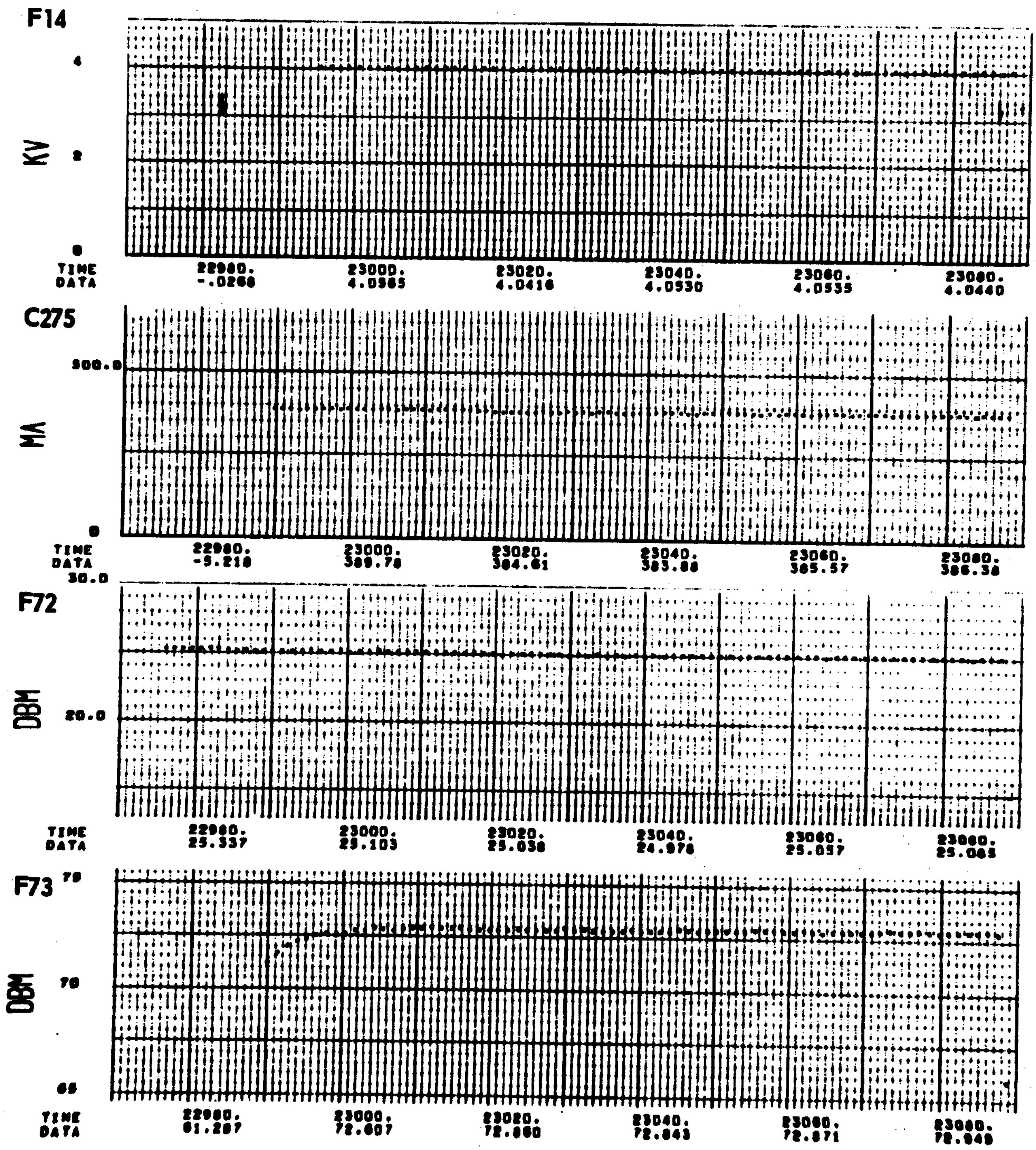
Pass 47 - Power Data



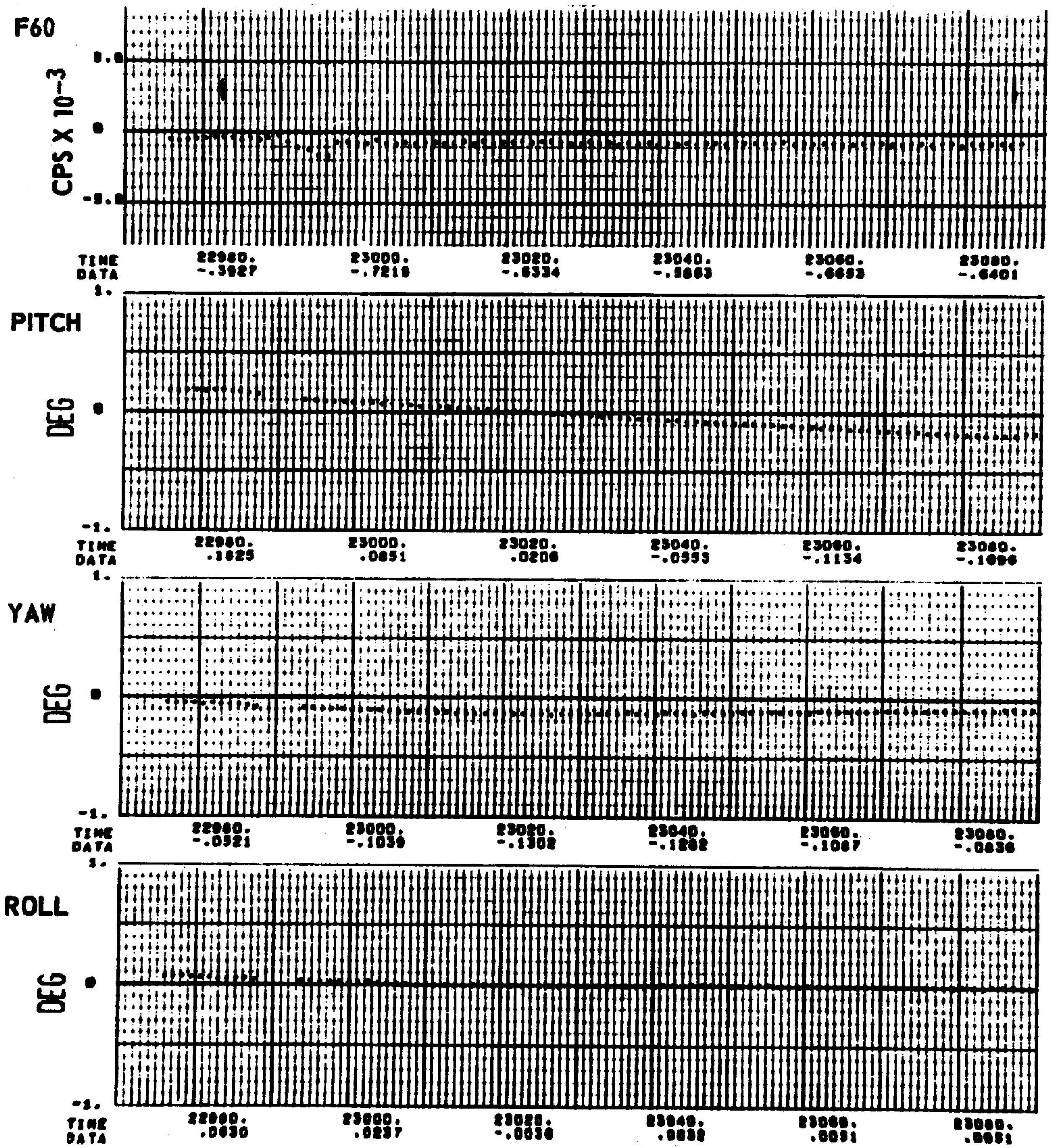
Pass 47 - Clutter Lock and Gyro Outputs



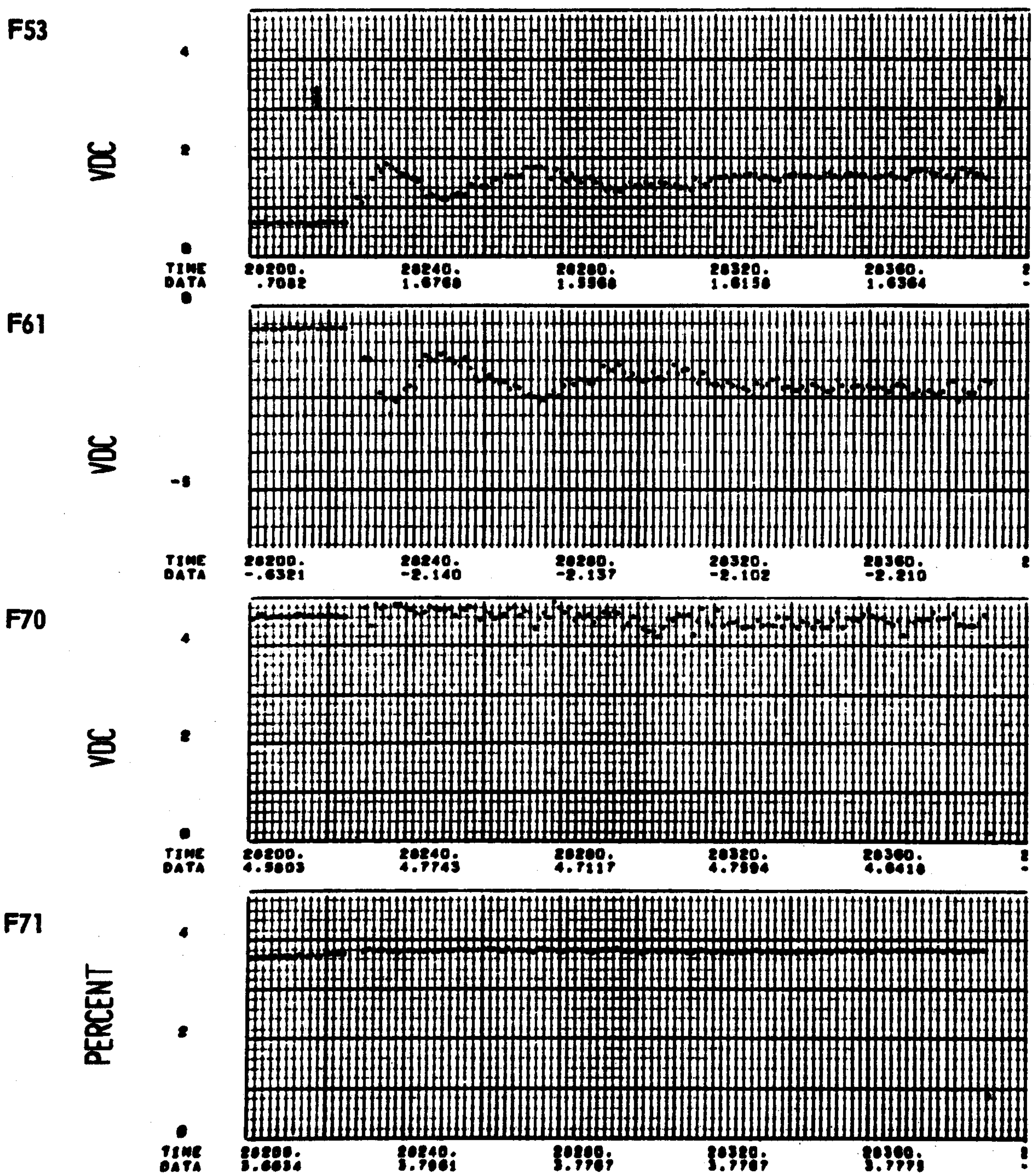
Pass 56 - Video Level and Gain Data



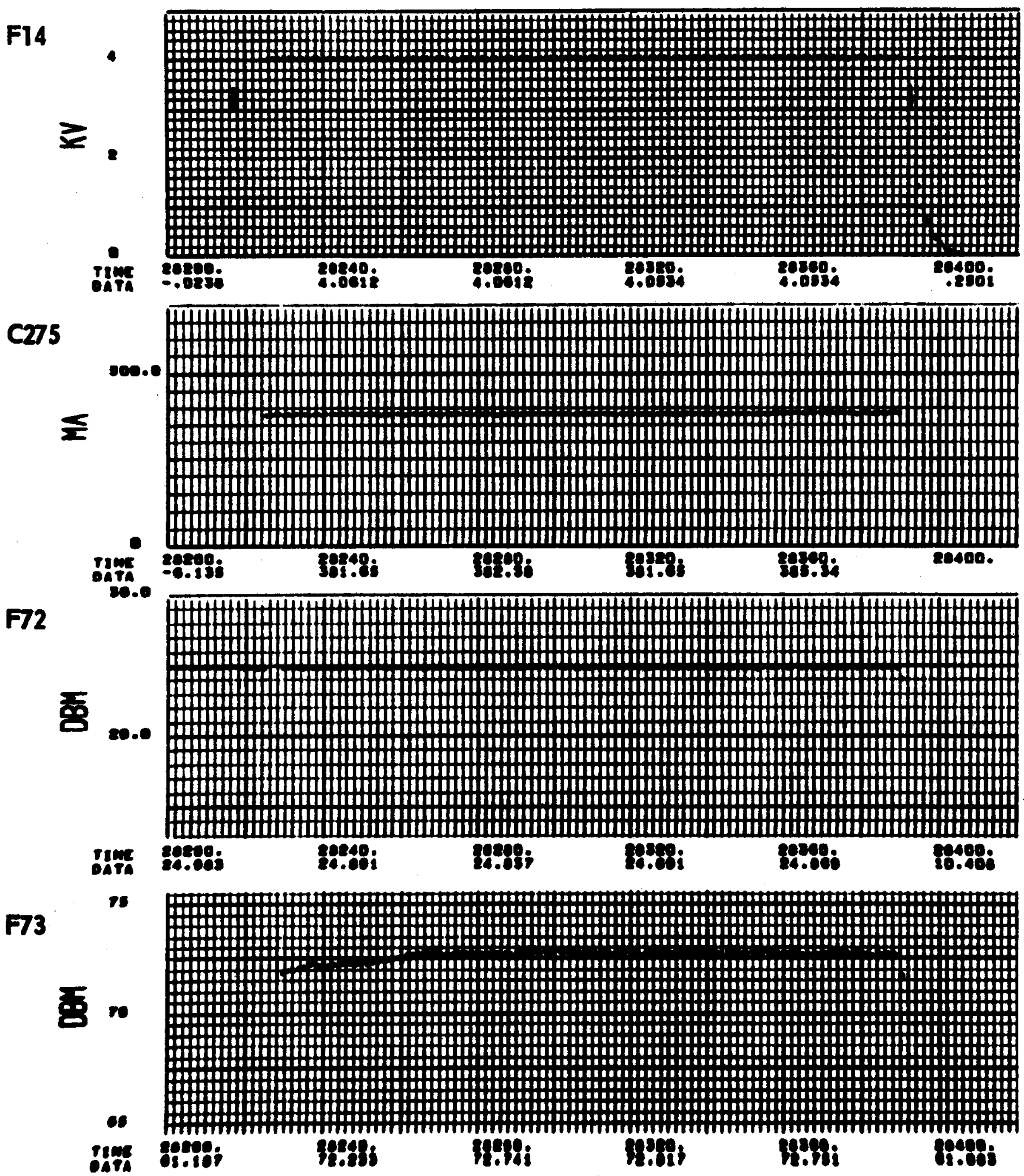
Pass 56 - Power Data



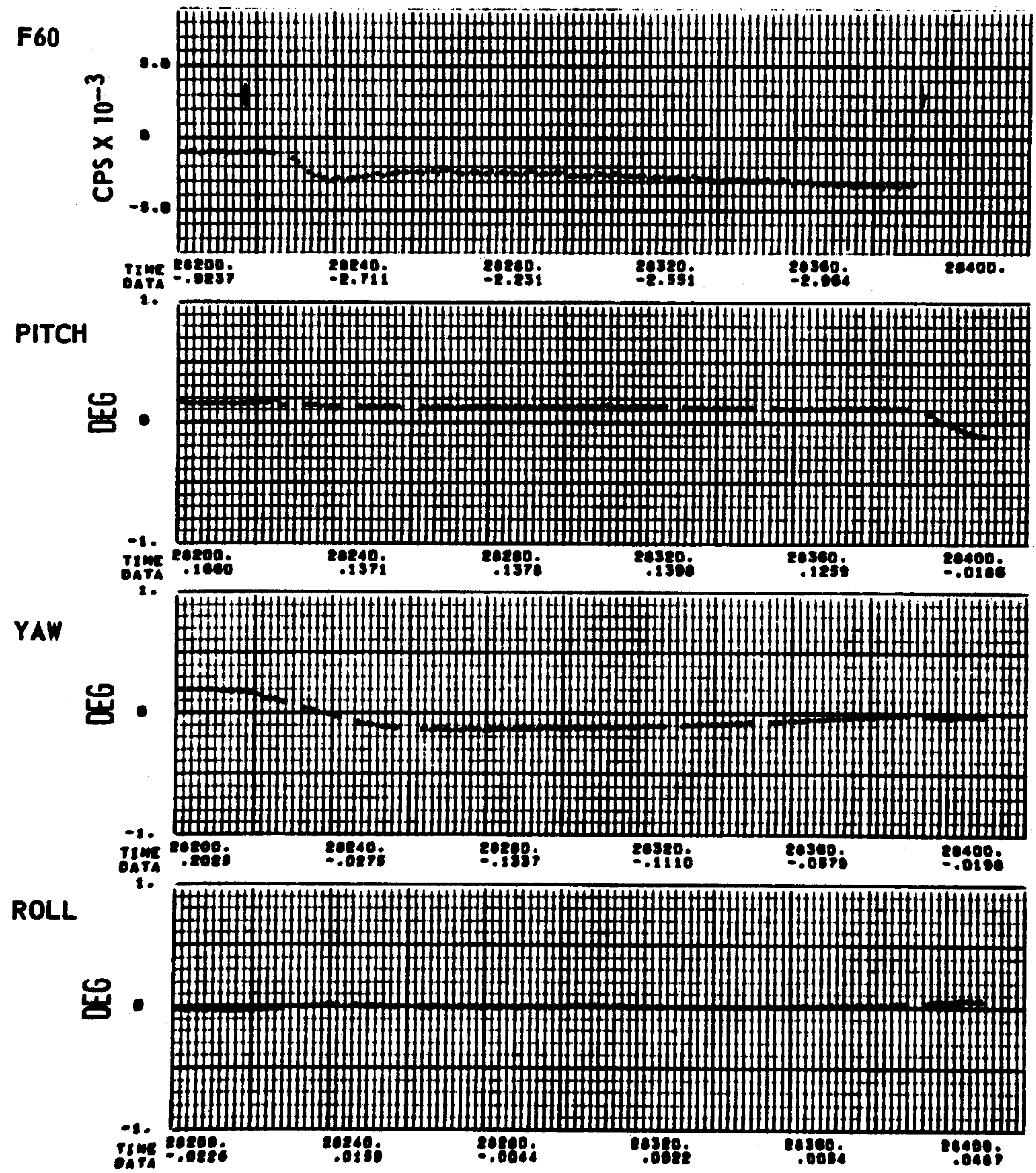
Pass 56 - Clutter Lock and Gyro Outputs



Pass 57 - Video Level and Gain Data

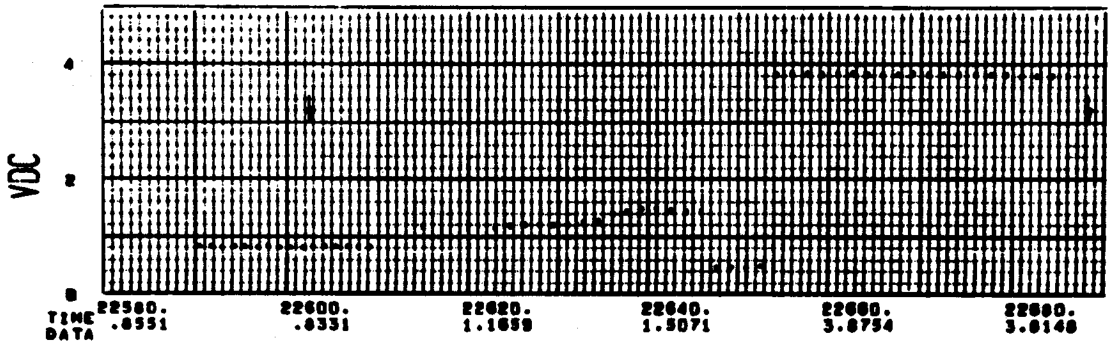


Pass 57 - Power Data

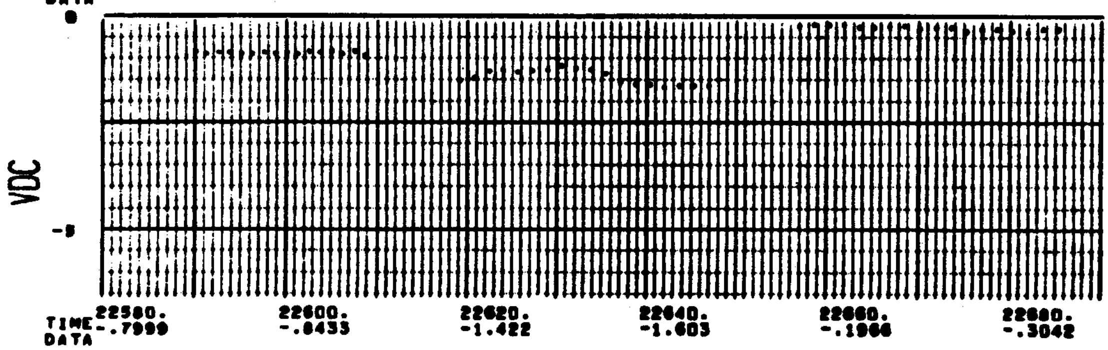


Pass 57 - Clutter Lock and Gyro Outputs

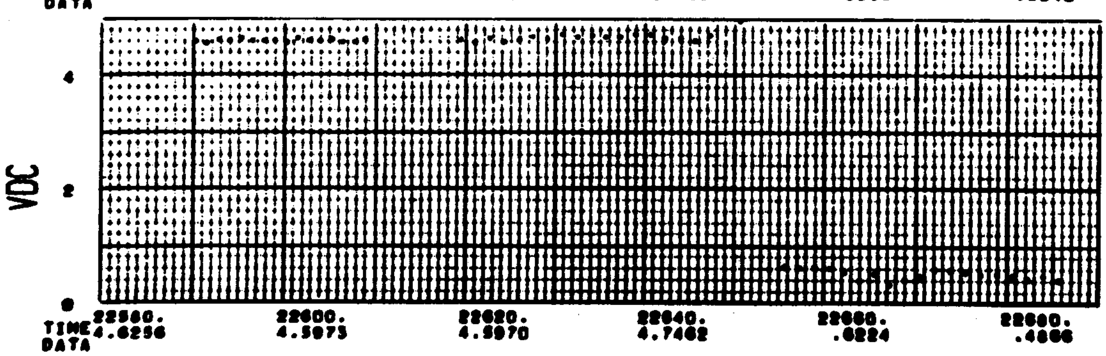
F53



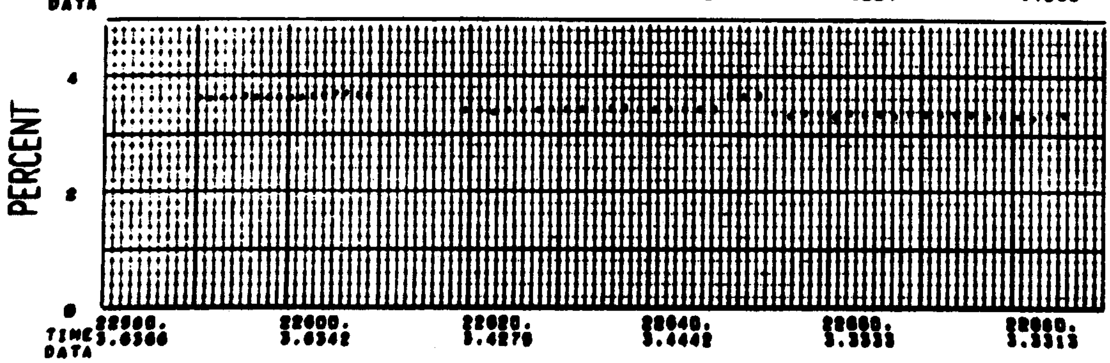
F61



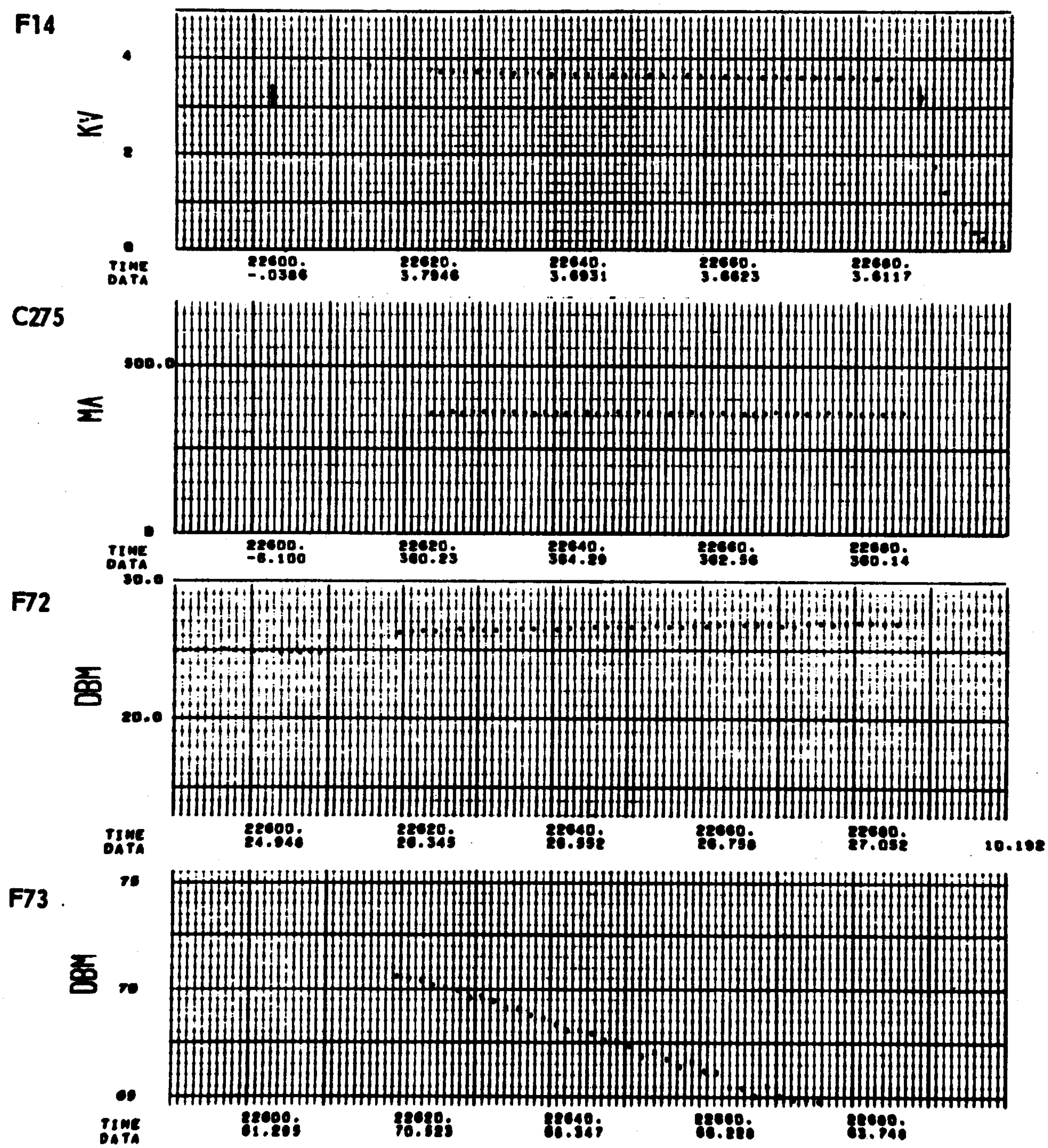
F70



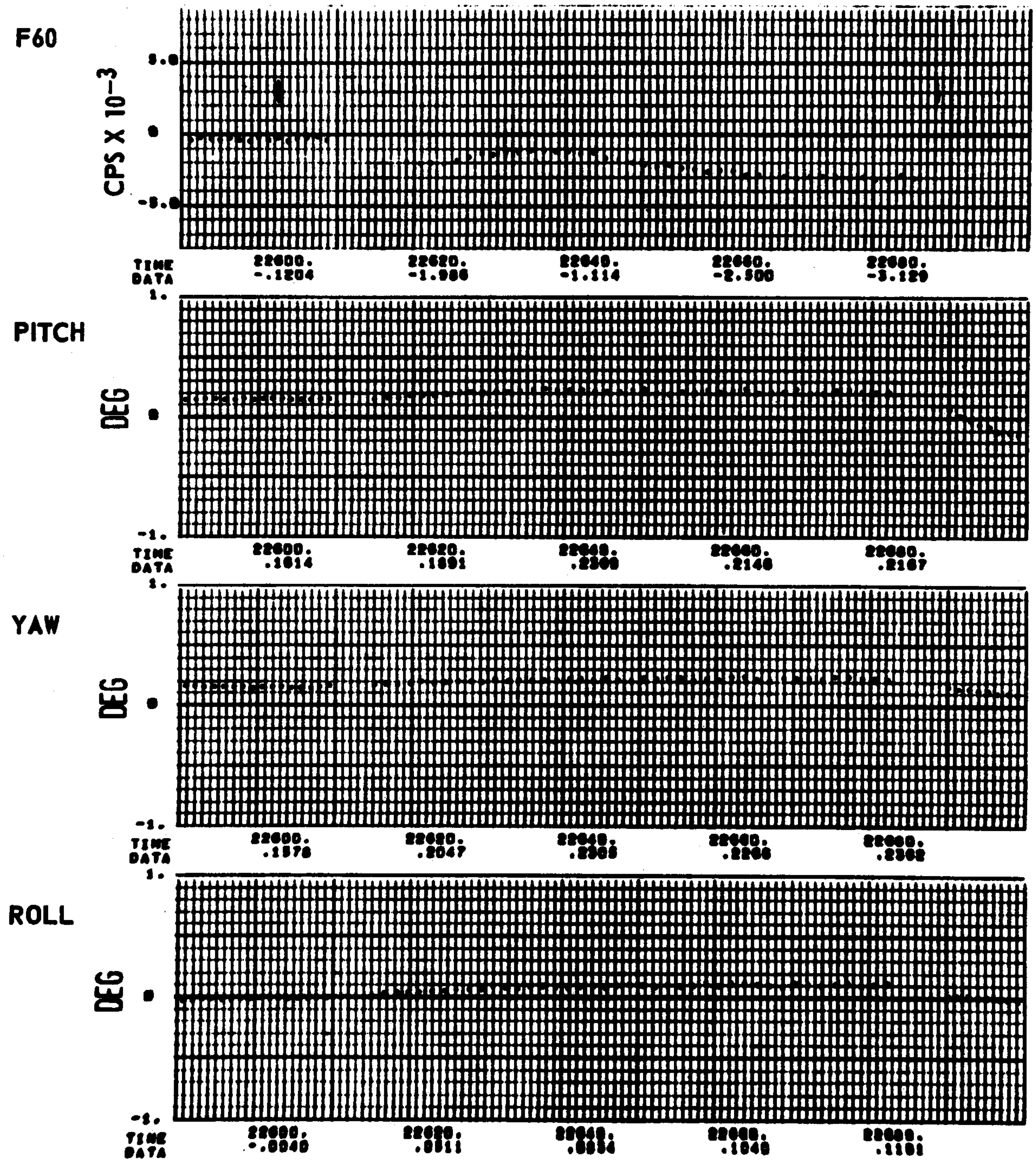
F71



Pass 72 - Video Level and Gain Data



Pass 72 - Power Data



Pass 72 - Clutter Lock and Gyro Outputs

3.4.5 Positioning of the Reflected Energy in the Range Gate

At the orbital altitude, depression angle and nominal PRF selected, approximately sixteen pulses are transmitted from the airborne radar system before the first target pulse returns from the center of the antenna pattern, (t_2 and t_2' in Figures 3.4.5.1 thru 3.4.5.4). The returning target video is recorded on the data film for a fixed time period (nominally 73.5 microseconds) between each transmitted pulse. (Crosshatched time periods in Figures 3.4.5.1 thru 3.4.5.4.) This 73.5 microsecond time period represents approximately 60 percent of the period between transmitted pulses. The PRF selection determines the location of the 73.5 microsecond period in the antenna vertical pattern. If the PRF is optimum, the 73.5 microsecond period is centered on the video returns from the center of the antenna vertical pattern (Refer to Figure 3.4.5.1).

As the PRF is adjusted above and below this optimum frequency the center of the range recorded (73.5 microsecond) moves off the center of the vertical antenna pattern. (Refer to Figures 3.4.5.2 and 3.4.5.3.) If the PRF is adjusted far enough from the optimum frequency, the 73.5 microsecond period being recorded covers portions of the video returns from two successive transmitted pulses including the ambiguous returns between the pulses. (Refer to Figure 3.4.5.4.) Two successive video returns displayed during a single unblanking period of the film recorder causes the far range video of the first pulse to be recorded first, then the ambiguity region between pulses, and finally the near range video of the second pulse. (Refer to Figure 3.4.5.4; t_1 and t_1' represent the start of the film record and t_3

and t'_3 represent the end of the film record.) This condition, which causes a loss of useful data is discussed also in Part I, under Positioning of the Reflected Energy in the Range Gate, Para. 1.6.

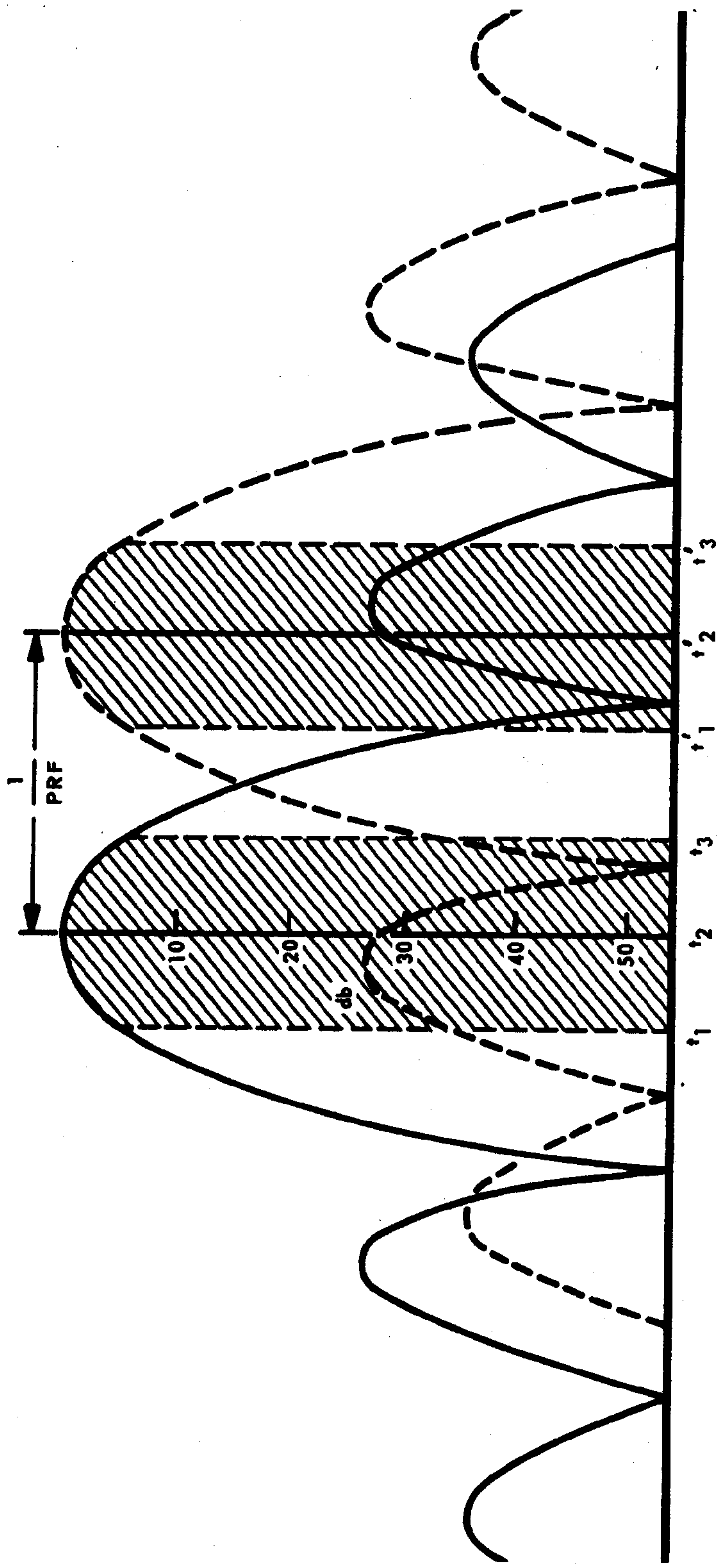


Figure 3.4.5.1 Antenna Vertical Two Way POWER PATTERN PRF Optimum (Step 10), Altitude = 130 NM

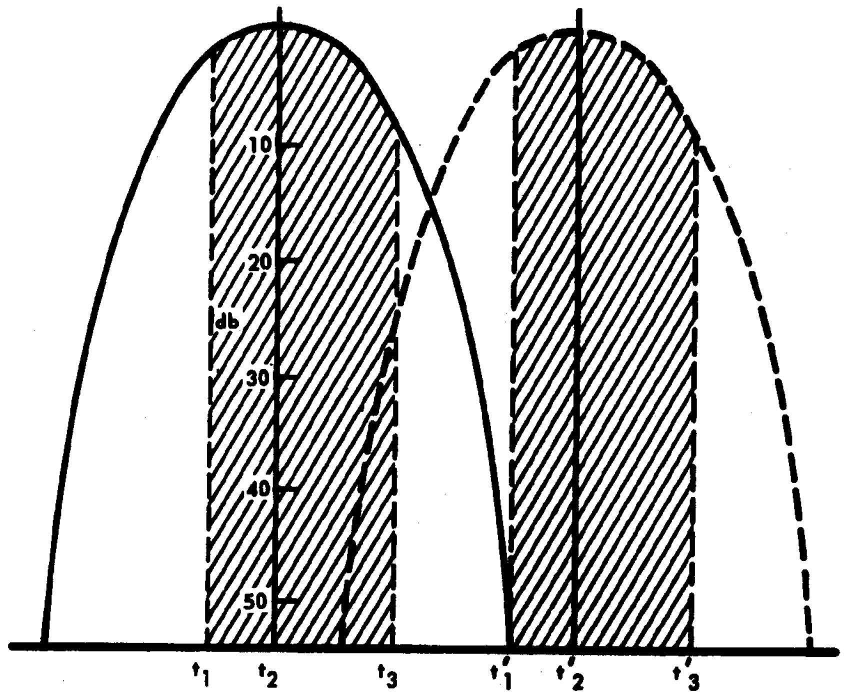


Figure 3.4.5.2 Antenna Vertical Two Way POWER PATTERN (Side Lobes Omitted for Clarity) PRF Low (Step 11), Altitude ~ 130 NM

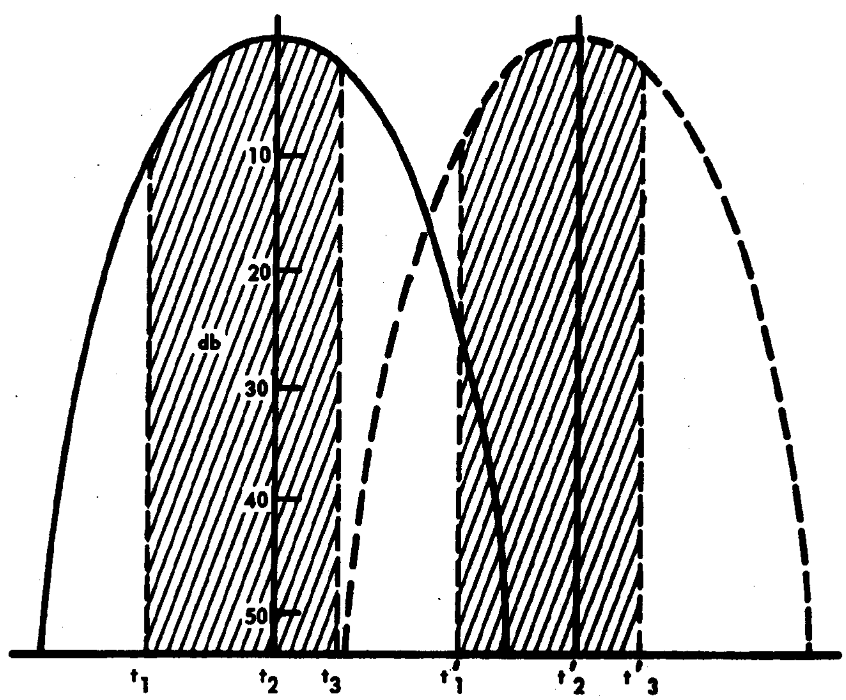


Figure 3.4.5.3 Antenna Vertical Two Way POWER PATTERN (Side Lobes Omitted for Clarity) PRF High (Step 9), Altitude ~ 130 NM

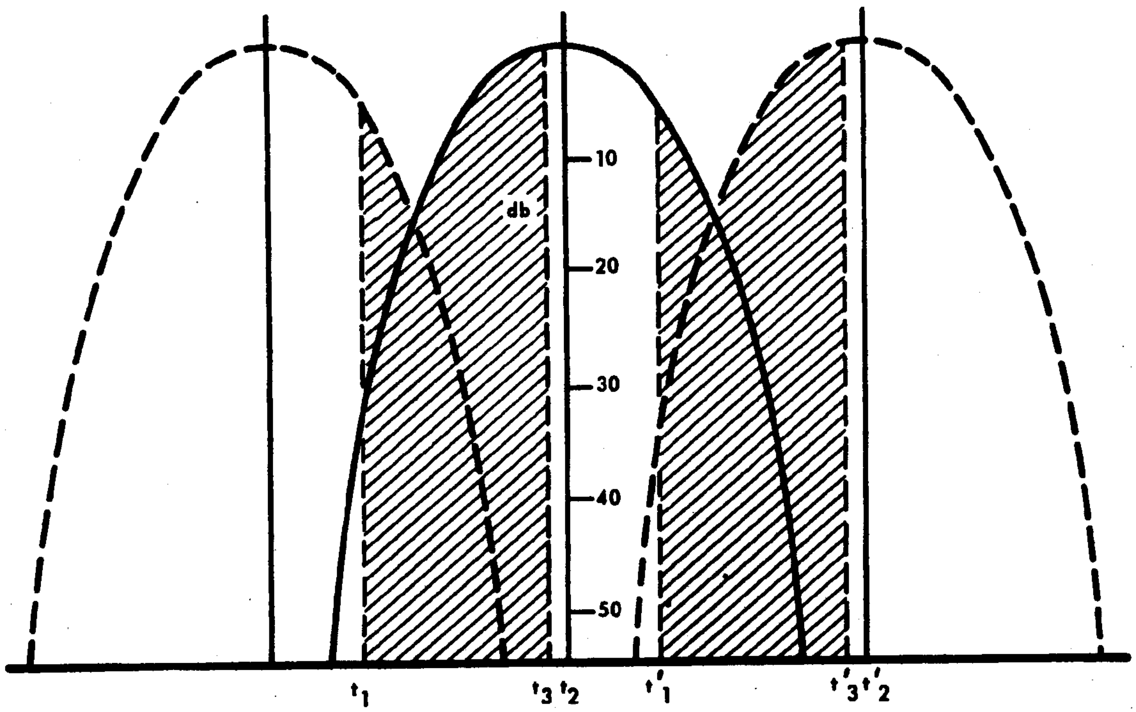


Figure 3.4.5.4 Antenna Vertical Two Way POWER PATTERN (Side Lobes Omitted for Clarity) PRF High (Step 5), Altitude ≈ 130 NM

3.4.6 Terrain Reflectivity

The quality and extent of "ground-painting" required of an imaging radar system is very much dependent upon its particular mission. It may be desirable, for some purposes, to have ground-painting with a sufficiently high signal-to-noise ratio that recognition of roads, runways and other paved areas (whose backscattering coefficients are very low) will be possible at least by virtue of their failure to be imaged while their non-paved boundaries are imaged. On the other hand, ground-painting with excessive SNR's is wasteful simply because ground-painting SNR is directly proportional to the average power consumed by the radar system, all other parameters being held constant. In the interest of efficient design, it is important to have available valid data on target-field reflectivity statistics. The published literature generally applies to homogeneous terrain samples but not to cultural target complexes and to varieties of cultural non-cultural target mixtures. This situation has been partially remedied through use of the AGC monitoring telemetry to periodically sample average return power along the length of each pass. Pre-flight calibration together with auxiliary telemetry and orbital information permits the average radar crossection of a "sliding" rectangular patch of terrain to be estimated; the result is a reasonable estimate of average reflectivity for the target conditions existent along the paths, although the high-spatial-frequency components of the reflectivity variations are lost.

The results of calculations of target-field reflectivity will be tabulated in the [redacted] report on the flight.

3.4.7 Direct Monitoring of Payload Radiation

The performance of the radar system in the azimuth dimension, particularly with respect to avoidance of "azimuth ambiguities" and realization of the limiting azimuth resolution, is very much dependent upon precise control of the azimuth-dimension beam pattern of the physical antenna carried by the vehicle. A direct measurement of the azimuth beam pattern was therefore made during the periods of payload operation on Passes 8 and 24; this measurement was made using a mobile receiving station of suitable design, which was positioned near the predicted swath center prior to payload-operate, based upon updated S-Look information. The measurement showed that the azimuth pattern of the physical beam essentially conformed to the pre-flight measurements on the antenna, (Ref. Part II, Para. 2.1.5) and that incident power levels at the mobile receiver were nominal.

A second direct ground-based measurement was prompted by the fact that telemetry data derived from on-board monitoring of the transmitter would provide an incomplete picture of the detailed character of the transmitted pulse. Because the vehicle would be within line-of-sight of the [redacted] facility during several of its operating periods, arrangements were made to monitor the transmitted pulse after one-way propagation from the vehicle, in most cases via a sidelobe of the satellite-borne radar antenna. The transmitter pulse was successfully observed and recorded during payload operation of Passes 8, 24 and 30; the pulse was of nominal structure and could be compressed, using an optical substitute for the receiver compression networks, to a pulse of 0.68 microsecond duration with good sidelobe structure. The length of the uncompressed pulse corresponded to the pre-flight examination of the transmitter pulse made by Goodyear shortly before launch. An attempted observation on Pass 14, which would have yielded a recordable pulse only in the presence of strong-back-lobes from the satellite-antenna configuration, did not produce a discernible signal.

3.5 EQUIPMENT TEMPERATURES AND THERMAL PERFORMANCE

Vehicle 2355 was launched at 11:09 PST on 21 December 1964 and had a useful life of 72 orbits. The Solar Incidence Angles (BETA) corresponding to this mission have been calculated to be:

- o Initial Beta = -9°
- o Final Beta = 9°

Flight temperature data, as well as a comparison of this data to predicted orbital temperatures, are included in Tables 3.5.1 and 3.5.2 Flight temperatures were obtained from wavetrains and digitized plots. In all cases differences between actual and predicted temperatures are within the range of allowable uncertainty for passive temperature control.

In response to several primary-battery flight failures, special attention was given the design of passive temperature controls for the primary batteries of Vehicle 2355. The design was intended to provide identical temperature environments for these three batteries even though they were separated within the vehicle. Assumptions used in the battery thermal analysis, such as temperature limits and internal power dissipation, were much more restrictive than for previous LMSC satellites. Table 3.5.1 presents flight data and predicted temperatures for the primary batteries.

Actual and predicted temperatures are included in Table 3.5.2 for Vehicle 2355 equipment which had external temperature instrumentation. Flight temperature represents the maximums and minimums recorded during at least five orbits between orbits 8 and 72. Predictions are for the average equipment temperature and include orbital fluctuations and changes resulting from the 4-day regression of the orbit plane. Predictions presented for the nitrogen control gas were based on the assumption that the Agena aft rack thermal-control surfaces had nominal optical surface properties. Inspection at VAFB showed significant degradation of these polished aluminum surfaces. However, aft rack thermal-control surfaces were not repaired since temperature predictions, including the effects of surface degradation, provided nitrogen-bottle temperatures of +95°F to +135°F, compared to specified temperature limits of -30°F to +165°F.

VAFB liftoff and first pass KTS data have been analyzed to determine the effects of ascent heating on internal equipment. Equipment temperature rises due to ascent heating were less than predictions, assuming a maximum heating trajectory.

Table 3.5.1
ID BATTERY OPERATING TEMPERATURES

Event	Battery Temperature (°F) Battery No. 1 Payload	Battery No. 2, No. 3
Liftoff	58	58
First Day		
Actual	58/73	58/70
Prediction	75	75
Second Day		
Actual	73	70/72
Prediction	76	76
Third Day		
Actual	73/79	72/75
Prediction	77	77
Fourth Day		
Actual	79/81	75/77
Prediction	79	81
Fifth Day		
Actual	81	77/78
Prediction	81	83

Table 3.5.2

EQUIPMENT OPERATING TEMPERATURES

Equipment	Temperatures (°F) Actual	Predicted
PAYLOAD EQUIPMENT RACKS		
Payload Power Supply	62/70	70/80
Type X dc/dc Converter	72/79	64/86
2 kc Inverter	64/68	60/78
400 cps 3 Ø Inverter	66/67	48/69
Payload Box No. 3	75/90	71/81
Payload Box No. 4	80/84	67/74
Payload Box No. 5	62/65	66/71
Payload Box No. 6	70/79	61/71
Payload Box No. 7	82/92	71/79
BTL GUIDANCE RACK		
Type X dc/dc Converter	72/75	69/85
Type VIII Transmitters	64/74	59/74
FORWARD RACK		
VHF Multicoupler	71/79	82/96
S-Band Beacon	58/72	79/99
Type XII Inverter	75/82	96/106
2-Watt Transmitters	74/89	90/100
Type IX dc/dc Converter	80/82	73/84
AFT RACK		
Nitrogen Control Gas	108/147	68/88
Lifeboat Flight Control Electronics	24/32	20/45
Acquisition Transmitter	21/46	20/45
Lifeboat Control Gas	49/67	40/60

3.6 Vacuum Measurements During Flight

Flight Test - All five monitors on Vehicle 2355 performed perfectly during flight. Figure 3.6.1 shows the gages reaction during the ascent and insertion phase of flight. Trace A is the theoretical ambient pressure levels for the altitudes shown in lower left. F100, F101, and F103 had decayed to approximately 1-5 microns by +3500 seconds with F104 at approximately 9 microns at this time. It should be noted that the recorder had a very slow vent rate as illustrated by the slow decay of F102. This monitor did not get down to 1-5 microns until pass 8. This is attributed somewhat to film outgassing. During pass 8 the payload was turned on for the first time. Approximately 22 seconds after "Payload ON" command, a disturbance was detected on the high voltage power bus. At the end of the disturbance, monitor F103 indicated a very slight level change - which may or may not have indicated an actual pressure change. This lasted for three seconds and then returned to normal. All other monitors remained constant during this period. This type gage is not suitable for monitoring of orbital pressures. A superior gage which will operate in the orbit pressure region will be utilized in a future flight of this type payload.

NOTE: Altitudes on Page 6-2 (Lower Left) are in hundred thousand foot increments, i.e. 0 to 750,000 feet.

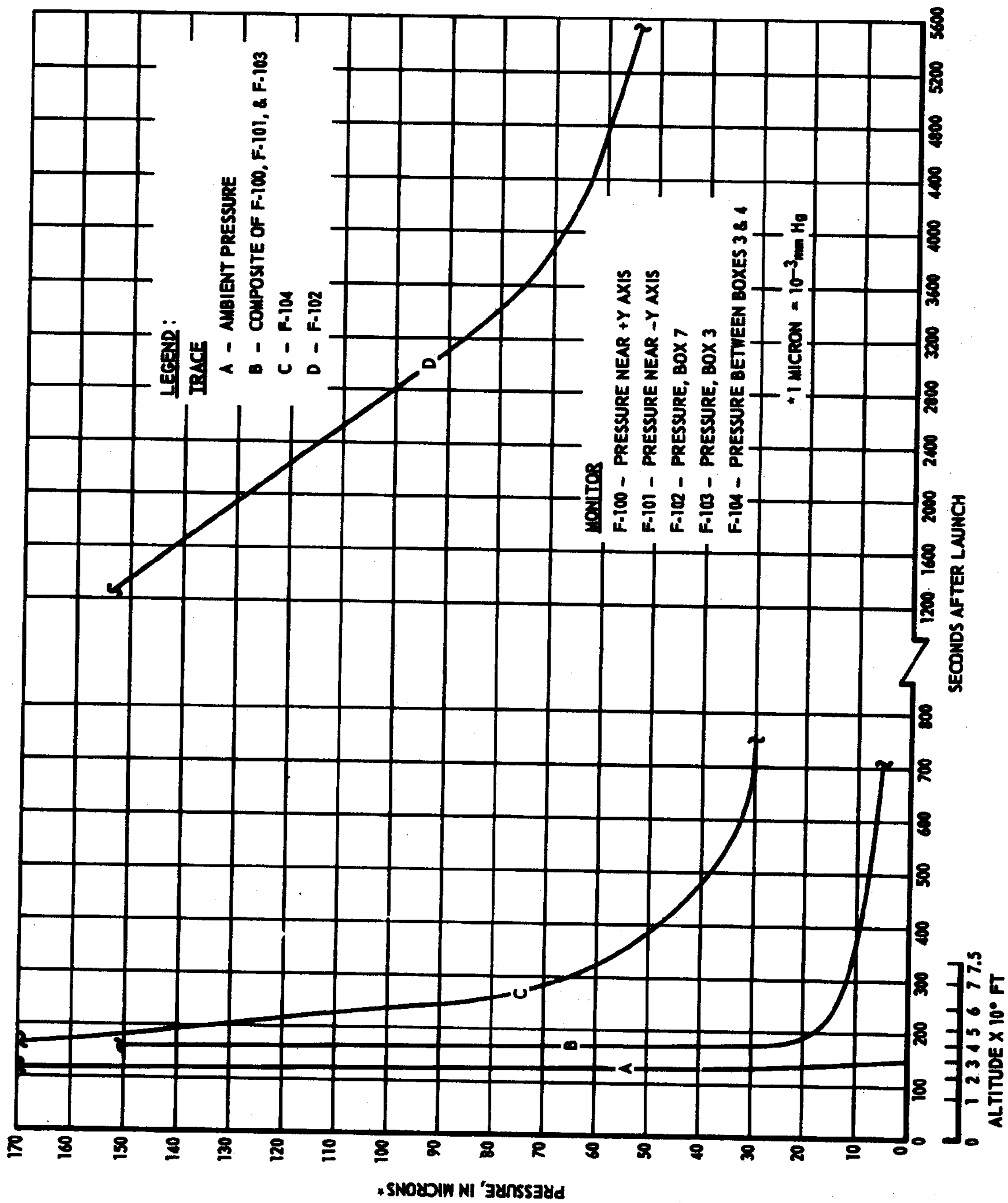


Figure 3.6.1 Pressure Decay - F-100 thru F-104

3.7 RECOVERY SUBSYSTEM

3.7.1 The recovery subsystem, as described in Para. 2.3.2.10 above, performed the payload on-orbit functions of maintaining film tension during nonoperate periods, taking film up into the recoverable cassette, with a constant tension, during operate periods, cutting the film prior to separation and providing a light-tight and protected environment during re-entry.

In addition, the capsule takeup mechanism maintained film tension during ascent. The takeup motor gear drive was prevented from unwinding by a ratchet. During ascent the ratchet (anti-backup) was held by solenoid action in the disengaged position to prevent ratchet damage from ascent vibration.

The capsule status on orbit was evaluated by the following telemetry points:

F-91	Footage Potentiometer (Cassette Hub Diameter)
F-93	Water Seal Position and Continuity Loop
F-97	Cassette Temperature
F-99	Takeup Idler/Cassette Commutator

The other capsule telemetry points were temperature monitors and recovery battery signal monitors:

F-92	Retro Temperature (Rocket)
F-94	Thrust Cone Temperature
F-95	Recovery Battery #2 Signal (V_oH)
F-96	Recovery Battery #1 Signal
F-98	Forebody Temperature

The capsule status telemetry point displays for F-91 and F-99 are shown in Para. 3.4. These indicated normal film transport operation. The cassette temperature was controlled by two 10-watt heaters in series, yielding 5 watts power dissipation, with a thermostat setting of 82°. The cassette temperature, monitored by F-97, was 73°F on Rev. 8 and decreased to 44°F on Rev. 25.

3.7.2 Weights

The capsule weight was increased to 120 pounds parachute suspended weight, as described in Para. 1.6. The capsule weights were:

Separation Weight	306.85 lbs.
After Retro Weight	223.25 lbs.
Weight on Parachute	120.00 lbs.

The corresponding descent rates on the parachute were:

Altitude (Feet)	Descent Rate (Ft/Sec.)
54,300	Parachute Deployment
35,000	32.5
30,000	29.5
25,000	27.0
20,000	24.9
15,000	23.0
10,000	21.2
5,000	19.6
Surface	18.0

3.7.3 Recovery

The recovery events and performance are given below in Table II. The predicted impact point was 24°N and 143° 38' W. The actual air catch was made at 23° 38' N and 143° 45' W, approximately 23 nautical miles South-Southwest of the predicted impact point.

The recovery area plot, and two views of the recovery positions, predicted versus actual for views up range and looking across range are given in figures 3.7.1, 3.7.2 and 3.7.3 respectively. The variations from actual prior to entering the atmosphere are due to minor variations in alignment from optimum during retrorocket thrust and to minor differences in total thrust value.

TABLE II

2355 RECOVERY SYSTEM PERFORMANCE DATA

SUMMARY

A successful air catch recovery was made on Orbit 33 on 23 December 1964. The impact point was within tolerance. All re-entry event times were within tolerance and appeared normal. The condition of the recovered capsule was satisfactory. A post-flight recovery sequence was conducted. No anomalies were revealed and no tests are pending.

GENERAL

Recovery System Serial No.	588
Blossom Telemetry Serial No.	62
Launch Date	12-21-64
Recovery Date	12-23-64
Impact	In Tolerance

PERFORMANCE

The performance of the recovery system was normal and all events occurred within tolerance. The following is a sequence of events and event times:

TABLE II (Continued)

RE-ENTRY SEQUENCE OF EVENTS

EVENT	SYSTEM TIME	DELTA TIME ACTUAL	DELTA TIME NOMINAL
Transfer	73354.40	---	---
Electrical Disconnect	73355.55	1.15	0.90 +.430 -.400
*Separation	73356.37	1.97	2.0 ±.25
**Spin	73358.88	3.33	3.4 ± .30
Retro	73366.43	7.55	7.55± .45
De-Spin	73376.98	10.55	10.75± .50
Thrust Cone Separation	73378.47	1.49	1.5 ± .15
Voltage Monitor Close	73451.63	72.16	104.0 ± .44
*** Voltage Monitor Open		---	---
*** "G" Switch Close		---	---
"G" Switch Open	73909.73		
Parachute Cover Off	73944.08	34.35	34.0 ±1.5
Deceleration Parachute Deployed	73944.70	0.62	.75± .08
Main Parachute Bag, Separate	73955.10	10.40	10.05±1.0
Main Parachute Deployed	73955.71	0.61	0.80± .20
Main Parachute Disreefed	73960.70	4.99	4.0 ±1.7

NOTE: * Delta time is taken from Transfer.
** Delta time is taken from Electrical Disconnect.
*** Events occurred during ionization.

NOTE: The above times and sequence of events are displayed pictorially in Part II, Para. 2.3.2.10, Page 3-47.

TABLE II (Continued)

SPIN RATE 70.5 RPM

RETRO VELOCITY 1270 Ft/Sec.

DE-SPIN RATE 10.8 RPM

PHYSICAL CONDITION

The condition of the recovered capsule was satisfactory with damage limited to localized aft cover blistering of paint due to the re-entry thermal environment. Diagrams showing the location of and temperatures by temp-plates installed on the capsule are enclosed.

POST-FLIGHT TESTING

A complete recovery sequence was conducted on the recovery system. All functions occurred within tolerance. No further testing is pending.

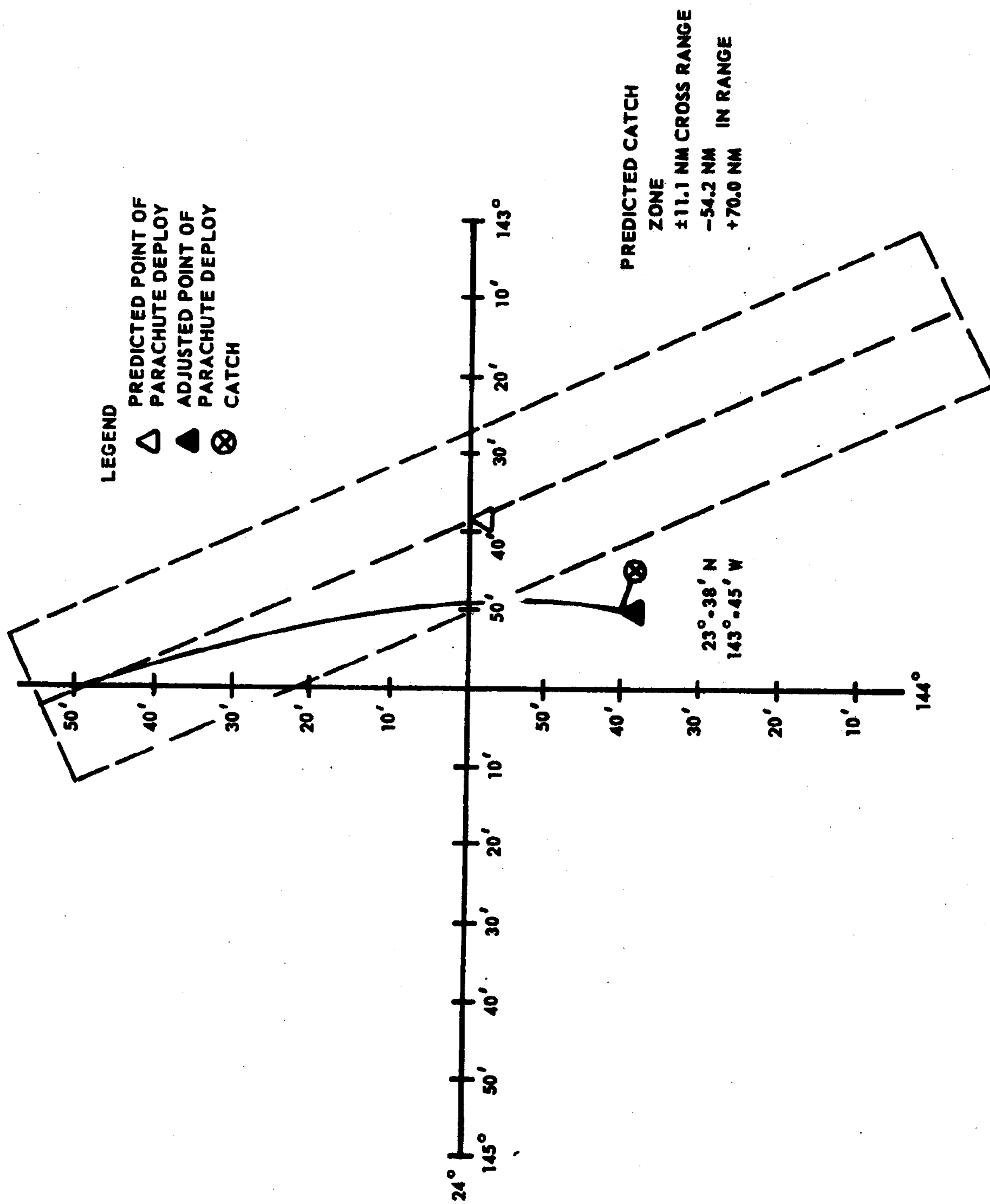


Figure 3.7.1 - Recovery Area Plot

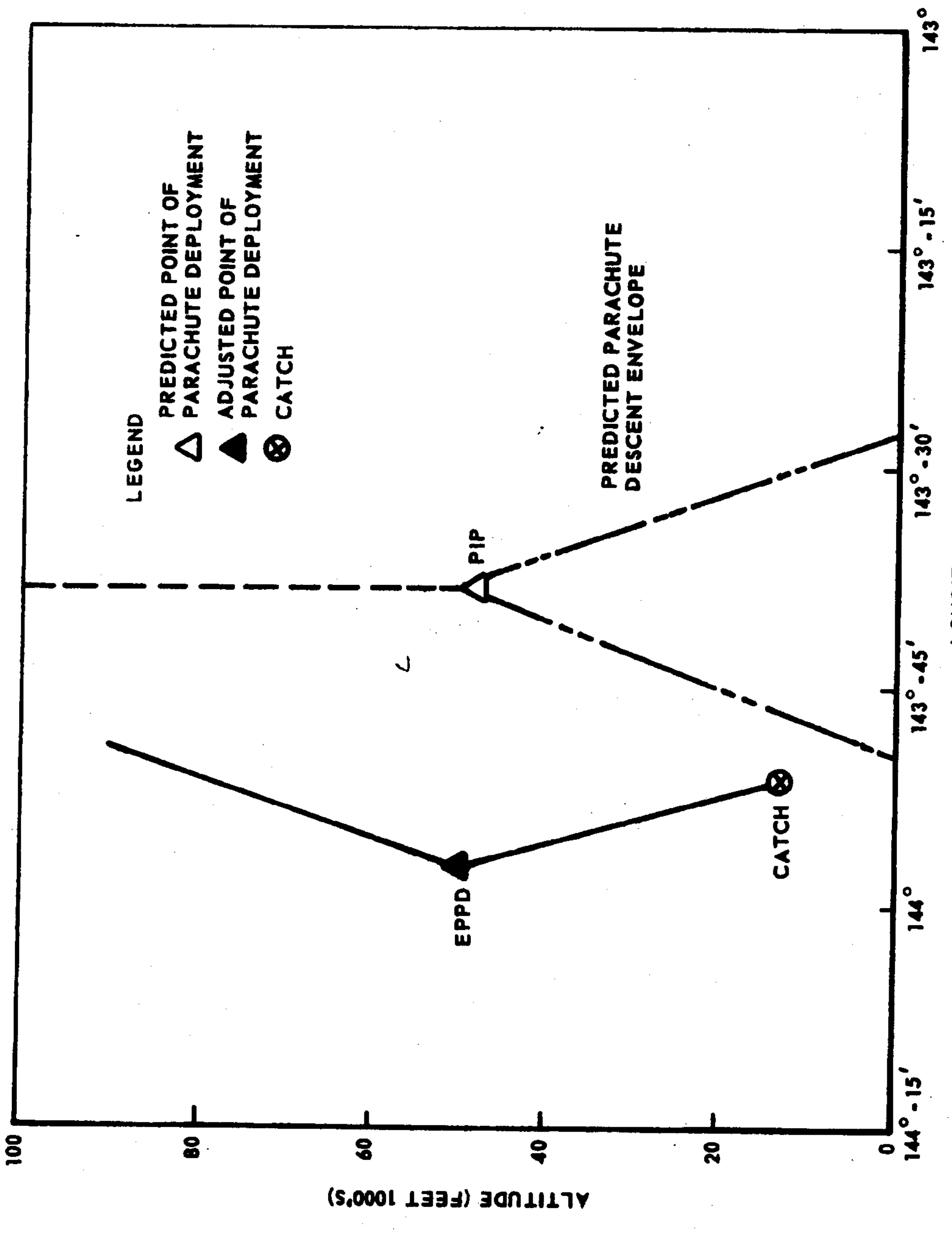


Figure 3.7.2 - View - Up Range

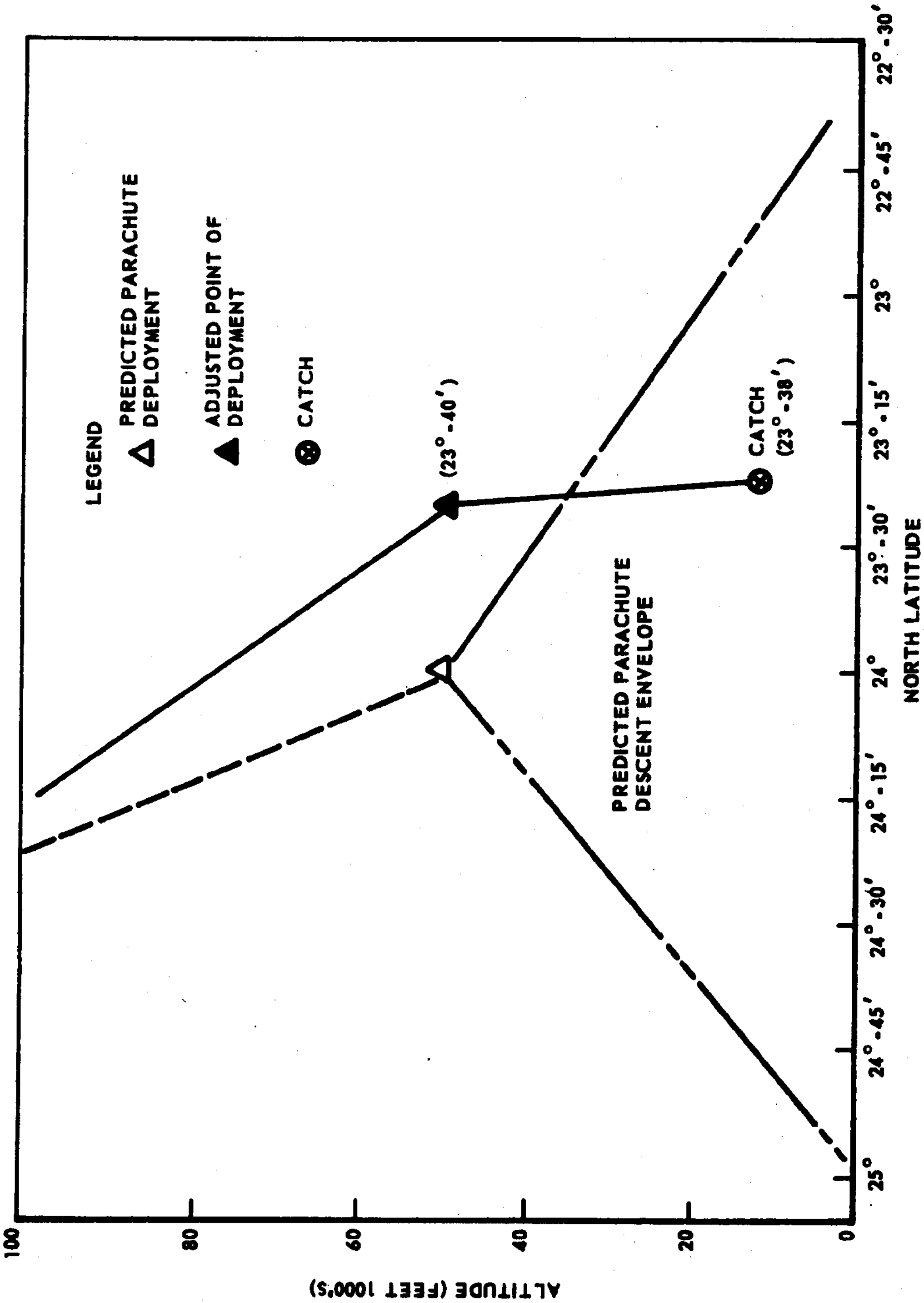


Figure 3.7.3 - View - Across Range

3.8 SATELLITE CONTROL FACILITY

3.8.1 Introduction

The SCF Configuration for Vehicle 2355 was predicated on two main objectives:

- o Maximum utilization of existing station equipment.
- o Minimum additional program peculiar hardware.

In accordance with these objectives, it was decided to utilize the Program [redacted] Screen Rooms at VTS and NHS as the location of the program peculiar equipment. This location permitted a secure storage and operation area as well as minimizing the installation of new cables, racks, power drops, etc.

The GFE program peculiar hardware located in the screen room were the Recorder (mounted on a dolly for convenience) and the Recorder Controller. Two LMSC built devices, the TM Display Panel and Command Computer Panel, were located in an existing rack in the Screen Room, as was a digital counter to display PRF/4(F-76). Other equipment used in connection with the operation were the GFE Simulator, Delay Register and DDE. Outside the Screen Room were located the AMIE (Wide Band Tape Recorder), "Little APE" (Photo Monitor) and WBDL Receiver Discriminator and Distribution Amplifiers. Each of these major items of hardware will be discussed in detail, both as to their performance during the operation and recommendations for the future. See Figure3.8 .1.1 and 3.8.1.2 for a description of the SCF configuration.

3.8.2 Wideband Data Link

The WBDL at VTS and NHS is a 2.2 Gc/s System capable of a nominal 6Mc/s information bandwidth. Elements comprising the system are the LMSC Type VIII Wide Band Transmitter in the vehicle, a 60 foot parabolic antenna and a

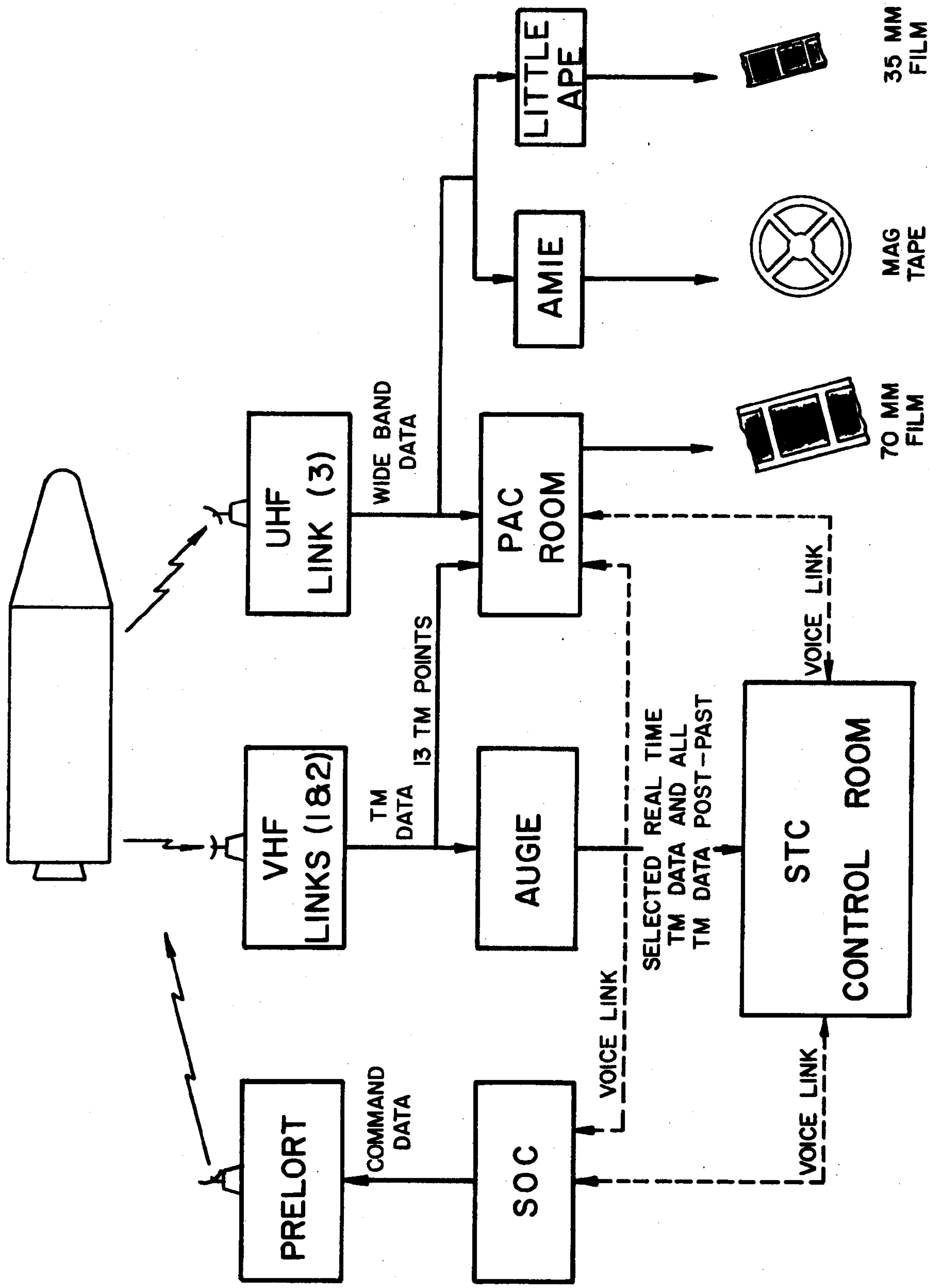


Figure 3.8.1.1 - SCF Configuration

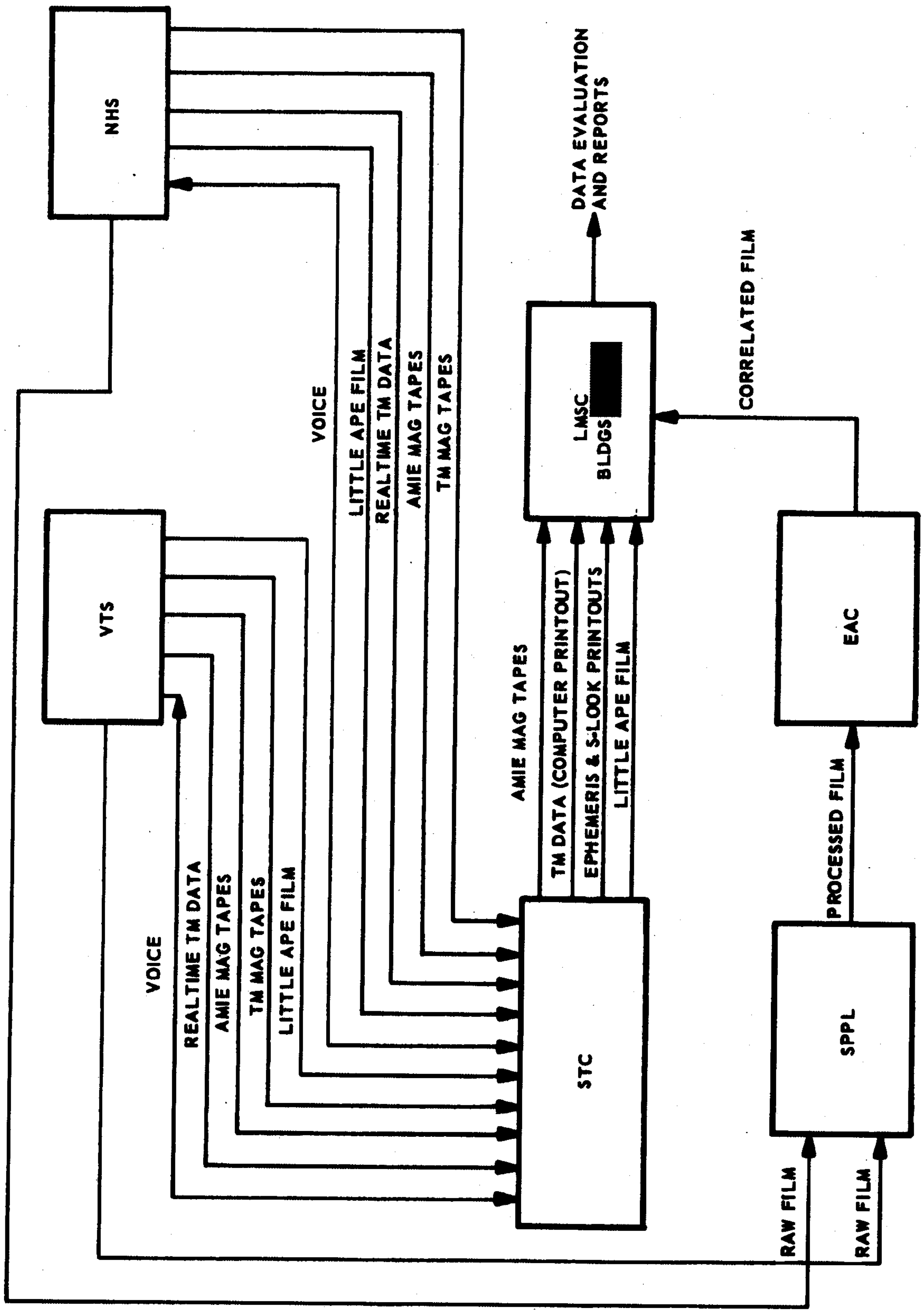


Figure 3.8.1.2 SCF Configuration and Data Flow

Philco Wide Band Receiver. The Type VIII transmitter in the vehicle is an all solid-state device except for the final output traveling wave tube (TWT). Frequency modulation of a 70 Mc/s VCO is accomplished by means of a solid-state voltage controlled capacitor (Varicap). The deviated carrier is then multiplied up to S-Band by means of Varactor harmonic generators and transistor frequency multipliers. The output TWT produces a power of 10 to 12 watts, depending on temperature and power supply voltage. On the ground, this radiation is picked up by the 60 foot parabolic tracking and detection (T and D) antenna. Located at the focus of the antenna is a parametric amplifier (paramp) which can provide up to 36 db gain. The antenna has two tracking modes; a 375 Mc/s beacon and a 2.2 Gc/s autotrack mode. For the Vehicle 2355 operation, the antenna was operated in 2.2 Gc/s autotrack. The Philco Wide Band Receiver is manually tuneable between 2.2 and 2.3 Gc/s. No AFC is incorporated, requiring manual adjustment during a pass to compensate for transmitter frequency drift and doppler shift. Since the T and D building is located at each site approximately 1000 feet from the screen room areas in which the ground recorders (GBOE) were located, it was decided to transmit the WB data at IF (100 Mc/s) from the T and D Building to the DA and P Building and have the receiver discriminator and video distribution amplifiers located only a few feet from the GBOE. This procedure eliminated any need for providing amplitude and phase equalization for the long coax line between buildings.

Preliminary link calculations indicated that the system equivalent noise temperature referred to the paramp input was 425°K, which equals a noise power KTB = -127.8 dbm. Based on a transmitter power of 10 watts, a transmitter antenna gain of 3 db, a receiver antenna gain of 49 db and an elevation angle of 5° (slant range of 970 n.m.), the power input to the paramp is equal to -79.3 dbm. Hence, the received carrier signal-to-noise ratio for worst case conditions should be 18.5 db. Actual measurement of received signal strength indicated that, for most passes, signal strengths were in excess of -70 dbm. Reasons for this unexpected improvement are discussed in the next paragraph. Because of the FM noise improvement factor, an 18.5 db carrier-to-noise ratio is equivalent to a detected signal output signal-to-noise ratio (peak-to-peak) of 26.2 db. Using the actual figure of approximately -70 dbm for received signal strength, a signal-to-noise ratio of about 35 db was typical for most passes.

As stated above, the nominal information bandwidth of the system is 6 Mc/s. However, considerable effort was expended in optimizing the system for this operation. The paramp, receiver RF and IF stages, and discriminator were realigned for wider and more linear pass-band. The receiver post-detection filters were redesigned. Most important, the antenna feed system was critically examined for VSWR and attenuation. Several problem areas were discovered in connection with the antenna rotary joints and the diplexer. Consequently, for the Vehicle 2355 operation, the entire antenna feed system was temporarily bypassed with approximately one hundred feet of 1-5/8" Styroflex semi-rigid, air dielectric coax. This temporary fix greatly improved performance by minimizing problems of impedance mismatch, multimode propagation and non-uniform attenuation over the data link pass band.

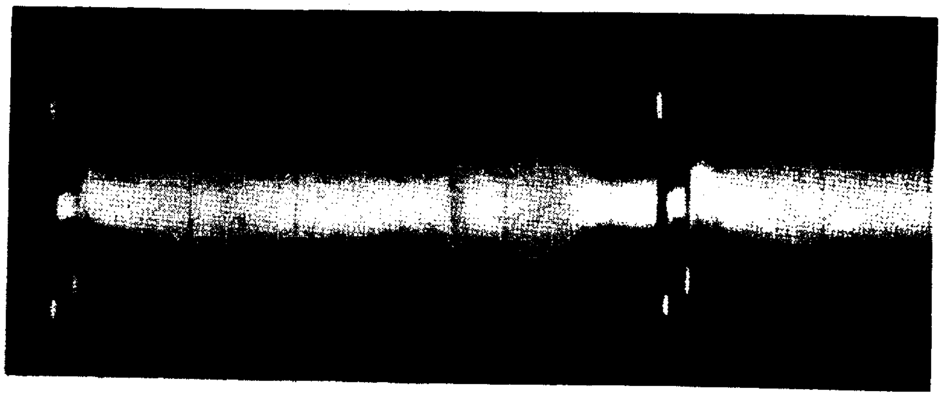
All of the above improvements resulted in a frequency response out to 7.5 Mc/s (-3db point) with a minimum of harmonic distortion (less than 5%). Similarly, the improved signal-to-noise ratio referred to in the above paragraph is believed due in large part to these improvements. The entire antenna feed problem should be extensively studied so that a satisfactory permanent fix can be achieved.

3.8.3 AMIE

The AMIE (Advanced Magnetic Information Equipment) is a wide band, rotary-head, transverse recording tape recorder. Specifications called for a frequency response of +0.5 to -1.5 db over the passband of 30 c/s to 6.0 Mc/s. Tests made prior to and during the Vehicle 2355 operation indicated a high frequency response (referred to 500 Kc/s) of -2 db at 4.5 Mc/s, -7 db at 6.0 Mc/s and no response above 6.2 Mc/s. Analysis of the radar map data indicated that this response was satisfactory for acceptable recording of the raw radar map data; however, the quality was somewhat inferior to that of the WBDL. The degradation is most noticeable in grey level rendition of the correlated map, indicating dynamic range and signal-to-noise ratio less than that of the WBDL. It appears, however, that the AMIE is operating at its maximum performance and that no further improvement can be obtained without extensive redesign.

3.8.4 Little APE

The "Little APE" (Analog Photo Equipment) is essentially a non-framing, adjustable film speed continuous recording camera mounted on an oscilloscope. A provision is made for simultaneously recording system time in dot-dash



Little APE Polariod - Sweep 20 usec/cm Exposure 1/100 sec.

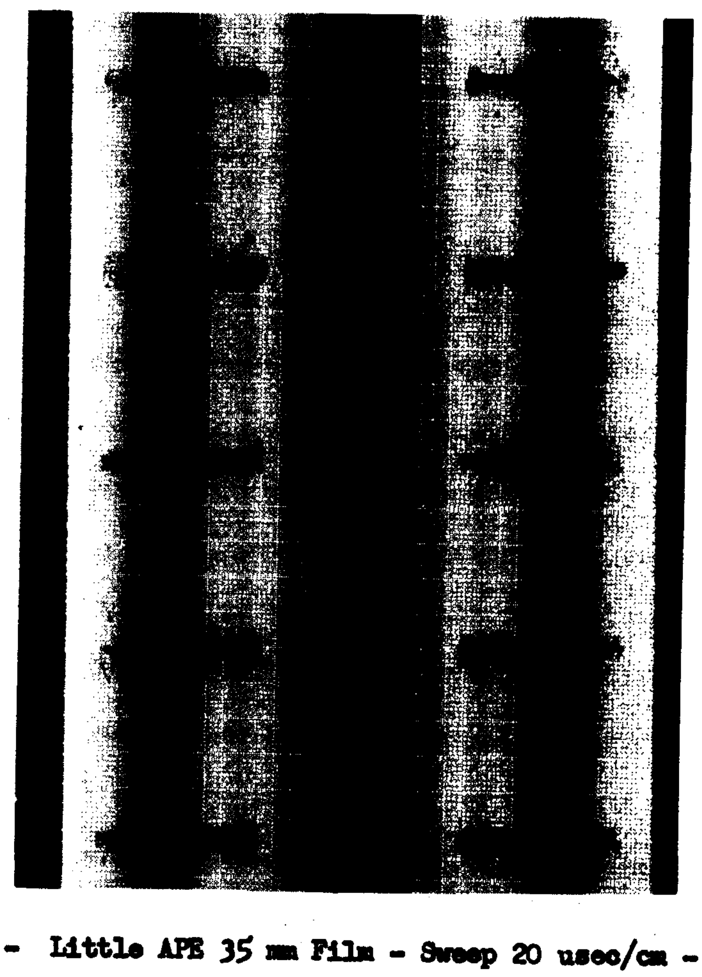


Figure 3.8.4.1 - Little APE 35 mm Film - Sweep 20 usec/cm - Single Sweep

binary form along the side of the film. It was originally decided to photograph a single frame of data once each second in order to monitor the WBDL video going to the AMIE and GBOE. Performance of the Little APE at both sites was marginal. The scope sweep speed of 20 µsec/cm required to display a single frame of data did not produce a bright enough trace to properly expose the film used in the camera at NHS. At VTS the scope was not synced properly, producing poor film records. After reviewing the AMIE playbacks of the WBDL data, it became obvious that the video raw mapping data is best described by its time-integrated envelope rather than by a single sweep. It is therefore recommended in the future that a new method of displaying the data (such as intensity modulation of the CRT with a gating pulse long enough to display 10-20 sweeps) be employed. A sample of "Little APE" data is shown in Figure 3.8.4.1.

3.8.5 GFE Recorder and Recorder Controller

The GFE Recorder (GBOE) and its controller were utilized to record photographically the video information transmitted from the vehicle by the WBDL. The GBOE's used at VTS and NHS were essentially identical to the recorder used in the vehicle. For convenience, however, each was mounted on a dolly. The function of the recorder controller was to provide a precisely regulated (frequency and amplitude) power supply for the film drive motor and CRT circuitry, and also to provide a sync pulse to trigger the CRT horizontal (range) sweep. In the vehicle, this sync is obtained from the circuitry producing the radar "main bang." On the ground, however, this sync must be obtained from sync pulses interspersed with the data at the PRF period.

These regenerated CRT sweep triggers for the GBOE are produced by a time averaging circuit which generates pulses at the time-integrated average received sync pulse rate rather than the instantaneous rate. Since this circuit necessarily has a time constant associated with it, there is a short (1-2 seconds) period of time after the payload is turned on or the PRF changed when the CRT triggers are not being produced at the correct rate, thereby causing meaningless data to be recorded. It is recommended that this circuit be studied and modified to minimize this time constant.

Analysis of the raw radar map data and the correlated map indicate a strong need for better identification of data material than that used for the Vehicle 2355 operation. For this operation the raw data film on the ground was identified as to pass number and origin by a 6 - bit binary code displayed by six small incandescent data lamp traces along the edges of the data film. No system time was recorded on either the ground film or the vehicle film, making precise analysis of the data very difficult. It is strongly recommended that system time in binary form be recorded on both ground and vehicle data for future operations. In addition, the correlator should be equipped with a system of time decoding and re-recording so that the correlated map will also have system time displayed.

3.8.6 TM Display Panel

The TM Display Panel was built to display in realtime 13 critical TM points associated with the payload. The points were as follows:

- o PRF Bit 1 -F42

- PRF Bit 2 -F43
- PRF Bit 3 -F44
- PRF Bit 4 -F45
- Attenuator Bit 1 -H34
- Attenuator Bit 2 -H35
- Attenuator Bit 3 -H36
- Pre-Operate -F9
- Warm-up -F14
- Payload On -F41
- Built-in Test Mode -F46
- RF Power Out -F73
- Waveguide Pressure -F104

The first eleven points were ON-OFF indications displayed on lights, while RF power and Waveguide Pressure were continuous values displayed on meters. During the operations, the primary use of the panel was to observe the status of the four PRF bits in order to ascertain the PRF step position number. This was necessary to compute the new step position if a change were required, and then to verify this new position was obtained. Waveguide pressure and RF Power Output Meter indications were used to determine any problems associated with high voltage breakdown and waveguide arcing. All other indications were used to check on payload status.

3.8.7 Personnel Performance

Personnel at both tracking stations were allocated as follows for the 2355 program peculiar equipment:

GFE Recorder Controller (A-Scope)	- 1 man
GFE Recorder (GBOE)	- 1 man
TM Display Panel	- 1 man
AMIE	- 1 man
Little "APE"	- 1 man
WBDL Discriminator & Distribution Amplifiers	- 1 man

It was the function of the "A-Scope watcher" to observe the incoming WBDL video signals and ascertain whether the pre-programmed PRF setting was correct. If not, he would communicate this to the man at the TM Display Panel with a recommendation as to which way (up or down) and by how many steps it should be changed. The man at the TM Display Panel, after noting the present PRF code displayed on the panel, entered a chart to obtain the proper BCD command numbers for the desired change. He would then communicate these command numbers to the SOC operator who then sent the PRF commands to the vehicle. All other commanding was done directly from the SOC under direction of the OD at STC. Other personnel operating the program peculiar equipment were responsible for insuring proper performance of the specific area of hardware to which they were assigned.

Personnel performance was generally satisfactory. The major exception was at VTS on Pass 9 when an incorrect PRF change was made. The pre-programmed PRF setting was step 10 and the "A-scope watcher" determined step 9 as the proper one. The correct BCD command number for the change was 05. However, what the man at the TM Display Panel actually called for was step 5, which corresponded to BCD command 09. The confusion probably resulted because of the accidental similarity between the step numbers and their equivalent BCD command numbers. In addition, this was also the first pass for VTS resulting in increased nervousness and tension for all operating personnel. Twenty-three seconds elapsed before the "A-scope watcher" realized that an error had been made and that PRF step 5 had been commanded. He then quickly commanded in sequence steps 6, 7, 8, and 9. The last step was reached just prior to turning the payload off.

This gross error in PRF commanding served to illustrate two points. First, it showed that some form of automatic PRF control is essential. The manual PRF command philosophy used for this operation was cumbersome, prone to error, and impractical for an operational situation. Second, it provided an interesting and instructive demonstration of the precise effects of incorrect PRF and of PRF changes on coherent radar mapping technique.

3.8.8 S-Look Program

The S-Look computer program was produced to quickly determine the ground position of the vehicle look point from a known vehicle position. The program was so written that it may be used in conjunction with other programs which determine the vehicle position from known orbit parameters. Figure 3.8.8.1 gives a pictorial illustration of the S-Look geometry. The geometric relationships used in the program are shown in figure 3.8.8.2.

The S-Look program is used first to determine the position of the ground swath for a nominal orbit. This result is used in all pre-flight planning. The primary use of the program occurs during the flight. It quickly locates

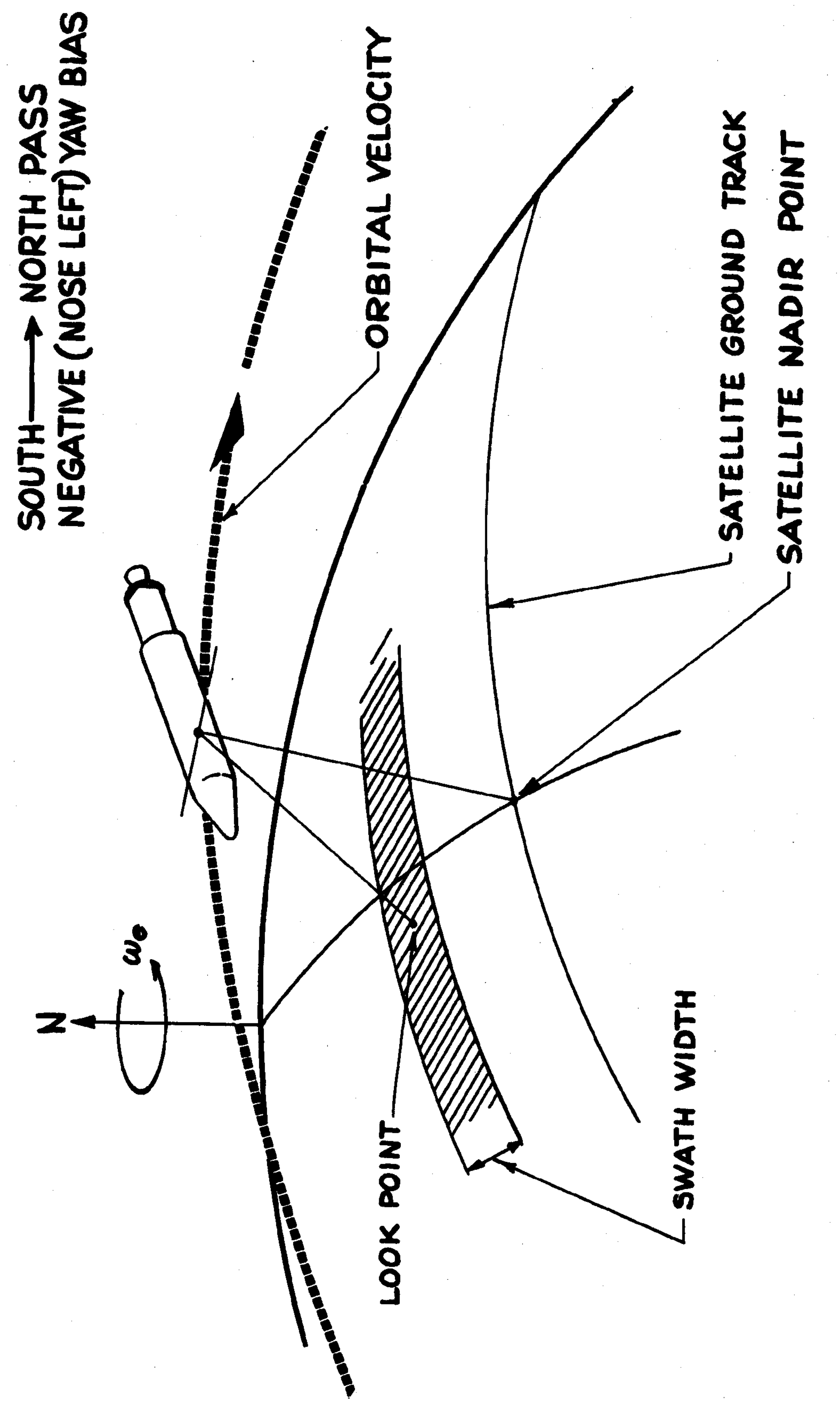


Figure 3.8.8.1 - Antenna Look Point - Pictorial

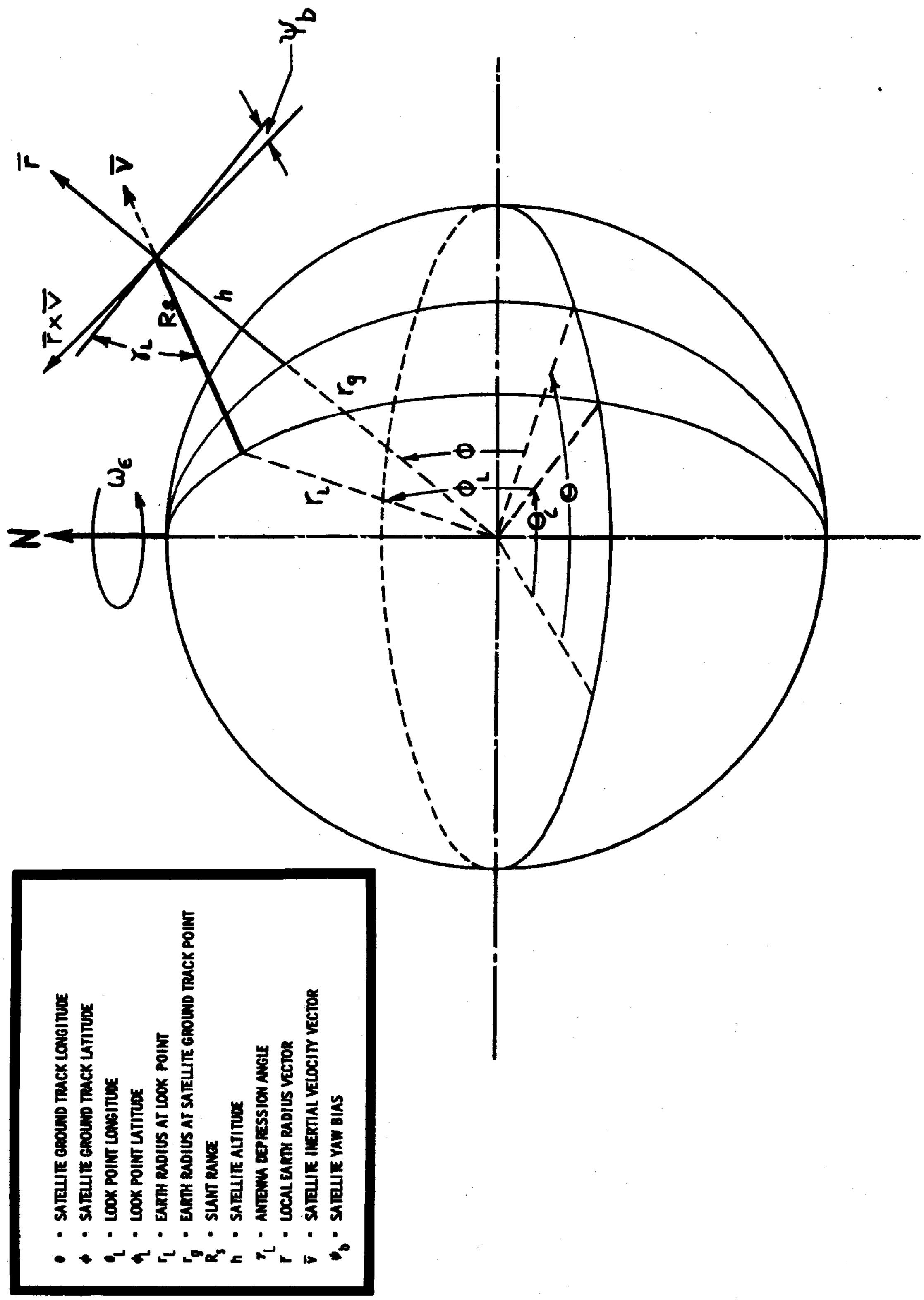


Figure 3.8.8.2 - Antenna Look Point - Geometry

the actual look points from the true orbit parameters. The true position of the swath width is necessary for the flight operation to determine the payload operate times. It is also used to position various calibration arrays which must be accurately placed with respect to the swath width.

It makes only two assumptions in its derivation. It assumes an elliptical earth with an eccentricity of .00336, and a smooth, sea-level surface. The deviation of the true shape of the earth from the elliptical model is insignificant because of the relatively short distance from the vehicle ground track to the swath width. However, the assumption of a smooth, sea-level surface will introduce small errors in some cases. These errors are approximately:

$$\text{elevation @ look point} \times \cot \gamma_L$$

The total error of the look point position depends on many parameters other than the S-lock itself. The main areas of error are vehicle attitude and PRF step. These are discussed in Sections 3.2 and 3.4.