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CORONA J  
PERFORMANCE EVALUATION REPORT  
MISSION 1104-1 and 1104-2  
FTV 1644, CR-4

Approved [REDACTED]

Manager

Advanced Projects

the NRO

In Accordance with E. O. 12958

on NOV 26 1997

Approved [REDACTED]

Manager

Program [REDACTED]

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6 March 1969


TO:

THRU:

FROM:

SUBJECT: MISSION 1104 FINAL REPORT (CR-4)

Enclosed is the Final Evaluation Report  
for Mission 1104.

  
\_\_\_\_\_  
Manager  
Advanced Projects

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FOREWORD

This report details the performance of the payload system during the operational phase of the Program [REDACTED] Flight Test Vehicle 1644.

Lockheed Missiles and Space Company has the responsibility for evaluating payload performance under the Level of Effort and "J" System contracts.

This document is the final payload test and performance evaluation report for Missions 1104-1 and 1104-2 which were launched on 7 August 1968.

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## INTRODUCTION

This report presents the final performance evaluation of Missions 1104-1 and 1104-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the CR-4 payload system and to identify the source of in-flight anomalies.

The performance evaluation was jointly conducted by representatives of Lockheed Missiles and Space Company (LMSC) and ITEK at the facilities of NPIC and AFSPPF. The off-line evaluation using Corona engineering photography acquired over the United States was performed at the individual contractors plants.

The quantitative data used for this report is obtained from government organizations. The diffuse density data, and MTF/AIM resolution are produced by AFSPPF. The vehicle attitude error values, frame correlation times are made at NPIC who also supply the Processing Summary reports published by [REDACTED]

Computer programs developed by A/P are utilized to calculate and plot the frequency distribution of the various contributors to image smear to permit analysis and correlation of the conditions of photography to the information content and quality of the acquired pictures. Computer analysis of the exposure, processing and illumination data provides the necessary data to analyze the exposure criteria selected for the mission.

This report contains certain data summarized from [REDACTED] Processing Summary, C-38-200613, and from AFSPPF TERO Report, 101-1-116.

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SECTION 1

MISSION SUMMARY

A. MISSION OBJECTIVES

The payload section of Mission 1104, placed into orbit by Flight Test Vehicle #1644 and THORAD Booster #522, consisted of two panoramic cameras, one DISIC camera, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipment. Figure 1-1 presents an inboard profile of the CR-4 payload system. The Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. A seven day -1 mission and an eight day -2 mission was planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2136:55Z (1436:55 PDT) on 7 August 1968. Ascent and injection were normal and the achieved orbit was within nominal tolerances. Tracking and command support was effected by the Air Force Satellite Control Facility



under central control of the Satellite Test Center at Sunnyvale, California. Mission 1104-1 consisted of a 7 day operation and was completed by air recovery on 14 August 1968. Mission 1104-2 was completed with an air recovery on 22 August 1968 following an 8 day photographic operation.

The comparison of the planned and actual orbit parameters is tabulated as follows:

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ORBITAL PARAMETERS

<u>Parameter</u>	<u>Planned</u>	<u>Orbit 2 Actuals</u>
Period (Min.)	88.67	88.72
Perigee (N.M.)	84.96	84.3
Apogee (N.M.)	142.83	143.7
Inclination (Deg.)	82.0	82.11
Perigee Latitude (Deg. N)	20.56	5.70
Eccentricity	0.008175	0.0084

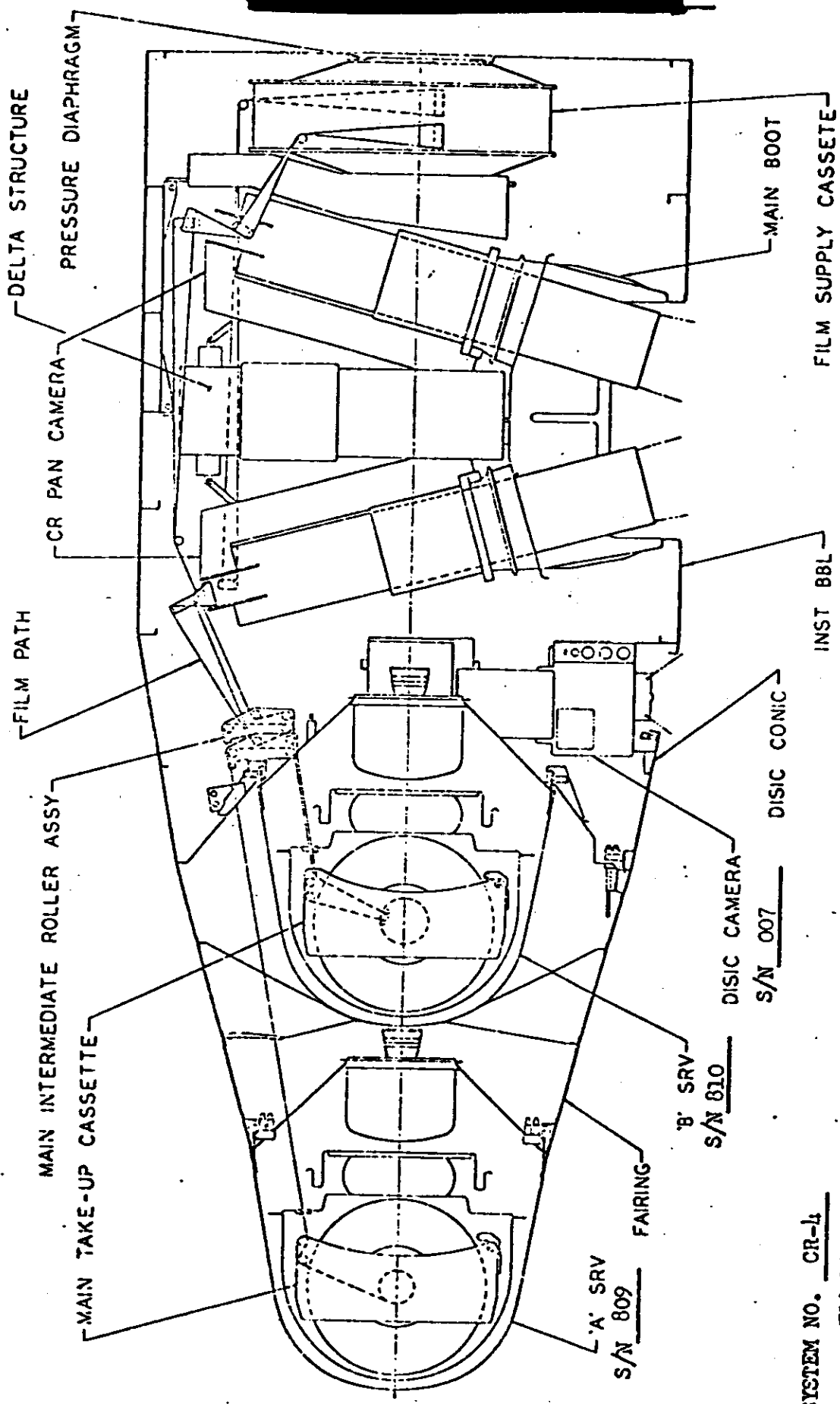
Three drag make-up rockets were fired during Mission 1104-1, and seven during 1104-2. An eleventh rocket was fired after the second recovery.

C. PANORAMIC CAMERAS

Both instruments operated satisfactorily throughout both missions, and produced very good image quality except where degraded by atmospheric attenuation. This was considered to be the best of any Corona system to date.

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PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-4  
 TEST Flight  
 PMU S/N 1005  
 SLOPE PROGRAMMER S/N 203  
 CLOCK S/N 618

S/N 308  
 S/N 309

S/N 305

FIGURE 1-1

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D. DISIC CAMERA

The DISIC camera operated satisfactorily throughout both the -1 and -2 missions. Most Stellar images appear as points rather than the common odd shaped stars. A minor light leak caused a few instances of obscured imagery.

E. OTHER SUB-SYSTEMS

The clock, command and thermal control subsystems performed satisfactorily. The 1104-2 SRV tape recorder failed after only one instrument operate. The pressure make-up system functioned erratically and was disabled from Rev. 124 to Rev. 200. The failure permitted significant degradation of the special color film imagery from the panoramic instruments.

F. COMPONENT IDENTIFICATIONS AND SETTINGS

1. Forward Looking Panoramic Camera

a. Component Assignment

<u>Component</u>	<u>Serial Number</u>
Main Camera	309
Main Camera Lens	I205
Supply Horizon Camera Lens	E23759
Take-up Horizon Camera Lens	E23779

b. Camera Data and Flight Settings

Main Camera:

Lens 24" f/3.5

Slit Widths

S<sub>1</sub> 0.199"

S<sub>2</sub> 0.232"

S<sub>3</sub> 0.298"

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S<sub>4</sub> 0.298"

F/S 0.238"

Filter Types

Primary Wratten 25

Secondary Wratten 15 + 0.9 N.D.

Film Types

Primary Eastman Type 3404 (15,200 Ft.)

Secondary Eastman Type SO-180 (800 Ft.)

Supply (Port) Horizon Camera:

Lens 55 mm f/6.3

Aperture Setting f/6.3

Exposure Time 1/100 second

Filter Type Wratten 25 (NG-3 Auxiliary)

Take-up (Starboard) Horizon Camera:

Lens 55 mm f/6.3

Aperture Setting f/8.0

Exposure Time 1/100 second

Filter Type Wratten 25 (NG-3 Auxiliary)

2. Aft Looking Panoramic Camera

a. Component Assignment

<u>Component</u>	<u>Serial Number</u>
Main Camera	308
Main Camera Lens	I 183
Supply Horizon Camera Lens	23766
Take-up Horizon Camera Lens	E 23786

b. Camera Data and Flight Settings

Main Camera:

Lens 24" f/3.5

Slit Widths

S<sub>1</sub> 0.151"

S<sub>2</sub> 0.163"

S<sub>3</sub> 0.205"

S<sub>4</sub> 0.256"

F/S 0.210"

Filter Types

Primary Wratten 21

Secondary SF05

Film Type Eastman Type 3404 (16,300 Ft.)

Supply (Starboard) Horizon Camera:

Lens 55 mm f/6.3

Aperture Setting f/8.0

Exposure Time 1/100 second

Filter Type Wratten 25

Take-up (Port) Horizon Camera:

Lens 55 mm f/6.3

Aperture Setting f/6.3

Exposure Time 1/100 second

Filter Type Wratten 25

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3. DISIC Camera

a. Component Assignment

<u>Component</u>	<u>Serial Number</u>
Camera	007
Index Reseau	107
Stellar Reseaus	
Port	10P
Starboard	8

b. Camera Data and Flight Settings

Stellar Cameras:

Lens	3 in. f/2.8
Exposure Time	1.5 second
Filter Type	None
Film Type	Eastman Type 3401 (2000 ft.)

Index Camera:

Lens	3 in. f/4.5
Exposure Time	1/500 second
Filter Type	Wratten 12
Film Type	Eastman Type 3400 (2000 ft.)

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## SECTION 2

## PRE-FLIGHT SYSTEMS TESTS

As a standard procedure, the CR payload systems are subjected to a series of tests which demonstrates a satisfactory level of confidence that the systems will indeed perform as required in their respective missions. The tests include an operational-type exposure to simulate thermal/altitude environment, a light-leak evaluation, and a dynamic measure of the photographic performance capabilities. Significant baseline levels and anomalies experienced with this system during the pre-flight testing are as follows:

## A. ENVIRONMENTAL TEST

The CR-4 payload system was subjected to an environmental HIVOS chamber test from 27 April through 3 May 1968. Payload performance, from instrumentation analysis, was satisfactory throughout the "A" and "B" missions.

The test film consisted of three types of material for each camera for the purpose of adding further dimension into the corona marking evaluations. During the "B" mission the automatic film change detector switched the No. 1 and 2 instrument filters to the alternate filter each time the alternate material was detected. The MCD units operated with no anomalies. Instrument 308 contained film types 3404, 3400 (1600 ft.) and SO-340 (1600 ft.), and Instrument 309 contained 3404, 3401 (1600 ft.) and SO-180 (1600 ft.).

The primary 3404 film showed no evidence of corona induced marking throughout the test. However, the other four, more sensitive materials exhibited a very distinct, repeatable corona marking pressure profile. The 3400, 3401, SO-180 and SO-340 films recorded virtually identical patterns

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of marking, differing only in extent and magnitude in direct proportion to their relative emulsion sensitivities. Each of the materials experienced objectionable marking over the full range of pressure (0 to  $200 \times 10^{-3}$  Torr) except for the region approximately 10 to  $20 \times 10^{-3}$  Torr. The SO-340 exhibited a relatively minor level of marking in this region also, which is suspected to be a result of the combined influences of a very much more sensitive emulsion and a much thicker material overall. The very high sensitivity of the SO-340 material also revealed minor system light transmission characteristics, which can be degrading to SO-340 photography, but are undetectable with the more conventional films. There are some instances of continuous density streaks along the film (very distinct on the SO-340), most probably associated with the take-up puck arm.

The DISIC terrain camera experienced only minor corona marking throughout the test. Very few frames were affected, and density levels were acceptable. The stellar record exhibited random corona marking throughout, with approximately 15 to 20% of the frames affected. However, the extent and density level of the marking is very minor and would not destroy the utility of stellar imagery. This test appeared to exhibit the least amount of corona marking in any DISIC unit to date.

The high pressure valve in the pressure make-up system (PMU) failed to open periodically throughout the portions of the test in which the PMU was enabled. The consumption rate averaged 10.3 lbs./min., which is approximately 20 percent lower than nominal. Subsequent testing of the PMU components at various environmental conditions failed to identify the anomaly, and the system was accepted for flight. The apparent anomaly experienced in the chamber test is opposite to the performance characteristics evident during

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Mission 1104 where the valve appeared to fail in closing properly resulting in a very high gas consumption rate. (Ref. Section 3)

Both the Switch and Slope Programmers operated satisfactorily throughout the test. No anomalies were reported.

The Command System operated satisfactorily except for UNCLE 101 commands. The time restriction of 3 seconds between commanding from Position 11 to Position 1 was not observed. This problem occurred two times in the "A" mission and one time in the "B" mission.

Payload Tape Recorder data was processed and computer outputs analyzed. All T/M anomalies, analyzed from Sanborn records, were reverified using tape recorder data.

Temperature profiles indicate that thermal limitations were not exceeded at any time during altitude testing. Special thermocouples installed on the rail of No. 2 instrument were recorded at 5 minute intervals during the 20 minute operates at Beta +65 and at 70° soak. The instrumentation indicated insignificant levels of thermal gradient across the rail and of thermal rise during camera operation.

During the switching functions of KZ-38, KZ-39, Arm, Transfer and Electrical Disconnect, T/M indicated no anomalies occurred except for the "B" SRV water seal. During "B" Arm Command, T/M indicated the water seal did not close. Post inspection verified the seal did close and, due to a sticky switch, T/M indication was in error.

As a result of the corona marking characteristics observed in this environmental test, the CR-4 pressure make-up system was modified to provide a nominal pressure of  $16 \times 10^{-3}$  Torr during the portion of the 1104 mission

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in which SO-180 film would be used. The standard  $50 \times 10^{-3}$  Torr pressure regulation was retained for use with the 3404 film.

B. RESOLUTION TEST

Initial resolution and theodolite tests were performed on 29 April 1968. Results of the thru-focus resolution tests of pan instruments 308 and 309 show the following characteristics:

Aft-Looking Instrument No. 308

Maximum high contrast resolution 234 lines/mm at 0.000 focal position.

Maximum low contrast resolution 136 lines/mm at +0.001 focal position.

Fwd-Looking Instrument No. 309

Maximum high contrast resolution 248 lines/mm at 0.000 focal position.

Maximum low contrast resolution 168 lines/mm at 0.000 focal position.

Additional Boston investigations of the film dynamics in the CR-4 camera system (Dr. "A" tests) induced an excessive shift in the peak focus position for Instrument 309. A 0.001" shim was removed and a final resolution run performed on 6 June 1968, demonstrating the following results:

Aft-Looking Instrument No. 308

Maximum high contrast resolution 212 lines/mm at 0.000 focal position.

Maximum low contrast resolution 141 lines/mm at 0.000 focal position.

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Fwd-Looking Instrument No. 309

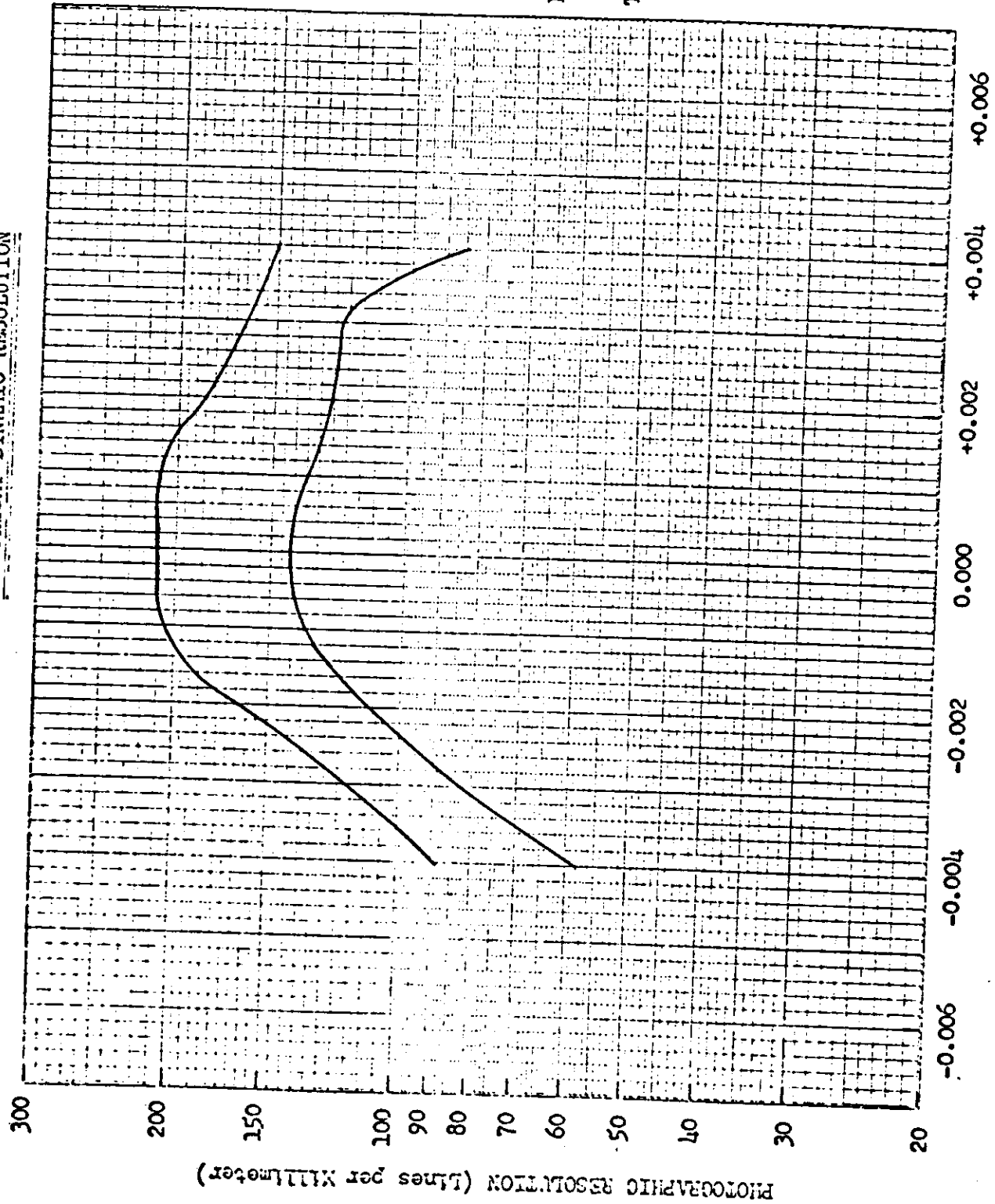
Maximum high contrast resolution 254 lines/mm at -0.001 focal position.

Maximum low contrast resolution 172 lines/mm at -0.001 focal position.

The final test data for both instruments is shown in Figures 2-1 and 2-2. Both instruments met the system requirements specification.

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PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 308  
Payload No: CR-4  
Resolution (1/mm)             
High Contrast: 212  
Low Contrast: 141  
Film Type: 3404  
Test Date: 6 June 1968

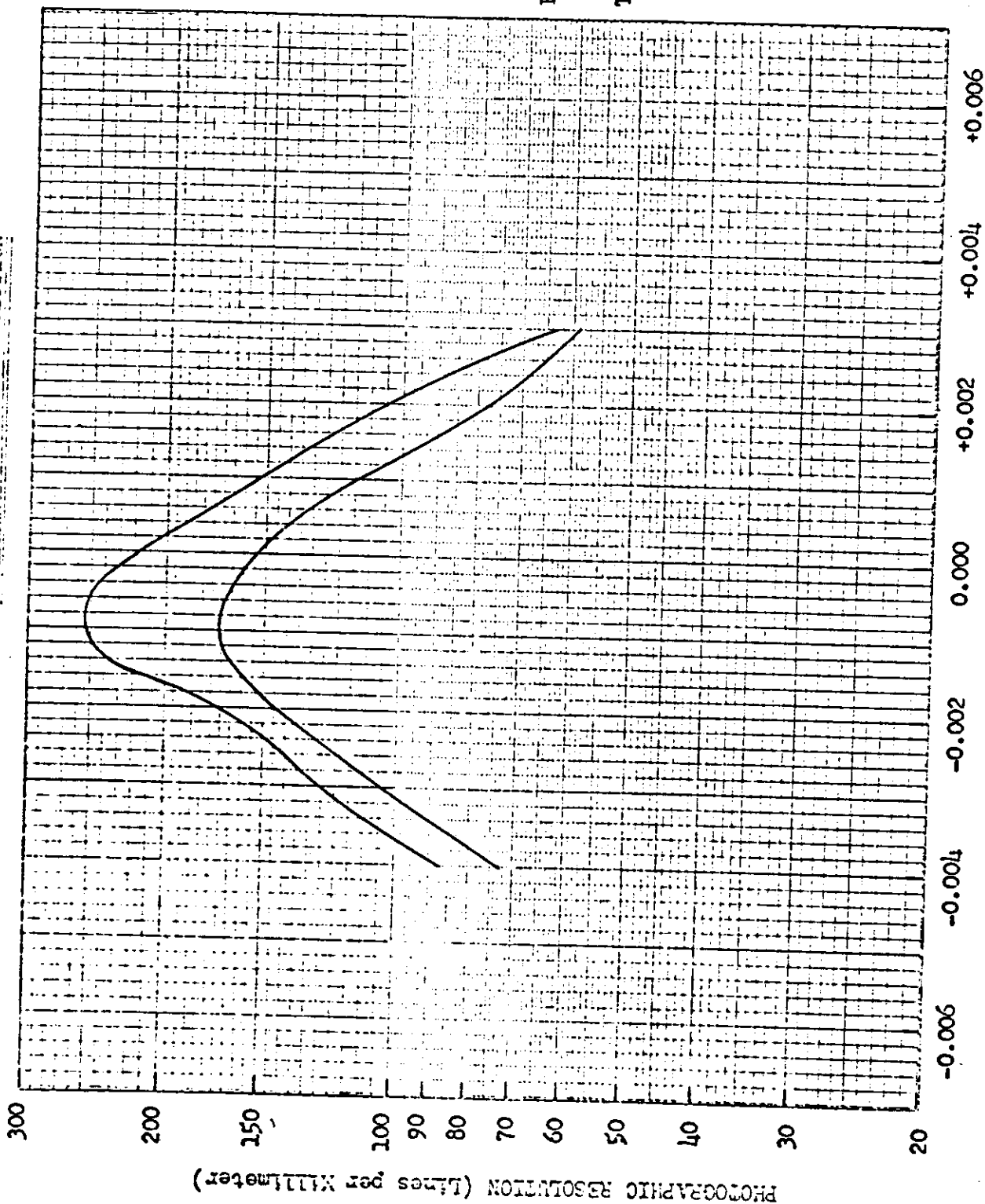
THROUGH FOCUS INCREMENTS (Inches)

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PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 309

Payload No: CR-4

Resolution (1/mm) 254

High Contrast: 172

Low Contrast: 172

Film Type: 3404

Test Date: 6 June 1968

THROUGH FOCUS INCREMENTS (Inches)

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FIGURE 2-2

C. LIGHT LEAK TEST

A live film light leak test of the CR-4 system was performed on 6 June 1968, revealing heavy density marks on the records from both instruments in the vicinity of the "A" SRV capsule cover. These marks were similar to forebody leak problems experienced in recent systems. No other leaks were detected.

Extensive testing of the forebody failed to detect any source of light fogging. Subsequent examination of the fairing revealed an apparent leak at a teardrop fitting near the forebody interface. The leak was plugged and verified by photomultiplier light search. For lack of supporting evidence to the contrary, it was assumed that this apparent leak was the cause of the marking in the live film test. The flight results indicate that there was indeed a forebody leak that escaped detection (ref. Section 4). Testing procedures have been implemented to reduce the possibility of flying a system with a potential light-leaking forebody on future missions.

D. FLIGHT LOADING AND CERTIFICATION

Loading of flight film was accomplished on 29 July 1968, and final pre-flight acceptance tests performed 1 August 1968. All functions were normal, with no indications of light leaks (using photomultiplier sensing techniques) or other sources of performance degradation.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Lift-off occurred at 1436:55 PDT (system time 77814.70) on 7 August 1968 from the SLC-3, West launch pad. All launch, ascent, and injection events occurred as programmed. The orbit achieved was within the predicted 3 Sigma dispersions.

Both Panoramic cameras operated satisfactorily throughout the flight. Average cycle periods for both cameras were within 1% of the pre-flight calibrations.

Telemetry monitors indicated the DISIC system operated normally throughout the flight.

The clock and A/P command systems operated satisfactorily throughout the flight.

The FMC programmer and exposure control programmer operated satisfactorily throughout the flight.

A malfunction of the PMU high pressure regulator resulted in excess consumption and the PMU was disabled from Rev. 124 to Rev. 200.

Ascent vibrations appeared normal and were within qualification levels. The thermal environment of the Panoramic cameras was within predicted tolerances and ranged from an average high of 75°F for the -1 mission to an average low of 56°F for the -2 mission. The No. 1 DISIC temperature sensor was biased by an approximate +27 degrees throughout the flight.

KIK-ZORRO 38 (Panoramic camera take-up switchover) was commanded during Rev. 103. Cut, wrap, and transfer from the -1 to the -2 recovery system

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occurred normally. However, the No. 2 instrument did not stow; this problem is presented in detail in Paragraph B, below.

KIK-ZORRO 39 (DISIC camera take-up switchover) was commanded during Rev. 104. Cut, splice, and transfer to the -2 recovery system occurred normally.

Both recovery systems were successfully recovered by air-catch with all events occurring as programmed. The impact point was within predicted limits for both systems.

Eleven (11) drag make-up rockets were utilized during the active portion of the flight. Three (3) rockets were fired during the -1 mission for period recovery and seven (7) rockets were fired during the -2 mission. The eleventh rocket was fired after the second recovery. Rocket number 12 was not fired. The following is a summary of DMU rocket performance:

DMU ROCKET PERFORMANCE

<u>DMU</u>	<u>Rev. No.</u>	<u>Velocity Change (FPS)</u>	<u>Period Change (Sec.)</u>
1	46	14.8	9.2
2	69	15.3	9.6
3	99	15.0	9.3
4	117	17.2	10.7
5	139	16.2	10.3
6	150	17.0	10.6
7	174	17.0	10.6
8	194	16.6	10.3
9	211	16.8	10.4
10	234	17.2	10.7
11	244	19.2	12.0
12	Not used		

Figures 3-1 and 3-2 are plots of orbit history and operation distribution data.



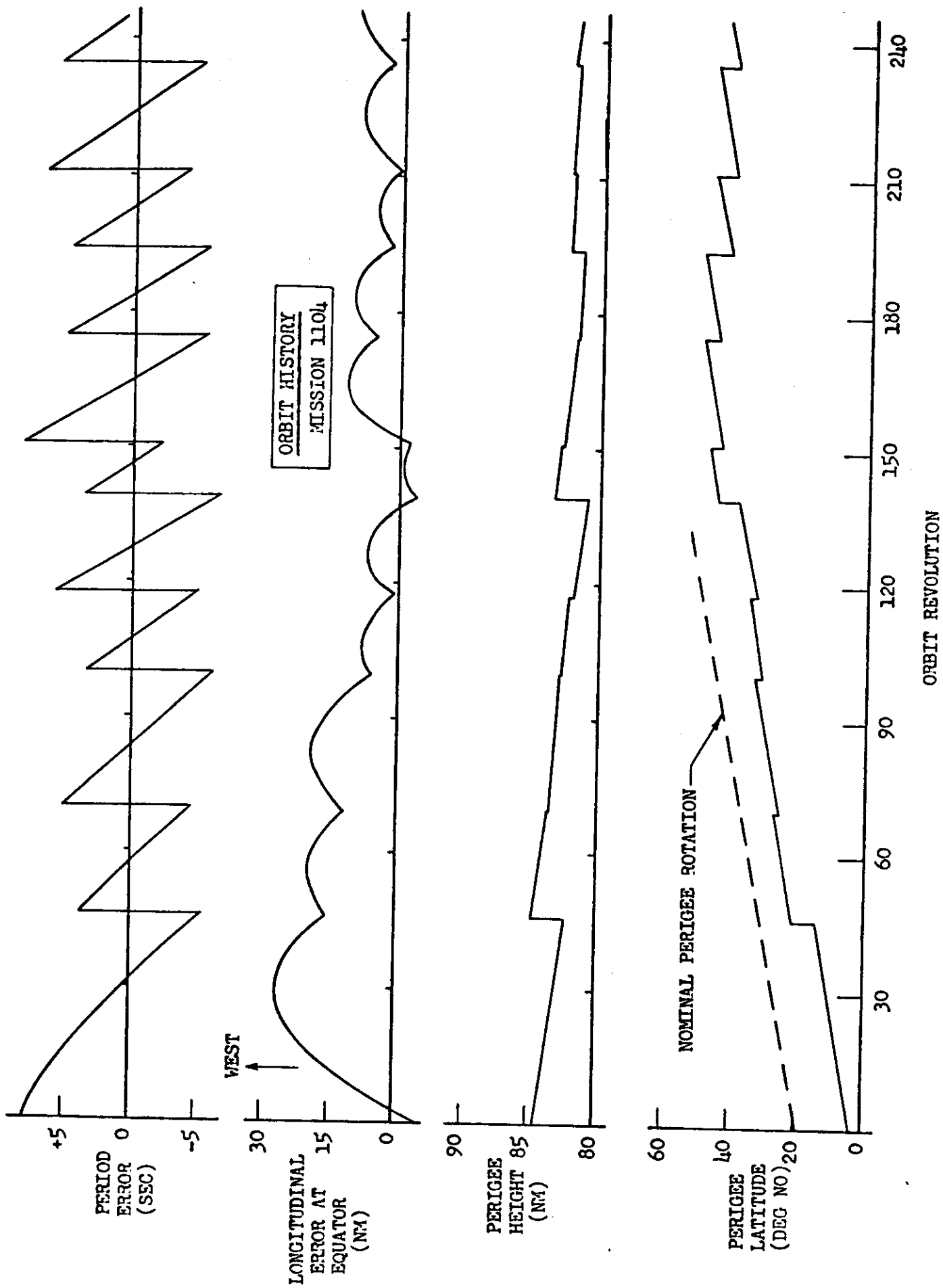


FIGURE 3-1

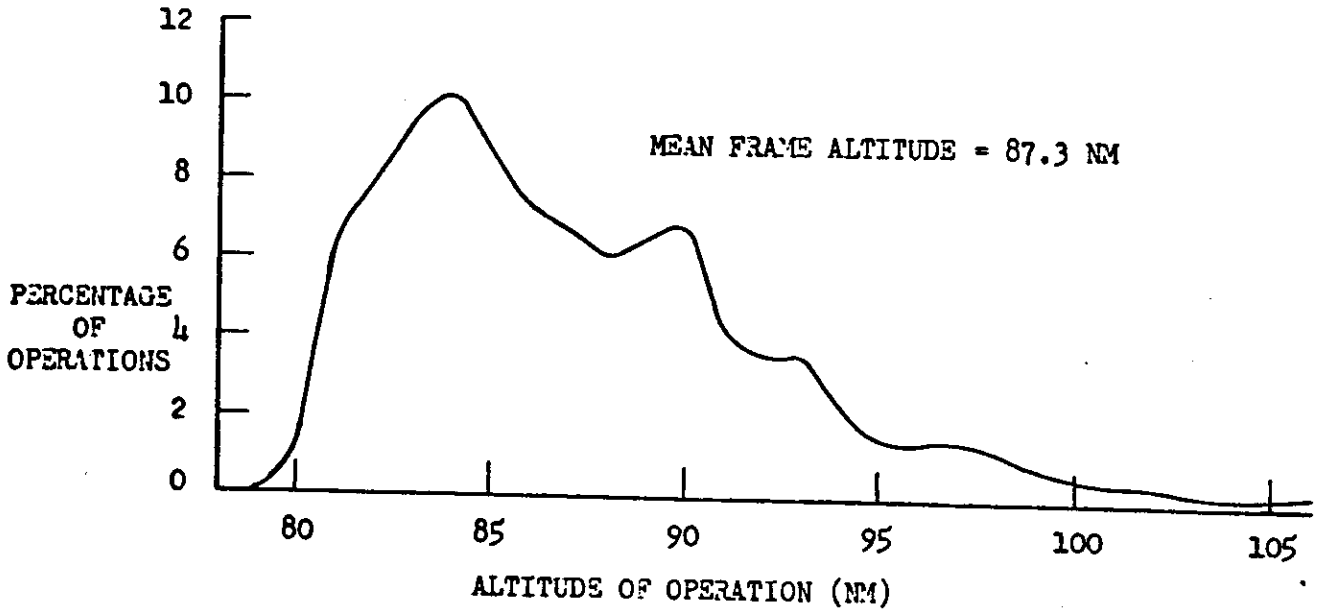
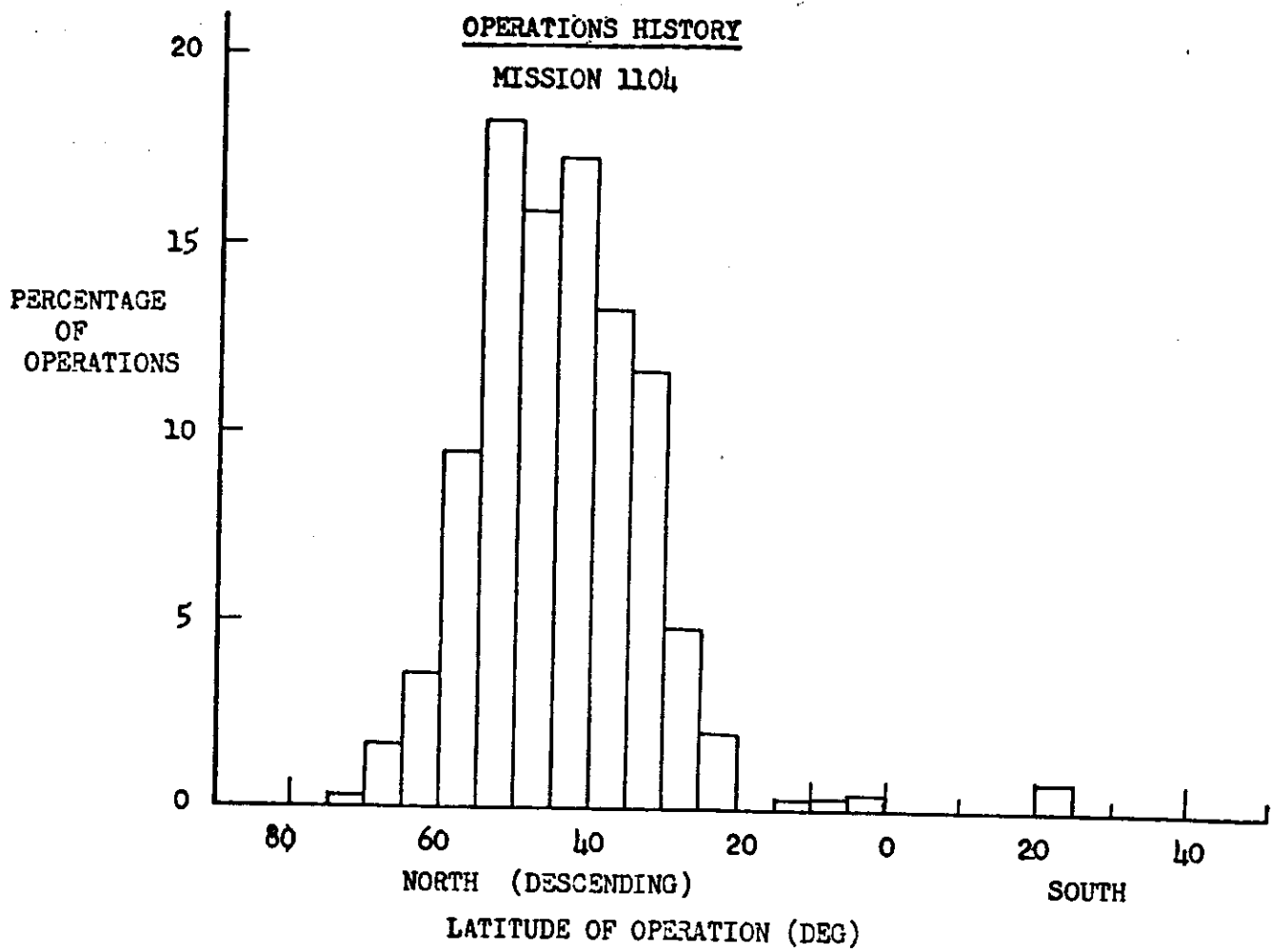


FIGURE 3-2

The -1 SRV tape recorder system functioned satisfactorily throughout the mission. The -2 tape recorder recorded only the first operate after KZ-38; this problem is presented in detail in Paragraph D, below.

There were no post-mission test requirements for this flight.

B. PANORAMIC CAMERA PERFORMANCE

Both Panoramic cameras operated normally throughout the flight. Camera system dynamic operation, 99/101 percent clutch operation, start-up, and transport functions were normal for all passes indicated by available telemetry data. Telemetry analysis indicated the Slave camera lens failed to stow on three(3) operations during the flight. However, the failure to stow on the KZ-38 operation was the only instance which produced detrimental effects on the film.

Instrument vibrations repeated the pattern recorded in Mission 1103. The greatest disturbance was again caused by the clamping and capping shutter functions. The A.O. solenoid firing was noticeable, but not prominent.

The average vibration level during scan was 0.1 g at 800-1000 cps. Maximum "g" values during the scan portion of a typical instrument cycle were as follows:

	<u>Peak g's</u>	
	<u>X-Axis</u>	<u>Y-Axis</u>
A.O. clamp	0.33 (peak)	0.33 (peak)
Capping shutter open	0.33 (peak)	0.33 (peak)
A.O. solenoid actuate	---	0.13
A.O. solenoid release	---	0.13
Capping shutter closed	0.16	---
A.O. unclamp	0.28	---

Power Spectral Density (PSD) plots of the instrument vibration through the scan area of instrument rotation produced the following peak "g's" at the indicated frequencies:

<u>Freq. (cps)</u>	<u>AXES (g's)</u>					
	<u>X</u>		<u>Y</u>		<u>Z</u>	
	<u>Mono</u>	<u>Stereo</u>	<u>Mono</u>	<u>Stereo</u>	<u>Mono</u>	<u>Stereo</u>
395					.0037	
475						.0135
520						.0134
560		.026				
580	.0185				.0076	
645					.0048	
780	.0173		.021			
795		.0136		.0187		.0129
800					.00324	
935				.017	.0044	
960		.0261				
985	.0167		.0123		.0063	
1050				.013		
1055	.0097		.013			

The general resonance build-ups occurred between 500 and 1100 cps. These values are well below the levels that would induce detectable degradation to the photographic quality of current systems.

The mission film supply was exhausted with the exception of the stellar film, which was in excess of flight programming.



Film Consumption - Cycles

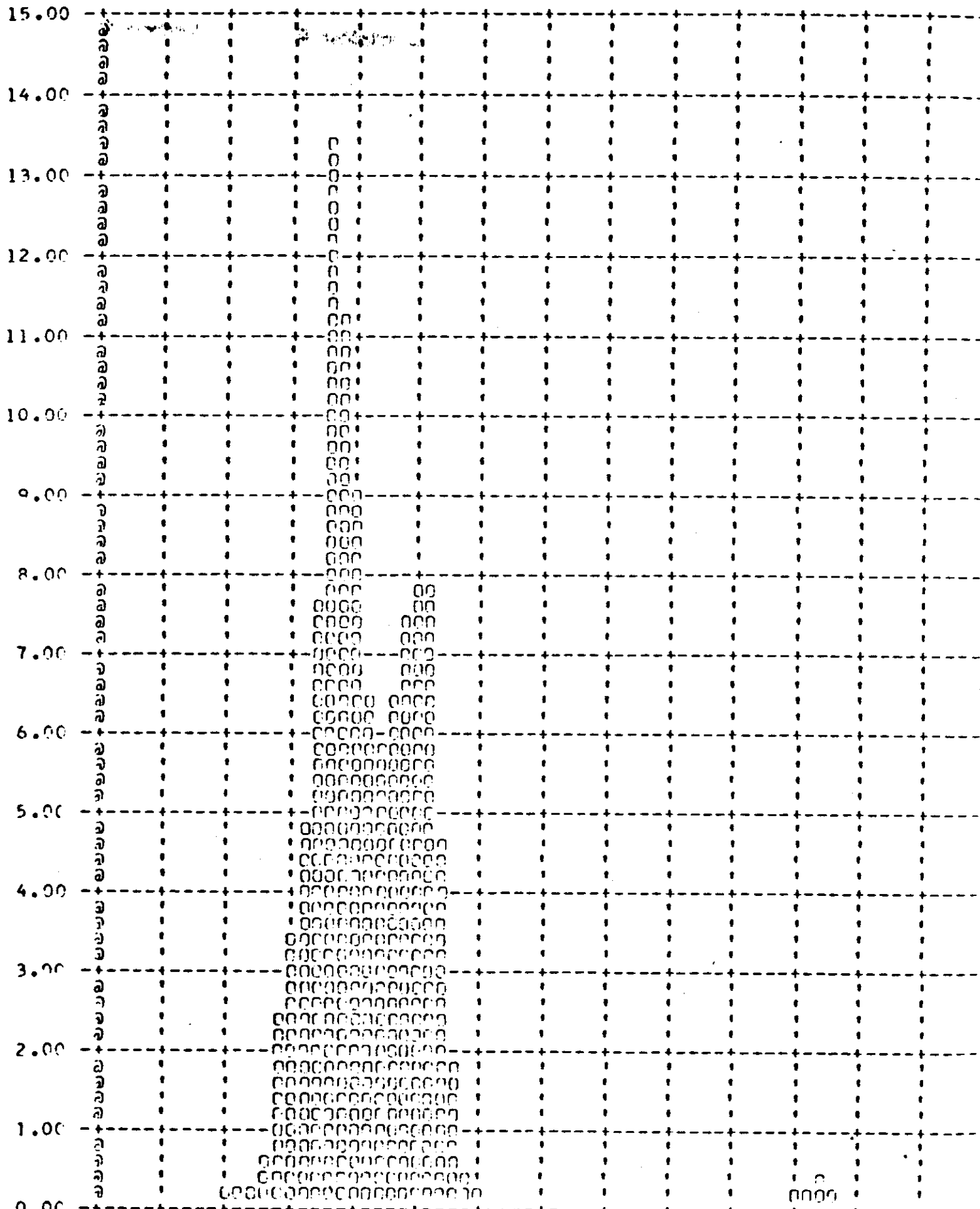
	<u>Pan 308</u>	<u>Pan 309</u>	<u>Stellar</u>	<u>Terrain</u>
Sample Off-Spooling	16	13	72	43
Pre-Launch	109	109	104	120
-1 Mission	2989	2978	2127	2134
-2 Mission	3056	2962	2588	2465
Total	<u>6170</u>	<u>6062</u>	<u>4927</u>	<u>4762</u>

FMC Match

A satisfactory ramp to orbit match was maintained throughout the entire mission, 90% photography being exposed at less than 1.25% error. The V/h match performance is statistically summarized in Figures 3-3 through 3-6.



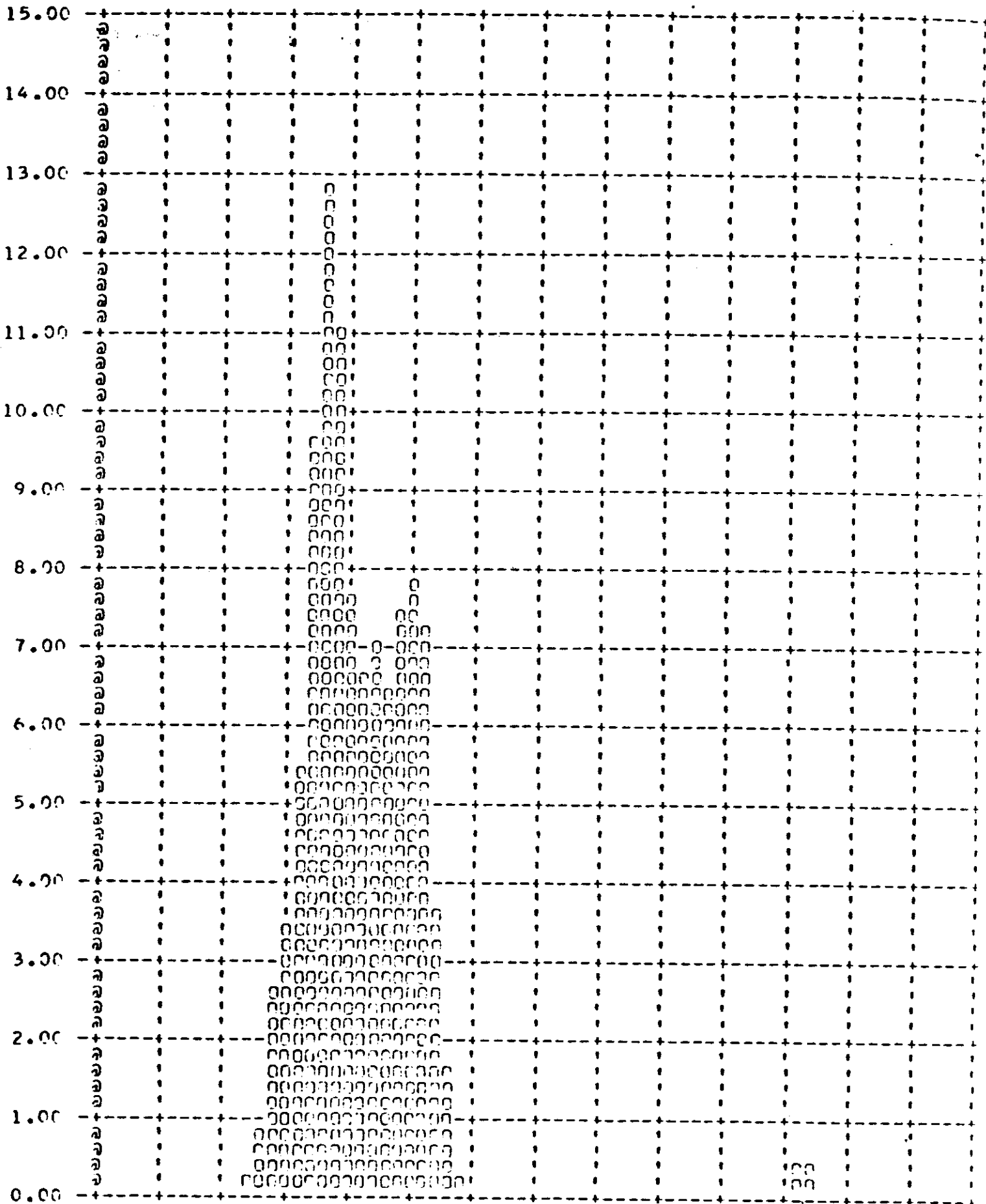
V/H RATIO ERROR - PERCENT (Y) VERSUS FREQUENCY - PERCENT (X)



MISSION 1104A1 TOP SECRET C/ [REDACTED] CONTROL NO. [REDACTED]

FIGURE 3-3

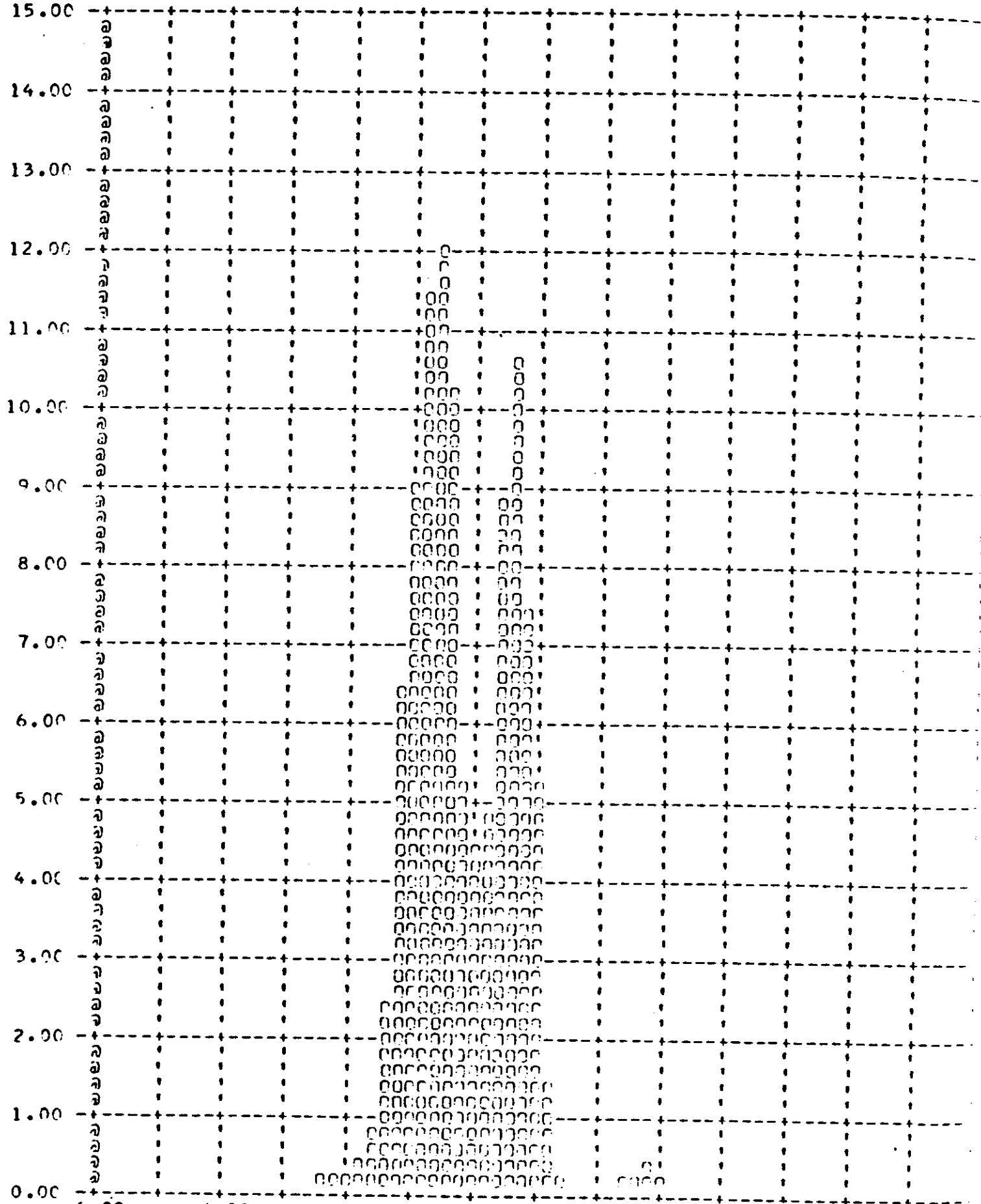
Y V/H RATIO ERROR - PERCENT (X) VERSUS FREQUENCY - PERCENT (Y)



MISSION 1104A2 TOP SECRET CONTROL No.

FIGURE 3-4

V/H RATIO ERROR - PERCENT (X) VERSUS FREQUENCY - PERCENT (Y)

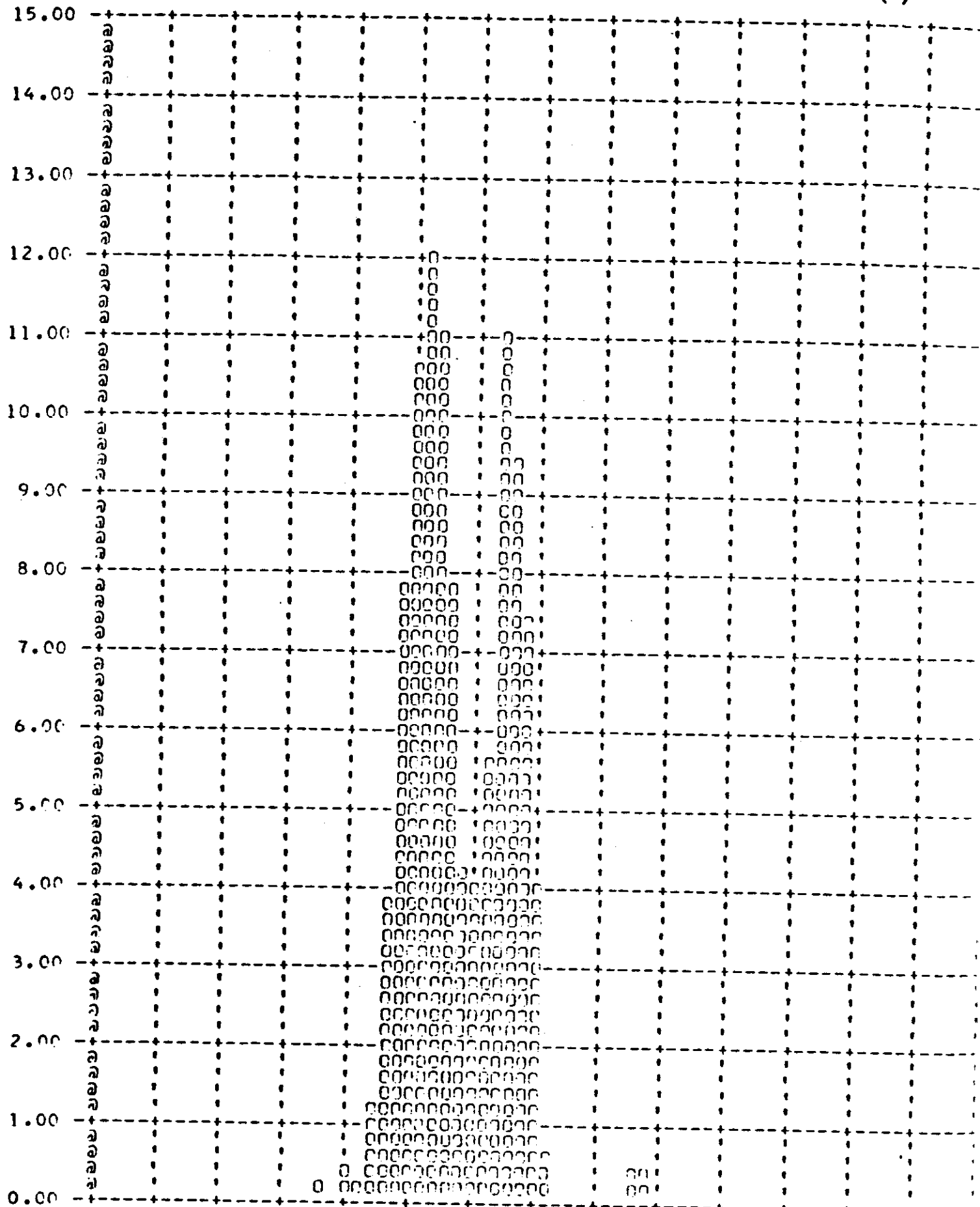


MISSION 110481 TOP SECRET CONTROL NO. [REDACTED]

FIGURE 3-5



Y V/H RATIO ERROR - PERCENT (X) VERSUS FREQUENCY - PERCENT (Y)



MISSION 110482 TOP SECRET CA [REDACTED] CONTROL NO. [REDACTED]

FIGURE 3-5

C. DISIC PERFORMANCE

Telemetry monitors indicated the DISIC system operated normally throughout the flight. Cut, splice, and transfer to second recovery system was initiated by KZ-39 during Rev. 104. All events occurred as programmed and were satisfactory.

The DISIC shutter-speed change mechanism (1/250 second exposure control) and the T2 timer function were disabled prior to flight.

D. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

The instrumentation system operated satisfactorily throughout the flight. Several tracking stations reported loss of sync of Link 2, Channels 15 and 16 with periodic commutator repetitive rates of 330-350 pulses per second. The normal rate of the 60 pin commutator is 300 pps or 5 RPM. This anomaly was first noted during pad checkout and corrective action was not considered necessary.

The payload command system operated satisfactorily throughout the flight. The UNCLE command system was utilized as the primary command link.

E. EXPOSURE CONTROL SYSTEM PERFORMANCE

The exposure control system functioned satisfactorily throughout the flight. There was no indication of a recurring malfunction of the exposure programmer relay K4 as experienced during Mission 1103.

F. CLOCK SYSTEM PERFORMANCE

The clock system operated normally throughout the flight. Satisfactory correlation between clock time and system time was obtained. However, a higher than normal drift rate was noticed throughout the flight. Correlation equations are as follows:

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First Order Fit

$$\text{System time} = A_0 + A_1 (\text{clock time})$$

where

$$A_0 = -93019.53281 \quad A_1 = 0.9999996815$$

$$\text{Sigma} = 0.00281$$

Second Order Fit

$$\text{System time} = A_0 + A_1 (\text{clock time}) + A_2 (\text{clock time})^2$$

where

$$A_0 = -93019.54308 \quad A_1 = 0.9999997127 \quad A_2 = 0.1881024688939 \quad \text{D-13}$$

$$\text{Sigma} = 0.00157$$

## G. PRESSURE MAKE-UP SYSTEM PERFORMANCE

The Pressure Make-Up System did not function properly. The malfunction of the system was first noticed during Rev. 32 when pressure dropped 310 psi in 3.5 minutes of instrument operate time (90 psi/min.).

The observed abnormalities associated with the PMU system were:

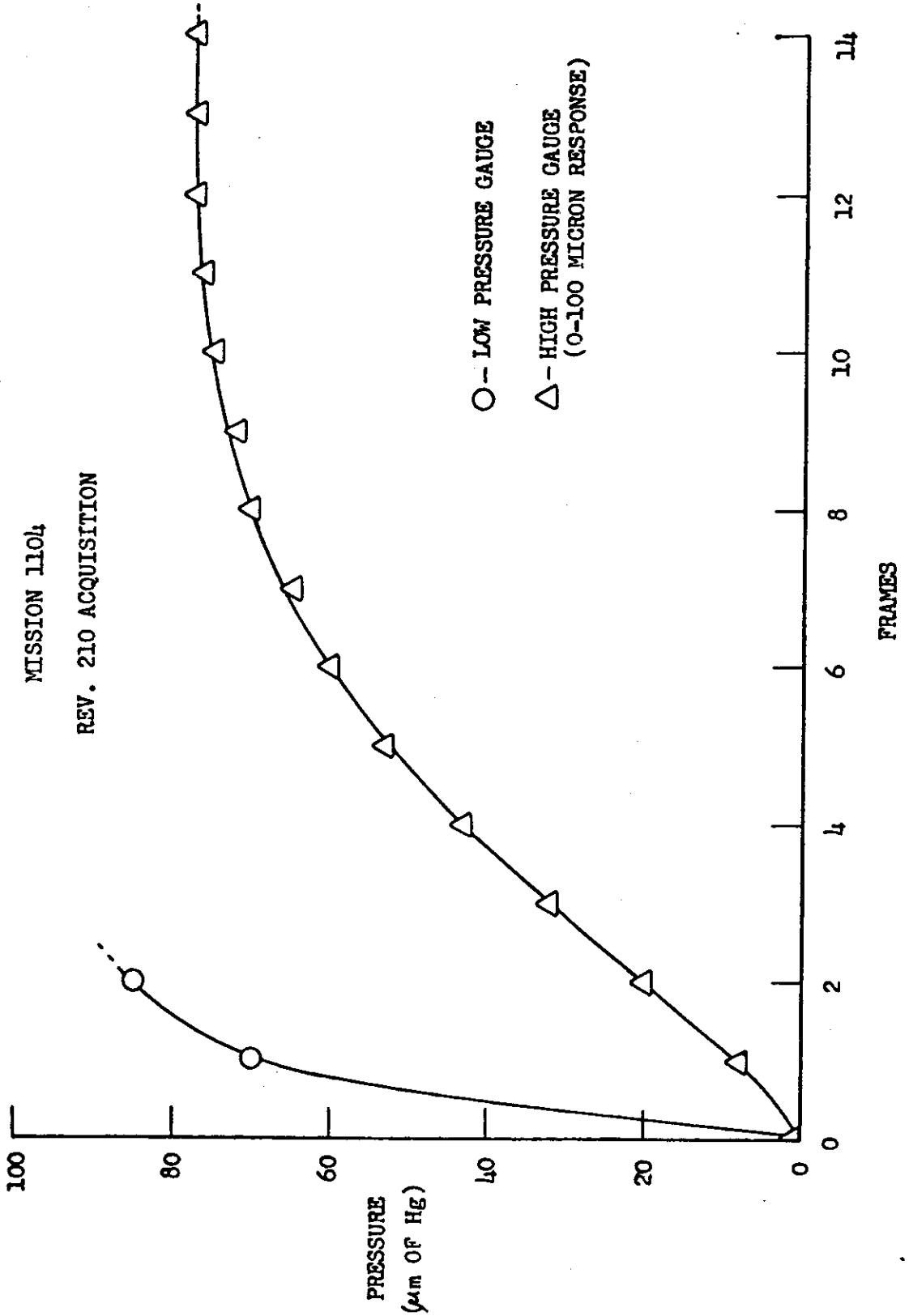
1. Stabilized pressures of 56 microns, 69 microns, and greater than 100 microns were observed during some operates, even when the lower range (16 micron) control was supposed to be in effect. Refer to Figure 3-7.
2. Supply pressure dropped 160 psi and 575 psi on two (2) operates and 100 to 150 psi per operate on several other instrument operates. Refer to Figure 3-9.
3. Pressure buildup, on occasion, exceeded 100 microns (gage limit) within 2 seconds. Refer to Figure 3-8.
4. Internal pressure fluctuated during instrument operation. During one such operate the pressure went to 66 microns, decreased to 62 microns, then increased to 70 microns at the "OFF" command.



PAYLOAD INTERNAL PRESSURE PROFILE

MISSION 1104

REV. 210 ACQUISITION



○ -- LOW PRESSURE GAUGE  
 △ -- HIGH PRESSURE GAUGE  
 (0-100 MICRON RESPONSE)

FIGURE 3-7



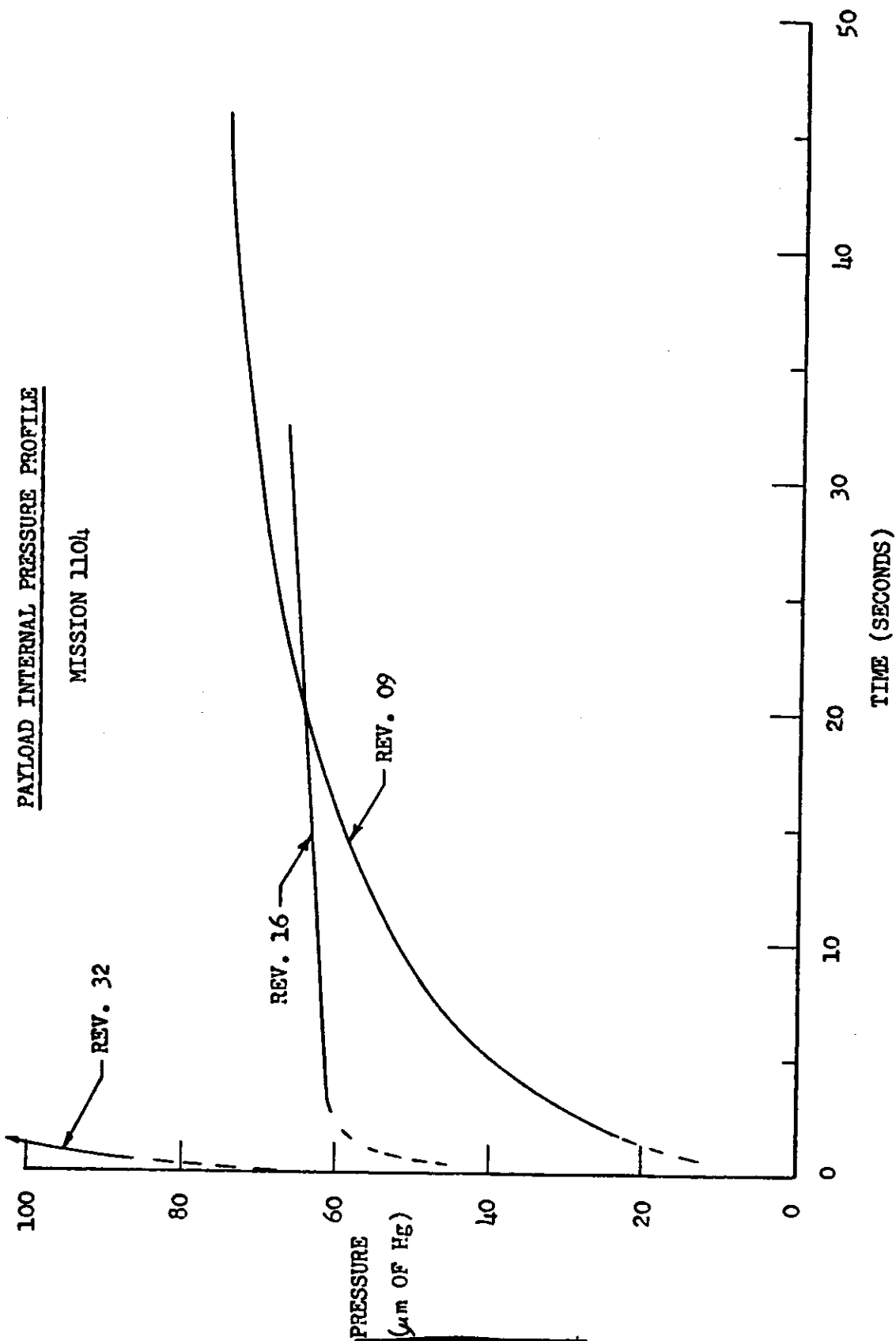
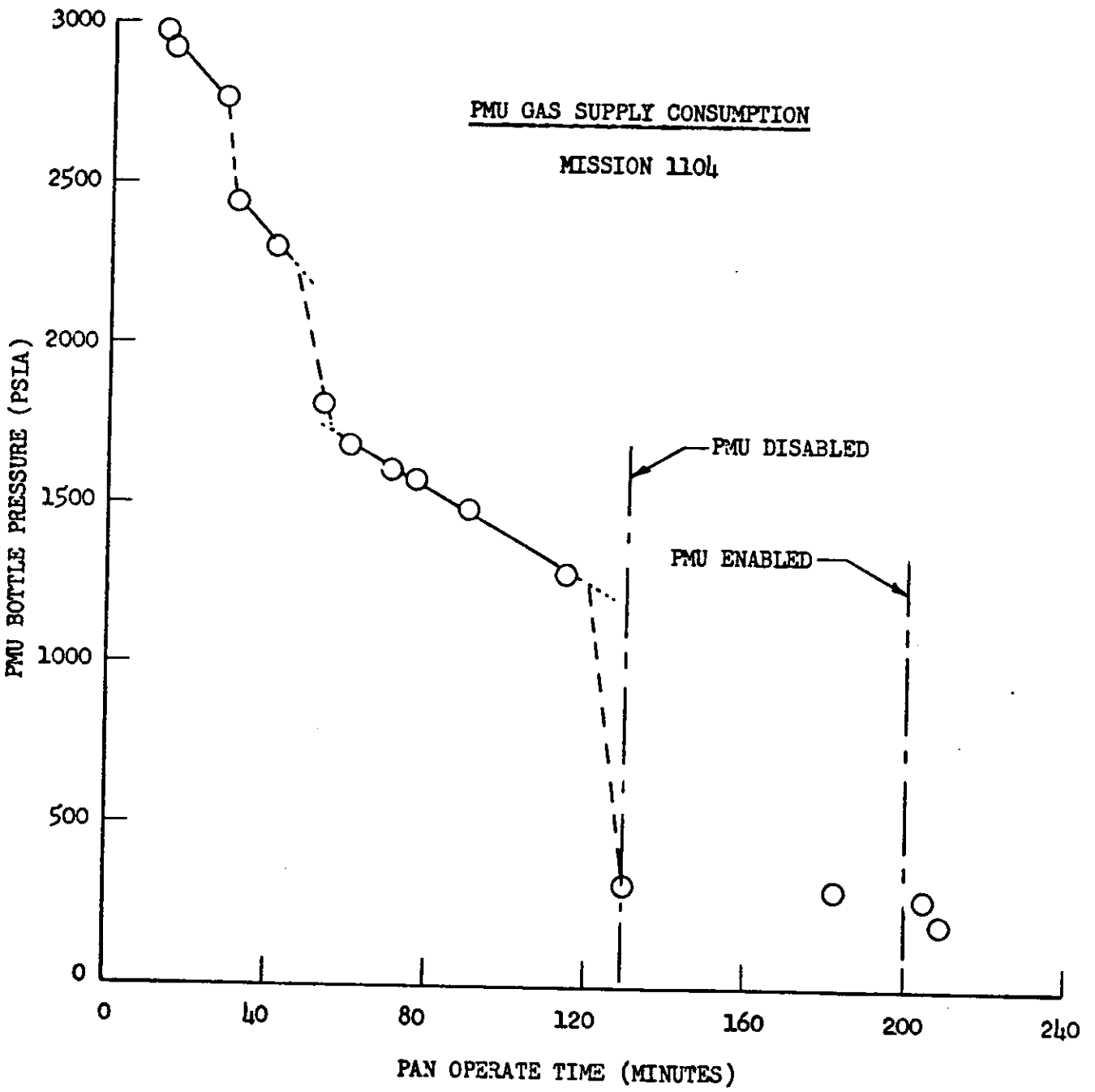


FIGURE 3-8

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FIGURE 3-9

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The problem was attributed to a faulty high pressure regulator. The PMU was disabled during Rev. 124, after 130 minutes of operate time, with a pressure of 350 psi remaining. The system was re-enabled during Rev. 200 and remained on for the balance of the flight, with the exception of Rev. 211. The supply pressure remaining at the end of the mission was 200 psi. Refer to Figure 3-9. The system apparently did not perform as desired for the SO-180 film employed in Instrument 309 at the end of Mission 1104-2. This condition was evidenced by the predominance of corona discharge marking recorded on this special material.

#### H. THERMAL ENVIRONMENT

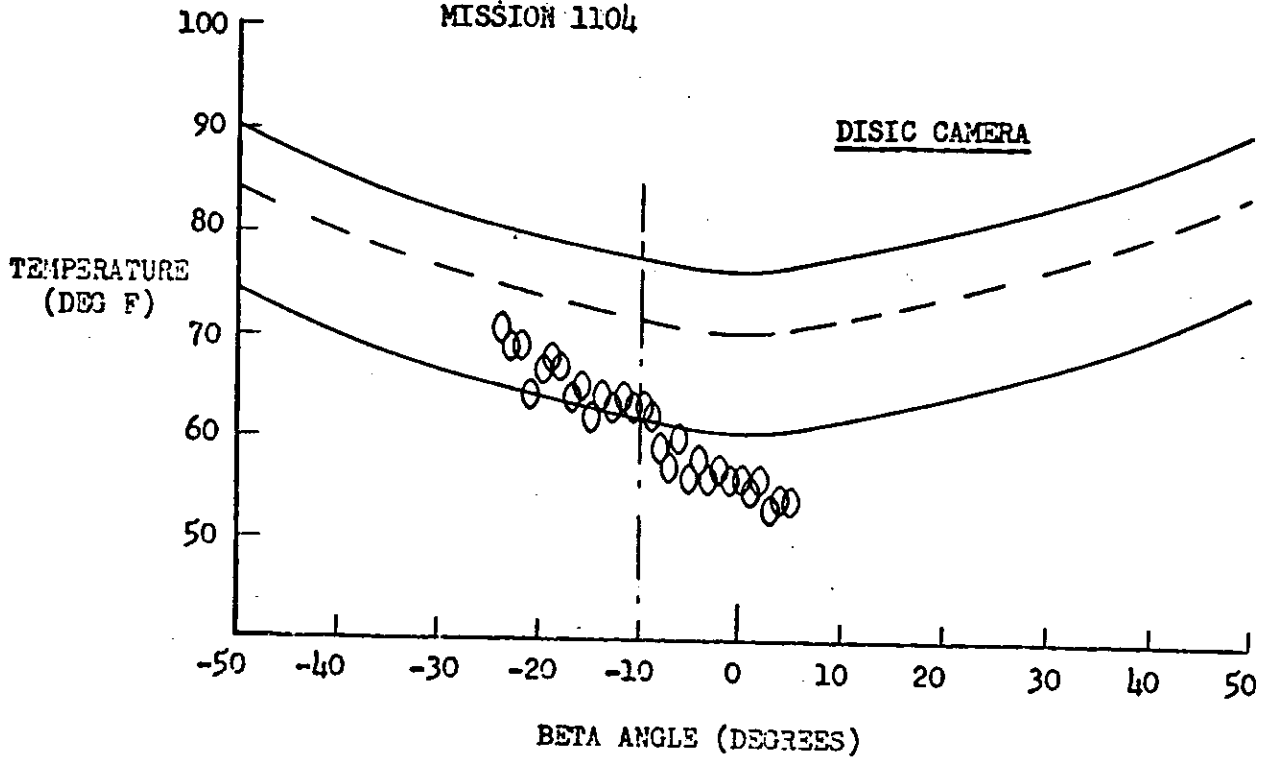
The camera system temperatures were within pre-flight predictions. DISIC temperatures fell slightly below predictions during the -2 mission. The No. 1 DISIC temperature sensor indicated 20-30 degrees higher than the No. 2 sensor. Because of the close physical proximity of the two sensors and vendor calibration data, it is believed the No. 1 sensor was damaged during installation and/or testing. Temperature versus Beta Angle shift is graphically presented in Figures 3-10 to 3-12.

Thermal data obtained from the Agena tape recorder were analyzed to provide an estimate of Panoramic camera rail temperatures during any camera operation. The temperature data presented in Figures 3-13 and 3-14 were obtained at five (5) minute intervals during selected revs and is plotted versus vehicle orbital position (quadrant-latitude). The rail temperatures for any camera operation can be interpolated from these figures.

The rail temperatures recorded during this flight were on the average slightly (2-5 degrees) higher than those observed during Mission 1103. The accuracy of any absolute temperature value is estimated at  $\pm 5^{\circ}\text{F}$ , and the accuracy of a temperature change on a sensor is estimated at  $\pm 1\frac{1}{2}^{\circ}\text{F}$ .

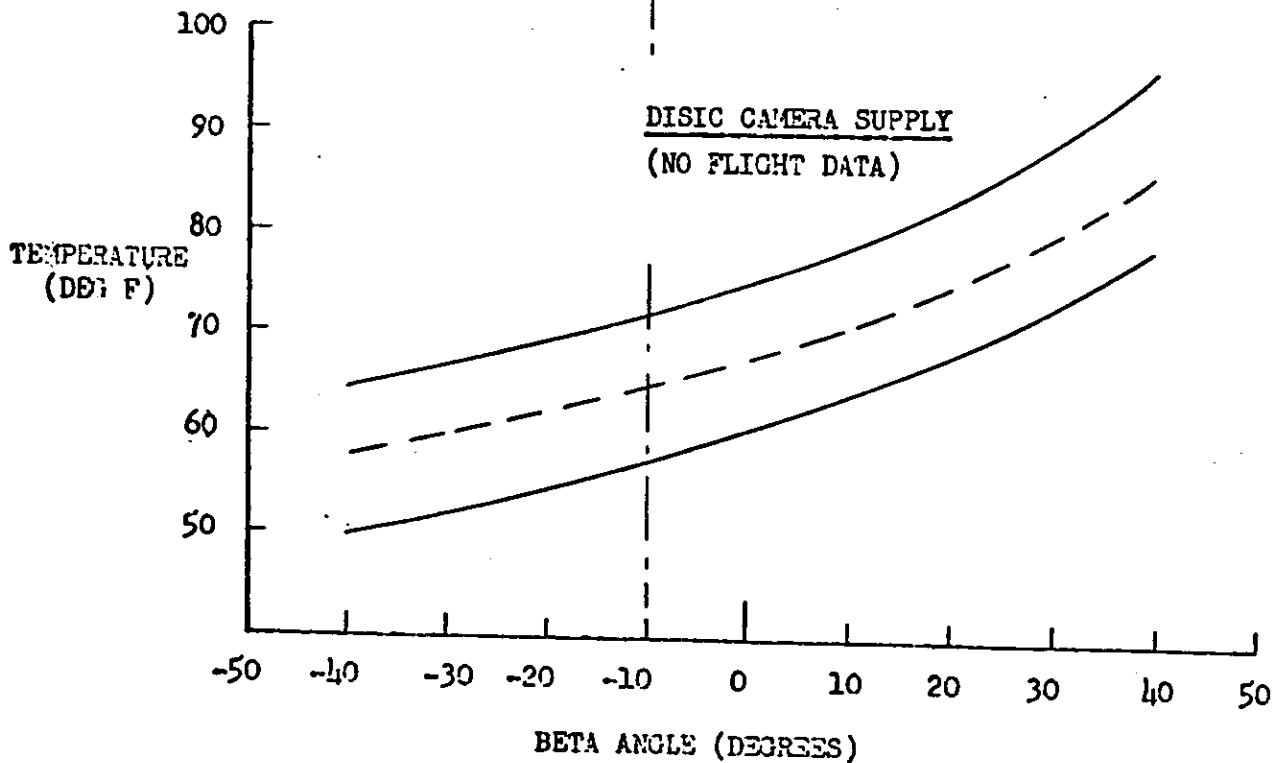
TEMPERATURE PERFORMANCE SUMMARY

MISSION 1104



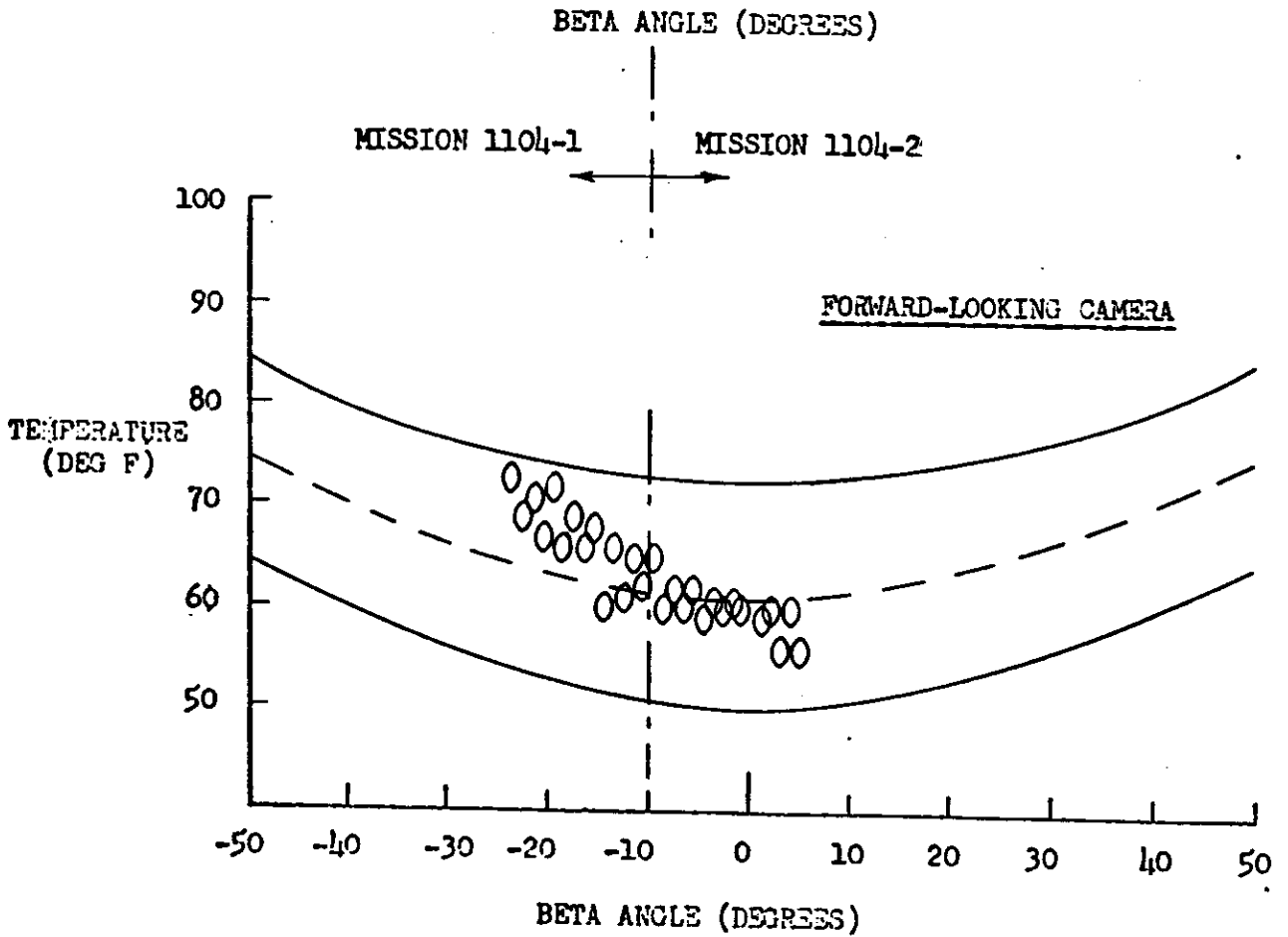
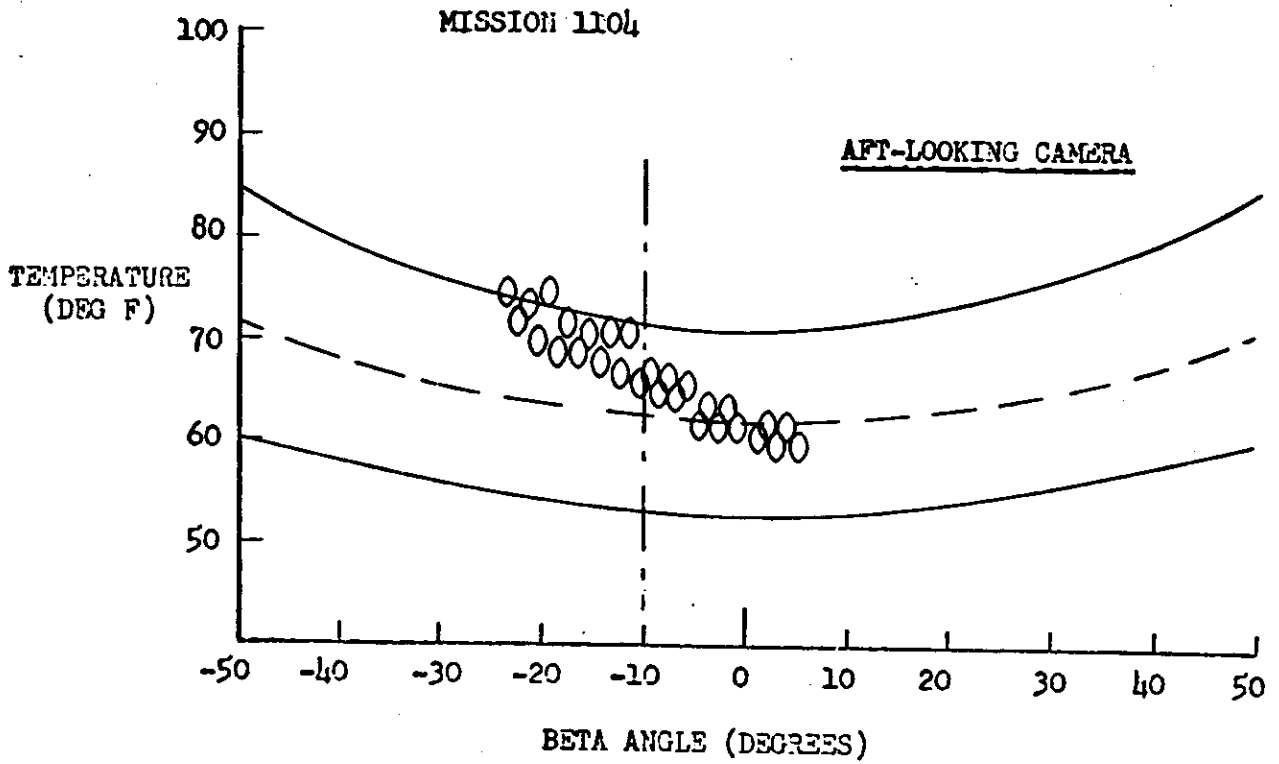
MISSION 1104-1

MISSION 1104-2

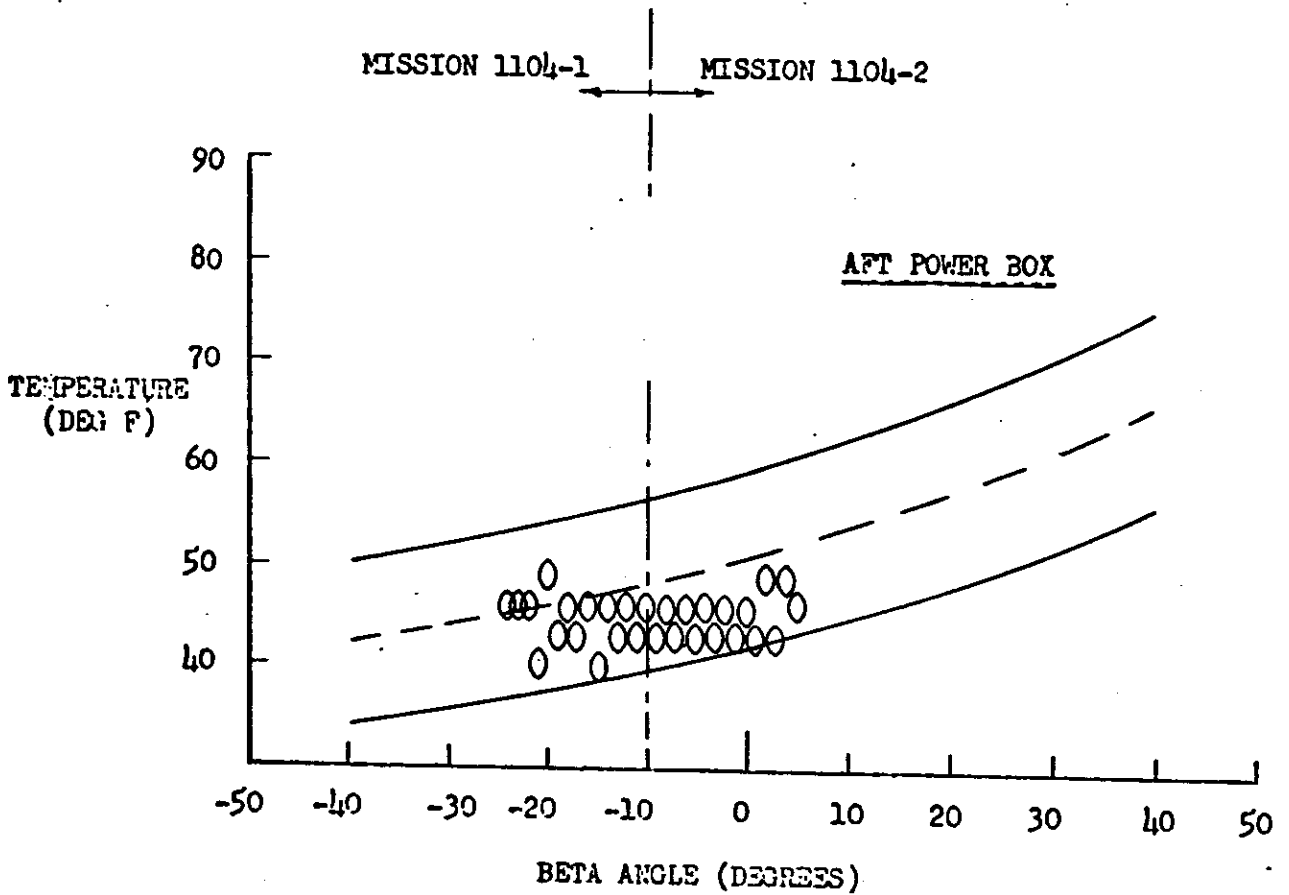
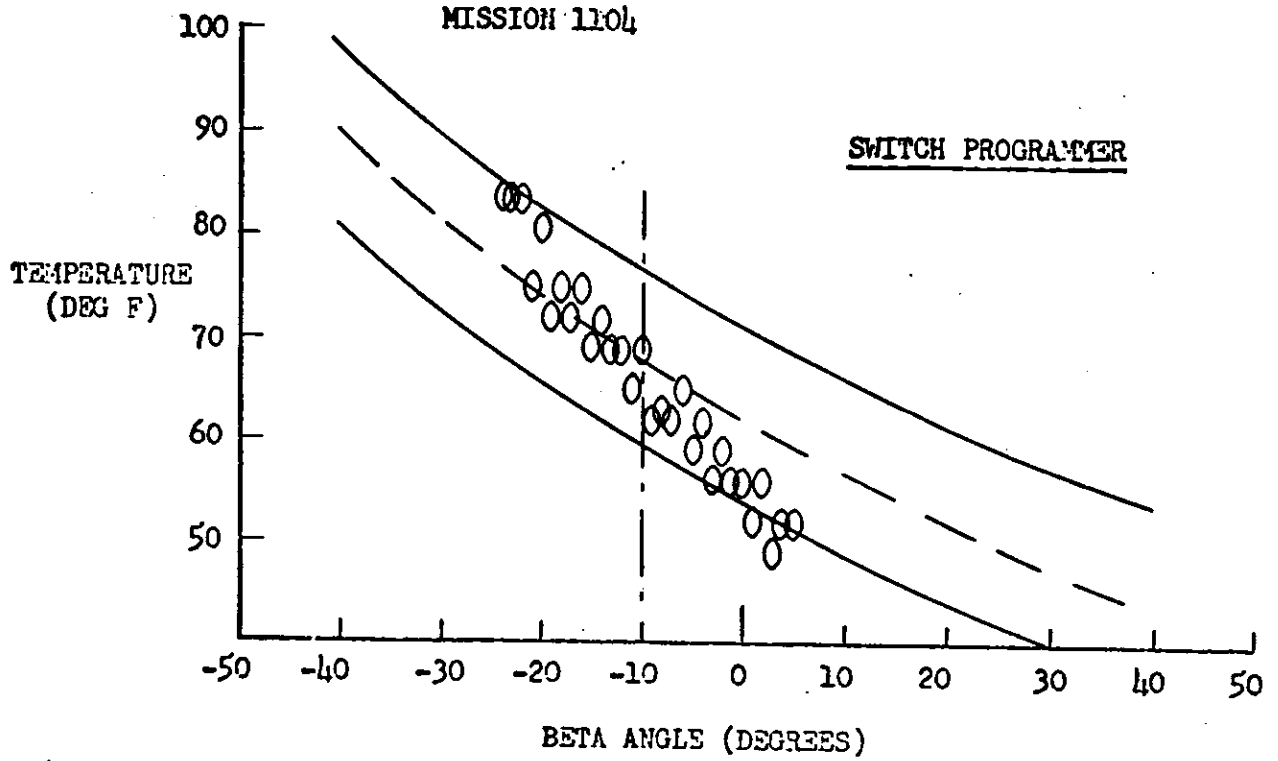




TEMPERATURE PERFORMANCE SUMMARY



TEMPERATURE PERFORMANCE SUMMARY



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FIGURE 3-12

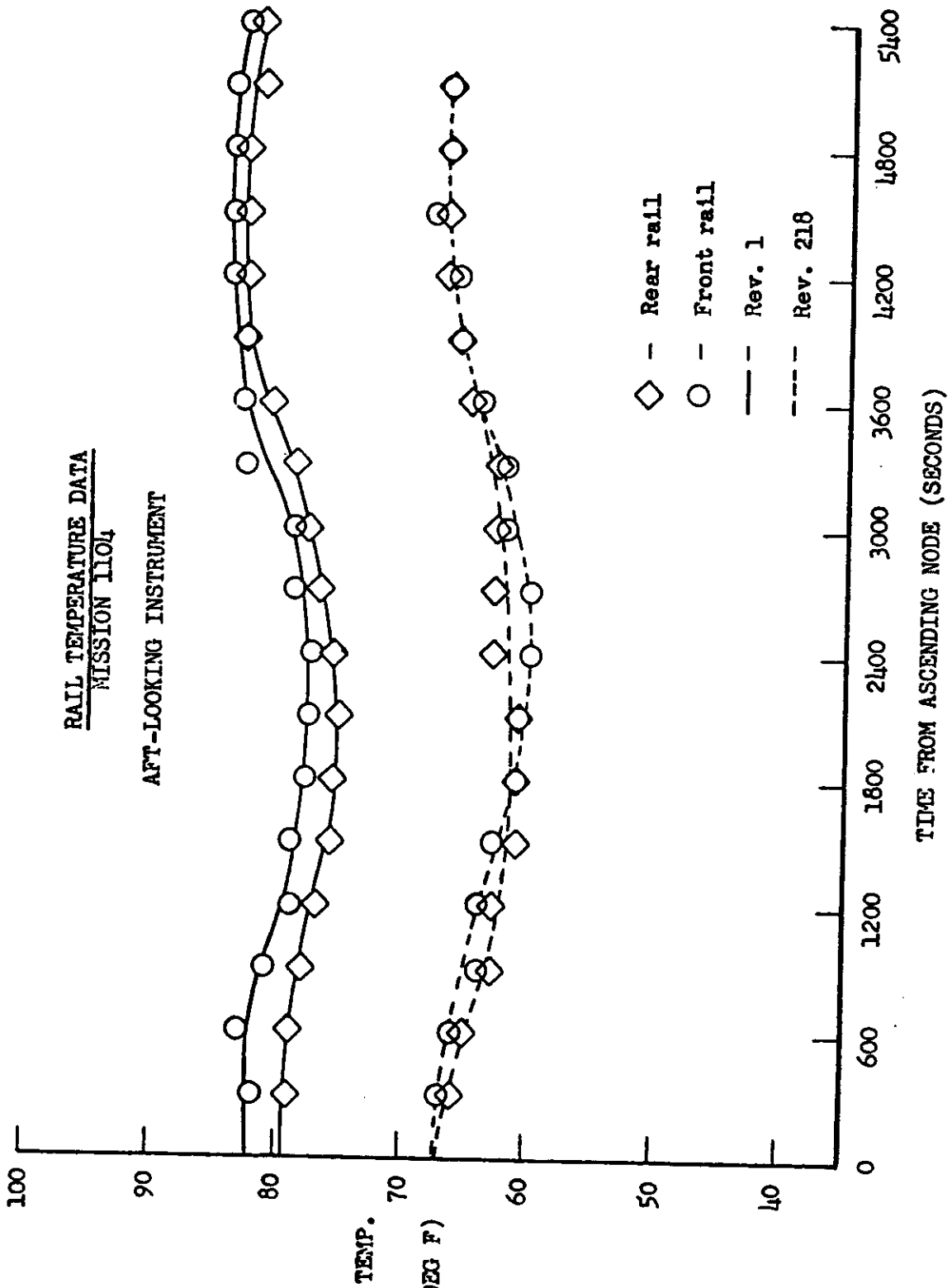


FIGURE 3-13

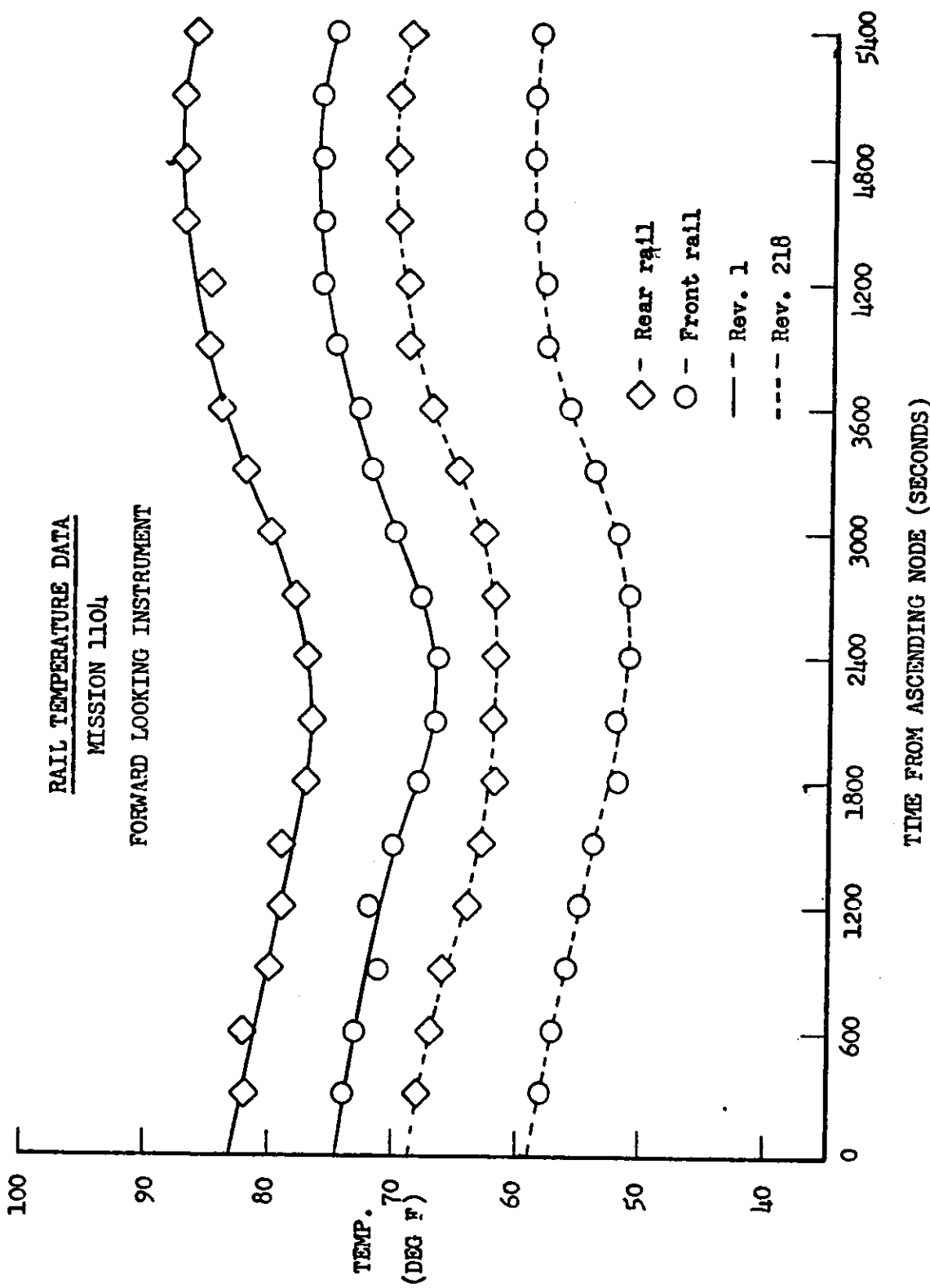


FIGURE 3-14

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I. RECOVERY SYSTEM PERFORMANCE

The re-entry capsules were recovered by air-catch during Revs. 115 and 244. Rev. 115 occurred on 14 August and Rev. 244 on 22 August 1968. All re-entry events occurred as programmed and within tolerance. A sequence of events and event times are presented in Table VII. Predicted versus actual impact points are as follows:

	<u>-1 Mission</u>		<u>-2 Mission</u>	
Predicted Impact	25° 32.7'N	162° 23.2'W	18° 28.1'N	156° 37.2'W
Actual Impact	25° 47'N	162° 28'W	18° 42'N	156° 27'W

J. SRV TAPE RECORDER PERFORMANCE

The -1 SRV Tape Recorder System functioned satisfactorily throughout the -1 mission.

The -2 SRV Tape Recorder System failed to record after the first two operations of the -2 mission. The recorded data indicated proper tape recorder operation with normal start-up and shutdown. Post recovery testing failed to indicate the cause of the in-flight failure. However, it appears the tape recorder itself did not fail, but the failure occurred in either the peripheral power or control systems. The prime failure mode is a defective three (3) amp fuse located in the operate circuitry within the transfer box.

K. POST MISSION TEST RESULTS

There was no requirement for a post-mission test plan. The "H" Timer tape depleted during Rev. 245. The vehicle re-entered during Rev. 312 on the 27th of August 1968.

L. RADIATION DOSAGE

Each recovery system flown on a Corona mission contains a sealed packet of Eastman Type 3401 and Royal X Pan emulsions to determine the total radiation

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received at the take-up cassette. Both film types have been irradiated by LMSC at various levels and the base plus fog densities recorded after controlled processing.

Following recovery the film dosimeter packets are removed at A/P and processed with a pre-flight sample of the same film type and sensitometric control film. The resulting base plus fog density measurement of the dosimeter strips is used to ascertain the total radiation level. The table below presents the base plus fog readings for the dosimeter strips and the radiation level equivalents.

<u>Emulsion</u>	<u>Mission 1104-1</u>		<u>Mission 1104-2</u>	
	<u>B + F Density</u>	<u>Radiation</u>	<u>B + F Density</u>	<u>Radiation</u>
Type 3401	0.16	0.4 R	0.19	0.6 R
Royal X Pan	0.23	0.4 R	0.26	0.5 R

These levels are below that which will degrade the photography.

M. YAW PROGRAMMER

The vehicle Yaw Programming functioned properly throughout the mission. However, there is an unresolved, minor disparity between the yaw angles achieved and those required. Efforts are continuing in an attempt to isolate the source of this error and to perfect the yaw programming performance in subsequent missions.



SECTION 4

PHOTOGRAPHIC PERFORMANCE

The photographic imagery obtained during Missions 1104-1 and 1104-2 was considered to be the best of any Corona system to date. The overall image quality was judged to be generally very good where not degraded by atmospheric attenuation; however, there was a predominance of cloud cover over the highest priority targets.

A. PANORAMIC INSTRUMENTS

The Forward-Looking camera produced 2946 frames (7942 feet) of photography during Mission 1104-1, and 2969 frames (7815 feet) during Mission 1104-2. The Aft-Looking camera produced 2984 frames (7968 feet) during Mission 1104-1, and 3063 frames (8062 feet) during Mission 1104-2. The Forward-Looking camera used, for the first time, a third generation lens, and resulted in slightly better image quality than that obtained by the Aft-Looking camera. The mission was given an MIP rating of 115.

Several fixed and mobile resolution targets were recorded throughout Missions 1104-1 and 1104-2. The best system resolution performance was judged to be five feet for the Forward-Looking camera and approximately six feet for the Aft.

A malfunction of the starboard horizon camera shutter on the Forward-Looking camera caused it to remain open during the film metering cycle on one occasion during Mission 1104-1 and once during 1104-2. The result was heavy fogging in two frames for each occurrence of the anomaly. This is the normal mode of failure for this device, i.e., to fail open for one horizon camera shutter cycle (equal to two main instrument cycles) and thence to

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close on the next H.O. shutter command. No further action was undertaken.

Fog patterns were present on the seventh from last frame of the Forward-Looking camera and on the sixth from last frame on the Aft-Looking camera for most operations throughout the 1104-1 mission, attributed to a light leak in the vicinity of the 1104-1 recovery system cover. The patterns varied in density from light to very heavy, commensurate with camera sit periods, and in some instances obscured imagery. This leak was observed in pre-flight live film testing, but subsequent attempts to identify the source were unsuccessful (ref. Section 2). A second light leak became noticeable intermittently during Mission 1104-2, apparently emanating from an access cover fitting in the center of the main barrel structure.

On the take-up end of the first frame on both cameras, a small (one inch square, maximum) start-up corona mark was occasionally detected. In all cases the marking was very minor with no loss of imagery. An entirely new pattern, which on the O.N. looks like pencil marks that on occasion separate or fork, was observed on Pass D169 starting with Frame 24 and stopping prior to the last two frames. The marking did not degrade imagery. Further investigation at A/P demonstrated this phenomenon to be a result of the "air twists" in the camera film path and is very sensitive to film tension and system pressure. The ultra thin base materials are much more susceptible to this marking behavior.

B. DISIC CAMERA

The DISIC film recovered from the 1104-1 mission consisted of 625 feet of stellar photography (2118 starboard frames and 2113 port), and 947 feet of terrain (2122 frames). The 1104-2 mission contained 691 feet of stellar film (2581 starboard frames and 2588 port), and 1035 feet of terrain (2465 frames).



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The stellar cameras functioned properly throughout the mission and recorded a full field of stars on both the port and starboard cameras. Most starboard frames have greater than 100 star images; most port frames contain more than 70 star images. Stars are recorded as point images. The terrain camera image quality is good and compares favorably with Mission 1103 terrain imagery.

In addition to common, minor anomalies such as skew-bead marks, dendritic edge static marks and dirt particles, there was a light leak apparently emanating from the "patio-pin" hole which created a fog pattern on the stellar record varying in density from light to very heavy, commensurate with camera sit periods. In some instances stellar imagery was obscured. A specific check-out of the "patio-pin" hole sealing has been added to written field test procedures to eliminate this source of degradation in future systems.

The terrain SLP data varied in density from normal to non-existent. Redundant data provided on the stellar record were machine readable throughout the mission. Since terrain data are redundant to stellar data, no stellar-terrain set is missing time data. This behavior resulted from intermittent and improper seating of the SLP head during exposure, most likely caused by a variation in SLP cable position. Improved SLP cable tie-downs and field check procedures are being investigated. The DISIC SLP data recording functioned properly throughout pre-flight testing.

C. ENGINEERING OBSERVATIONS

1. Bicolor: Mission 1104 acquired a very limited amount of bicolor photography (4 domestic passes, 1 denied area pass). The photointerpreters reported that, "the aft camera imagery, exposed through the SF-05 filter is poor". The image quality is poor because of the use of a poor quality filter and is not inherent in the bicolor process. Bicolor (SF-05)

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photography has been acquired on Missions 1102, 1103 and 1104. Mission 1102, employing a high quality filter produced imagery which has been comparable with normal J-1 performance. With good SF-05 filters, this is the kind of performance that can be expected from the bicolor mode. The following points should be made relative to the SF-05 filter used on Mission 1104.

- (a) This filter was flown because it was the only SF-05 available at the time. It was determined just prior to launch that the filter was poor. For this reason, only minimal bicolor was recommended, particularly over denied areas; only one operational bicolor pass (Rev. 7) was taken.
- (b) Pre-flight tests had indicated that the SF-05 had a loss in resolution of approximately 30 percent as compared to previously used filters. This was the major problem with the filter on 1104.
- (c) The spectral band pass of this filter was not as it should have been. In particular, the long wavelength cut-off was 590 millimicrons instead of 610 millimicrons. This has three effects. First, it caused the filter factor to be increased from 2.8 to 3.0. This itself is not a significant problem. Secondly, it caused a reduction in contrast by eliminating the 590-610 millimicron region. This also is only a minor contributor to quality degradation. Thirdly, and more important, the shift in the filter's band pass toward the shorter wavelengths caused an additional loss in resolution due to poorer lens performance in that spectral region.

Action has been taken to procure additional SF-05 filters. These filters will be extensively tested for optical quality and spectral

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transmission prior to inclusion in the system. In the future, only high quality SF-05 filters will be employed.

2. SO-180 Engineering Test: This mission contained 800 feet of type SO-180, Ektachrome infrared aero color film, on the end of the forward camera. This test was run as part of the J-3 system capability studies and had the prime purpose of investigating the capability of the Corona system to handle type SO-180 film. Portions of the SO-180 film exhibited excellent exposure, color balance and resolution compatible with the maximum that could be achieved with this film/camera combination. (The limiting performance factor was the recognized lower resolution capability of type SO-180 film compared to 3404.) When the weather conditions were favorable, and there were no degrading effects (i.e., static marking). It was estimated that the ground resolved distance of film type SO-180 was approximately 25 feet. It has been reported previously that significant portions of the test were degraded by electrostatic discharge which recorded as a red image on film type SO-180. There was a second anomaly that caused a heavy bluish/green cast on film type SO-180 over the entire format on the first few frames of each operation. The corona discharge degradations can be attributed directly to the failure of the pressure make-up unit (PMU) (ref. Section 3).

(a) Static Marking: Some of the imagery contains corona and electrostatic fog which appears red on film type SO-180. This condition varies from no marking to extremely severe marking. This condition occurs on those operations when the PMU provided system pressures other than the desired  $10$  to  $20 \times 10^{-3}$  Torr range.

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