88 Pages

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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1105-1 AND 1105-2

FTV 1646, CR-5

Approved: [redacted]ger
Advanced Projects

Approved: [redacted] Manager
Program [redacted]

17 June 1969

TO: [redacted]

THRU:

FROM:

SUBJECT: MISSION 1105 FINAL REPORT (CR-5)

Enclosed is the Final Evaluation Report for Mission 1105.

[redacted] Manager
Advanced Projects

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1646.

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

This document constitutes the final payload test and performance evaluation report for Mission 1105 which was launched on 3 November 1968.

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INTRODUCTION

This report presents the final performance evaluation of Corona Mission 1105. The purpose of this report is to define the performance characteristics of the CR-5 payload system and to evaluate the technical aspects of the Mission, including analysis of in-flight anomalies.

The payload system was assembled, tested, and certified for flight at the Advanced Projects (A/P) facility of Lockheed Missiles and Space Company (LMSC). A/P also provided services including pre-flight mission parameter planning, preparation of the flight program, in-flight operations support and data analysis, and mission reporting to the community. The initial evaluation of the recovered film was made by NPIC personnel at the processing facility. The Performance Evaluation Team (PET) meeting at NPIC included representatives of LMSC, ITEK Corporation, Eastman Kodak Company, and cognizant government organizations. Off-line evaluation was performed at facilities of individual contractors, using engineering photography acquired over the United States.

The quantitative data summarized in this report is originated by governmental and contractor organizations. Diffuse Terrain Density measurements are produced by the Air Force Special Projects Production Facility. The Processing Summary report and Target Density measurements are provided by [redacted]

These quantitative data are used by A/P computer programs to provide processed information allowing correlation of operational photographic conditions with image quality. Analyses are made of image smear components, limiting ground resolution, and exposure/processing data.

SECTION 1

MISSION SUMMARY

A. MISSION DESCRIPTION

Corona Satellite Mission 1105 was planned to acquire cartographic and reconnaissance photography of selected terrain areas. Two mission segments were planned to total eighteen days of orbital operation. Each mission segment would return approximately 9000 panoramic frames and each frame would nominally cover 1160 square miles.

The flight configuration included a THORAD booster and AGENA satellite vehicle. The on-orbit support provided by the AGENA includes real time command and telemetry links, electrical power, stored payload program timer, and attitude stabilization and control.

The payload was a J-3 configuration, consisting of a space structure containing two panoramic cameras and associated control/support equipment and recovery subsystems for each mission segment. The DISIC Stellar-Terrain camera, normally flown as part of the J-3 configuration, was omitted from Mission 1105.

The flight system was launched into the planned orbit from Vandenberg AFB at 21:31 GMT on 3 November 1968.

The panoramic cameras operated throughout both mission segments. Both cameras demonstrated acceptable operation during Missions 1105-1 and -2 until film depletion. At film depletion film wrap-up occurred in the film transport systems of both cameras. The aft camera stalled. The forward camera continued to rotate. The stalled aft camera caused an unusually high power drain.

Mission 1105-1 was successfully completed, after eight days of flight, with an air-catch of the recovery capsule. The second mission segment was similarly terminated after ten days of orbital flight.

Photographic performance of the panoramic cameras varied from poor to good. The best image quality of Mission 1105 is equivalent to the best imagery of Mission 1102.

Mission 1105 was the first system to use SO-380 ultra thin base (UTB) material as the primary film load. The aft looking camera film supply was terminated with 500 feet of SO-121 color film.

B. FLIGHT CONFIGURATION

Mission No.	1105
Vehicle No.	1646
System No.	CR-5
Forward Looking Camera Serial No.	311
Aft Looking Camera Serial No.	310
DISIC Camera Serial No.	Not Applicable
Lens Data	
Forward Looking Camera (Main Lens)	
Lens Serial No.	I 207
Measured Slit Width (Inches)	
Position 1	0.180
Position 2	0.229
Position 3	0.310
Position 4	0.337
Failsafe	0.314
Optics Filter Type	
Primary	W-25
Alternate	W-23A
E.O. Focal Length (Inches)(Vacuum)	24.002

Resolution	
Static (Lines/Millimeter)	
Filter	W-25
High Contrast	293
Low Contrast	182
Dynamic (Lines/Millimeter)	
ITEK Post-Vibration	
Filter	W-25
High Contrast	255
Low Contrast	173
A/P Test	
Filter	W-25
High Contrast	279
Low Contrast	187
Distortion/Pincushion (MM)	
Angle Off Axis (Deg.)	
3	0.004
2	0.001
1	0.000
0	0.000
359	0.000
358	0.001
357	0.002
Aft Looking Camera (Main Lens)	
Lens Serial No.	I-168
Optics Slit Width (Inches)	
Position 1	0.138
Position 2	0.149
Position 3	0.192
Position 4	0.271
Failsafe	0.198

Optics Filter Type	
Primary	W-21
Alternate	W/2E+CC2C+0.4 N.D.
E.O. Focal Length (Inches)(Vacuum)	24.002
Resolution (Lines/MM)	
Static	
Filter	W-21
High Contrast	257
Low Contrast	150
Dynamic (Lines/MM)	
ITEK Post-Vibration	
Filter	W-21
High Contrast	219
Low Contrast	132
A/P Test	
Filter	W-21
High Contrast	265
Low Contrast	158
Distortion/Pincushion (MM)	
Angle Off Axis (Deg.)	
3	0.003
2	0.001
1	0.000
0	0.000
359	0.000
358	0.002
357	0.004

Horizon Optics

Forward Looking Camera

Take-up (Starboard)

Lens Serial No.	E23795						
Exposure Time (Sec.)	1/100						
Aperture	F/8.0						
Filter Type	W-23 (Auxiliary-None)						
Oper. Focal Lenghth (MM)	55						
Radial Distortion (MM)							
10 Deg. Off Axis	0.005						
20 Deg. Off Axis	0.04						
Tangential Distortion	0.03						
Resolution (Lines/MM)							
Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	209	208	184	181	156	119	23
(Tangential)	187	161	144	138	116	96	62

Supply (Port)

Lens Serial No.	E23777						
Exposure Time (Sec.)	1/100						
Aperture	F/6.3						
Filter Type	W-25 (Auxiliary-None)						
Oper. Focal Length (MM)	55						
Radial Distortion (MM)							
10 Deg. Off Axis	0.01						
20 Deg. Off Axis	0.05						
Tangential Distortion	0.02						
Resolution (Lines/MM)							
Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	166	165	145	127	124	119	32
(Tangential)	166	164	144	123	116	86	49

Aft Looking Camera

Take-up (Port)

Lens Serial No.	E23809
Exposure Time (Sec.)	1/100
Aperture	F/6.3
Filter Type	W-25 (Auxiliary-None)
Oper. Focal Length (MM)	55
Radial Distortion (MM)	
10 Deg. Off Axis	0.01
20 Deg. Off Axis	0.03
Tangential Distortion	0.025
Resolution (Lines/MM)	

Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	209	186	184	181	156	119	32
(Tangential)	209	185	181	155	130	109	62

Supply (Starboard)

Lens Serial No.	E23753
Exposure Time (Sec.)	1/100
Aperture	F/8.0
Filter Type	W-25 (Auxiliary-None)
Oper. Focal Length (MM)	55
Radial Distortion (MM)	
10 Deg. Off Axis	0.015
20 Deg. Off Axis	0.05
Tangential Distortion	0.024
Resolution (Lines/MM)	

Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	187	186	184	181	175	118	32
(Tangential)	187	185	161	123	116	96	62

DISIC Camera — Not Applicable

Film Types

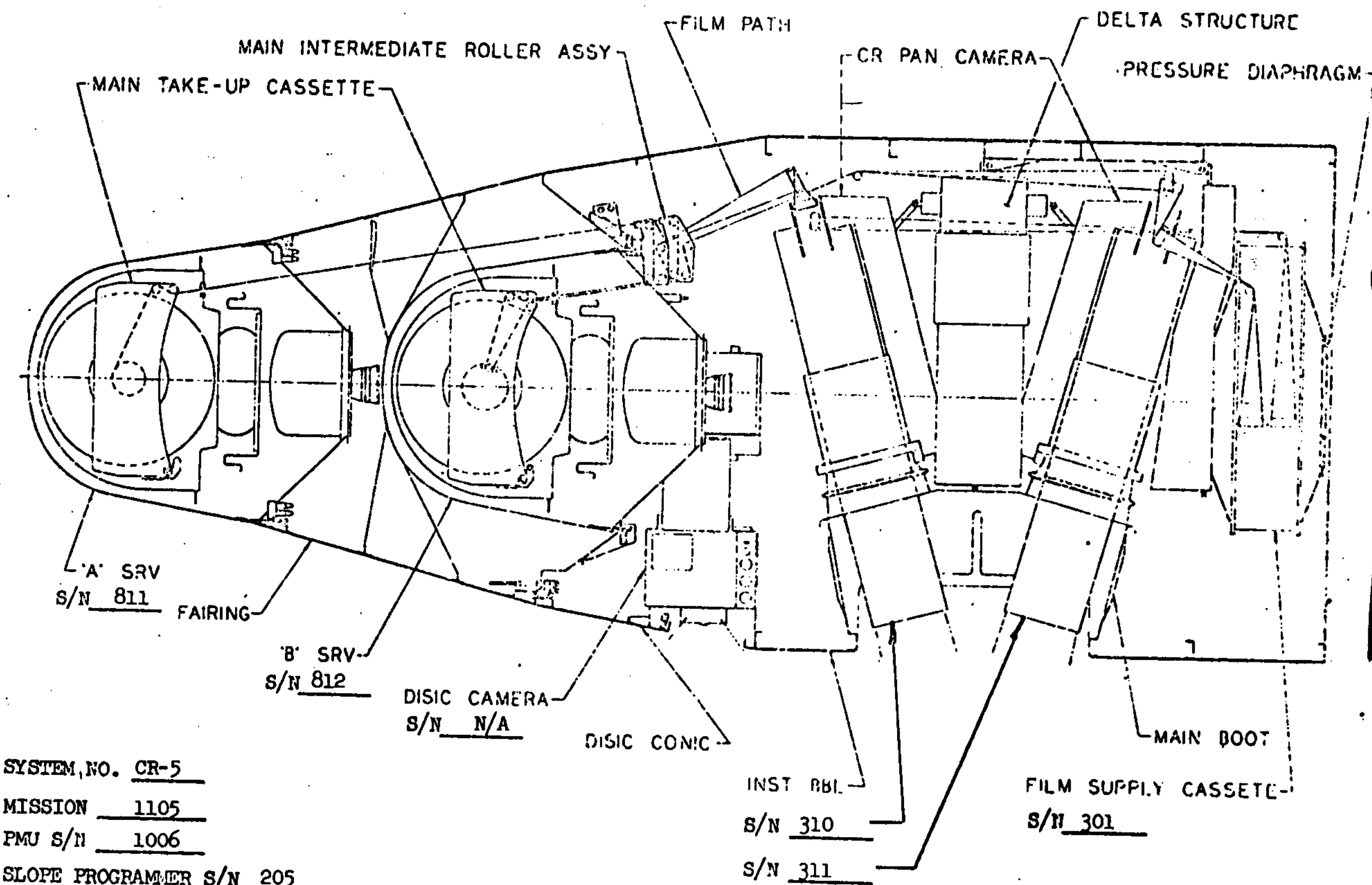
Forward Looking Camera

Split Load	No
Film Type	SO-380
Length (Ft.)	24,000
Splices	7
Length Between Splices (Ft.)	2890-3330-3591-1458-3339-2965-3347-3080C
Emulsion Data	157-5-10-6-10-8
Payload Weight (Lbs.)	86.1-78.6
Spool No.	188B
Box Serial No.	32

Aft Looking Camera

Split Load	Yes
Film Type	SO-380/3404/SO-121
Length (Ft.)	23,000/50/500
Splices	9
Length Between Splices (Ft.)	2235-3275-3870-3820-3285-3265-3250(50 FT 3404)-MCD-(500 FT SO-121)C
Emulsion Data	SO-380:157-10-10-8/3404:415-2-2 SO-121:44.1
Payload Weight (Lbs.)	86.6-79.1
Spool No.	151T
Box Serial No.	32

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM, NO. CR-5
MISSION 1105
PMU S/N 1006
SLOPE PROGRAMMER S/N 205
CLOCK S/N 601
SWITCH PROGRAMMER S/N 205

SECTION 2

PRE-FLIGHT SYSTEMS TEST

A. SUMMARY

As a standard procedure, the J payload systems are subjected to a series of tests with flight type film which demonstrate that the system will perform as required during flight. The principal tests include the following:

1. Exposure of the J payload to a thermal/altitude environment that approximates flight conditions.
2. A system light leak test that ascertains the light tight integrity of the J system.
3. A dynamic resolution test that determines the high and low contrast resolution characteristics of each panoramic camera.
4. A flight readiness test that assures that the payload is acceptable prior to loading with flight film.
5. A flight certification that establishes the flight worthiness of the complete payload including the flight film.

The CR-5 system successfully passed all phases of the testing operations providing acceptable performance and a high degree of operational confidence.

B. ENVIRONMENTAL TEST

The CR-5 system was subjected to environmental testing from 4 thru 13 June 1968 and again from 5 thru 14 September 1968.

The primary purpose of the first environmental test was to determine the corona marking characteristics of the panoramic cameras and operational performance of the system at altitude. The second test conducted in September 1968 was performed to determine the positional characteristics of the ultra thin base film plane during exposure at altitude and is termed the Aschenbrenner Grid test (AG test).

During the first test conducted in June 1968 the CR-5 flight system was subjected to internal system pressures at altitude that ranged between 1 and 64 microns by programmed on and off use of the Gas Pressure Make-up system. Three special pressure sweeps that occurred during the "B" SRV portion of the test extended the internal camera pressure range of the panoramic cameras during operation to approximately 160 microns.

The panoramic camera payload (film type SO-380 UTB) was processed to the intermediate level prior to analysis.

The CR-5 system operations during the first altitude test produced the following film consumption:

First Altitude Test-Film Consumption (Cycle Counter)

Operation	Panoramic Camera No.	
	#310	#311
A SRV Frames	4050	4017
B SRV Frames	4254	4352
Total Frames	8304	8269

Corona was produced on the second to last frame of several operations by panoramic camera #310 as revealed by plus density fog patterns in film type SO-380. The most probable cause of the start-up corona appears to be the frame metering roller. Start up corona occurred with the gas pressure make-up system (PMU) off at internal camera pressures ranging from 1.8 to 5 microns. Corona density was 0.06 above the base level. Start up corona was also observed on the last frame and the first two start-up frames of film type SO-121 (color). The corona fog evidenced in SO-121 film was produced at an internal camera pressure of approximately 2 microns. Corona fog in SO-121 film appeared blue/green. No corona occurred in either film type <u>during</u> camera operation. SO-121 color film was used in camera #310 only. The corona marking produced by camera #310 was very minor and within acceptable limits. No corona was produced by camera #311.

While the second altitude test was not conducted to test for corona some minor start-up corona fog was produced by panoramic camera #310 on film type SO-380. Film type SO-121 was not used in the second altitude test.

The start-up corona, in the second altitude test conducted in September 1968, was observed with PMU off at internal system pressures between 0.8 and 4.0 microns. The last and next to last frame of several operations were affected by minor start-up corona to a maximum density of 0.55 above the base level. Corona density exceeded the acceptance maximum of 0.4 above the base level. Since the corona was minimal and occurred on only one to two start-up frames of photography during some operations a waiver was recommended. No corona was produced by the panoramic cameras during operation of the gas pressure make-up

(PMU) system in either the first or second altitude tests. Internal camera pressure with the PMU system on is in the 50 to 60 micron range.

Second Altitude Test-Film Consumption (Cycle Counter)

Operation	Panoramic Camera #	
	#310	#311
A SRV Frames	4381	4382
B SRV Frames	4356	4344
Total Frames	8737	8726

Auxiliary data recording was acceptable. Visual analysis of film from panoramic cameras #310 and #311 revealed that imagery of the serial number, time track, H.O. fiducials, start of pass mark, PG traces, and rail holes were acceptable. Microdensitometer measurements revealed that imagery of the time word from both main cameras was acceptable.

A plus density wavy mark was present intermittently throughout the film during "A" and "B" SRV operations. The mark was approximately 1/8 inch wide with a density of +0.01 to 0.015 above the base plus fog level. No physical damage is associated with the mark. The mark has been observed at ambient pressure as well as at altitude. Marking is characteristic of SO-380 UTB film in the panoramic film transport system. The density of the marking is very low and is not expected to interfer with the interpretation of flight imagery.

Rail scratches were light. Investigation revealed that light and intermittent rail scratches have been a characteristic of the CR-5 system with UTB film at ITEK Corporation and Advanced Projects.

Operations for the most part proceeded according to plan. Cycle rates were computed. The average cycle rate error during the first altitude test was approximately 0.4% throughout the "A" mission. During the "B" mission the cycle rate error remained at approximately 0.4% except for Revs 20 and 23. The error during these revs exceeded the specification limit of 1%. This anomaly was attributed to the high temperature range of the Slope Programmer which was found to be 95° to $100^{\circ}F$ during Revs 20 and 23. Examination revealed that the Slope Programmer performance was acceptable. During the second test cycle rates were checked and were found to be well within limitations.

The clock system accuracy was computed to determine clock performance. As a result the accuracy of the clock over an eight day period was found to be within specification.

The footage potentiometers in both panoramic cameras indicated approximately 60 cycles less film consumption than the actual count. The footage potentiometers were subsequently recalibrated to bring their indicated film consumption to within the specified 50 cycle maximum deviation from the cycle counters for each panoramic camera.

The exposure control system and FMC system for both panoramic cameras were acceptable throughout environmental testing.

Exposure of the CR-5 system to the altitude environment for the second time was required in order to conduct the Aschenbrenner Grid test (AG test). The AG test was devised to determine the position of the UTB film plane during panoramic exposure at various points in the format. From the data generated, ITEK Corporation determined the suitability of the focus setting of each panoramic camera.

The following AG test data represents the performance estimate in lines/mm expected from panoramic cameras #310 and #311. The results are based on the reduction of frame 10 of operation #6 and are considered acceptable and representative of the overall performance.

AG Test Data Frame #10, Operation #6

Flatness Variation (Inches)	Per cent Format Included	Estimated Performance Range (li/mm)
Pan Camera #310 (Type II Petzval)		
±0.0005	52	130-145
±0.0007	75	127-140
±0.0010	86	125-135
Pan Camera #311 (Type III Petzval)		
±0.0005	77	150-185
±0.0007	90	145-185
±0.0010	99	135-180

From the above data plus similar AG test data for many other operations conducted during CR-5 system exposure to the thermal/altitude environment, ITEK Corporation recommended that CR-5 system be used for flight as focused.

C. LIGHT LEAK TEST

The CR-5 system was tested for light leaks on 29 July 1968. Panoramic instruments #310 and #311 were threaded with film type 3401 per the standard operating procedure. The CR-5 system was placed in flight configuration and exposed to external illumination for 90 minutes per side. At the conclusion of the test the payload was retrieved, processed to the full level, and evaluated.

Heavy fog was present on instrument #310 film to a density of 2.1. Instrument #311 film was fogged to a density of 0.4. Fog marks were located in the vicinity of the forebody/fairing interface. The unacceptable light leak was traced to the pin puller teardrop fitting on the minus "Z" axis. The light leak was corrected by the addition of a rubber light shield under the teardrop fitting at the forebody/fairing interface. Subsequent light leak testing verified that the light leak had been eliminated.

D. RESOLUTION TEST

The CR-5 system was subjected to a thru focus dynamic resolution test on 24 June 1968 using film type SO-380 (UTB). The results from this test revealed that the peak focus of both panoramic cameras occurred at +0.0015 inches from collimator zero at Advanced Projects. The cause of the change in peak focus from collimator zero was unknown. The scan head and field flattener assemblies of panoramic cameras #310 and #311 were moved away from the lens by addition of a 0.0015 inch shim to shift the peak focus of each camera to approximately the 0.000 collimator position.

A post shim resolution test performed on 27 June 1968 produced peak focus results as follows:

<u>Pan Camera #310</u>

Maximum high contrast resolution lines/mm 220 at 0.000 focal position.

Maximum low contrast resolution lines/mm 128 at 0.000 focal position.

<u>Pan Camera #311</u>

Maximum high contrast resolution lines/mm 242 at -0.001 focal position.

Maximum low contrast resolution lines/mm 185 at -0.001.

Further investigation by Boston revealed that an additional +0.0005 inch shim was desirable for panoramic camera #310.

Prior to the final resolution test pan camera #310 was shimmed +0.0005 inches. Final resolution results produced on 5 October 1968 are shown as follows:

Pan Camera #310

Maximum high contrast resolution lines/mm 265 at 0.000 focal position.

Maximum low contrast resolution lines/mm 158 at 0.000 focal position.

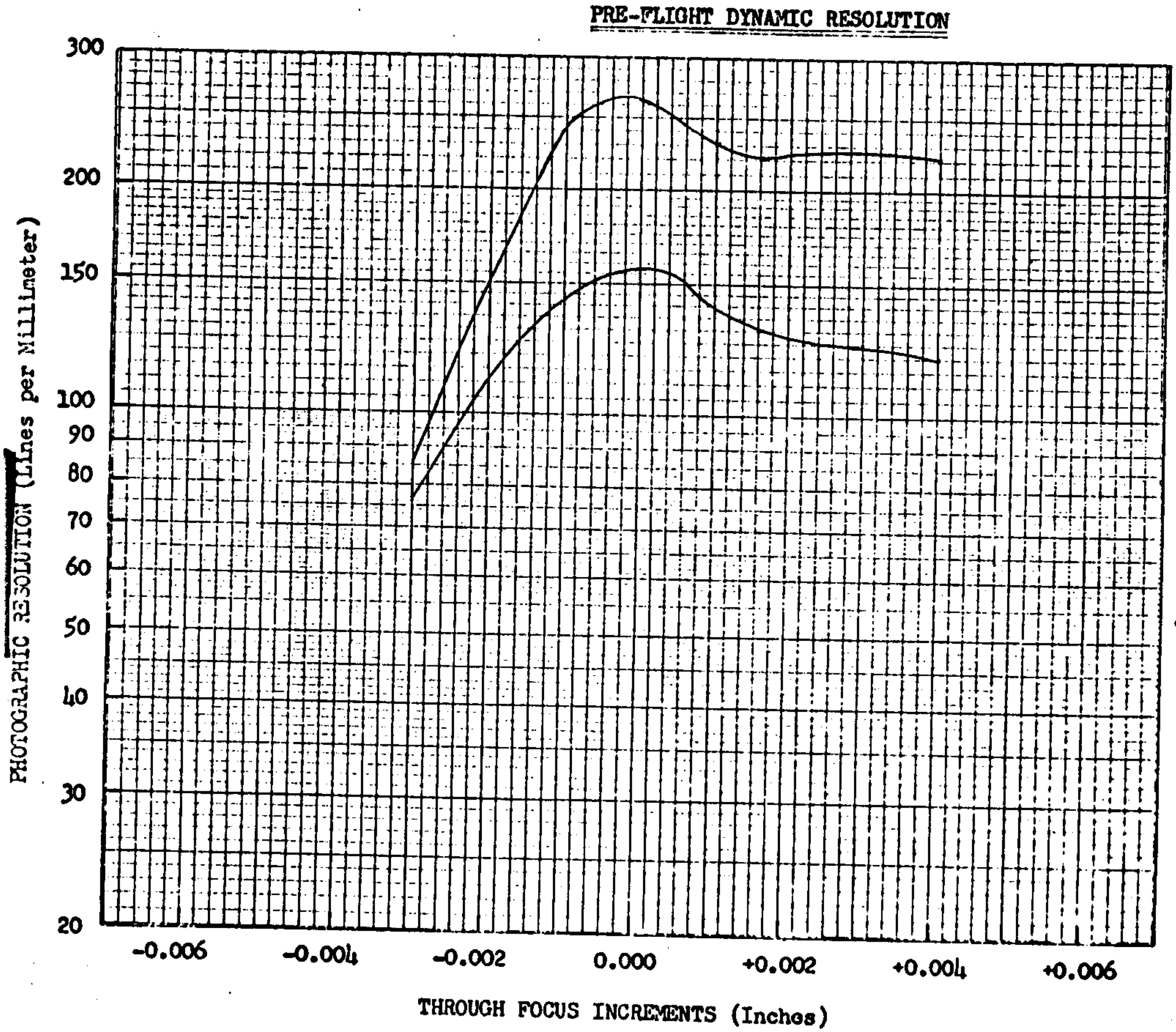
Pan Camera #311

Maximum high contrast resolution lines/mm 279 at 0.000 focal position.

Maximum low contrast resulution lines/mm 187 at -0.000 focal position.

The final through focus resolution test is graphically shown in Figures 2-1 and 2-2 for panoramic cameras #310 and #311 respectively. The CR-5 system met the specified resolution requirements and was considered acceptable without further resolution testing.

[redacted]



Camera No: 310

Payload No: CR-5

Resolution (1/mm)

High Contrast: 265

Low Contrast: 158

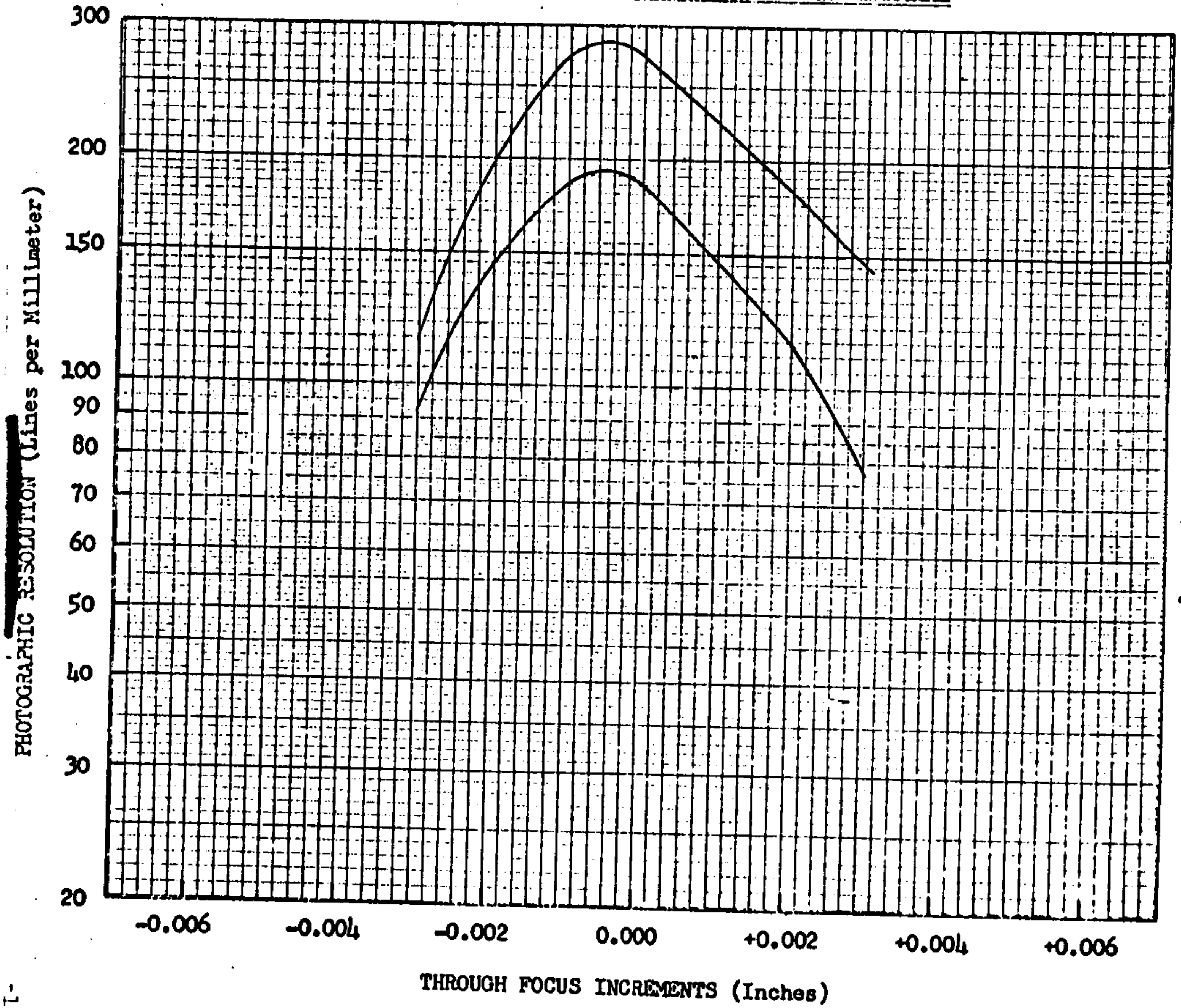
Film Type: SO-380 UTB

Test Date: 5 October 1968

FIGURE 2-1

[redacted]

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 311

Payload No: CR-5

Resolution (1/mm)

High Contrast: 279

Low Contrast: 187

Film Type: SO-380 UTB

Test Date: 5 October 1968

FIGURE 2-2

E. FLIGHT READINESS TEST

The first CR-5 Flight Readiness test was conducted on 16 October 1968. This test revealed the presence of heavy scratches in the active format area of the SO-380 payload of instrument #310. The scratches were traced to interference of the input A.O. clamp with the film during film meter. Further investigation revealed that the mechanical timing sequence of Instrument #310 was out of adjustment. As a result, the star wheel assembly of Instrument #310 was replaced. In addition, the first Readiness test revealed anomalies in the processed test film as follows.

Instrument #310

1. The start of pass lamp was out. This was corrected prior to the second Readiness test.
2. The instrument serial No. was faint but present on alternate formats.
3. The last frame of several instrument shutdowns contained an incorrect time word. Since this anomaly occurred for the creep frame which has little photographic value in flight, a waiver was recommended.
4. The #3 and #3A fiducials were partially blocked on the input and output auxiliary optics (A.O.). The fiducials were cleaned prior to the second Readiness test.

Instrument #311

1. Anomalies present in Instrument #311 were minimal and were the same as items 3 and 4 shown for Instrument #310.

A second Readiness test conducted on 20 October 1968 demonstrated acceptable Instrument #310 and #311 performance as revealed by the processed test film exhibits.

While the #3 and #3A A.O. fiducial images are somewhat weak on Instrument #310, the fiducials are present. The presence of acceptable A.O. fiducials in the #1, 2, and 4 positions is adequate to meet program objectives.

It was recommended that CR-5 system be accepted without further readiness testing.

The CR-5 cam/slit sequence and slit width values were verified as part of the first Readiness test. Evaluation of the processed SO-380 film revealed that the exposure cams do provide specified exposure slit widths in the correct sequence.

Measurements of processed slit images revealed the following slit values:

Slit No.	Command Position	SLIT WIDTH (INCHES) Camera 310 AFT	Camera 311 FWD
1	2	0.138	0.180
2	3	0.149	0.229
3	4	0.192	0.310
4	5	0.271	0.337
Failsafe	11	0.198	0.314

F. FLIGHT CERTIFICATION

Flight film loading of the CR-5 Panoramic Cameras occurred without incident of 21 October 1968. Sensitometric examination of samples of the flight film verified satisfactory photographic characteristics.

The confidence run, to certify the CR-5 system for flight, was conducted on 23 October 1968. Rail scratches were continuous but very light on the emulsion side of both panoramic payloads. Minor acceptable brush marks were present of the backing side of the film installed in Instrument #310.

The CR-5 system was checked for light leaks following the last camera operation of the confidence run. The space structure proved to be light tight as indicated by the photomultipliers employed in the light leak test. One minor light leak was detected in the camera drum area of Instrument #310. Corrective action was not considered feasible and no further testing was recommended.

The CR-5 system was accepted for flight on 24 October 1968.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Mission 1105 was launched normally into the planned orbit without incident. All ascent and injection events occurred as programmed. The orbit achieved was within the 3 sigma predicted dispersions. The total mission lasted for 18 days with an 8-day first segment and a 10-day second segment.

The panoramic cameras operaated satisfactorily throughout the flight. Both panoramic cameras experienced in-flight failure at film depletion at the end of the mission. Photographic performance varied from poor to good. The variable photographic performance was partially attributed to the unstable physical characteristics of ultra thin base film at lower than normal system film tension. Lower than normal film tension, established to reduce tracking strain marks, may have contributed to the soft imagery observed along the center of the SO-121 color film flown in aft-looking panoramic camera #310.

Mission 1105 flew without the DISIC camera subsystem.

B. LAUNCH

The flight was launched at 21:31 GMT on 3 November 1968 from Satellite Launch complex 1 west at Vandenberg AFB. Ascent and injection were normal. Launch was within the specified 21:30 to 22:30 launch window. The window was selected to optimize northern latitude coverage throughout the flight. Door ejection, instrumentation switchover and panoramic camera transfer to orbit mode occurred as planned.

C. ORBIT

Mission 1105 was launched into the planned orbit. All orbit parameters attained were well within the specified tolerances.

Orbit conditions computed from Rev 2 data are shown in Table 3-1.

TABLE 3-1

Mission 1105 Orbit Parameters (Rev. 2)

Orbit Parameter	Predicted	Tolerance	Actual
Period (Min)	88.96	+.29, -.48	88.91
Perigee (NM)	80.7	+7, -6	83.2
Apogee (NM)	165.4	+13, -21	161.5
Eccentricity	0.0120	+.0023, -.0034	0.0111
Inclination (Deg)	83.01	+0.39, -0.16	83.14
Arg. of Perigee (Deg)	147	+41, -43	145

Drag make-up (DMU) rockets were employed throughout the flight to maintain orbit period. Five DMU rockets were utilized for period recovery during Mission 1105-1. However, Rocket No. 4 apparently blew out the side of the case providing approximately 25% of nominal thrust. All seven of the remaining rockets were necessary to maintain orbital period through Mission 1105-2. Figure 3-1 shows the orbit history maintained throughout the mission. A summary of the DMU firings is shown in Table 3-2. Figure 3-2 shows the frequency distribution of operations and mean frame altitude of Mission 1105.

1105/CR-5 ORBIT HISTORY

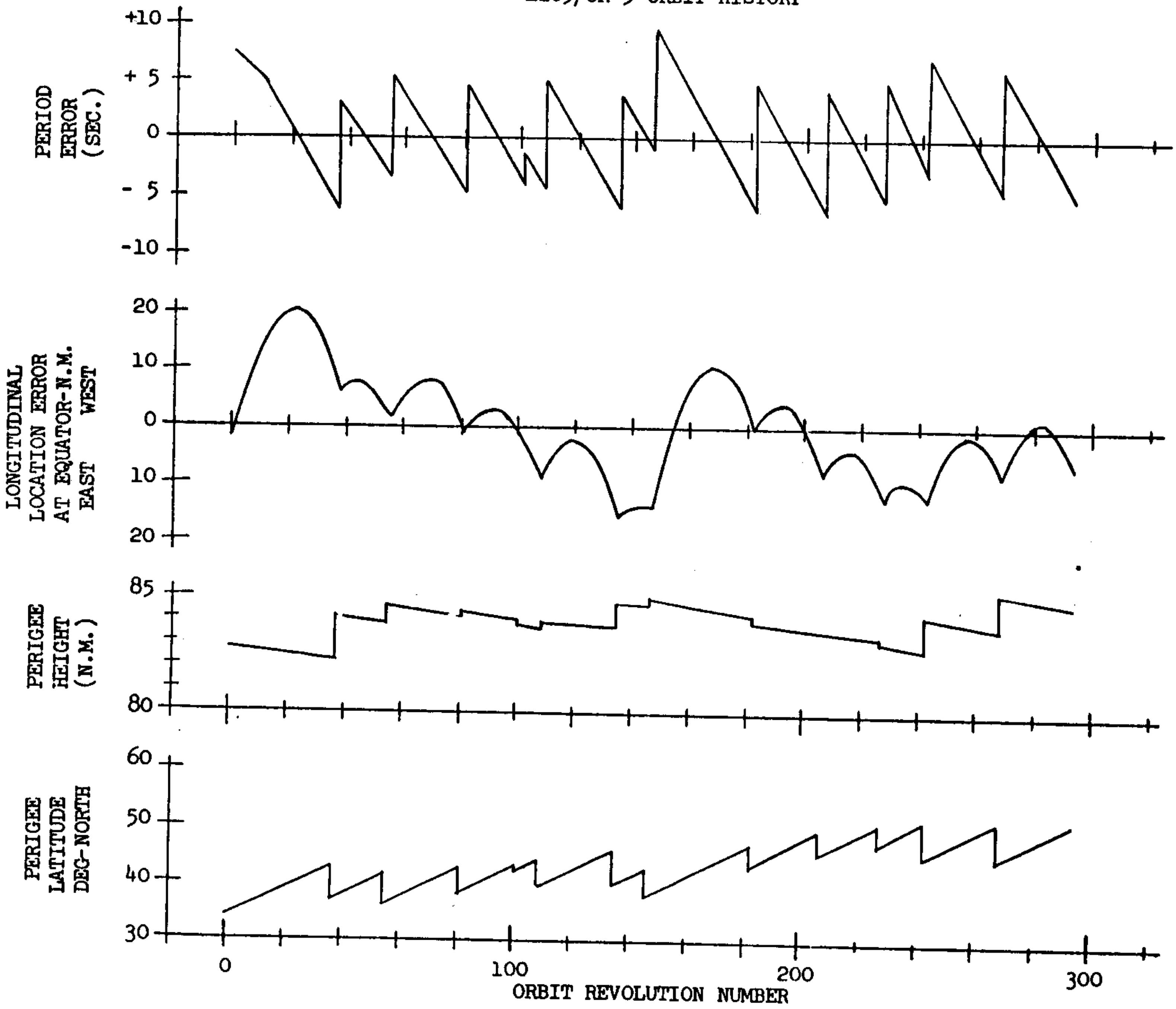


FIGURE 3-1

1105/CR-5 OPERATIONS

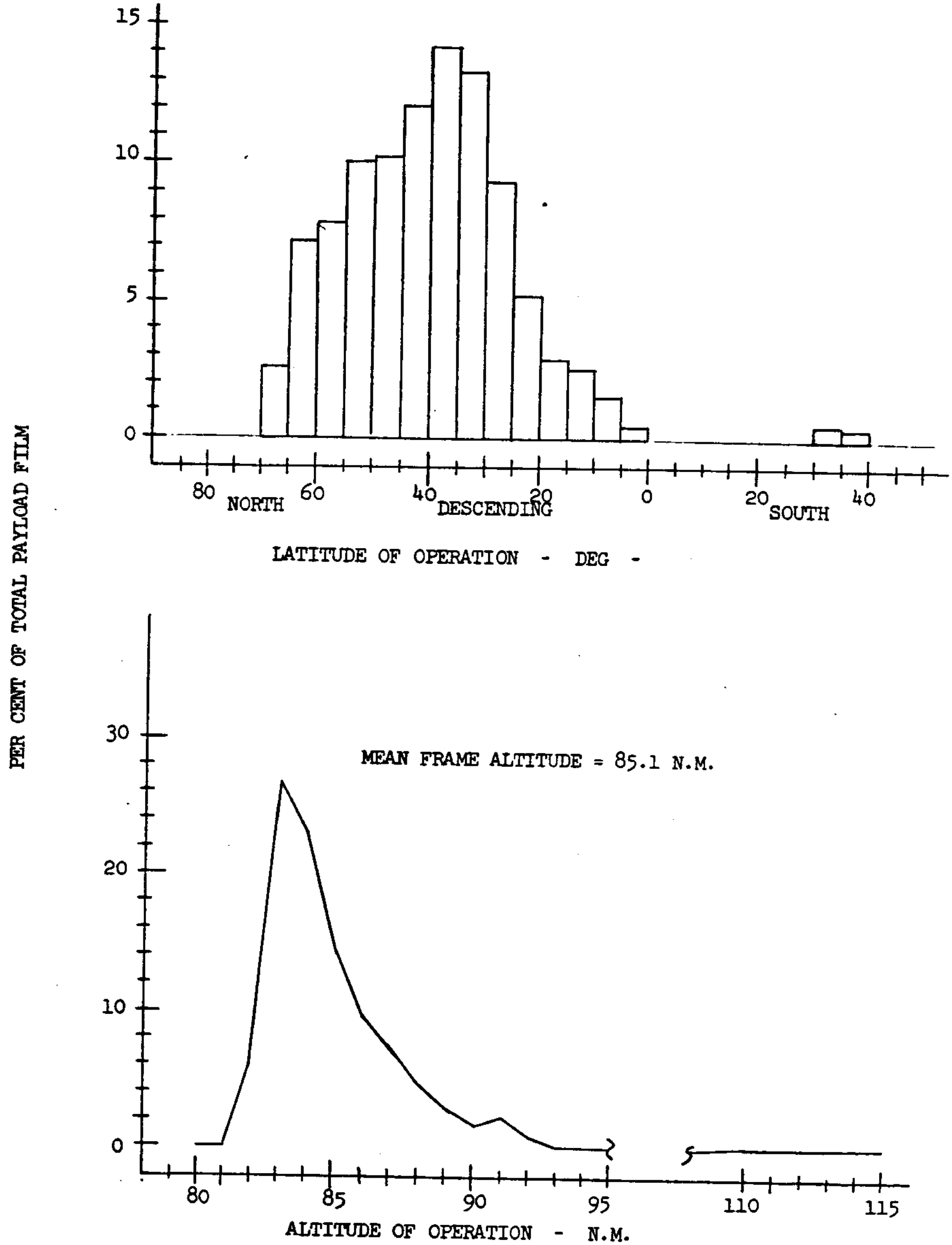


FIGURE 3-2

TABLE 3-2

Rocket Firings and Orbital Effects

Rocket No.	Pass Fired	System Time	Period Change (Sec)	Velocity Change (Ft/Sec)	Period at Firing (Min.)
1	37	16683	9.77	15.55	88.69
2	55	25948	9.50	15.25	88.73
3	81	77845	9.63	15.48	88.78
4	101	11382	2.65	4.3	88.74
5	108	48866	9.55	15.3	88.71
6	135	84345	10.45	16.75	88.69
7	146	78516	10.65	17.07	88.78
8	182	10966	10.83	17.34	88.68
9	206	52418	11.25	18.00	88.69
10	227	77774	10.93	17.51	88.70
11	242	71839	10.95	17.56	88.74
12	268	37591	11.15	17.80	88.72

D. PANORAMIC CAMERAS

The panoramic cameras operated properly throughout Mission 1105-1 and 1105-2. The first photographic operation occurred during Rev1 [redacted] acquisition. This was a short stereo confidence check. Reconnaissance operations began on Rev 5.

There were 74 in-flight photographic operations during Mission 1105-1. Night engineering operations were performed on Revs 9, 105, and 121. Daytime engineering operations programmed over the United States included Revs 16, 32, 48, 64, 80, and 95. The last photographic operation of Mission 1105-1 occurred on Rev 127.

Mission 1105-2 contained 88 in-flight operations. One night engineering operation occurred on Rev 234. Daytime engineering operations over the United States included Revs 129, 145, 161, 177, 209, 273, and 274. The last photographic take was made on Rev 283.

The aft-looking panoramic camera utilized a film change detector for control of the photographic filter from film type SO-380 (UTB) to the last 500 feet of payload which was SO-121 colored film. The film change detector and filter response were normal. The forward-looking camera employed film type SO-380 throughout both mission segments.

Both panoramic cameras experienced a failure at film depletion at the end of the mission during Rev 283. The failures occurred in the film transport system on both cameras. In the aft-looking camera (#310) a film wrap-up occurred on the frame metering roller which sheared the drive pin, but retained enough drag to stall the unit. This stalled condition caused an abnormal power consumption. The forward-looking unit (#311) failed in a similar manner but was free to continue rotation. Film wrap-up following film depletion appears to be a possible characteristic failure mode of the panoramic cameras. It also occurred on Mission 1104 forward-looking camera.

The primary adverse effect of film wrap-up at film depletion is continuous power usage prior to the second recovery. To eliminate the possibility of continuous power usage due to the failure mode the internal camera operate command will be modified on all future CR systems to remove power.

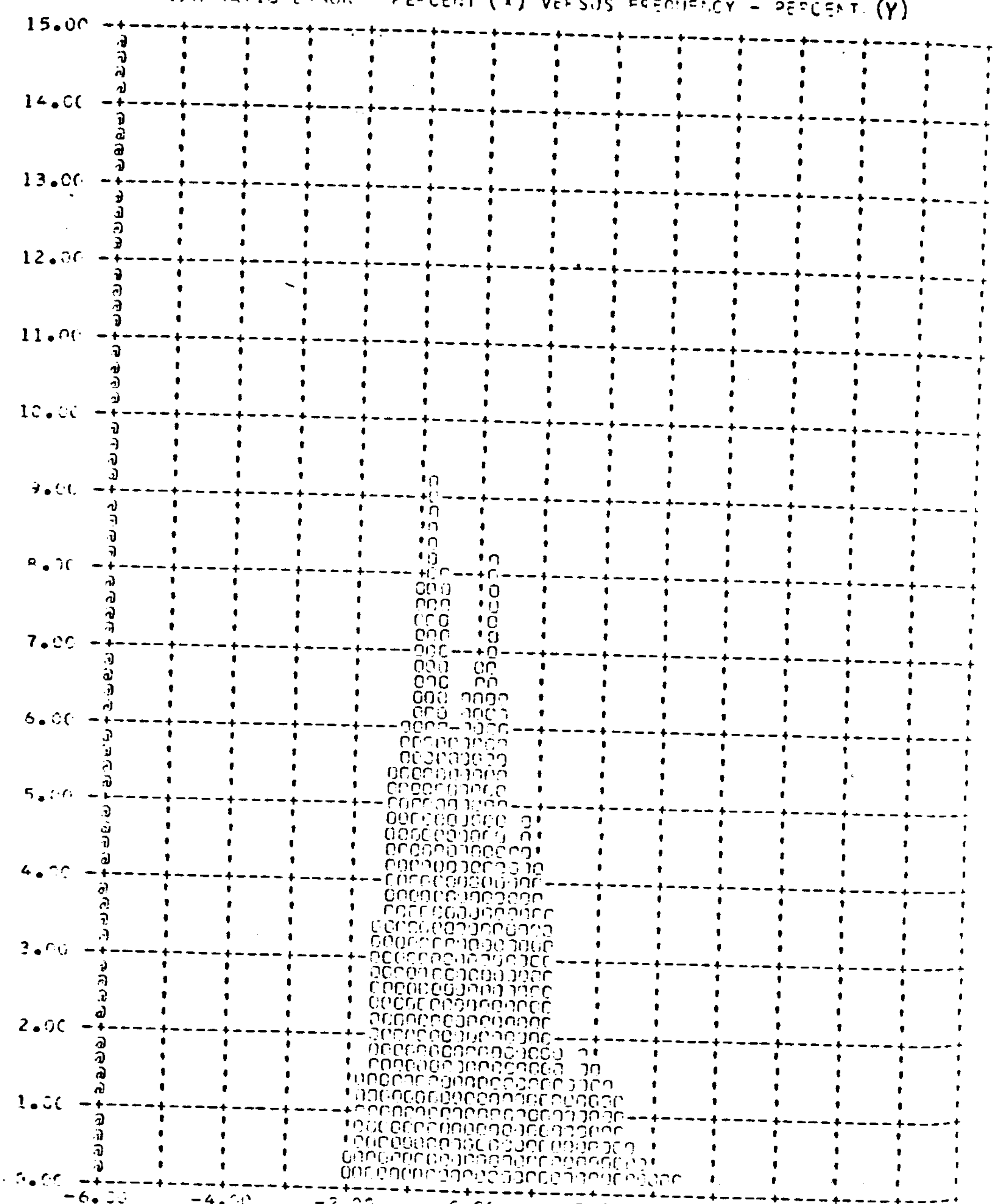
A satisfactory FMC-to-orbit match was maintained during the flight. Generally the mismatch was within ± one per cent. During operations on Revs 101 through 105 the mismatch was approximately two per cent with the latitude coverage being slightly biased from nominal. This error was a result of the below-nominal performance of the DMU rocket fired on Rev 101. The V/H match performance is shown in Figures 3-3 through 3-6.

The forward and aft looking cameras produced 4443 and 4447 frames of photography respectively during Mission 1105-1. During the second mission segment 4443 frames were produced by the forward camera while the aft camera produced 4232 frames of photography.

E. INSTRUMENTATION AND COMMAND

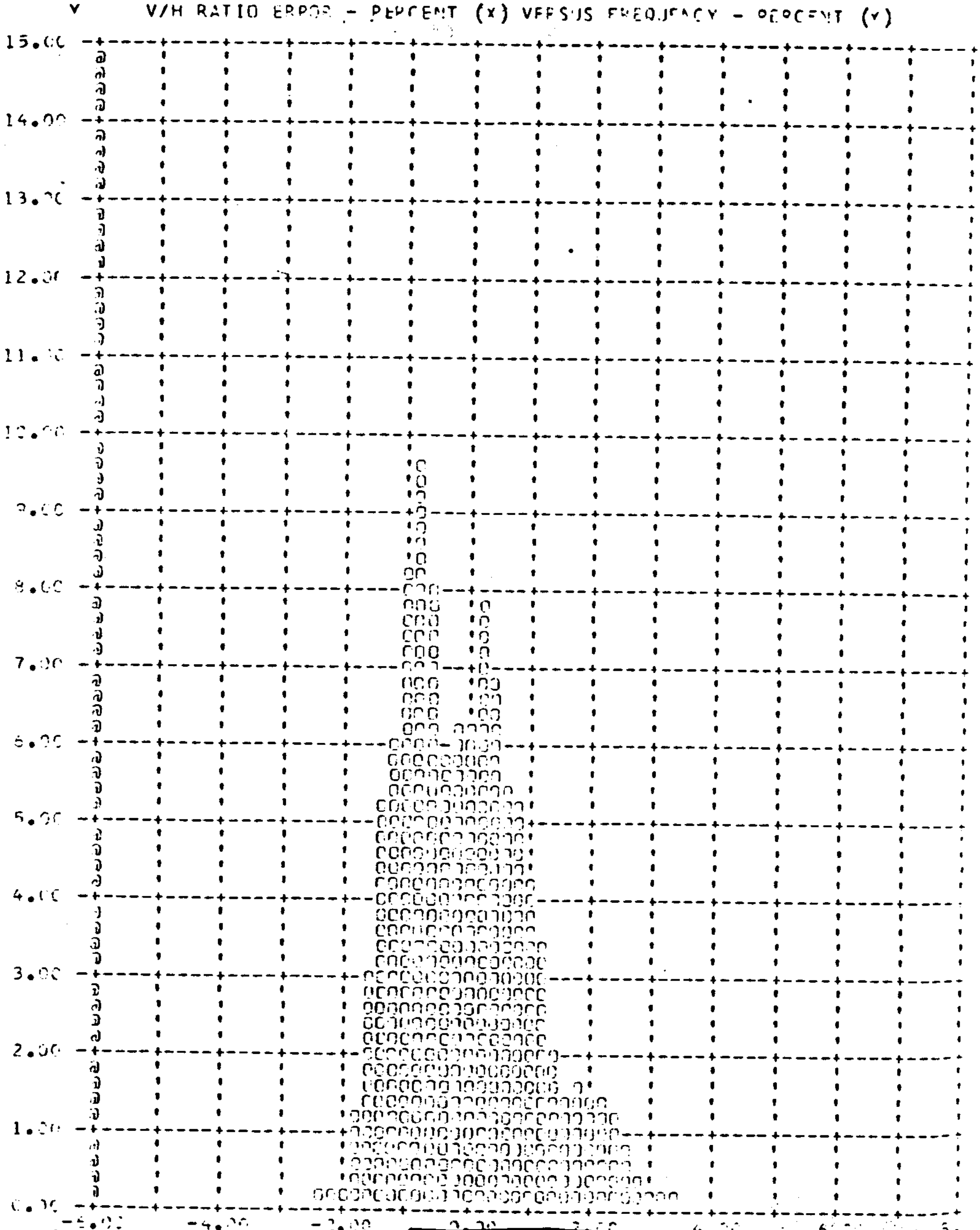
The instrumentation system operated normally throughout the flight.

The command system operation was normal. All commands issued were received and executed by the command system.



MISSION 1105A1 TOP SECRET C [redacted] - CONTROL NO. [redacted]

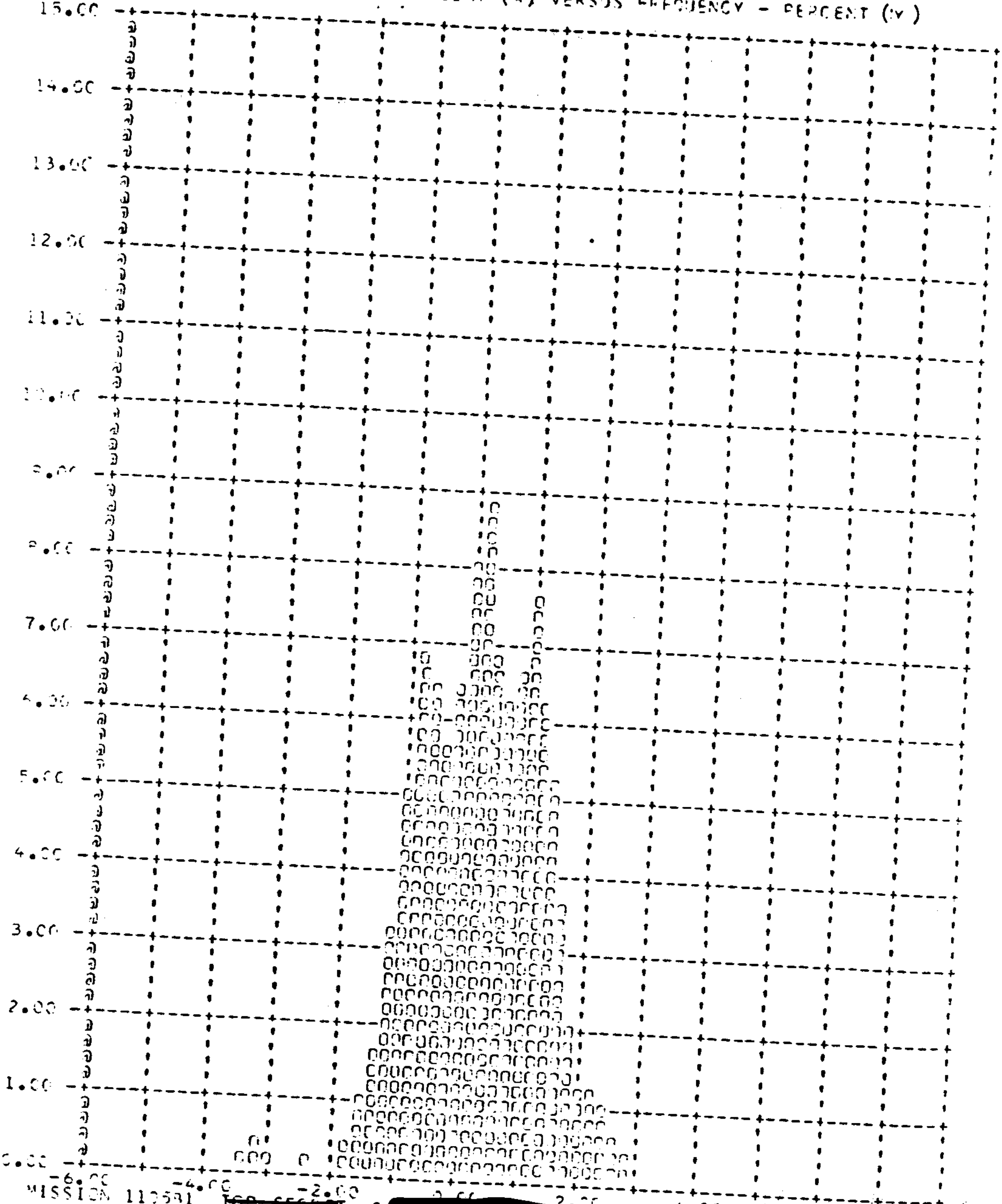
FIGURE 3-3 V/H Match Mission 1105-1 FWD LOOKING CAMERA



MISSION 1105A2 ~~TOP SECRET~~ C[redacted] - CONTROL NO. [redacted]

FIGURE 2-4 V/H Match Mission 1105-1 AFT LOOKING CAMERA

... RATIO ERROR - PERCENT (X) VERSUS FREQUENCY - PERCENT (Y)



MISSION 1105B1 TOP SECRET C[redacted] - CONTROL NO. [redacted]

FIGURE 3-5 V/H Match Mission 1105-2 FWD LOOKING CAMERA

AFT LOOKING CAMERA

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

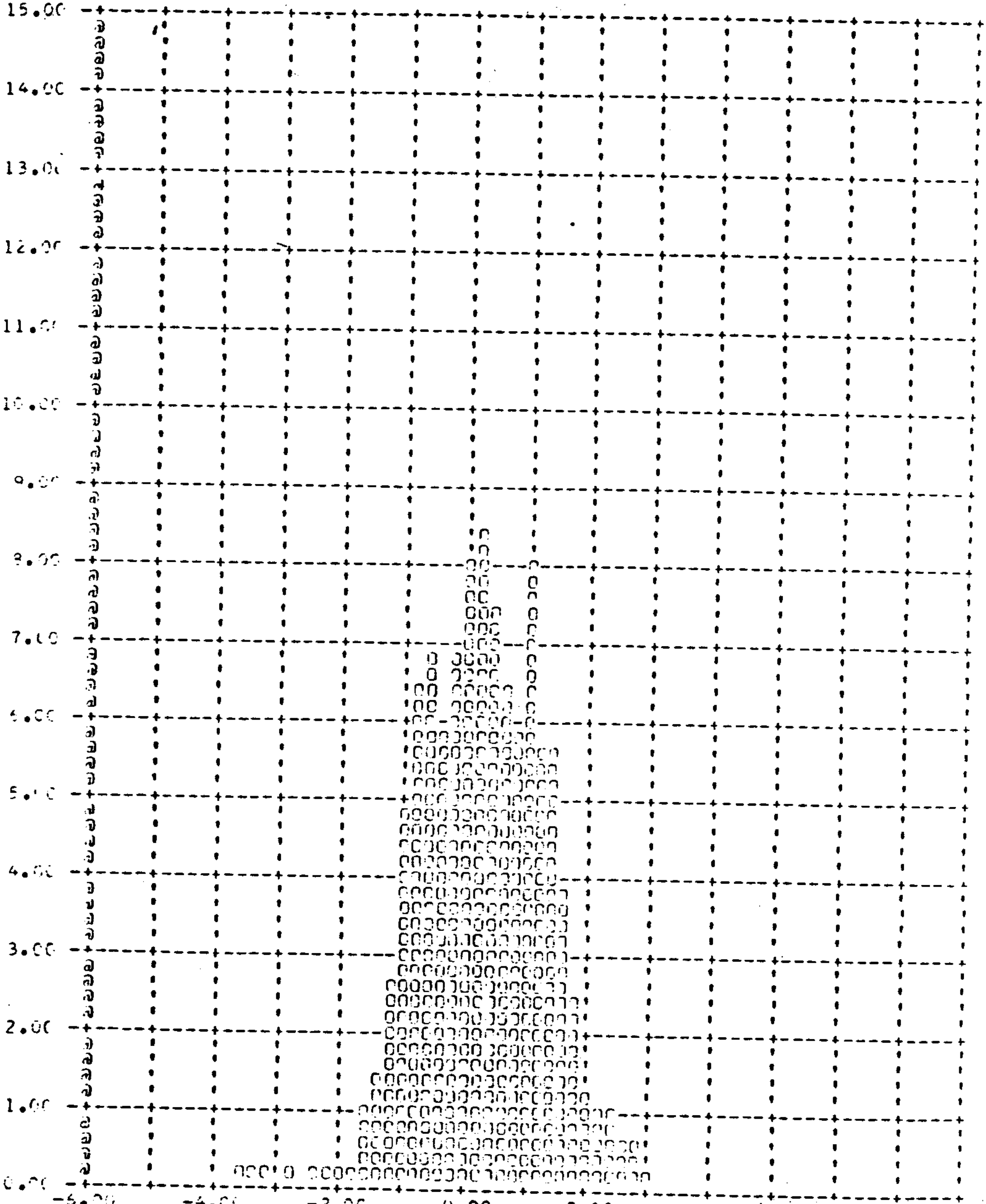


FIGURE 3-6 V/H Match Mission 1105-2 AFT LOOKING CAMERA

F. EXPOSURE CONTROL SYSTEM

Two anomalies occurred with the exposure control programmer. The first, on Rev 2, resulted in an early time out of approximately 95 seconds of timer T1. The second anomaly occurred on Rev 17 and resulted in a failure of T1 to time out during acquisition which lasted for 50 seconds beyond the normal time-out time for T1.

During both of these anomalies Uncle 101 was commanded from Position 11 to Position 1 (slit width failsafe reset).

For the remainder of the flight a command restriction was imposed on Uncle 101 during the time out of switch programmer time T1. No further malfunction occurred.

These anomalies did not impair the operational mission as there were no operations programmed on either rev.

All other portions of the exposure control system performed normally.

G. CLOCK SYSTEM PERFORMANCE

The clock system operated normally throughout the flight. Good correlation between clock and system time was obtained.

H. PMU SYSTEM OPERATION

The PMU system on CR-5 was the first dual bottle PMU to be flown on the program. PMU operation was apparently normal with an average gas consumption of 5.90 delta PSI/min. with a total of 267.74 minutes of operation. There was 1420 PSI of gas remaining at the end of the mission. Figure 3-7 shows a plot of the PMU gas consumption versus operate time.

I. THERMAL ENVIRONMENT

Temperature data acquired by the [redacted] show that panoramic camera temperatures were higher than the nominal prediction but within the 70 ± 30°F specified envelope. Camera temperatures averaged approximately 78 to 82°F at the beginning of the Mission 1105-1 to approximately 68°F at the end of Mission 1105-2. Figure 3-8 shows a graphical plot of the actual average camera temperatures versus the predicted temperature as a function of the beta angle in degrees.

J. RECOVERY SYSTEM PERFORMANCE

Mission 1105-1 Recovery System

The -1 recovery capsule was successfully recovered by air-catch on Rev. 131. All re-entry events monitored occurred within tolerance. The predicted versus actual impact points are as follows:

Predicted Impact	17° 28.6'N	163° 27.8'W
Actual Impact	17° 22'N	164° 20'W

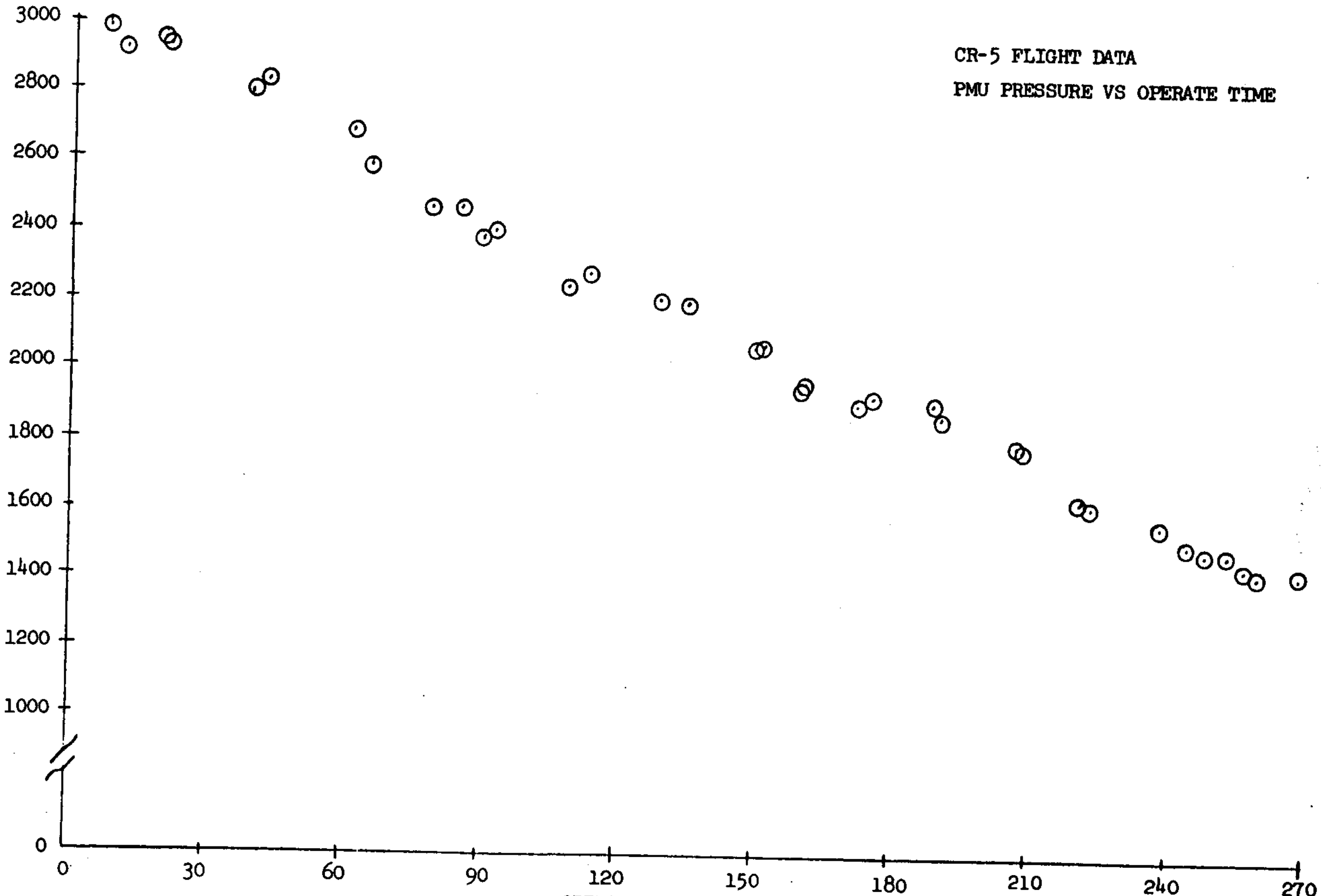
Mission 1105-2 Recovery System

The -2 recovery capsule was successfully recovered by air-catch on Rev 292. All re-entry events monitored occurred within tolerance. The predicted versus actual impact points are as follows:

Predicted Impact	19° 29.1'N	161° 45.6'W
Actual Impact	19° 37'N	161° 45'W

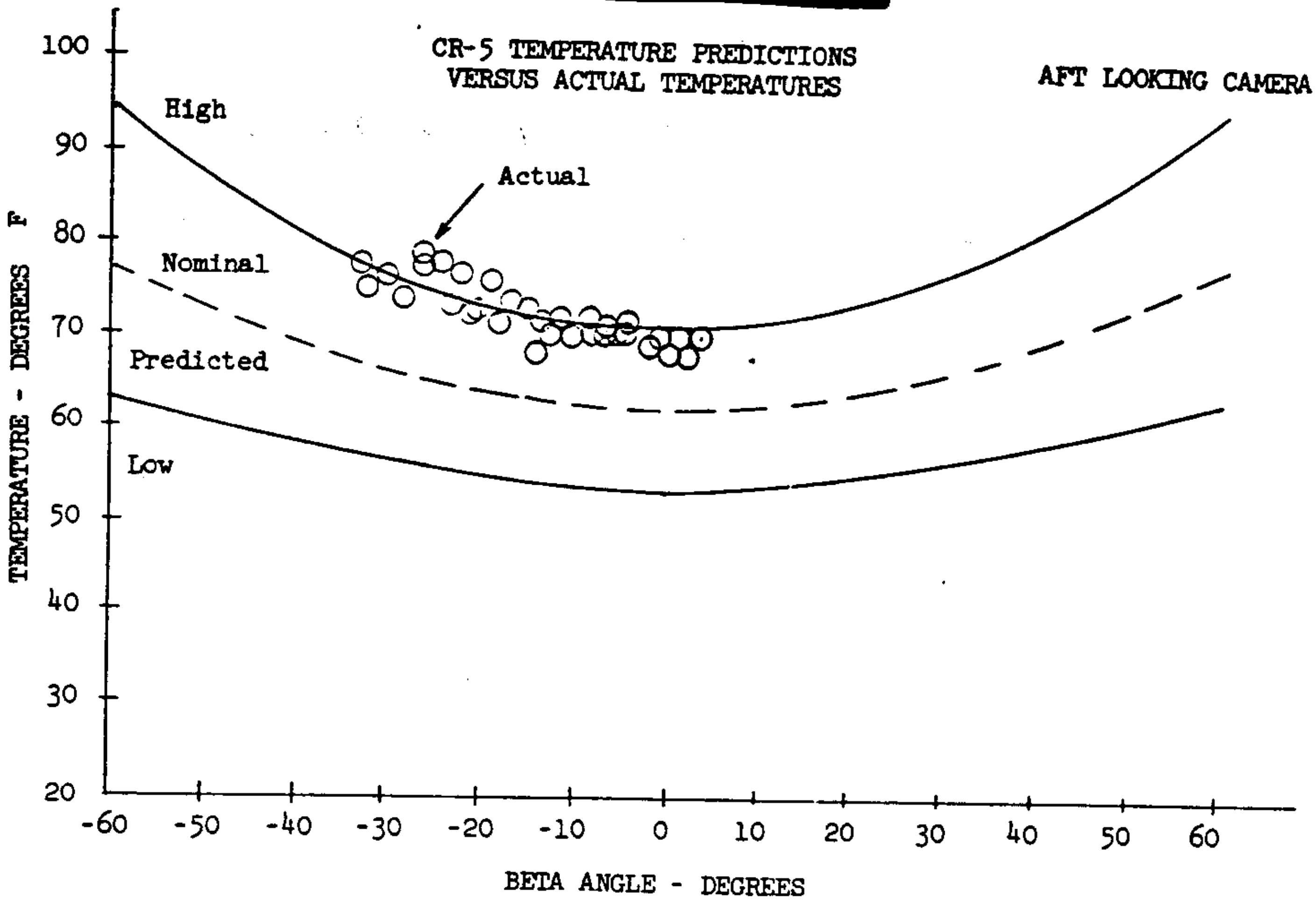
As a result of the film jam up of Instrument 310 the take-up was in a stalled condition until the time of arm. At this time the film was cut and the take-up began free running. Free running continued until electrical disconnect (76 seconds). The take-up was then braked for one

[redacted]



[redacted]

FIGURE 3-7 PMU PRESSURE VS OPERATE TIME


CR-5 TEMPERATURE PREDICTIONS
VERSUS ACTUAL TEMPERATURES
AFT LOOKING CAMERA
High
Actual
Nominal
Predicted
Low
TEMPERATURE - DEGREES F
100
90
80
70
60
50
40
30
20
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
BETA ANGLE - DEGREES

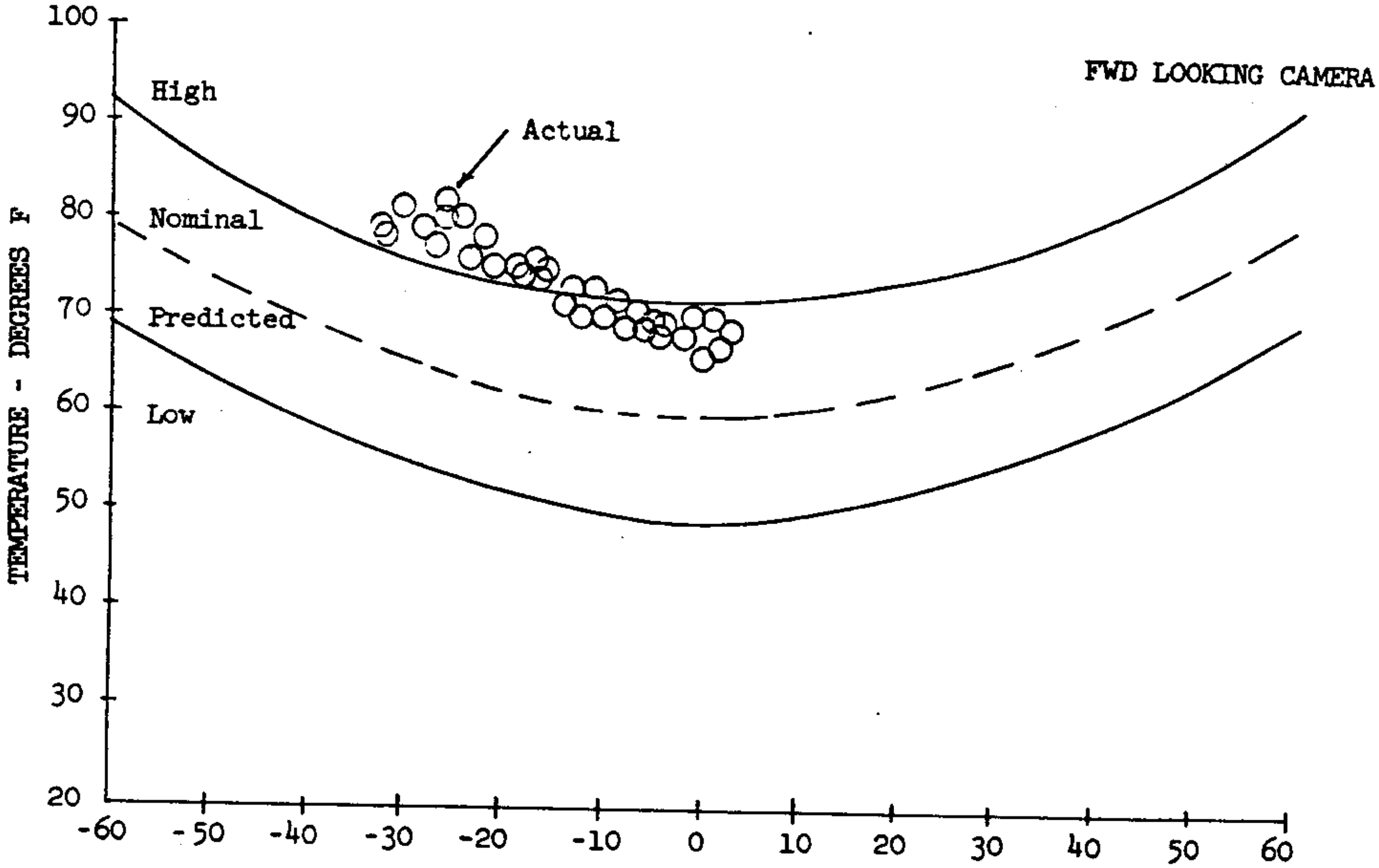

FWD LOOKING CAMERA
High
Actual
Nominal
Predicted
Low
TEMPERATURE - DEGREES F
100
90
80
70
60
50
40
30
20
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60

FIGURE 3-8

second prior to separation. It was feared that the braking would not be sufficient to overcome the free running of the take-up, resulting in an attitude error at retro causing a dispersion in the impact. It appears from the actual impact point that the braking was adequate to overcome the free running take-up preventing an attitude error at separation.

K. SRV TAPE RECORDER SYSTEM

The tape recorder systems performed satisfactorily on both mission segments. All recorded data was retrieved.

L. POST MISSION TESTING

A test plan to evaluate the exposure control programmer problem was formulated. However, due to the panoramic camera jam up resulting in a stalled current drain the batteries were depleted before the testing could be completed. It was intended to issue all commands during the exposure control programmer time-out time of T1. The only commands issued prior to battery depletion were as follows:

Command	No. of Times
U-116	11
U-118	16
U-119	16
U-121	20
U-122	20
U-124	2
U-125	20
U-102	2
U-103	10
U-104	10

There was no adverse effect on the exposure control programmer during this commanding.

M. 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 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.

	Mission 1105-1		Mission 1105-2	
Emulsion	B + F Density	Radiation	B + F Density	Radiation
Type 3401	0.11	0.1R	0.13	0.2R
Royal X Pan	0.22	0.2R	0.25	0.3R

These levels are below that which will degrade the photography.

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

The quality of the photography produced by both panoramic cameras proved to be quite variable throughout both mission segments. Imagery varied from poor to good. Although a MIP of 100 was assigned to Missions 1105-1 and -2, this did not represent the overall quality. Both panoramic cameras operated properly for the programmed 18 day duration of the flight.

The DISIC camera, which normally supplies the Stellar and Terrain photography for the flight, was not flown with the CR-5 system. This is the first time that the DISIC camera subsystem has been deleted from the Corona J-3 series.

Aerial film flown in the panoramic cameras included;

Forward (FWD) Camera	AFT Camera
SO-380 (UTB) - 24,000 feet	SO-380 (UTB) - 23,000 feet
	SO-121 (Color) - 500 feet
	3404 - 50 feet

B. PANORAMIC CAMERAS

1. Image Quality:

SO-380 (Ultra Thin Base - UTB Film)

Imagery produced by the Forward and Aft cameras was degraded in varying degrees throughout both mission segments as reported by PET in the PEIR message. The appearance of the imagery was one that resembled an out-of-focus condition at times. The quality of the imagery varies within a frame as well as between frames. Imagery from Mission 1105-1 and -2 was in general degraded relative to Mission 1104 (CR-4 System). The image quality was extremely variable and evidenced soft focus and image smearing. The best image quality of Mission 1105 was equivalent to the best photography from Mission 1102. However, the amount of such high quality imagery was limited. The overall quality was comparable to the J-1 series. The poorest quality imagery was considerably poorer than normally experienced with a J-1 camera and the best quality photography was better than the best of any J-1 mission.

The overall image quality of Mission 1105-2 was better than that of Mission 1105-1. This was attributed to the fact that forward camera performance was less variable in 1105-2 than on 1105-1, while the aft camera imagery generally remained constant throughout both portions. Further evidence of this condition was obtained by noting that the MIP frame for Mission 1105-1 was chosen from the aft camera, whereas the MIP frame from Mission 1105-2 was chosen from the forward camera. Mission 1105 was the first corona system to fly with a full load of SO-380 (Ultra Thin Base - UTB) film. The image quality variations are directly attributable to the interaction of the UTB film with the CR-5 system. Modifications were made to CR-5 to enable reliable handling of UTB. The major modification was a reduction in system film tensions. It would appear that this reduction in tension caused an in-flight variablility in film lift and dynamics in the scan head area during exposure. This variability was not observed in extensive simulated environmental testing.

Several favorable photographic conditions were evident which helped to mitigate the degrading effects. For example, the mission experienced generally clear weather over denied areas. Further, there was a large percentage of light snow cover which resulted in favorable high contrast imagery with long shadows.

Bar target and cultural areas in the domestic duplicate positive engineering film exhibits were evaluated at the A/P facility of Lockheed Missiles and Space Co. Evaluation of bar target and cultural imagery from the AFT camera photography indicate fairly normal performance for a second generation lens whereas the bar target imagery produced by the FWD camera suggests below normal performance for a third generation lens.

Cultural imagery produced by both cameras included cars, trucks, and planes. Nacelles on aircraft were present in photography from both cameras.

Evaluation of FWD and AFT camera imagery from Pass D-129 clearly revealed the 36 inch and 30 inch cables that support the Golden Gate and Bay Bridges at San Francisco, California. Structural cross brace members that measure 18 to 24 inches were also clearly visible as part of the Bay Bridge detail. At Fresno, California, Pass D-145, both cameras produced imagery that revealed a football field grid line pattern within a stadium complex. While soft imagery has been observed in photography from both cameras it appears that the information content of the imagery is also fairly high for the FWD and AFT cameras.

A relative comparison of the bar target imagery recorded by the FWD and AFT cameras was made and is shown in Table 4-1. The FWD camera evidenced noticeable smear in the scan direction as indicated in the table by the bar target ground resolution of 20 feet shown for Pass D-161. The AFT camera bar target values frequently reveal superior ground resolution when compared with the corresponding FWD camera bar target imagery. This is contrary to what was expected since the FWD camera produced a peak low contrast dynamic resolution of 187 li/mm during pre-flight testing with the third generation lens compared to the AFT camera resolution of 158 li/mm with the second generation lens.

SO-121 Color Film

The tail end of the AFT camera film supply contained 500 feet of color film, type SO-121. The exposure and color balance were judged to be good.

The image quality of the SO-121 record was extremely variable, and ranged from good to very poor. The amount of good quality imagery is limited and is generally restricted to the edges and ends of the format. The center portion of the format is generally poor. This condition would appear to have been caused by the film being curled away from

TABLE 4-1

MISSION 1105-1 AND -2

Visual Evaluation of Positive Bar Target Imagery from FWD and AFT Camera Engineering Operations

Film Type SO-380 UTB

Camera, Rev, Frame #	Ground Resolution FMC/Scan (Feet)	Geographic Location	Location In Frame X	Location In Frame Y	Bar Target Type, Contrast	Weather Comments
FWD,D16,F7	9/8	Edwards AFB, Cal.	56.1	3.5	B-2, Hi 16/1	Clear
	10/9	Edwards AFB, Cal.	56.7	3.5	B-1, Low 4/1	
AFT,D16,F13	9/8	Edwards AFB, Cal.	21.0	2.5	B-2, Hi 16/1	Clear
	10/11	Edwards AFB, Cal.	20.4	2.4	B-1, Low 4/1	
FWD,D16,F13	16/-	Ontario, Cal.	56.1	1.6	T-Bar, 5/1	Haze, scattered clouds
AFT,D16,F19	16/16	Ontario, Cal.	19.3	4.6	T-Bar, 5/1	Haze, scattered clouds
FWD,D32,F3	9.5/8.5	Indian Springs, Nev.	50.9	4.6	MIL STD 150A, MED. 11/1	Clear
AFT,D32,F9	8.5/8.5	Indian Springs, Nev.	26.3	1.0	MIL STD 150A, MED. 11/1	Clear
FWD,D32,F5	7.5/8.5	Pahrump, Nev.	30.5	0.9	MIL STD 150A, MED. 11/1	Clear
AFT,D32,F11	8.5/7.5	Pahrump, Nev.	46.8	4.8	MIL STD 150A, MED. 11/1	Clear
FWD,D32,F13	7/7	Valleywells, Nev.	40.2	5.2	T-Bar, 5/1	Clear
AFT,D32,F19	8/8	Valleywells, Nev.	37.0	0.2	T-Bar, 5/1	Clear
FWD,D48,F35	16/-	Stanfield, Ariz.	56.5	4.4	T-Bar, 5/1	Thin cloud over target
AFT,D48,F41	16/16	Stanfield, Ariz.	21.9	1.1	T-Bar, 5/1	Thin cloud over target
FWD,D64,F4	12.5/12.5	Fort Huachuca, Ariz.	19.6	0.7	MED C 11/1	Thin cloud next to target
AFT,D64,F10	8/9	Fort Huachuca, Ariz.	57.8	5.8	MED C 11/1	Thin cloud next to target

TABLE 4-1 (Continued)

Film Type SO-380 UTB

Camera, Rev, Frame #	Ground Resolution FMC/Scan (Feet)	Geographic Location	Location In Frame X	Location In Frame Y	Bar Target Type, Contrast	Weather Comments
FWD,D129,F13	---	Palo Alto, Cal.	--	--	T-Bar, 5/1	Heavy haze, can not see target
AFT,D129,F19	---	Palo Alto, Cal.	--	--	T-Bar, 5/1	Heavy haze, can not see target
FWD,D145,F6	12/12	Fresno, Cal.	25.8	4.9	T-Bar, 5/1	Haze, scattered clouds
AFT,D145,F12	8/7	Fresno, Cal.	51.3	0.9	T-Bar, 5/1	Haze, scattered clouds
FWD,D161,F3	10/11	Edwards AFB, Cal.	7.7	1.6	B-2, Hi 16/1	Possible haze
	---	Edwards AFB, Cal.	7.8	1.9	B-2, Low 4/1	Possible haze, unresolved target
	13/20(Smear)	Edwards AFB, Cal.	8.1	1.6	C , Low 4/1	Possible haze, unresolved target
FWD,D161,F12	12/12	Palm Springs, Cal.			T-Bar, 5/1	Thin cloud over target
AFT,D161,F9	9/10	Edwards AFB, Cal.	70.3	4.1	B-2, Hi 16/1	Possible haze
	11/1	Edwards AFB, Cal.	70.0	3.8	B-1, Low 4/1	Possible haze
	12.6/14/2	Edwards AFB, Cal.	69.8	4.1	C , Low 4/1	Possible haze
AFT,D161,F18	8/8	Palm Springs, Cal.			T-Bar, 5/1	Thin clouds in the general area
FWD,D177,F15	---	Indian Springs, Nev.	--	--	MIL STD 150A, MED. 11/1	Haze, unresolved target
AFT,D177,F21	---	Indian Springs, Nev.	--	--	MIL STD 150A, MED. 11/1	Haze, unresolved target
FWD,D177,F21	12/12	Boulder City, Nev.	19.4	3.1	T-Bar, 5/1	Clear
AFT,D177,F27	8/12	Boulder City, Nev.	58.1	3.0	T-Bar, 5/1	Clear

the focal plane during exposure. The best imagery appears to be comparable to the best that could be achieved with the Corona camera and SO-121 film. The best ground resolved distance is estimated to be about 15 to 20 feet. Pre-launch system testing indicated that a potential 15 feet of ground resolution (low contrast) could have been achieved.

<u>3404 Film Type</u>

A 50 foot strip of film type 3404 was included between the SO-380 and SO-121 on the AFT camera. This film was included to provide a more gradual change in film thickness when proceeding from the UTB to the thicker SO-121.

The image quality of the 3404 strip showed less variability than imagery on film type SO-380. However, in general the quality of the imagery on film type 3404 was comparable to the imagery recorded on film type SO-380.

2. Data Recording

The FWD and AFT cameras produced acceptable auxiliary data imagery throughout Missions 1105-1 and -2. Imagery of the PG rail holes, 200 pulse per second time track, slur pulse, camera serial number, time word, start of pass mark, and horizon fiducials were present and acceptable. The requirement for nod dot imagery has been deleted for the J-3 systems. Nod dot imagery was not a requirement for Mission 1105.

3. Anomalies

There are certain anomalies that recur from mission to mission and others that are characteristic of a particular system. While these anomalies have not been eliminated their effects on flight imagery have been minimized. Mission 1105 photography from both the FWD and AFT cameras exhibited certain characteristic anomalies that included dendritic static, rail scratches, and minor light leak fog. In addition, the AFT camera film contained a minor plus density wavy streak caused by UTB film twists that were normal for the film path of this camera.

Rail scratches produced by both cameras were very light during all pre-flight operations and during flight. While this condition has not been observed in previous CR systems flown it has been a characteristic of Mission 1105 cameras.

The variation in the sharpness of imagery from both the FWD and AFT cameras is considered to be a result of interaction between the SO-380 ultra thin base film and the camera system. Changes were made to the panoramic cameras during pre-flight testing to enable the system to handle UTB film. The principal modification to the camera system consisted of a reduction in static film tension from the normal case of 46 ounces to 36 ounces for both the FWD and AFT cameras. The panoramic cameras had received extensive testing with UTB film that included tracking, resolution, and environmental tests. In addition, the film flatness characteristics during dynamic operation were evaluated with the AG test at the 36 ounce film tension level. Pre-flight results indicated acceptable performance. Mission image quality variations indicate greater excursions in film plane position than were indicated during ground testing. The reasons for the apparent difference in ground test versus flight results are not clearly understood.

It was observed that the imagery of the FWD camera varied in sharpness more than the imagery of the AFT camera. This difference in image variation is attributed to the fact that the third generation lens of the FWD camera has much less tolerance to film plane excursions, even though the peak focus is higher than the AFT camera that contained a second generation lens. The second generation lens of the AFT camera has a much greater tolerance to film plane variations because it has a much greater depth of focus than the third generation lens of the FWD camera.

The fifth frame of the AFT camera had a 0.5 inch wide out of focus band along the binary edge. The image frequently varied from good to bad on 1105-1 but was noticeably improved on 1105-2. During camera shutdown, frame five of the next operation was in a twist condition thus causing film deformation along the inboard edge. The lack of this anomaly in Mission 1105-2 suggests a film tension change and/or less film curl. Effective on CR-8, modifications which lengthen the air twists are expected to reduce this effect.

A base rub was observed throughout Mission 1105-2. The base rub was faintly visible on the original negative material. The actual cause of this minor anomaly was not determined.

A plus density streak 0.1 inch wide was located along the time track edge of the film beginning in FWD Frame 10 of Pass D-197 and ending at a manufacturer's splice Frame 73, Pass D-198. This streak was outside the active format area. In addition, Frame 10 to 19, Pass D-197, exhibited edge fluting along with the plus D streak. It is suspected that the film rubbed against a flange. Variations in edge tension are considered the cause of the film path change.

There was an intermittent emulsion scratch located one half inch from the data block edge beginning in Pass D-64 and continuing to the end of the mission. This scratch was up to ten inches long and was present at the take-up end of the frames. This intermittent emulsion scratch was attributed to a sticking drum roller.

Holes were torn in the film from both cameras near the water seal cuts of Mission 1105-2. A hole, about one-quarter inch by one eighth inch, was torn in the SO-121 film (AFT camera) about 23 3/4 inches from the water seal cut. Additionally, an emulsion scratch, about one sixteenth inch by two inches, was located about 16 inches from the water seal cut. On the SO-380 film (FWD camera) there are two holes: one was about 1 5/8 inches by one-eighth inch, and was located 61 inches from the water seal cut; the other hole was triangular, about one-quarter inch on a side, and was 30 1/2 inches from the water seal cut. There was no trace of other mechanical damage in the vicinity of the holes on either film. A crease about 10 inches long following the larger hole on the SO-380 film, occurred during processing. A search of the recovery bucket produced no torn pieces of film. An analysis of system operation has provided no clue to the origin of the holes in the film.

Plus density marks approximately 0.01 to 0.02 inches in size were present in the AFT-looking camera record from both mission segments. The marks occur with a repeating pattern near the center of the film with a spacing of approximately 6 1/4 inches. A second sequence of marks occurs 3/8 inches in from the time track with a pattern repetition at intervals of approximately 1 9/16 inches. Usually the marks have a characteristic spider like appearance of fine lines emanating from a common center. The marks are often associated with a single fine emulsion scratch that begins near the start of scan and terminates just before the end of scan. The scratch is interrupted by the marks.

The marks and scratches are not observed in the horizon format area. In addition, the FWD looking camera record exhibits a plus density mark approximately 0.01 inch in size repeating at intervals of 2 5/16 inches.

Similar marks in the FWD looking camera record are soft in appearance and are not associated with a common scratch. All marking has occurred randomly throughout both mission segments. At the start of the mission, no marks were present in either the FWD or AFT camera photography. Marking appears to be an electro-static discharge associated with foreign particle build-up on various roller surfaces. The scratches noted in the Aft camera record appear to be related to the static discharge marks.

A wavy plus density (plus D) streak is present intermittently throughout the material from the FWD and AFT cameras from Missions 1105-1 and -2. The streak was approximately 0.2 to 0.3 inches wide. In addition, photography from the FWD camera, Mission 1105-2, contained an intermittent minus density (minus D) streak approximately 0.2 inches wide. Degradation to the imagery was minor in both cases. The wavy marking is attributed to normal air twists in the camera film path that induce buckles in the film that cause strain sensitization and desensitization. In particular, the air twist from the supply cassette to the input nod roller on the FWD instrument and the short film twist located on the output side of the shuttle assemblies, are considered the most likely areas of strain induced marking. This anomaly is peculiar to the use of (UTB) SO-380 film. Lengthening the air twist on the output side of the shuttle assembly and increasing the path length in the area of the wing bracket and constant tension assembly on the FWD looking instrument beginning with CR-8 and up is expected to eliminate film streaking with UTB film. Plus density streaking was characteristic of the FWD and AFT-looking cameras during pre-flight testing with SO-380 UTB film.

A minor light leak fog band located within two inches of the take-up end of the format appears on the first frame of both cameras on a few passes. Occasionally other frames within a pass were similarly affected. The degradation to imagery was very minor. These fog patterns result from the unique location of the steering rollers at the ends of the formats on this system. Image-forming light passes through the film in the platen and struck film of the following frame just above the horizon camera guide rollers.

Minus density spots were observed on the original negative from Mission 1105-2. These spots were infrequent, random and ranged in size from .025 to .050 inches. They were observed on both the SO-380 and 3404 film. These spots contain no imagery. The cause of this anomaly is currently unknown. The degradation to imagery was inconsequential.

Both cameras failed at film depletion. Failure occurred in the film transport system. In the AFT cameras the film wrapped around the frame metering roller and caused the drive pin to shear off. Apparently enough drag remained in the gear drive to stall the unit. The stalled AFT camera caused an abnormal high power consumption which could drain sufficient power to cause an abnormal recovery if not corrected on future systems. Since the primary adverse effect is heavy power consumption, a change to the internal operate command to remove power in the event that this failure mode should occur on future system has been designed and will be installed in all future CR systms.

The FWD camera failed in a similar manner but was free to rotate and no excessive power drain occurred with this camera.

A secondary result of this type of failure is the fact that approximately 3 to 6 frames of film will remain in the camera system at the tail end of the second mission segment.

C. HORIZON CAMERAS

Veiling of the port horizon imagery from both pan cameras gradually developed as the mission progressed. Imagery appeared sharp at the beginning of Mission 1105-1. The horizon imagery was still well defined and usable throughout both mission segments. This was the first 1100 series mission to exhibit veiled horizon imagery and the first mission including the 1000 series to produce veiled imagery on the port side. Investigation has failed to reveal any known cause.

D. DISIC STELLAR/TERRAIN CAMERA

The DISIC camera subsystem was omitted from Mission 1105.

SECTION 5

PANORAMIC EXPOSURE

INTRODUCTION

Exposure of the panoramic camera film is a function of the scan rate, filter and slit width selected. Since scan rate is adjusted in flight to compensate for forward image motion, exposure reduces to the selection of the filter and slit.

The filter is selected prior to flight and is therefore fixed for a given film type. However, the slit width is selectable by real-time command in flight within limits established by the pre-flight choice of five slit positions including the failsafe position.

FILM TYPE SO-380

The Wratten 25 (W-25) and Wratten 21 (W-21) filters were selected for the FWD and AFT looking cameras respectively. The somewhat heavier light filtration of the shorter wavelengths below the red region provided by the W-25 filter reduces the amount of non-image forming haze light that appears to be more pronounced in the FWD camera. Since the W-25 filter provides more light filtration than the W-21, the slits selected for the FWD camera are wider than the corresponding slits selected for the AFT camera.

The exposure slits selected for the FWD and AFT cameras were as follows:

SLIT WIDTH (INCHES)

SLIT I.D.	FWD	AFT
S_4	0.337	0.271
S_3	0.310	0.192
S_2	0.229	0.149
S_1	0.180	0.138

Typical slit usage for Missions 1105-1 and -2 are shown in Figures 5-1 thru 5-6 for orbits 45, 135 and 225. The solid curve in Figures 5-1 thru 5-6 represent the basic exposure criteria dated September 1966. The actual exposure time produced through the programmed use of slits S_4 thru S_1 generally produce a slight underexposure, by design, relative to the basic exposure criteria. Figures 5-1 thru 5-6 include the relative distribution of camera operations for the portion of the mission represented by each plot.

[redacted]

EXPOSURE POINTS

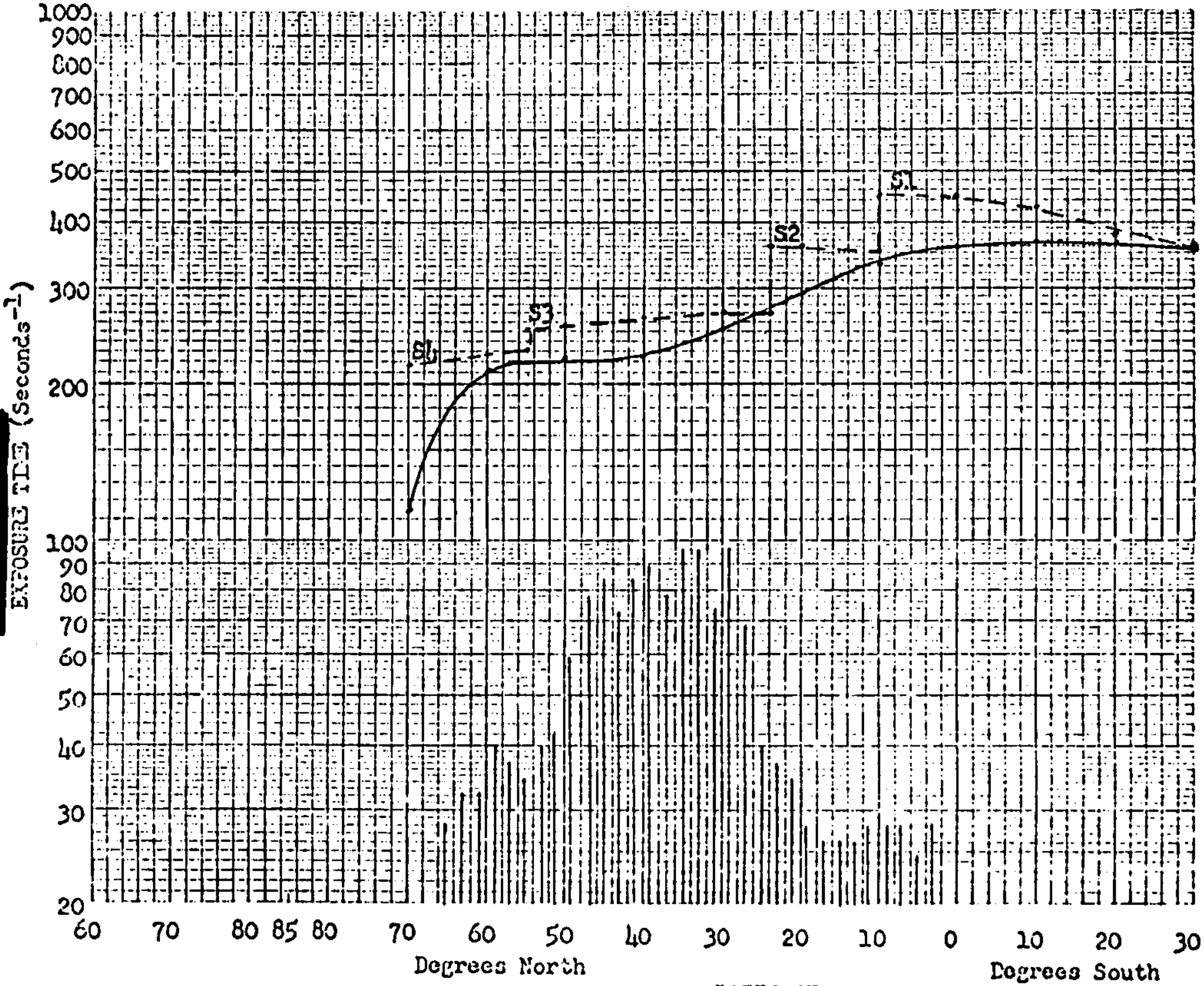


FIGURE 5-1: NOMINAL SLIT USAGE(S4-S1) VS BASIC EXPOSURE CRITERIA- ORBIT 45 FWD CAMERA #311

Mission No: 1105

Payload No: CR-5

Camera No: FWD #311

Pass No: D-45

Launch Date: 3 NOV. 1968

Launch Time: 2131z
~~.337,.310,.229~~
.180,F/S.314

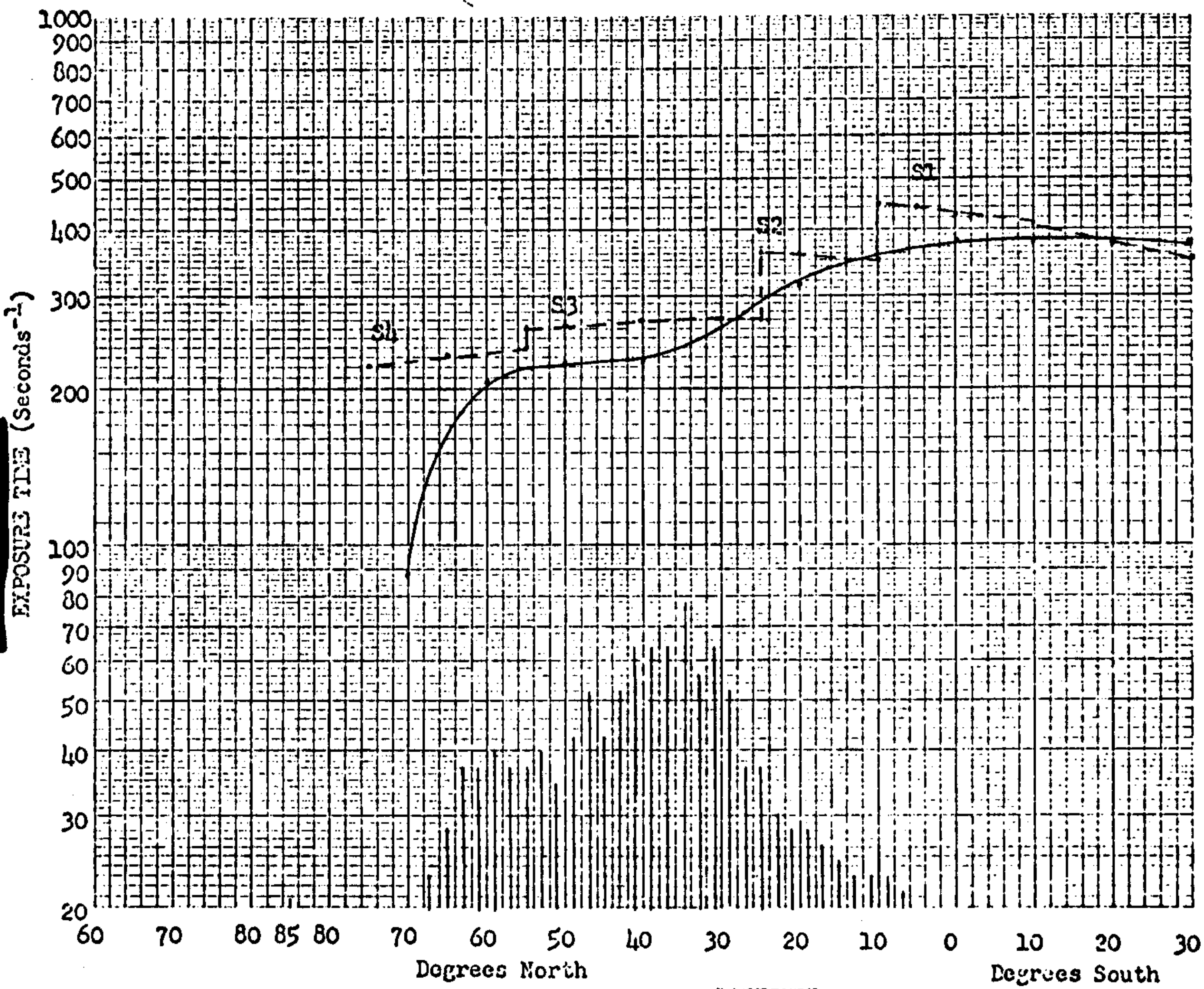
Slit Width:

Filter Type: W25

Film Type: SO-380

[redacted]

EXPOSURE POINTS



[redacted]

Mission No: 1105

Payload No: CR-5

Camera No: FWD 311

Pass No: D-135

Launch Date: 3 NOV. 1968

Launch Time: 2131 Z

Slit Width: .337, .310, .229 .190, F/S .314

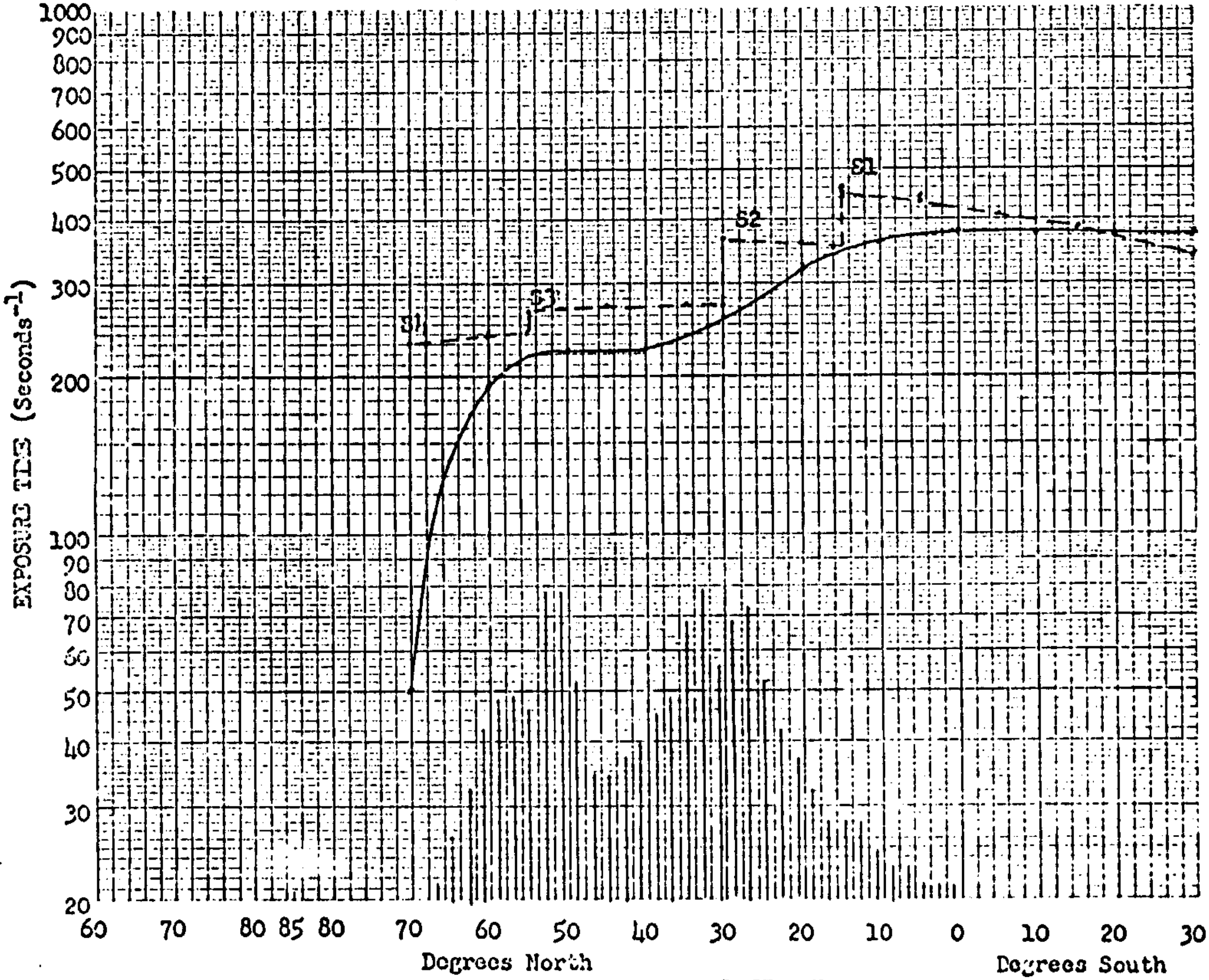
Filter Type: W25

Film Type: SO-380

[redacted]

FIGURE 5.2 : NOMINAL SLIT USAGE(S4-S1) VS BASIC EXPOSURE CRITERIA - ORBIT 135 FWD CAMERA # 311

EXPOSURE POINTS



Mission No: 1105

Payload No: CR-5

Camera No: FWD 311

Pass No: D-225

Launch Date: 3 NOV.1968

Launch Time: 2131 Z

Slit Width: .337,.310,.229 .180, F/S .3[redacted]

Filter Type: W25

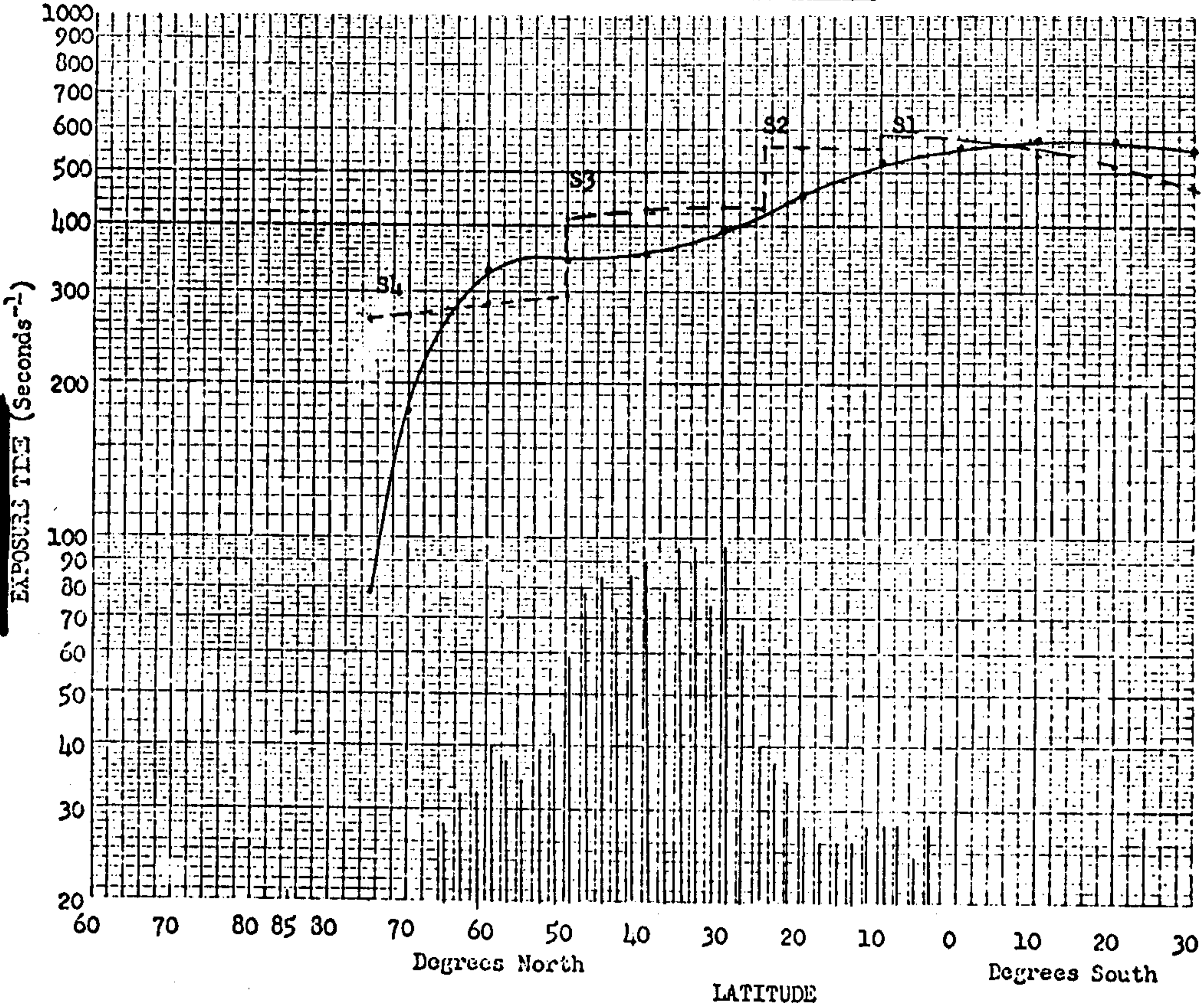
Film Type: SO-380

FIGURE 5-3 : NOMINAL SLIT USAGE(S4-S1) VS BASIC EXPOSURE CRITERIA - ORBIT 225 FWD CAMERA # 311

[redacted]

[redacted]

EXPOSURE POINTS



Mission No: 1105

Payload No: CR-5

Camera No: AFT #310

Pass No: D-45

Launch Date: 3 NOV. 1968

Launch Time: 21:31 Z

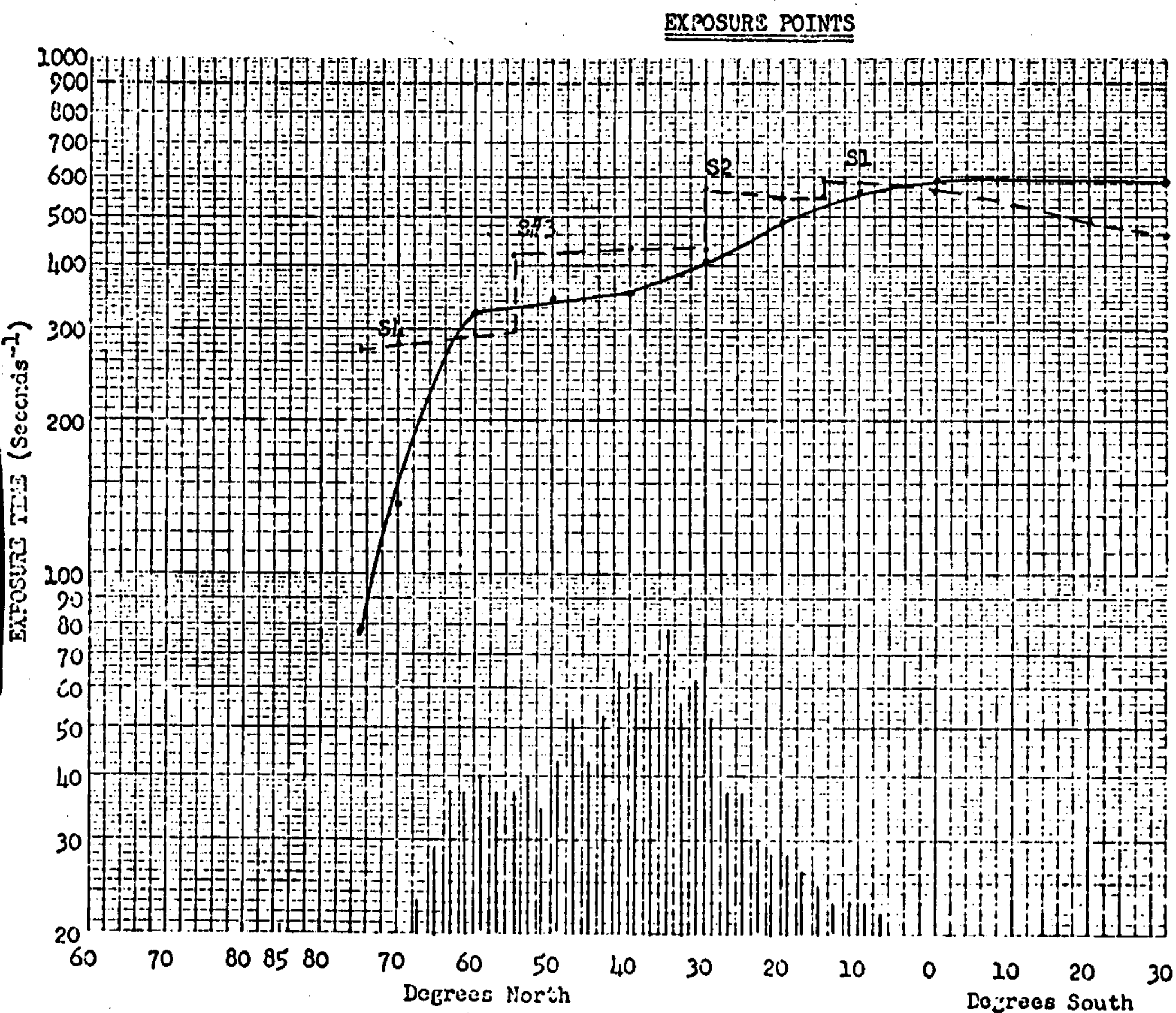
Slit Width: .138, .149, .192, .271, F/S .198

Filter Type: W-21

Film Type: SO-380

FIGURE 5-4 : NOMINAL SLIT USAGE(S4-S1) VS BASIC EXPOSURE CRITERIA - ORBIT 45 aft CAMERA # 310

[redacted]



[redacted]

Mission No: 1105

Payload No: CR-5

Camera No: Aft #310

Pass No: D-135

Launch Date: 3 NOV. 1968

Launch Time: 2131 Z

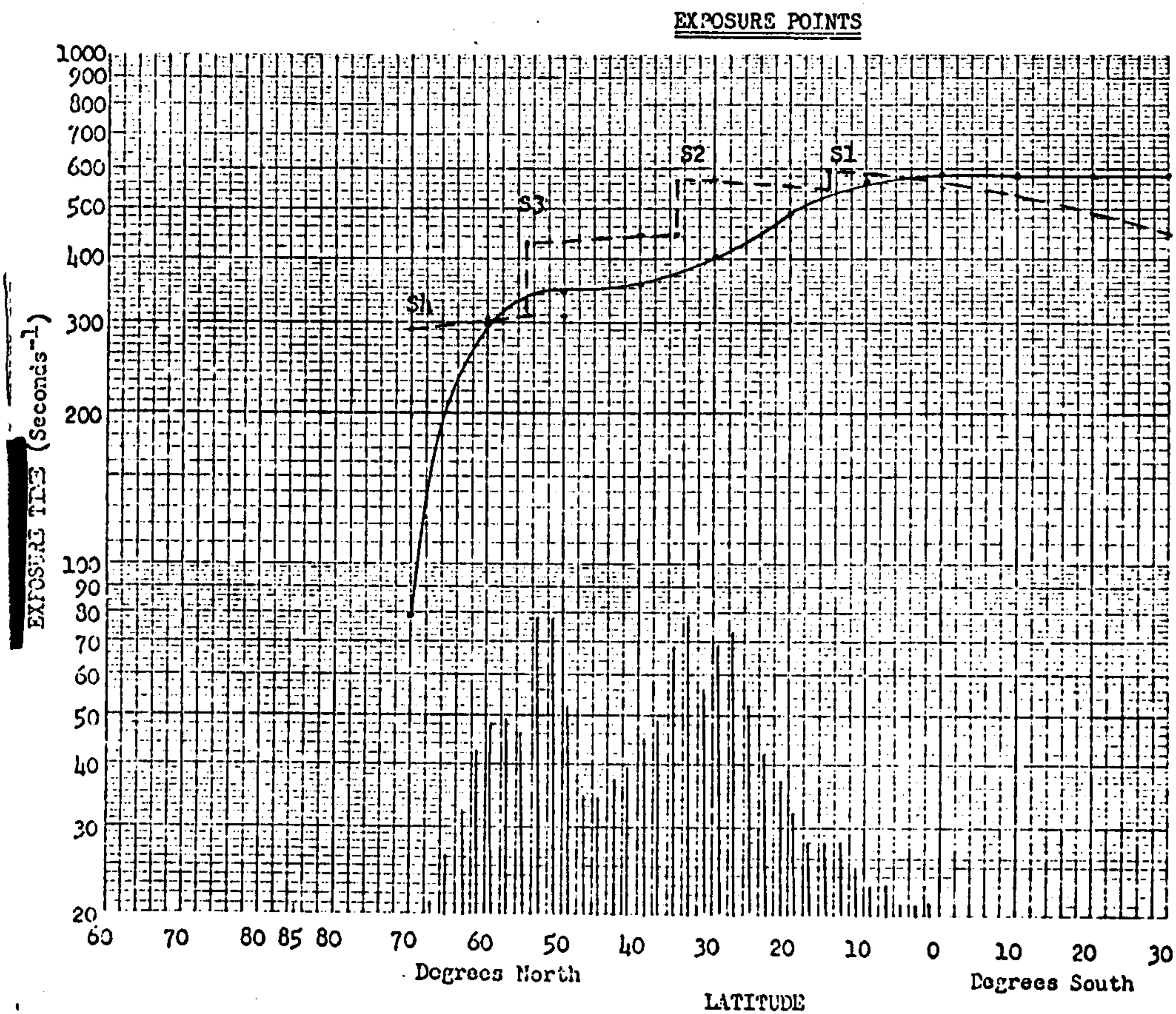
Slit Width: .138, .149, .192, .271, F/S .198

Filter Type: W21

Film Type: SO-380

FIGURE 5-5: NOMINAL SLIT USAGE(S4-S1) VS BASIC EXPOSURE CRITERIA - ORBIT 135 AFT CAMERA #310

[redacted]



Mission No: 1105

Payload No: CR-5

Camera No: Aft 310

Pass No: D-225

Launch Date: 3 NOV.1968

Launch Time: 2131 z

Slit Width: .138,.149,.192, .271,F/S .198

Filter Type: W21

Film Type: SO-380

FIGURE 5-6 :NOMINAL SLIT USAGE(S4-S1) VS BASIC EXPOSURE CRITERIA - ORBIT 225 AFT CAMERA # 310

The missions with the more desirable cultural imagery will probably be described as having a significant percentage of the mission under-exposed when using the criteria that D-min less than 0.4 represents under-exposure. Table 5-1 shows the per cent of Mission 1105-1 and -2 that was classified under exposed, exposed correctly, and over exposed. The basis for these exposure classifications is the assumption that the exposure is correct when the scene minimum density (D-min) in the processed negative ranges between 0.4 and 0.9 and that underexposure will result when scene D-min is less than 0.4. The scene is considered over exposed when D-min exceeds 0.9. However, D-min values obtained from the original negative are made subjectively from gross natural and cultural areas selected indescriminantly. This will usually produce D-min values that are generally lower for the mission than if all the D-min values are taken from cultural target areas were maximum intelligence is generally derived. Selection of D-min values from natural terrain features will often result in D-min values below the 0.4 minimum level since the reflectance level of natural areas tends to be lower than for cultural areas.

Table 5-1 - TERRAIN DENSITY ANALYSIS OF EXPOSURE

Mission 1105-1

Panoramic Camera	Under[1] Exposed	Correct[2] Exposure	Over[3] Exposed
FWD	25%	66%	9%
AFT	17%	74%	9%

Mission 1105-2

Panoramic Camera	Under[1] Exposed	Correct[2] Exposure	Over[3] Exposed
FWD	43%	50%	7%
AFT	37%	56%	7%

1. D-min less than 0.4
2. D-min 0.4 to 0.9 inclusive
3. D-min greater than 0.9

Representative terrain diffuse D-min, D-max values for Missions 1105-1 and -2, FWD and AFT cameras, are shown in Figures 5-7 to 5-14. These macro-density measurements (500 μ spot) were supplied by AFSPPF. The film was dual gamma processed using the Yardleigh processor. Figures 5-15 and 5-16 show the process control standard and actual process for the FWD camera flight record, Mission 1105-1, respectively. Figure 5-17 shows the characteristic curve for the FWD camera flight film sampled on R-2 day.

The terrain D-min, D-max data in Figures 5-7 to 5-14 may be compared with Figure 5-17 to show the distribution of terrain density data relative to the R-2 day characteristic curve for film type SO-380.

MISSION * 1105-1 * INSTR * FWD * PLOT OF D MIN * TERRAIN * PROCESSING, * DUAL GAMMA

ARITH MEAN * 0.56 * MEDIAN * 0.49 * STD DEV * 0.22 * RANGE * 0.30 TO 1.43 WITH 404 SAMPLES

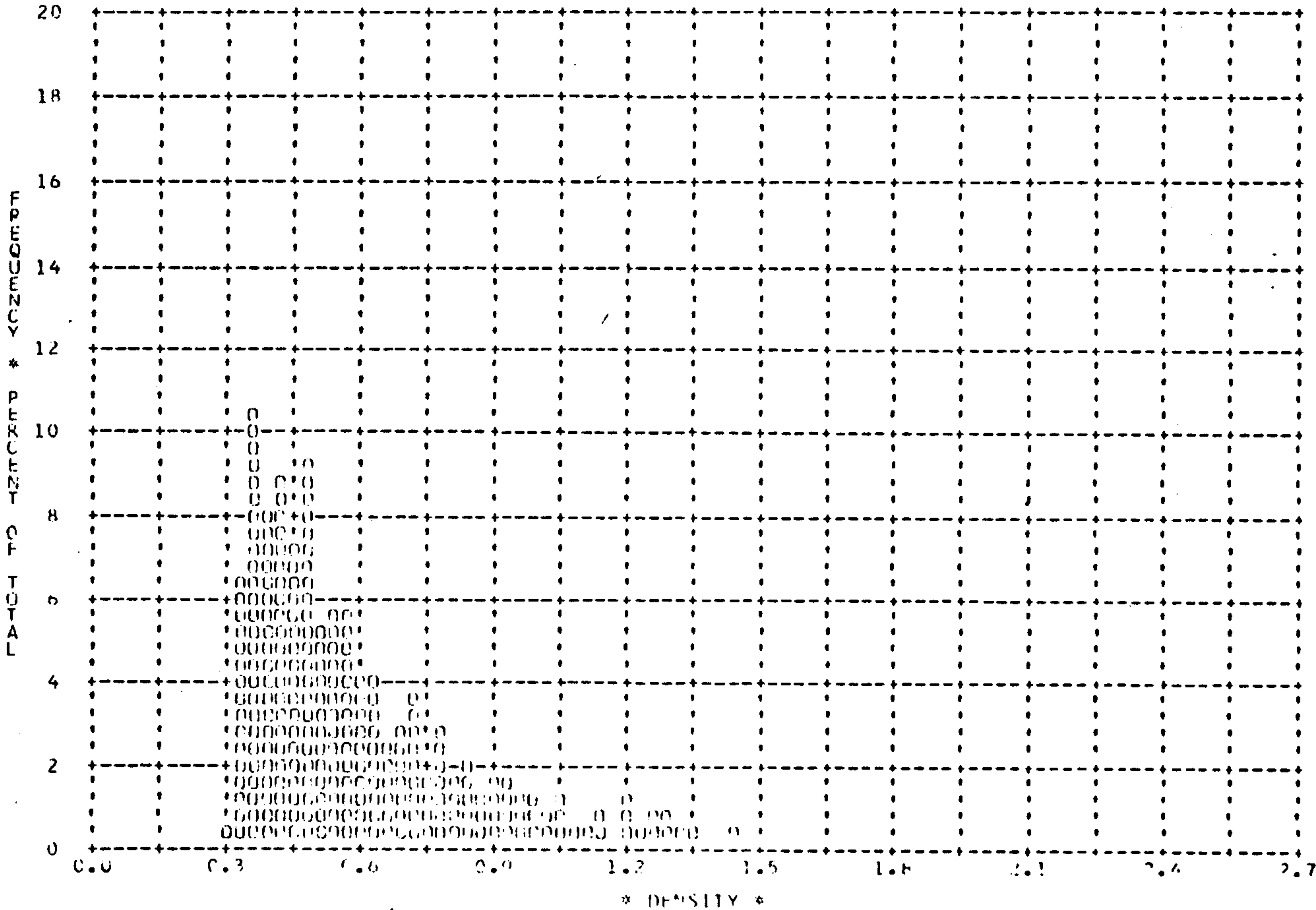


FIGURE 5-7

MISSION * 1105-1 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.38 * MEDIAN * 1.43 * STD DEV * 0.26 * RANGE * 0.58 TO 1.78 WITH 404 SAMPLES

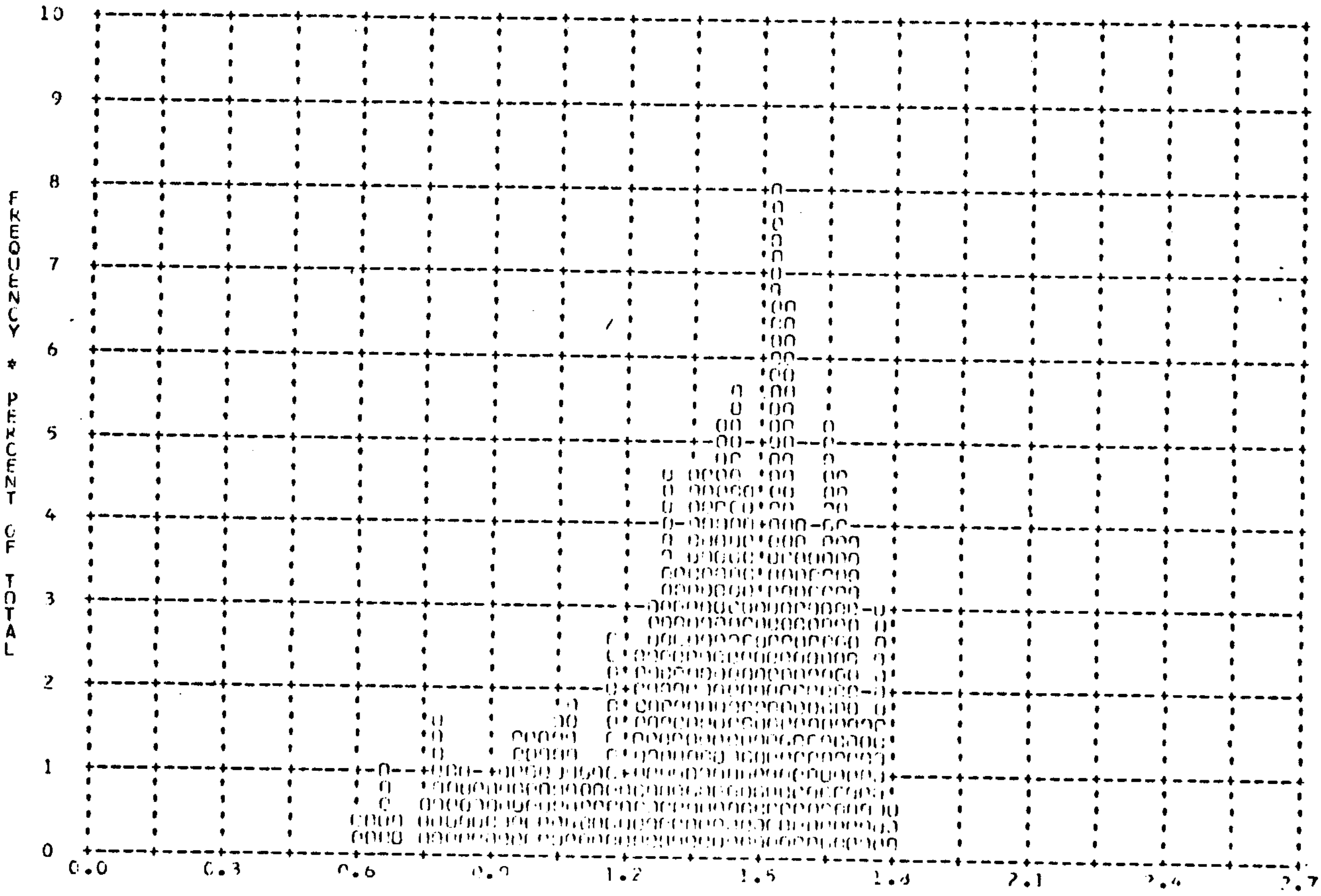


FIGURE 5-8

MISSION * 1105-1 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING, * DUAL GAMMA

ARITH MEAN * 0.57 * MEDIAN * 0.52 * STD DEV * 0.21 * RANGE * 0.30 TO 1.26 WITH 427 SAMPLES

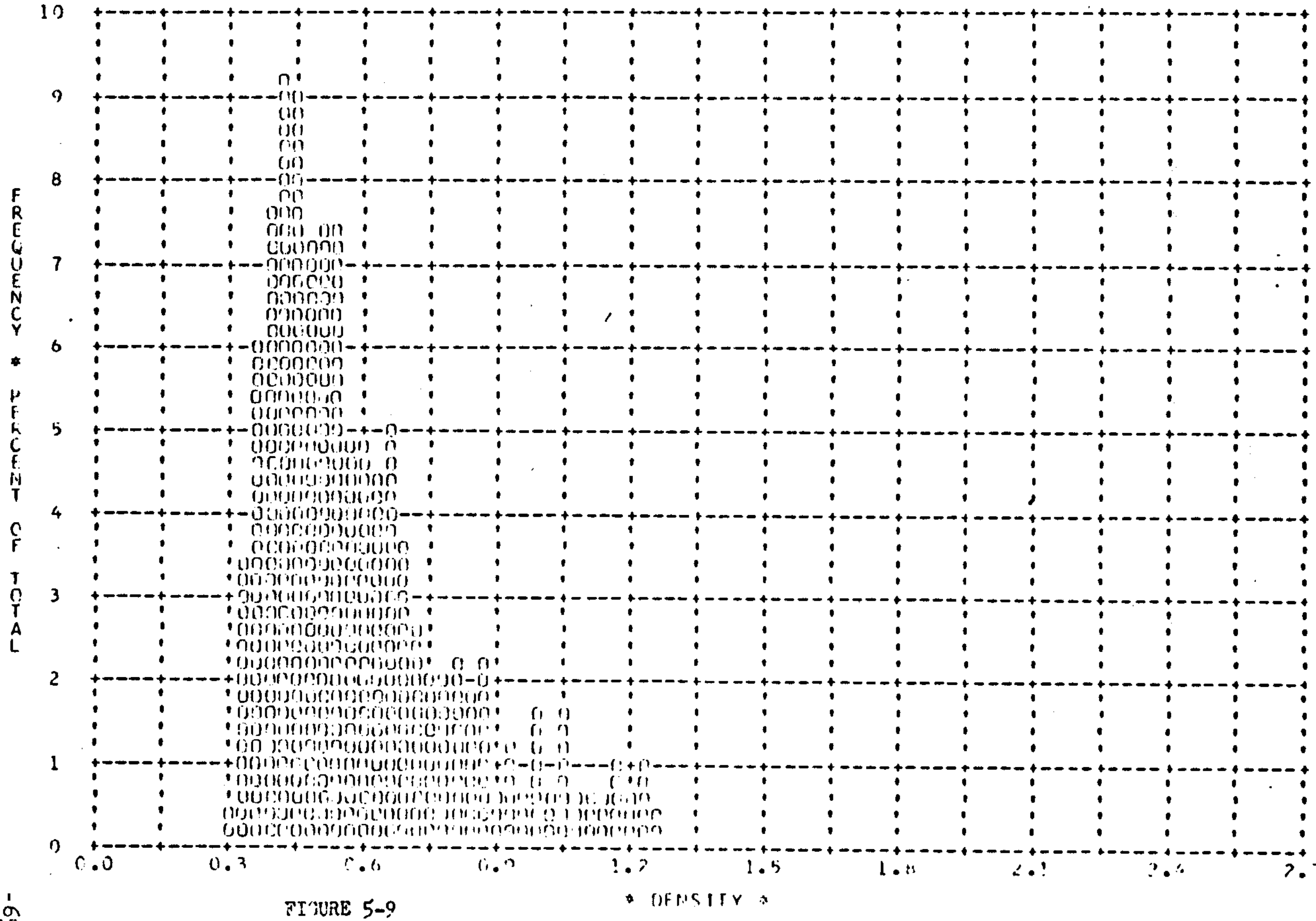


FIGURE 5-9

MISSION * 1105-1 * INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.37 * MEDIAN * 1.41 * STD DEV * 0.24 * RANGE * 0.60 TO 1.80 WITH 427 SAMPLES

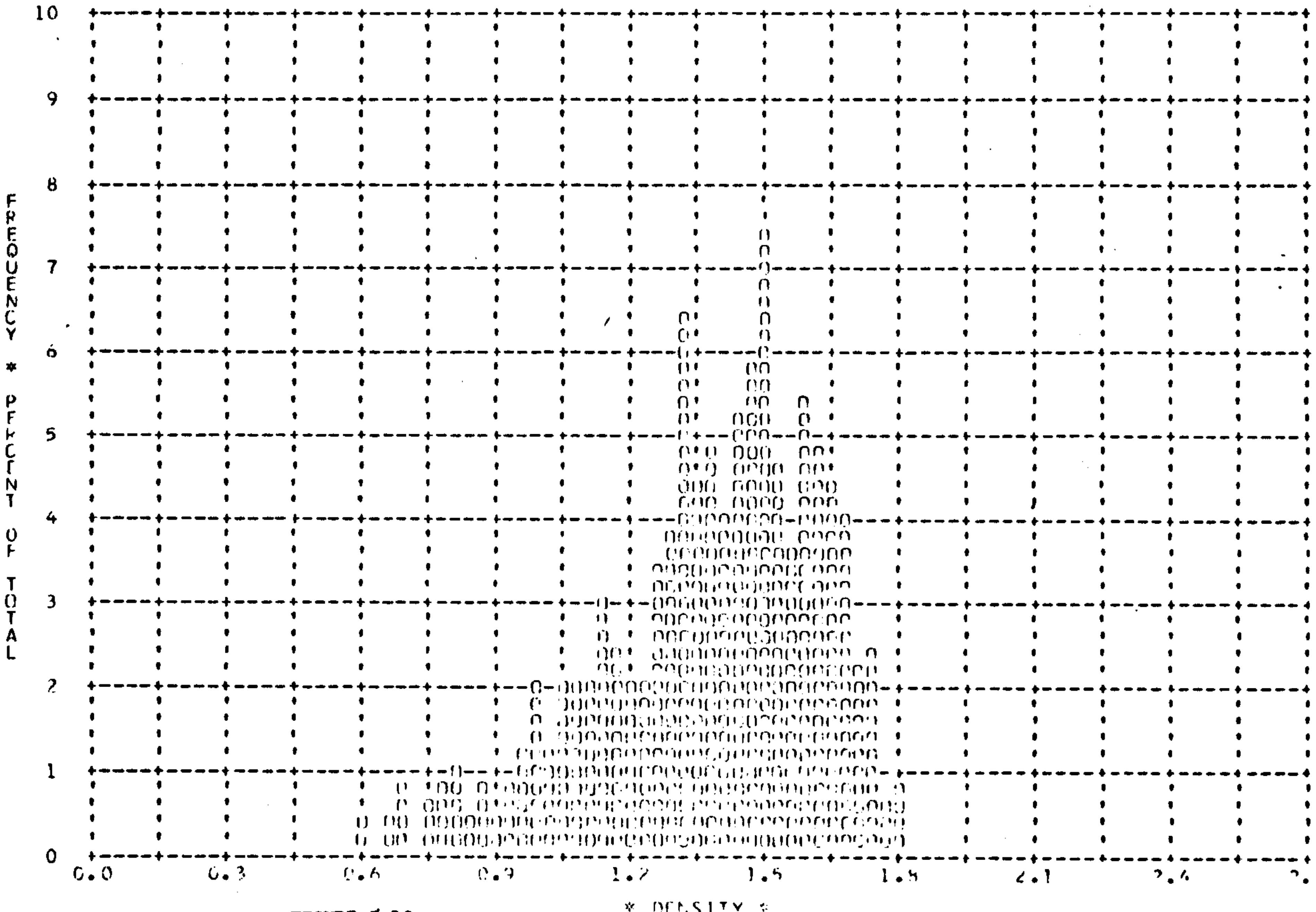


FIGURE 5-10

MISSION * 1105-2 * INSTR * FWD * 1/17/69 PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.49 * MEDIAN * 0.42 * STD DEV * 0.21 * RANGE * 0.29 TO 1.33 WITH 453 SAMPLES

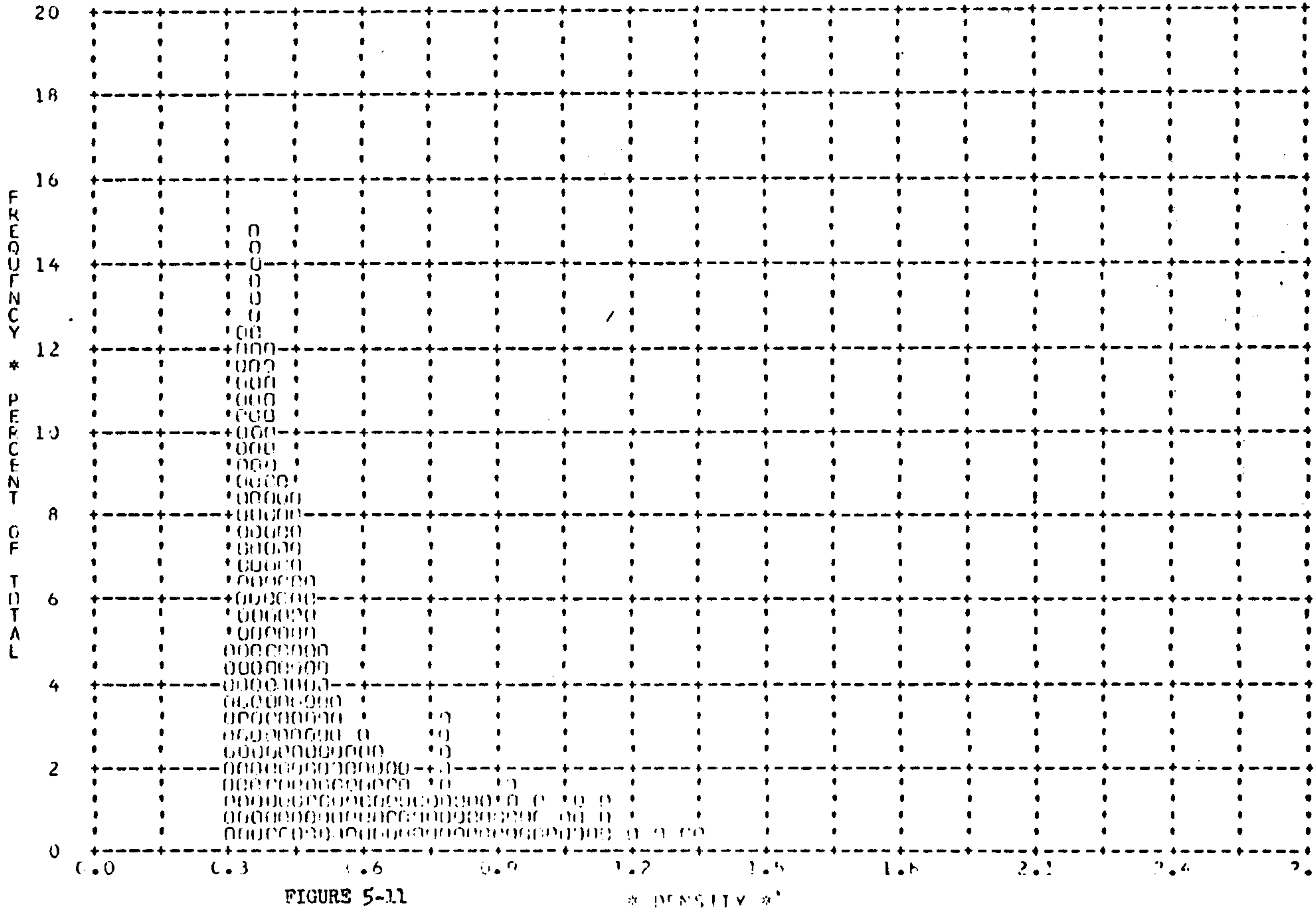


FIGURE 5-11

MISSION * 1105-2 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.34 * MEDIAN * 1.37 * STD DEV * 0.26 * RANGE * 0.56 TO 1.76 WITH 453 SAMPLES

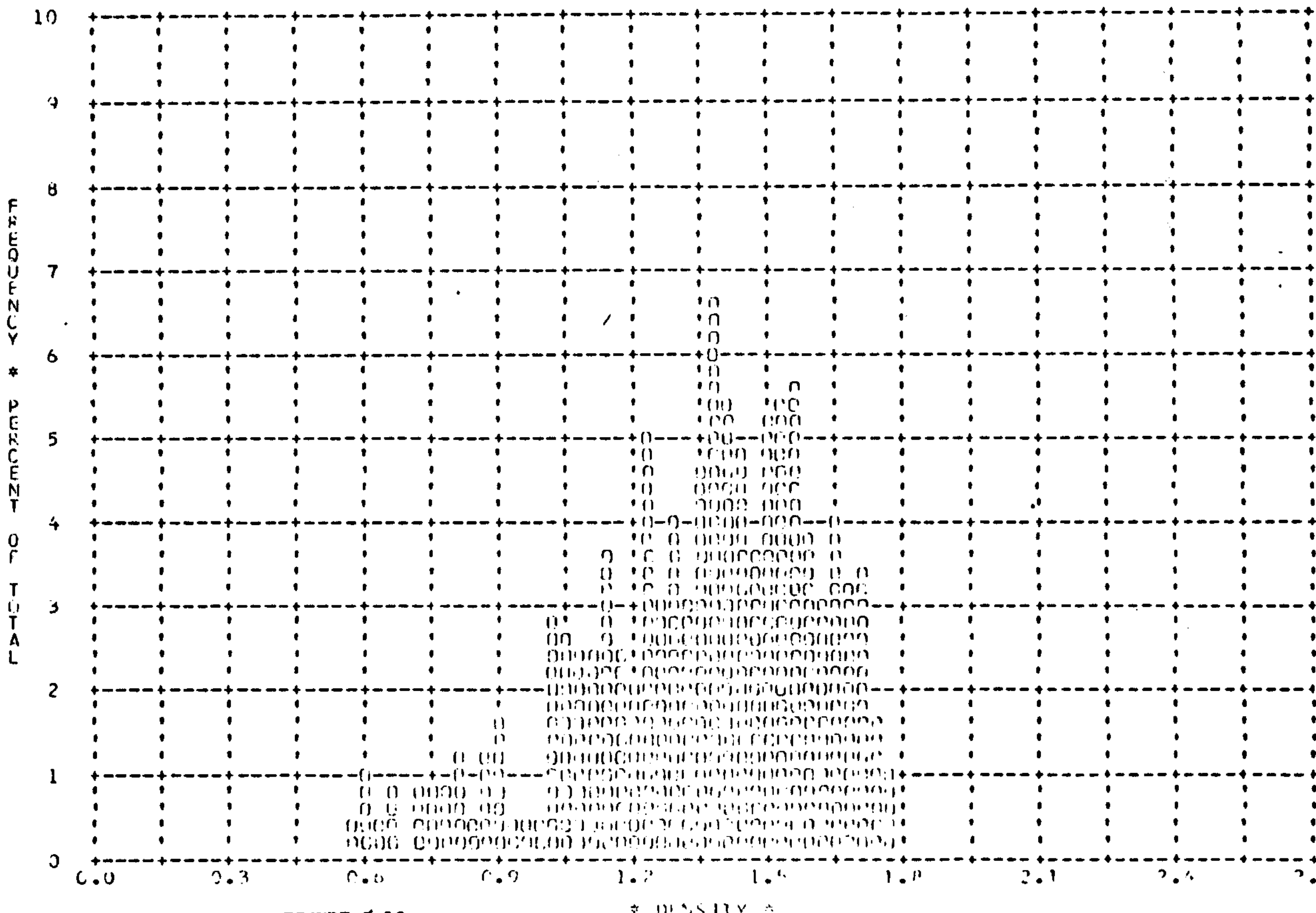


FIGURE 5-12

[redacted]

MISSION * 1105-2 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * **DUAL GAMMA**

ARITH MEAN * 0.52 * MEDIAN * 0.44 * STD DEV * 0.21 * RANGE * 0.29 TO 1.27 WITH 467 SAMPLES

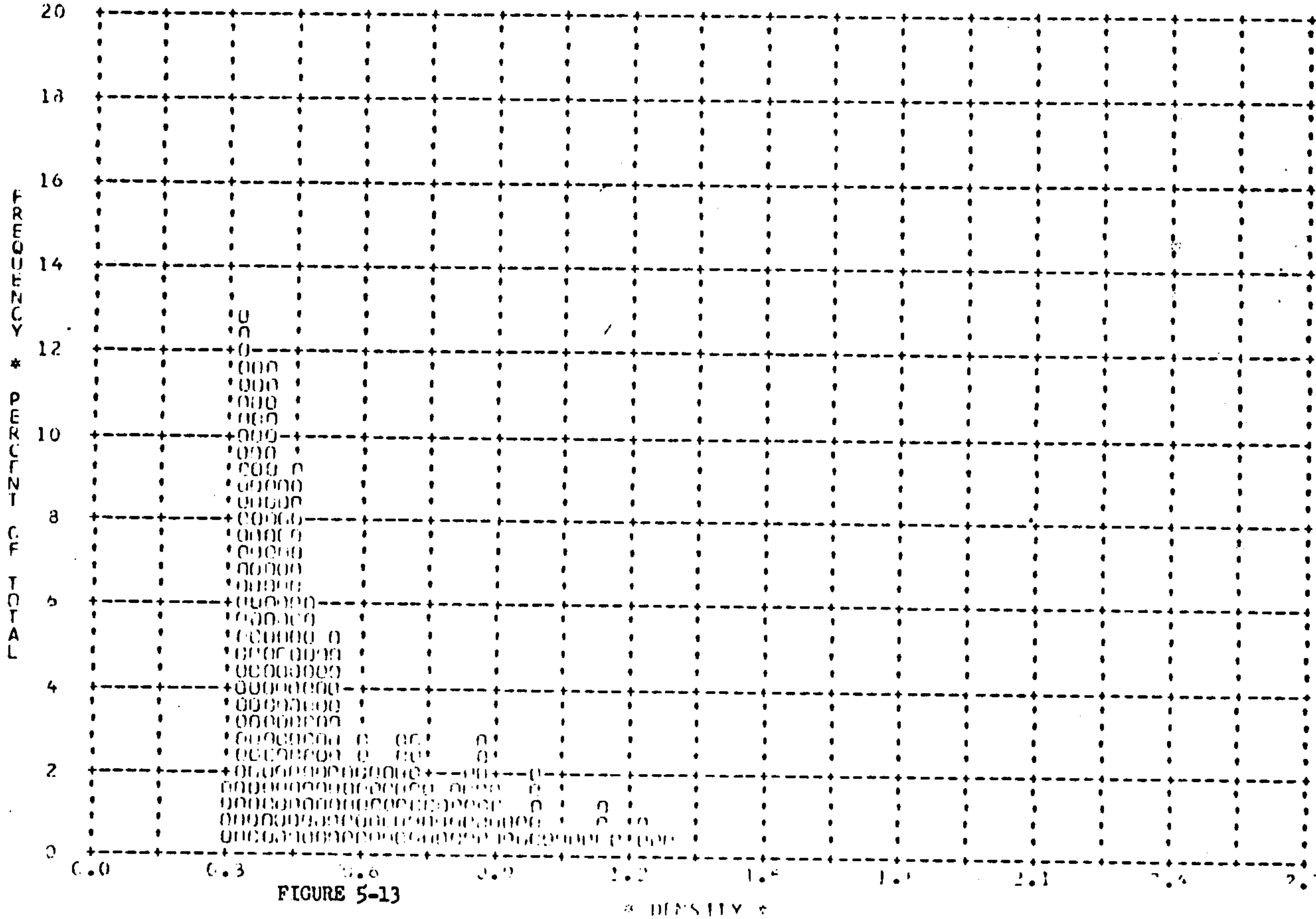


FIGURE 5-13

MISSION * 1105-2 * INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.35 * MEDIAN * 1.40 * STD DEV * 0.25 * RANGE * 0.46 TO 1.76 WITH 467 SAMPLES

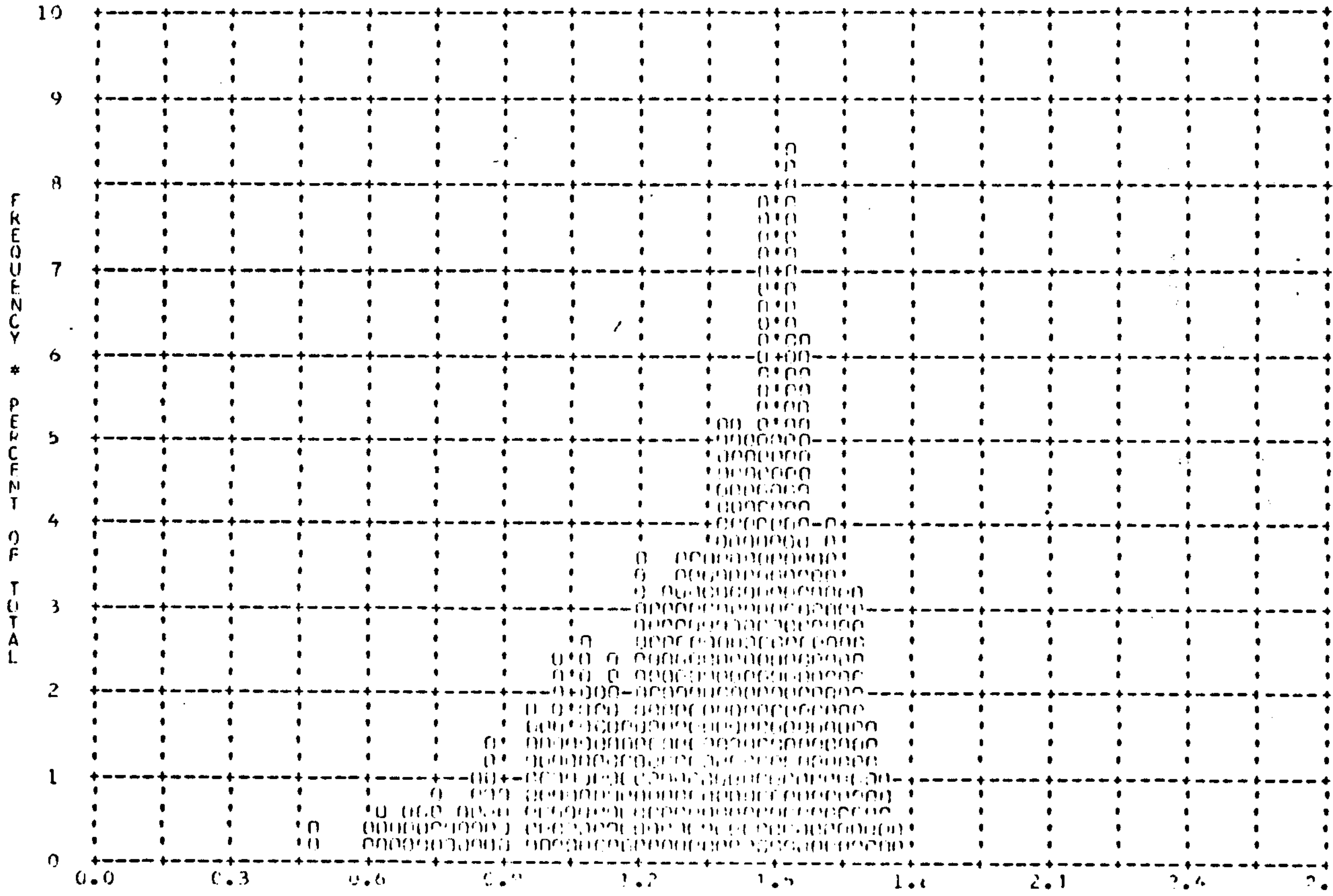


FIGURE 5-14

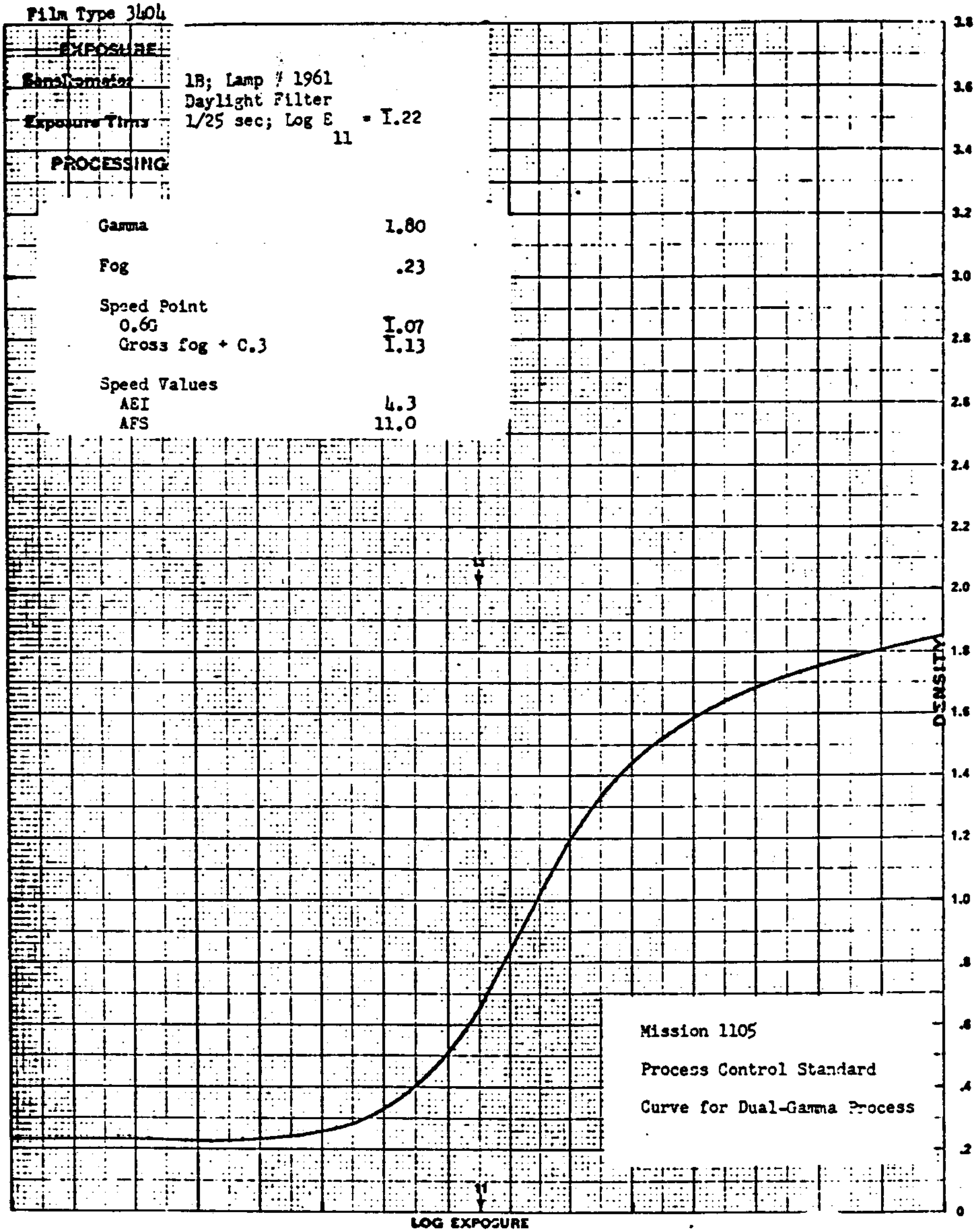

Film Type 3404
EXPOSURE
Sensitometer 1B; Lamp # 1961
Daylight Filter
Exposure Time 1/25 sec; Log E11 = Ī.22
PROCESSING
Gamma 1.80
Fog .23
Speed Point
0.6G Ī.07
Gross fog + 0.3 Ī.13
Speed Values
AEI 4.3
AFS 11.0
Mission 1105
Process Control Standard
Curve for Dual-Gamma Process
DENSITY
LOG EXPOSURE
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0

FIGURE 5-15

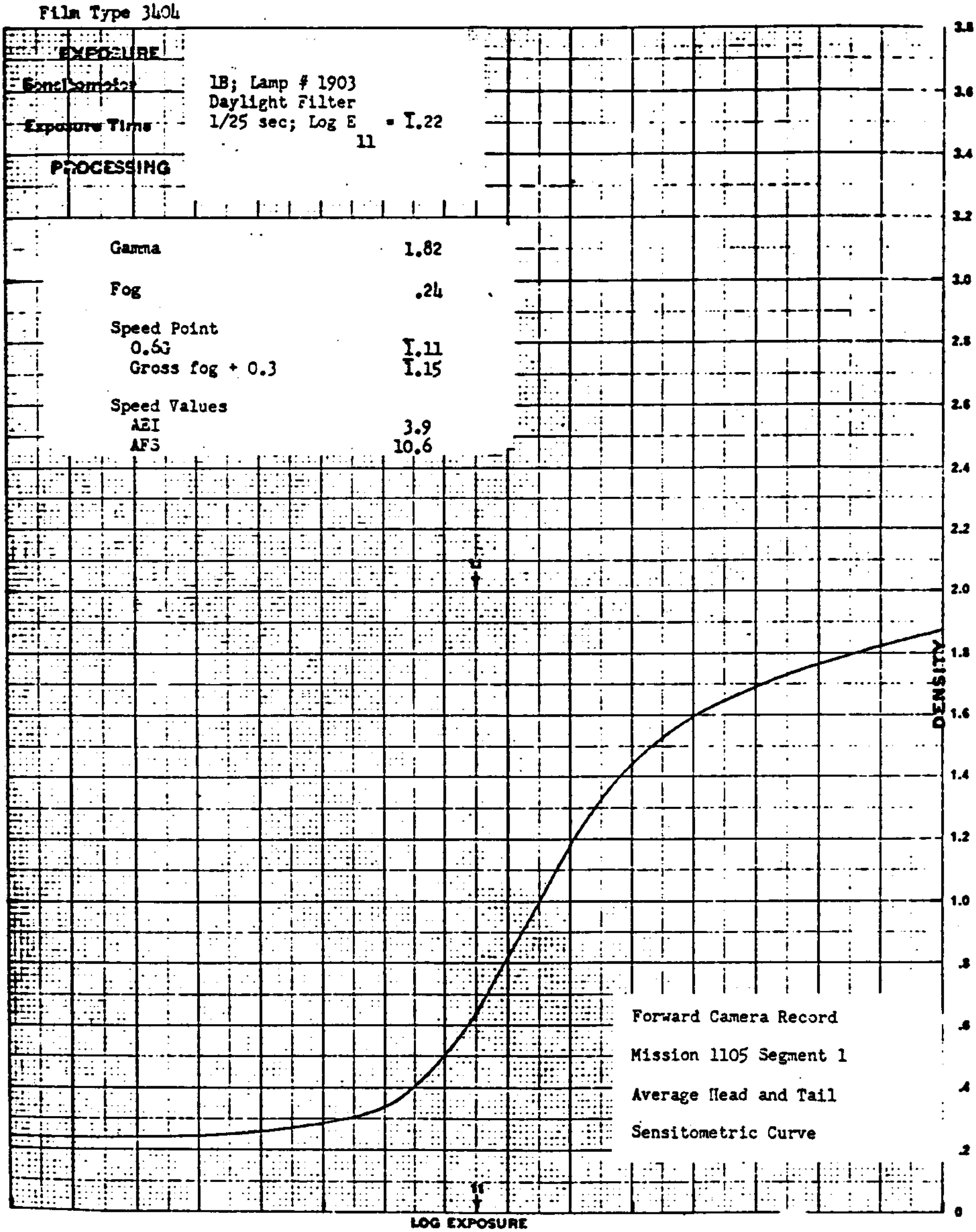

Film Type 3404
EXPOSURE
Sensitometer
1B; Lamp # 1903
Daylight Filter
Exposure Time
1/25 sec; Log E_{11} = $\bar{1}.22$
PROCESSING
Gamma 1.82
Fog .24
Speed Point
0.6G $\bar{1}.11$
Gross fog + 0.3 $\bar{1}.15$
Speed Values
AEI 3.9
AFS 10.6
Forward Camera Record
Mission 1105 Segment 1
Average Head and Tail
Sensitometric Curve
DENSITY
LOG EXPOSURE
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0

FIGURE 5-16

Film Type SO-380-157-5

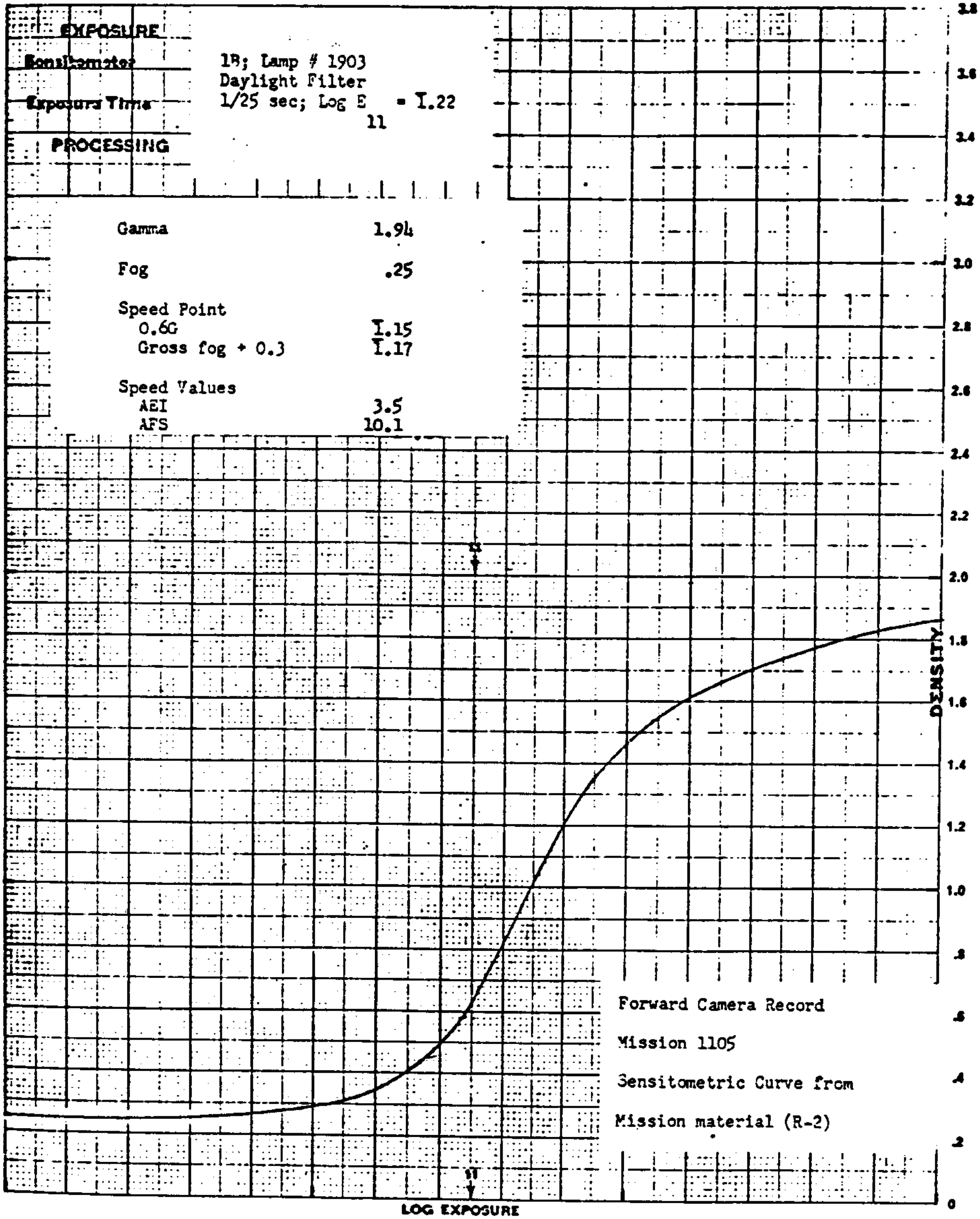


FIGURE 5-17

The processing agency has supplied [redacted] density values of specific targets for Mission 1105. Target density values are shown in Table 5-2 for the FWD and AFT cameras of Mission 1105. The frame D-min values were obtained using a 500 micrometer spot diameter. All target densities shown were made with microdensity equipment using an 11.5 micrometer spot diameter. Included in Table 5-2 is the process agency's recommended exposure level change for each target listed. The vast majority of targets listed are shown as being correctly exposed based on a subjective evaluation of the target area even though the target and frame D-min value is less than 0.4. This appears to justify setting Mission 1105 cameras for a slight underexposure as shown in Figures 5-1 thru 5-6 and verified by Table 5-1 for Mission 1105-1 and -2.

Table 5-2

TARGET DENSITIES [redacted]: MISSION 1105 FORWARD LOOKING CAMERA

TARGET I.D.	FWD CAMERA TARGET NUMBER	FRAME[1] D-MIN 500 SPOT	TARGET[2] D-MIN 11.5 SPOT	TARGET[2] D-MAX 11.5 SPOT	TARGET* D-DB	RECOMMENDED* EV
Test Tower	1	.44	.30	1.58	1.16	-.67
Test Tower	2	.44	.54	1.14	.83	0
Stockpiles	3	.50	.48	1.67	1.23	0
Ship at Dock	4	.50	.30	1.51	.72	0
Radar Antenna	5	.38	.40	1.44	1.04	0
Airplane on Runway	6	.36	.69	.96	.80	0
Launch Pad Structure	7	.41	.31	1.23	.83	0
Stockpiles	8	.50	.31	.97	.63	+.33
Launch Pad Structure	9	.78	.58	1.79	.95	0
Stockpiles	10	.36	.44	1.23	.82	0
Ship at Dock	11	.36	.31	1.34	.55	0

Table 5-2

TARGET DENSITIES [redacted] MISSION 1105 AFT LOOKING CAMERA

TARGET I.D.	AFT CAMERA TARGET NUMBER	FRAME[1] D-MIN	TARGET[2] D-MIN	TARGET[2] D-MAX	TARGET* D-DB	RECOMMENDED* EV
Test Tower	1	.50	.33	1.36	.80	0
Test Tower	2	.61	.65	1.33	.85	0
Stockpiles	3	.50	.59	1.70	1.37	0
Ship at Dock	4	.44	.30	1.36	.78	0
Radar Antenna	5	.43	.47	1.29	.95	0
Airplane on Runway	6	.40	.37	.61	.45	+.67
Launch Pad Structure	7	.46	.34	1.19	.80	0
Stockpiles	8	.48	.38	1.16	.68	+.33
Launch Pad Structure	9	.68	.40	1.52	.91	0
Stockpiles	10	.46	.41	1.08	.85	0
Ship at Dock	11	.46	.34	1.27	.63	0

NOTE: 1. Frame D-min values were obtained using a 500 micrometer spot diameter.

2. Target D-min and D-max densities were obtained using an 11.5 micrometer spot diameter.

* Target D-DB densities and exposure recommendations are subjective values provided by the processing agency and do not necessarily represent the consensus of the community.

The [redacted] exposure criteria for optimum Target resolution corresponds to Log E $\bar{1}.30$ meter candle seconds. Referring to the D Log E curve for SO-380 film (Figure 5-17) Mission 1105, optimum exposure corresponds to a Target design brightness density (Target D-DB in Table 5-2) of 0.78. A comparison of the 0.78 density criteria with the Target D-DB values in Table 5-3 shows that most targets were somewhat overexposed. However, in most cases overexposure is very minor. Examples of excessive overexposure are Targets #1, 3, and 5 for the FWD camera and Target #5 for the AFT camera. Examples of excessive underexposure are targets #8 and 11 for the FWD camera and Targets #6, 8 and 11 for the AFT camera.

In summary, the average target exposure for Mission 1105 was correct and within the acceptable [redacted] exposure criteria. In the near future starting with Mission 1106 the basic exposure criteria shown in Figures 5-1 thru 5-6 will be based upon [redacted] data.

Solar direction, relative to system flight direction, was on the starboard side of the ground track. Table 5-3 shows the ranges of solar direction, elevation, and exposure time for Missions 1105-1 and -2 using film type SO-380.

TABLE 5-3

RANGE OF SOLAR ANGLE, EXPOSURE TIME: MISSIONS 1105-1 AND -2, FWD/AFT CAMERAS, FILM TYPE SO-380

		NORTHERN	SOUTHERN
Sun Elevation: (Degrees)	1105-1	4.7 to 59.2	61.3 to 65.6
	1105-2	0.8 to 63.7	73.1 to 75.8
Sun Direction: (Degrees)	1105-1	58.7 to 16.9	139.5 to 130.7
	1105-2	19.2 to -9.5	173.8 to 173.0
		FWD	AFT
Exposure Time: (Seconds)	1105-1	1/217 to 1/453	1/273 to 1/594
	1105-2	1/217 to 1/450	1/273 to 1/586

FILM TYPE SO-121 COLOR

The AFT camera was supplied with 500 feet of film type SO-121 color film at the tail end of Mission 1105-2. SO-121 film was exposed using a special filter number (W/2E + CC2C + 0.4 ND). The 0.4 ND component of the filter was necessary to compensate for the fast speed of SO-121 film relative to SO-380 film so that the slit widths, selected for SO-380 using the W-21 filter, could be used for SO-121. As a result the exposure times produced in flight were approximately the same for both film types. The SO-121 film was exposed in the AFT camera on Revs 273 to 283 as shown in Table 5-4.

TABLE 5-4: SO-121 COLOR FILM EXPOSURE - AFT CAMERA

Rev. No.	Slit Width (Inches)	Frame Count	Exposure Time (Seconds)	Sun Elevation (Degrees)	Sun Direction (Degrees) PORT SIDE
273	.192	56	1/433	27 to 34	-4.4
274	.192	27	1/438	32 to 35	-4.7
279	.271	17	1/302	28 to 30	-5.3
	.192	10	1/428	30 to 31	-5.4
281	.271	21	1/302	16 to 19	-4.7
	.192	5	1/429	19	-4.9
283	.271	19	1/298	12 to 14	-4.7
	.192	64	1/429	14 to 22	-4.9
	.138	59	1/555	61 to 69	-10.2

SECTION 6

IMAGE SMEAR

A. VEHICLE ATTITUDE

Vehicle attitude data, normally derived from the Stellar photography by NPIC, is not available for Mission 1105-1 and -2, due to the deletion of the DISIC camera system from this mission. However, analysis of TM records of vehicle attitude gas consumption throughout the flight revealed normal gas usage indicating that normal attitude control was maintained during Missions 1105-1 and -2. Further, a subjective evaluation of horizon imagery produced by the FWD and AFT cameras indicated that good vehicle attitude was maintained.

B. SMEAR ANALYSIS

Data containing the time word for each panoramic photograph are supplied by NPIC to A/P. These times are correlated with the LMSC Precision Fit ephemeris to produce an analysis of V/H error, and are then combined with the vehicle attitude data to produce the net image motion compensation (IMC) errors as well as the total intrack and crosstrack ground resolution limits. Since no Stellar attitude data was produced during Mission 1105, the IMC error and intrack/crosstrack resolution limits, normally shown in this section, cannot be calculated for Mission 1105. However, the normal V/H analysis was performed using the time word data supplied. The results of this analysis is presented in Section 3.

SECTION 7

Reliability estimates presented in this section begin with samples taken from the Mural Program, M-7 system. As a result most of the Mural Program and all of the "J" program have been included in the reliability analysis. The DISIC camera (1100 series missions) is treated separately from the Stellar-Index camera (1000 series missions).

Reliability estimates are shown for the primary category that includes the panoramic cameras, main panoramic door ejection, payload command and control, payload clock, and overall payload functioning on orbit. The secondary reliability category includes the auxiliary camera functions such as the DISIC and Horizon cameras.

Reliability estimates deal entirely with the payload. Only electrical and mechanical functions are considered. Vehicle failures are not included. Early recovery is treated as a complete mission provided that early termination was not caused by payload malfunction.

The following tabulation summarizes the reliability estimates for Mission 1105. A 50 per cent confidence level is used.

PRIMARY FUNCTION (M-7 and Up)	Opportunities To Operate	Failures	Estimated Reliability
Panoramic Cameras	226	3	98.4%
Panoramic Camera Doors	135	0	99.5%
Command and Control	14280 (Hrs)	2	96.8%
Clock	14280 (Hrs)	0	99.2%
Total Combined Functions above	-	-	96.6%
Recovery System	105	1	98.4%

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