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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1050-1 and 1050-2

FTV 1651, J-43

Approved: [redacted], Manager [redacted]
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TOP SECRET C[redacted]

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1651.

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 1050 which was launched on 19 March 1969.

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INTRODUCTION

This report presents the final performance evaluation of Corona Mission 1050. The purpose of this report is to define the performance characteristics of the J-43 payload system and to evaluate the technical aspects of the Mission, including analysis of inflight 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 preflight mission parameter planning, preparation of the flight program, inflight 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 Density measurements and MTF/AIM values are produced by the Air Force Special Projects Production Facility. Vehicle attitude readings and frame correlation times are provided by NPIC. The Processing Summary report is published 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 and limiting ground resolution, and also of illumination/exposure/processing components in order to investigate exposure criteria.

SECTION 1

MISSION SUMMARY

A. MISSION DESCRIPTION

Corona Satellite Mission 1050 was planned to acquire search, cartographic, and reconnaissance photography of selected terrain areas. Two mission segments were planned to total fifteen days of orbital operation. Both segments nominally would return approximately 6,000 panoramic frames of stereo photography per mission segment, each frame covering approximately 1,725 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 standard J-1 configuration, consisting of a space structure containing two panoramic cameras and associated control/support equipment, with separate stellar-index cameras and recovery subsystems for each mission segment. Figure 1-1 shows the Inboard Profile of the J-43 system with major components designated.

The flight system was launched into orbit from Vandenberg AFB at 21:38Z on 19 March 1969. The orbit achieved was well within the planned parameters. Photographic operations were initiated on Rev 1 without incident. Camera operations continued to be programmed as planned through Rev 22. During

Rev 22 an Agena attitude control system failure occurred, causing loss of control in the Yaw axis. At this point, the flight system continued to rotate completely around 360 degrees at a typical rate of 1800 degrees per hour. Drag on the system became excessive. It became apparent that early Lifeboat recovery would be necessary because of high orbit decay. Early recovery was effected on Revs 34 and 50 by air catch. The first segment of the flight contained 57% of a normal film load. The second segment recovery system was filled to capacity with film.

Photographic performance of both panoramic cameras through pass D-22 of Mission 1050-1 was rated good. Following pass D-22 and to the end of the -2 segment, image quality was fair to poor due to varying image smear with random examples of good imagery.

B. FLIGHT CONFIGURATION

VEHICLES:	THORAD Booster (SLV-2G)			035
	AGENA Satellite (SS-01B)			1651
	RECOVERY (SRV-MK5):	1050-1	USE -	737
		1050-2	USE -	738

PANORAMIC CAMERAS: Assembly No.	210 (Master)	211 (Slave)
MAIN: Look Direction	Forward	Aft
Slit (Inches)	0.100	0.080
Filter (Wratten Type)	23A	21
Aperture (T/Number)	4.0	4.0
Focal Length (Inches) (Vacuum)	24.0001	24.0010

COMPONENTS		1050-1	1050-2
Clock		611	611
Film Cassettes:			
	Supply	53	53
	Take-up	T103E	T104E
Pressure Make-up System		1037	1037
Orbit Sine Function Generator		635	635

		Forward Looking (210)		Aft Looking (211)	
HORIZON:	Location	Input	Output	Input	Output
	Look Direction	Port	Starboard	Starboard	Port
	Exposure Time (seconds)	1/100	1/100	1/100	1/100
	Filter (Wratten Type)	25	25	25	25
	Aperture (F/number)	6.3	8.0	8.0	6.3
	Focal Length (millimeters)	55.0	55.0	55.0	55.0
FILM	Kodak Type	SO-230		SO-230	
	Length (feet)	16300		16300	
	Emulsion No., date	104, Feb. 69		104, Jan. 69	
	No. Splices	7		7	
STELLAR/INDEX CAMERAS		1050-1		1050-2	
ASSEMBLY NO.		D-113		D-114	
STELLAR:	Reseau No.	145		143	
	Exposure Time (seconds)	1.8		1.7	
	Aperture (F/number)	1.8		1.8	
	Focal Length (millimeters)	85		85	
	Film (Kodak Type)	3401		3401	
	Emulsion No., Date	288, Jan. 69		288, Jan. 69	
INDEX:	Reseau No.	141		142	
	Exposure Time (seconds)	1/400		1/420	
	Filter (Wratten Type)	21		21	
	Aperture (F/number)	4.5		4.5	
	Local Length (millimeters)	38.18		38.39	
	Film (Kodak Type)	3400		3400	
	Emulsion No., Date	189, Dec. 68		189, Dec. 68	

SCHEMATIC INBOARD PROFILE - CORONA J SYSTEM

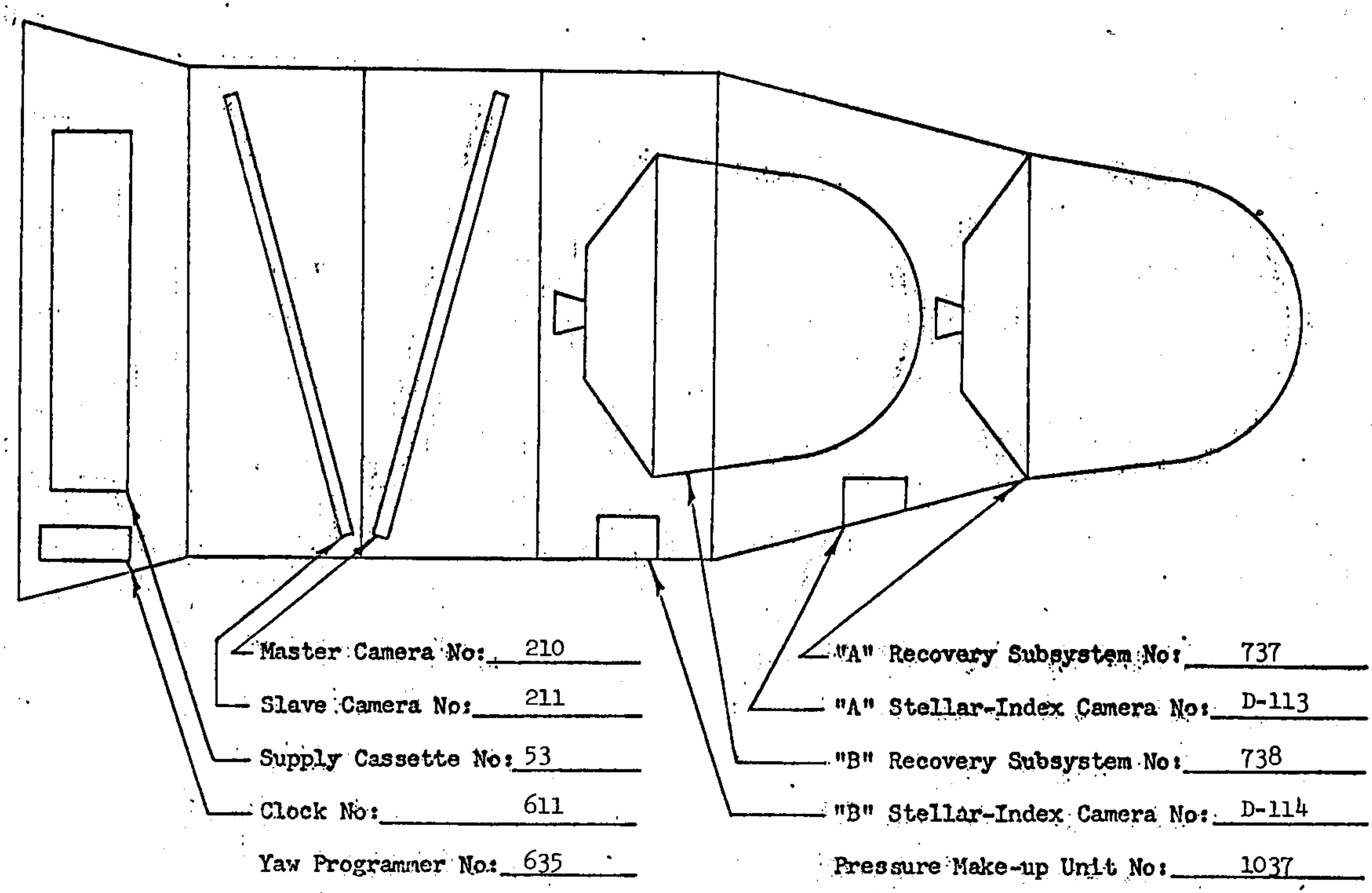


FIGURE 1-1

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 to resolve any system problem that may exist and to demonstrate that the system will perform satisfactorily in flight. The principal tests include exposure of the J payload to a thermal/altitude environment that approximates flight conditions, system light leak, dynamic resolution, flight readiness, and flight certification.

The J-43 system successfully passed all phases of the testing operations providing acceptable performance and a high degree of operational confidence.

B. ENVIRONMENTAL TEST

The primary purpose of the environmental testing was to determine the corona discharge marking characteristics of the panoramic and stellar/index cameras with flight type film during operation at altitude. The first environmental test conducted 15-22 November 1966 was not considered acceptable because of excessive corona marking by the Master camera on film type 3404. The system was completely dependent upon the pressure make-up system for corona-free functions. Other anomalies were observed in the time trace and data recording along with heavy film scratches.

The time trace on both instruments gradually switched from 200 PPS to 400 PPS early in the "A" SRV test, then back to 200 PPS after 29 instrument operations. No slur pulse was noted during these operations, but did occur during the subsequent normal-appearing operations. The slave time trace was noted to turn on after scan start (typically 1 to 8 inches) for the first frame of operations late in the "B" SRV test. The cameras and clock were later checked. The problem mode was not reproduced, and the problem did not recur in subsequent testing.

Dimming of the serial number, data block indices, and H.O. fiducials on both instruments was frequently noted, especially near the end of the "B" test. The master was affected to an unacceptable level. This condition was remedied and verified during later testing.

Physical marking of the film was pronounced on the master camera. A heavy pressure mark or abrasion was noted occasionally just outside the rail mark on the time trace side. Heavy scan head scratches were noted throughout the test along the slave time trace, but not in the format area; these scratches would interfere with post-flight time trace measurements. The cameras were subsequently cleaned and the scan head rollers honed. This marking did not appear during later tests.

The second environmental test, conducted 27-31 January 1967 using film type 3404, was designed primarily to demonstrate that replacement of the master camera metering rollers would eliminate the unacceptable corona marking. The test was completely successful. No corona of any type was noted on the master film. However, the slave, which had been corona-free during the first test, showed a tendency to develop light to medium acceptable startup-type corona during the second test. All major anomalies noted during the first test were absent during the second test. The data recording was consistently good.

After prolonged storage, the system was refurbished and subjected to a final HIVOS test from 25 September to 2 October 1968. The test consisted of programming film type SO-230 through the panoramic camera during a flight simulated thermal profile under vacuum conditions. The total pan camera film consumed during the HIVOS test was as follows:

	Pan Camera Film Consumption (Footage)	
	Master (#210)	Slave (#211)
"A" SRV	7920	7670
"B" SRV	7710	7750

In addition S/I #D-123 and S/I #D-124(B) were tested with film type 3401 in the stellar film paths and film type 3400 in the index film paths.

The processed film types were examined and the following observations noted.

CAMERA #210 (MASTER) FINAL TEST

Instrument #210 exhibited minor acceptable start-up corona. Low density corona, 0.01 to 0.04 density above the base plus fog level, occurred on the 28th and 29th frame of the pressure sweep at an internal system pressure of 11 to 12 microns. Although the corona that occurred during the pressure sweep was minor it was unacceptable per the J-1 requirement specification. However, because of the singular occurrence of low density corona during the pressure sweep, a waiver was recommended.

The time track, binary word, start of pass mark, H.O. fiducials, and H.O. shutter exposure lamps were all present and acceptable. The serial number exhibited excessive blooming. Plus density marks and multiple scratches were present in the format area of both horizon cameras. Marking was attributed to excessive horizon camera clamp pressure and interference with the test film. The horizon clamps were corrected to a flight acceptable configuration on 23 November 1968. The rail scratches were moderately heavy.

CAMERA #211 (SLAVE) FINAL TEST

No corona static was evidenced in the processed test film. All of the auxiliary data recording was acceptable. One extra pulse was present in the time track record on approximately 5 to 10% of the panoramic formats. The extra pulse was generated by an electrical transient from the center of format switch. Rail scratches were considered light to moderate.

All five Permacel splices examined in the Master and Slave test films were excellent. No splice adhesive or tacking was evidenced.

S/I #D-123 ("A" SRV) FINAL TEST

Approximately 75% of the stellar formats were affected by corona fog outside the active format area. This was an unacceptable level per the J-1 requirement specification. Since the corona occurred outside the active format and did not interfere with stellar imagery a waiver was recommended. No corona was observed on the index film exhibit.

Twenty-two double exposed stellar/index formats were observed. A faulty metering solenoid caused the multiple exposures. The solenoid was repaired on 17 October 1968. The reseau, serial number, and correlation lamp images were all acceptable.

S/I #D-124 ("B" SRV) FINAL TEST

The stellar formats contained minor acceptable corona marking while the index contained no corona. All auxiliary data recording was acceptable.

C. LIGHT LEAK TESTING

The J-43 system was subjected to the Light Leak test on 23 September 1968. Film type 3401 was subsequently processed and evaluated with the following observations noted.

An unacceptable light leak fogged the test film from both panoramic cameras. Fogging occurred in the vicinity of the fairing/"A" SRV interface at the teardrop fitting (-Z axis). The fog was +0.6 density above the base level on the test film from the Master camera (#210) and +0.25 density above the base level on the film from the Slave camera (#211). In addition, the Slave camera contained minor acceptable fog in the platen area.

The J-43 system was examined and the unacceptable light leak at the fairing/"A" SRV interface was corrected. A light search conducted on 17 October 1968 verified that the light leak had been eliminated.

D. RESOLUTION TESTING

The first J-43 system thru focus resolution test was performed 30 November 1966. During this test the Slave camera (#211) experienced interlock timing problems that significantly degraded bar target imagery in the FMC direction. The interlock was retimed, followed by a second test on 15 December 1966. Film type 3404 was employed for both tests. The test of 15 December 1966 was acceptable as shown in Table 2-1 for a collimator set to accommodate a camera lens vacuum focus shift of 0.016 inches.

However, subsequent to the above tests ITEK determined that the vacuum focus shift of the first generation Petzval lens was approximately 0.014 inches. As a consequence Instrument 210 was shimmed +0.0015 inches and Instrument 211 was shimmed +0.002 inches. A final resolution test conducted on 10 October 1968 verified that the shimmed instruments both produced acceptable results using film type SO-230. The peak resolution of Instruments 210 and 211 was 113 and 116 li/mm respectively at the -0.002 inch collimator position. The -0.002 inch collimator position is considered compatible with a standardized vacuum focus shift of 0.014 inches when the collimator is set for a vacuum focus shift of 0.016 inches.

The peak focus resolution values for each panoramic instrument are shown underlined in Table 2-1.

A/P resolution values shown in Table 2-1 were averaged values composed of 5 bar targets in the FMC direction plus 5 in the scan direction.

Instruments 210 and 211 met the minimum resolution acceptance criteria for the Corona J-1 Program.

E. FLIGHT READINESS AND CERTIFICATION

The J-43 panoramic cameras were subjected to the Flight Readiness test on 6/7 March 1969. Testing was performed using film type SO-230. Test films were subsequently processed and evaluated with the following noted.

The first test showed that the #6 binary time word lamp was out on camera #211. The A.O. shutter exposure, A.O. fiducials, time track, blanked pulse, start of pass mark, and all other time word lamp images were present on formats from camera #210 and #211. The #6 binary lamp was corrected and a second test performed to verify the correction. The second readiness test revealed that the #6 binary lamp of camera #211 was acceptable. However, the index bit of camera #211 was partially blocked. Inspection of the data head after its removal revealed blockage was caused by a foreign particle in the index lamp housing. A third test revealed that all auxiliary data recording imagery was present and acceptable for both cameras.

Minor minus density streaks present on the film from the first test of camera #210 were a result of foreign particles on the filter. The filter was cleaned. Subsequent tests verified that the minus density streaks had been corrected. No significant minus density streaks were observed in the film exhibits from camera #211.

Heavy rail scratches were present on all film exhibits from both cameras. Imagery of the format edge along the time word side of both cameras #210 and #211 showed some irregularity, indicating emulsion particle buildup along the rails. The film exhibits from camera #211 contained a minor intermittent scan head roller scratch on the time track outside the active format area. Very minor banding was observed on several frames of material from camera #210.

During the start of the final readiness test the A.O. exposure lamps burned out due to the inadvertent use of 400 cycle test power. As a result, the final readiness test payload contained no fogged A.O. formats.

The final processed readiness test film exhibits from S/I cameras #D-113 and #D-114 revealed acceptable camera performance. All auxiliary data such as imagery of the correlation lamp, reseau, reseau serial #, and shutter operation were present. The Stellar cameras employed film type 3401; the Index cameras, film type 3400.

The supply cassette of panoramic cameras #210 and #211 was loaded with flight film on 10 March 1969. The loading proceeded without incident. Spool 32A/T (Box 31) was installed for use by the Forward Looking camera (#210). Spool 146T from Box 68 was selected for use in the Aft Looking camera (#211). Both spools contained 16,300 feet of film type SO-230 with seven splices in each spool.

Film samples from each spool were removed, exposed on the sensitometer, processed, and evaluated. Sensitometric characteristics including film speed were acceptable.

The supply cassette and payload system were assembled. Electrical checks were made to verify the flight status of the payload. On 11 March 1969 the panoramic cameras were operated and approximately 79 feet of flight film were programmed through each camera. Film tracking through both cameras was good. Dry nitrogen gas purge was maintained in the supply cassette to minimize potential humidity anomalies with film type SO-230. Rail scratches were present on the emulsion side of both panoramic flight films. Film curl, concave on the emulsion side, was quite noticeable when observed through the fairing access door. Film curl did not appear to degrade the tracking characteristics of the system.

On 12 March 1969 the J-43 system light leak search demonstrated that the J-43 system was effectively sealed from all detrimental light leaks. No light leaks were detected by the light sensor.

The J-43 system was accepted for flight 12 March 1969.

TABLE 2-1

J-43 SYSTEM

THRU FOCUS LOW CONTRAST (2/1) RESOLUTION (Li/mm)

COLLIMATOR SET FOR VACUUM FOCUS SHIFT OF 0.016 INCHES

FILM TYPE: COLLIMATOR FOCUS (INCHES)	3404 BOSTON EAST COAST	SO-230 A/P TEST 10 OCT. 1968 BOSTON	[redacted]	3404 A/P TEST 15 DEC. 1966 BOSTON	[redacted]
		INSTRUMENT 210			
-0.005	-	63	57	-	-
-0.004	47	97	89	43	37
-0.003	-	109	103	-	-
-0.002	95	113	110	103	79
-0.001	123	96	94	110	94
0.000	120	90	93	105	89
+0.001	109	85	93	98	74
+0.002	97	-	-	94	68
+0.003	-	94		-	-
+0.004	96	-		95	70
+0.				-	
		INSTRUMENT 211			
-0.005		60	44		
-0.004	49	82	72	31	24
-0.003	-	101	94	-	
-0.002	96	116	109	60	51
-0.001	119	94	101	85	87
0.000	122	80	83	114	104
+0.001	110	72	82	117	104
+0.002	98	-	-	110	83
+0.003	-	83		-	
+0.004	89	-		94	64

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

The launch and orbit achieved by corona Mission 1050 occurred as scheduled and were well within the predicted performance envelope.

The nominal mission plan called for 15 days of photographic operation that would have produced approximately 240 revs. However, during Rev. 22 the Agena guidance system malfunctioned, causing the loss of attitude control in the yaw axis. Because of the loss of attitude, vehicle drag became excessive which required early recovery.

Mission 1050-1 was terminated on Rev. 34 by air catch. Mission 1050-2 was recovered by air catch on Rev. 50.

The camera system functioned well throughout the mission, using film type SO-230. The -1 segment of Mission 1050 was filled to 58% of capacity; the -2 segment was filled to 100% of capacity.

B. LAUNCH/ORBIT

Corona Mission 1050 was launched from VAFB at 21:38Z (13:38 PST) on 19 March 1969. Launch, ascent, and injection events were normal and occurred as programmed. Agena flight vehicle S/N 1651 was boosted by Thorad missile S/N 035.

The orbit achieved was as planned and within the 3 sigma dispersion. The orbit is described by the following Rev. 2 parameters:

	Predicted	Actual
Period (minutes)	88.67	88.61
Perigee (nautical miles)	90.8	90.6
Apogee (nautical miles)	136.7	134.6
Eccentricity	.0065	.0063
Inclination (degrees)	83.00	82.99
Argument of Perigee (degrees)	159	154

A drag make-up (DMU) rocket was fired on Revs. 2 and 14. The DMU firing on Rev. 2 was required to achieve the nominal orbit while the Rev. 14 firing was utilized for period control. Additional firings were not attempted due to the unstable attitude conditions that existed after Rev. 22.

The DMU rocket performance is shown as follows:

Rocket No.	Rev.	Period Increase Seconds	Velocity Increase ft./sec.	Impulse lb./sec.
1	2	8.5	13.7	1720
2	14	10.15	16.4	2028

C. PHOTOGRAPHIC OPERATIONS

The first photographic operation occurred during Rev. 1[redacted]acquisition. This was a short stereo confidence run. Reconnaissance operations began on Rev. 2.

There were 35 photographic operations during Mission 1050-1 including 2 nighttime engineering checks programmed over the continental United States. Daytime domestic operations were implemented on Revs. 16 and 31. The first nighttime engineering check occurred on Rev. 9; the second occurred on Rev. 25. Reconnaissance operations during Mission 1050-1 were terminated on Rev. 31. Because of the loss of vehicle attitude control beginning on

Rev. 22, principally in the Yaw direction that caused excessive vehicle drag, photographic operations were accelerated and the average operate length was increased to accommodate early Mission 1050-1/-2 recovery.

The photographic operations for Mission 1050-2 began on Rev. 32 following a normal cut and wrap of 4 cycles.

Three consecutive engineering operations were programmed, consisting of 40 cycles on Rev. 32 over the continental United States, 4 cycles on Rev. 34 over Alaska, and 11 cycles on Rev. 34 over Hawaii. Reconnaissance photography began on Rev. 35. There were 46 inflight photographic operations during Mission 1050-2. Domestic engineering operations occurred on Revs. 32, 47, and 48.

D. PANORAMIC CAMERA PERFORMANCE

Both panoramic cameras indicated normal operation throughout the flight. Camera system dynamic operation, 99/101 clutch, start-up, shutdown, and film transport functions were normal on the observed engineering operations over the [redacted] tracking station.

The cut and wrap operation and transfer to the -2 recovery system was normal on Rev. 32 over the [redacted] tracking station. The Kik-Zorro 38 command (early -1 to -2 switchover) was utilized.

The panoramic film was not depleted on either instrument.

The cycle rates obtained from the engineering operations over the [redacted] tracking station are shown in Table 3-1.

Film consumption during Missions 1050-1 and -2 is shown as follows:

	Camera #210	Camera #211
Pre-Launch	83	81
1050-1	1714	1723
1050-2	3106	3121
Total	4903	4925

Due to the loss of yaw attitude control on Rev. 22 satellite drag was excessive, necessitating early recovery of both mission segments. Early recovery required that approximately 1227 and 1225 frames be left unexpended in the flight system. The "A" SRV was only 58% full. The "B" SRV was filled to capacity.

A satisfactory ramp-to-orbit match was maintained during the -1 mission. The FMC errors for some operations during the -2 mission were slightly greater than normally considered acceptable. Due to fast orbit decay, the emphasis during the -2 mission was maximum film utilization in the shortest period of time. This was accomplished by utilizing the programs with the maximum coverage.

The maximum ground track error experienced through Rev. 22 was 13 nautical miles east of nominal.

E. STELLAR/INDEX CAMERAS

The -1 and -2 stellar/index cameras functioned normally throughout the flight. Telemetry data indicated the programmer, metering functions, and shutter monitor performed satisfactorily on the observed engineering passes. The stellar and index cameras contained film at the end of the -2 mission.

TABLE 3-1

PANORAMIC CAMERA CYCLE RATE DATA

	Ramp				Camera #210			Camera #211			
Rev.	R	A	Time Up Ramp (Secs)	System Calib. (Secs)	Actual (Secs)	Unit Dev. %	System Dev. %	Actual (Secs)	Unit Dev. %	System Dev. %	210/211 Difference %
09	3	8	80	2.792	2.810	.57 S	.63 S	2.781	.35 F	.41 F	-1.03
16	3	8	1763	2.217	2.250	1.26 S	1.50 S	2.230	.83 S	.60 S	- .89
25	3	8	250	2.771	2.750	.82 F	.75 F	2.750	.69 F	.75 F	0.0
32	3	7	1845	2.205	2.199	.57 F	.26 F	2.190	.37 F	.67 F	- .41
48	1	7	1901	2.187	2.181	.67 F	.28 F	2.172	.31 F	.69 F	- .41

Dev. = Deviation
F = Fast
S = Slow
R = Reference Level
A = Amplitude
Secs = Seconds

The "-" sign indicates Camera #210 is slower than Camera #211

F. INSTRUMENTATION AND COMMAND SYSTEM

The payload command system performed satisfactorily throughout the flight. The Uncle command link was utilized as the primary system and there were no reported problems.

The payload instrumentation system operation was normal throughout the flight with no anomalies reported.

G. CLOCK SYSTEM

The clock system operation was normal throughout the flight. Satisfactory time correlation between the flight clock and the [redacted] tracking station was obtained. The ratio of clock units to system time was 0.999999907265.

H. PRESSURE MAKE-UP SYSTEM PERFORMANCE

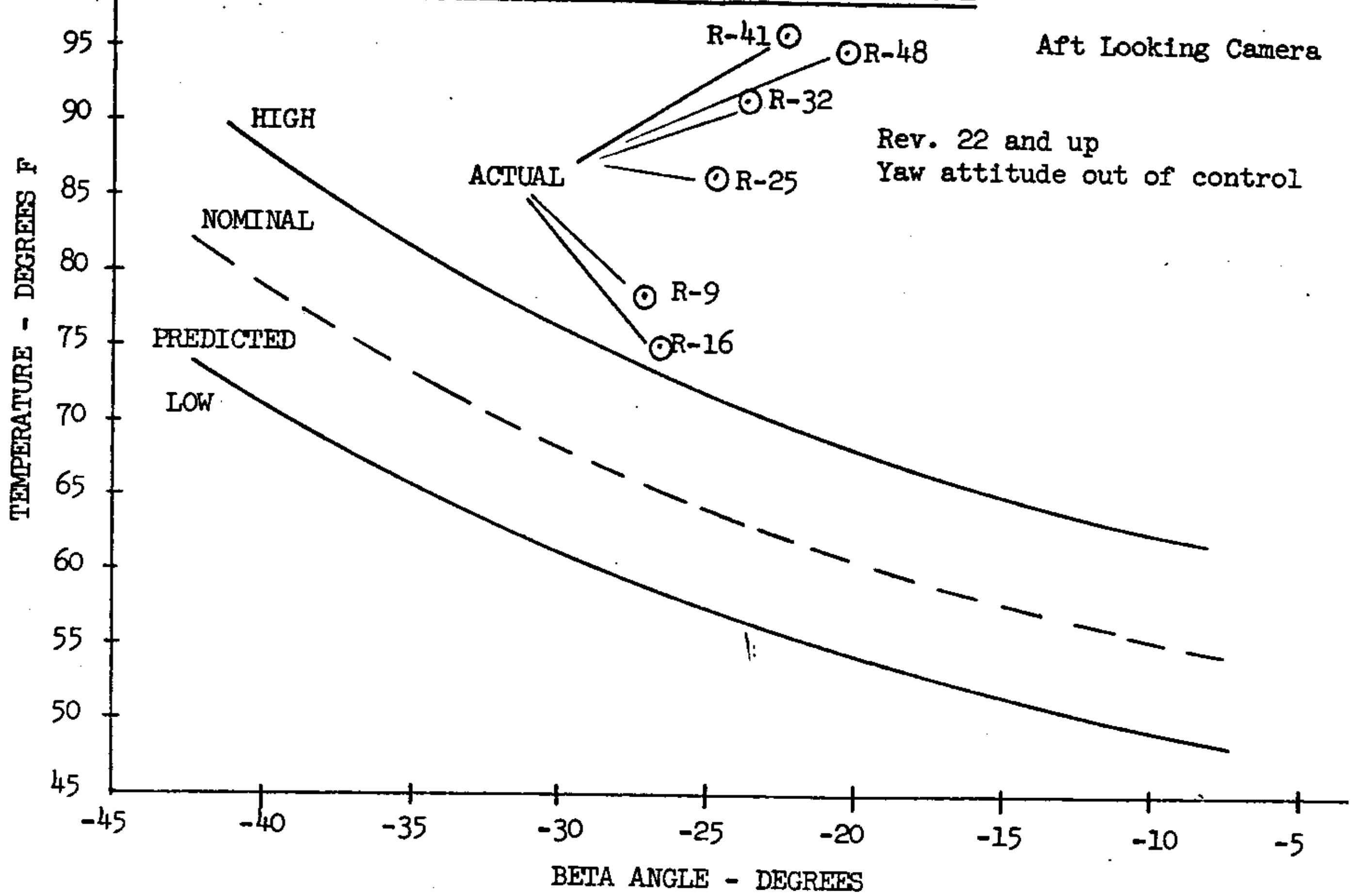
The pressure make-up system (PMU) operated satisfactorily throughout the flight. The total operate time was approximately 187 minutes for 82 camera operations. The PMU flow rate of 5.6 lbs./min. of camera operating time was acceptable due to the large amount of long duration camera operations. A surplus of 1300 lbs. of gas existed at the end of the -2 mission.

I. THERMAL ENVIRONMENT

The thermal environment achieved with this system was slightly higher than the predictions. Temperature comparisons can only be made prior to Rev. 22 because of the loss of paint pattern orientation due to vehicle instability beginning on Rev. 22. The actual system temperature was approximately 76°F and 75°F for the master and slave cameras respectively as compared with a temperature prediction between 60°F and 74°F. Figure 3-1 shows a graphical plot of the actual average camera temperatures versus the predicted

C [redacted]

J-43 TEMPERATURE PREDICTIONS VERSUS ACTUAL



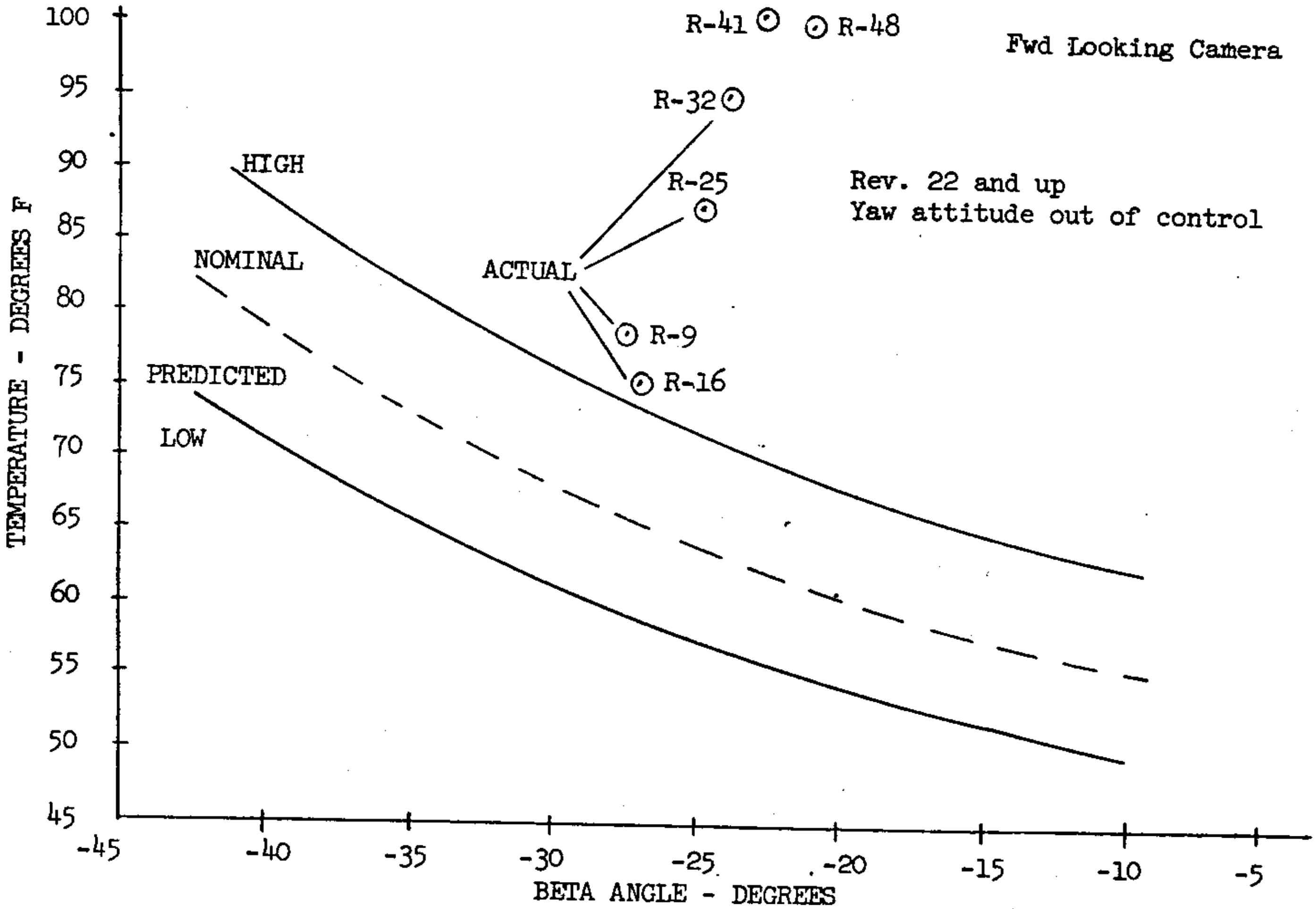


FIGURE 3-1

temperature as a function of the beta angle in degrees. The temperatures shown for Revs. R-25, R-32, R-41, and R-48, Figure 3-2, are abnormally high due to the yaw attitude problem that developed on Rev. 22.

J. RECOVERY SYSTEM

The recovery capsule from Mission 1050-1 was successfully recovered by air catch on Rev. 34 at 1632 PST on 21 March 1969. Recovery was performed utilizing the full Lifeboat system with capsule impact approximately 40 miles south of the predicted. The re-entry events occurred within tolerance.

The recovery capsule from Mission 1050-2 was successfully recovered by air catch on Rev. 50 at 1604 PST on 22 March 1969. Recovery was performed utilizing the full Lifeboat system with capsule impact very close to the predicted. The re-entry events occurred within tolerance. The re-entry sequence of events for both mission segments are shown in Table 3-2.

K. YAW PROGRAMMER

The Yaw Programmer operated properly through Rev. 24, at which time it was turned off to avoid interference with the analysis of the attitude control problem that developed on Rev. 22 when a yaw attitude control valve failed.

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 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 1050-1		Mission 1050-2	
Emulsion	B + F Density	Radiation	B + F Density	Radiation
Type 3401	0.14	0.4R	0.16	0.5R
Royal X Pan	0.21	0.4R	0.27	0.5R

These levels are below that which will degrade the photography.

TABLE 3-2

MISSIONS 1050-1 AND -2

RE-ENTRY SEQUENCE OF EVENTS (Seconds)

Event	System Time		Delta Time		
	1050-1	1050-2	1050-1	1050-2	Nominal
*Arm	86007.38	84545.36	76.87	76.87	77.0 ± 1.0
*Transfer	86082.27	84620.25	1.98	1.98	2.0 ± .25
Electrical Disconnect	86083.17	84621.16	.90	.91	.9 + .43 - .40
Separation	86084.25	84622.23	——	——	——
**Spin	86086.61	84624.54	3.44	3.38	3.4 ± .30
Retro	86094.16	84631.90	7.55	7.36	7.55 ± .45
Despin	86104.89	84642.37	10.73	10.47	10.75 ± .54
T/C Separation	86106.39	84643.77	1.50	1.40	1.5 ± .15
***"G" Switch Open	00149.96	85079.52	455.80	447.62	451.1 & 456.3
Parachute Cover Off	00183.70	85112.46	33.74	32.94	34.0 ± 1.5
Drogue Chute Deployed	00184.42	85113.18	.72	.72	.63 ± .08
Main Chute Bag Separate	00194.19	85122.45	9.77	9.27	10.25 + 3.0 - 2.2
Main Chute Deployed	00194.78	85122.99	.59	.54	.52 ± .13
Main Chute Disreef	00199.05	85127.31	4.27	4.32	4.5 ± .80

* From separation ** From elect. disc. *** From retro

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

Panoramic camera photography from Mission 1050-1 is considered to be of somewhat better than average quality thru Rev. 22 for the Corona J-1 Program. An MIP rating of 85 was awarded to Mission 1050-1. After Rev. 22 loss of attitude control, principally in the yaw direction, caused the imagery to be of poor quality due to image smear degradation. A few random formats of good imagery were produced after Rev. 22. Film type SO-230 was used in the panoramic cameras.

Stellar camera photography from Mission 1050-1 was good thru Rev. 22. Subsequent to Rev. 22 most stellar formats contained no imagery. However, many stellar formats contained elongated images of the brighter stars. Film type 3401 was used.

Terrain DISIC camera imagery using film type 3400 was good throughout both mission segments.

B. PANORAMIC CAMERAS

1. Image Quality

The overall image quality produced on film type SO-230 through Rev. 22 of Mission 1050-1 was considered by the Photographic Evaluation team and the Photo-Interpreters to be good to fair, with the best of the photography being somewhat better than an average J-1 mission. A comparison of the MIP frames of Mission 1050-1 from the forward and aft looking cameras indicated that the aft camera produced sharper imagery with better detail in the low and mid brightness ranges and more consistency in focus across the minor axis of the format.

Following Rev. 22 (after the vehicle attitude control failure) and continuing throughout the balance of both segments of the mission, the image quality was usually poor because of image smear with random examples of good imagery. The small slit widths associated with the faster speed of film type SO-230 (compared to film type 3404) reduced the smear component and contributed somewhat to the random examples of good imagery.

The superior image quality of the aft looking photography is attributed to two factors: Slit dimension and look direction.

The smaller slit used on the aft camera provides a greater tolerance to image motion and camera noise. The look angle of the aft camera is such that haze light from the atmosphere is generally much less for the aft camera than for the forward camera. Since the forward camera is equipped with a more effective haze cutting filter with a higher filter factor than the aft camera, it follows that the forward camera slit width is wider than for the aft camera for the same exposure conditions. The aft camera was equipped with the narrowest exposure slit in the history of the J-1 Program, namely 0.080 inches.

Engineering photography was examined in detail at the A/P facility to determine the degree of fine detail recorded by the panoramic system. Only duplicate positive (DP) material was evaluated.

DP material from Revs. 1 and 16 (fwd and aft cameras) taken of Alaska and California contained imagery that appeared good in every respect and was consistent with the MIP rating of 85 for Mission 1050-1 thru Rev. 22. Rev. 1 and 16 photography contained terrain imagery but no culture.

Photographic quality from domestic Revs. 31, 32, 47, and 48 was mostly degraded by uncompensated image motion due to uncontrolled satellite rotation principally in the yaw direction. The rate of yaw rotation varied from the end of Rev. 22 to the end of the second mission segment. Typically, the vehicle yaw rate was approximately 1800 degrees per hour.

Although the imagery was degraded on Rev. 31 and caused the loss of most fine detail such as vehicular traffic in cultural areas at Minneapolis and St. Paul, Minnesota, larger imagery was recognizable such as roads, buildings, separate lanes of divided highways, and road and river bridges. Large and small aircraft were recognizable but had smear components. The main airport at Minneapolis/St. Paul was recorded on Rev. 31, frames 25, 26, 27, 28, 29, 35, 36, 37, and 38. A varying degree of image smear was observable in aircraft from frame to frame. Imagery of aircraft showed wings, fuselage, and tail assembly clearly visible on some frames while on other frames image smear increased to a level that caused wing and tail sections to be blurred and sometimes completely missing.

Domestic imagery recorded on Revs. 32 and 48 were for the most part obscured by clouds and haze. Domestic photography acquired on Rev. 47 was principally snow covered terrain.

Fixed resolution bar targets from the controlled range network (CORN) were not photographed due to a combination of factors such as the early recovery of Missions 1050-1/-2, weather, and camera operation selection.

2. Data Recording

The forward and aft looking panoramic cameras produced acceptable imagery of the horizon fiducials, start of pass mark, serial number, time word and time word indices.

Approximately 12 inches of the image of the 200 pulse per second time track produced by the aft looking camera was missing at the start of scan on the first frame of some passes in both mission segments. This condition was minor and did not interfere with data reduction. The forward camera produced a normal acceptable time track.

3. Anomalies

a. Characteristic Anomalies

Certain anomalies recur from mission to mission that display basic generic characteristics. While these characteristic anomalies have been minimized they have not been entirely eliminated. Characteristic anomalies observed in Mission 1050-1 and -2 film include minor light fogging in the vicinity of the main camera drum area, during long non-operate periods, and also in the vicinity of the number one SRV/fairing interface. Minor banding is present in the take-up end of most frames of both main cameras. Minor dendritic static fog patterns are present intermittently along the film edges from both panoramic cameras from both mission segments 1 and 2. A minus density streak is present intermittently on film from the aft camera throughout both mission segments. The minus density streak is attributed to a foreign particle in the scan head assembly.

Emulsion buildup on the inboard film guide rail of both panoramic cameras caused a ragged format edge and almost totally obscures the shrinkage marks on the take-up end.

b. Unique Anomalies

The forward looking material displays a soft focus area along the data block side of most frames throughout the mission. The change in focus across the format is slight and not defined by specific boundaries. This condition is confined to the data block side and shows variations in image quality probably caused by changes in film lift. It does not appear that this condition is the result of or is aggravated by emulsion buildup characteristics formerly attributed to SO-230 film. The cleanliness of this mission in respect to emulsion particle buildup on the film support rails was satisfactory; in this respect it was judged to be equal to an average J-1 mission with 3404 film. No cause for this anomaly has been determined. The degree of defocusing is not considered serious enough to warrant major expenditure of additional effort at this late time in the J-1 program.

Minus density bands located perpendicular to the major axis and varying in width, are present intermittently throughout both missions. Similar bands have been observed on 1049 and 1046 material as well as film from most ground tests using SO-230. This phenomenon, not fully understood, is characteristic of the film during extended inoperative periods. The bands are images of the system film path components, formed as a function of environment and are not the result of a light leak. Because of the minor nature of this anomaly no action is recommended.

C. HORIZON

All four horizon cameras demonstrated acceptable performance throughout Missions 1050-1 and -2. Veiling was not present during Missions 1050-1 and -2. The horizon line was well defined throughout the format through Rev. 22. Minor vignetting was observed at the ends of all horizon images. After Rev. 22 and during the remainder of Mission 1050-1 and all of 1050-2, some frames contained little or no horizon image due to the yaw attitude control problem that developed subsequent to Rev. 22.

Horizon fiducials were present throughout both mission segments.

D. STELLAR/INDEX CAMERAS

1. First Mission

Stellar/Index camera #D-113 was operational during Mission 1050-1. Over 15 acceptable stellar images were detectable on most frames up to Rev. 22. For the rest of Mission 1050-1, the number of stars recorded varied from 0 to 15 with significant elongation of star imagery. The utility of star imagery after Rev. 22 was significantly limited. Approximately 30% of the stellar exposures are completely flared and contain no imagery.

The first seven frames contained streaked images referred to as jettisoned fuel particles. These streaks have been observed on most previous flights and always affect several frames at the beginning of the first mission segment. Their origin is not well understood.

One to two minus density spots are present on each frame of the last half of the photography. Their effect on stellar image reduction is inconsequential.

Stellar photography recovered consisted of 362 frames (35 feet of film type 3401) and 361 frames of terrain exposures (66 feet of film type 3400). Approximately 22% of the stellar and index camera film remained in orbit due to the early recovery on Rev. 34.

Terrain photography appeared acceptable throughout. Minor dendritic static was present along the camera number edge at the end of the mission.

2. Second Mission

Stellar/Index camera #D-114 operated satisfactorily through the shortened second mission segment. Film recovered consisted of 465 frames (54 feet) of stellar photography and 464 frames (109 feet) of terrain photography.

Approximately 30% of the stellar exposures are completely flared and contain no detectable star imagery. Of the remaining photography 30% contain no star imagery. Where star exposures were present, star imagery is greatly elongated and produced star tracks rather than point images. Excessive light flare and star image tracks were caused by the vehicle attitude control problem that developed on Rev. 22 and persisted through Mission 1050-2.

Pieces of emulsion were bonded to the stellar reseau plate on frames 133 and 334. Both pieces were imaged on the remaining stellar frames. The cause is attributed to the unstable vehicle yaw condition after Rev. 22 that resulted in the direct impingement of sunlight on the stellar lens. On those frames that contained stars, the number of star images varied from one to approximately 15.

Dendritic static was present along both film edges intermittently.

Terrain photography appeared acceptable throughout the second mission segment.

SECTION 5

PANORAMIC EXPOSURE

Panoramic camera exposure depends upon the slit width, filter attenuation, and scan rate. Since scan rate is a function of the camera cycle rate required for FMC control to match the orbit, the primary variables for setting nominal exposure are the slit and filter.

A 0.100 inch slit and Wratten 23A filter were selected for the forward looking camera, with a 0.080 inch slit and Wratten 21 filter for the aft looking camera. These selections were based upon Project Sunny brightness data that culminated in the use of interim Exposure Value (EV) vs Solar Elevation data. This data is based upon the Dual Gamma single level process. The slit and filter selections provide approximately one-half stop less exposure than recent flights but are consistent with Project Sunny data. Film type SO-230 was used throughout both mission segments.

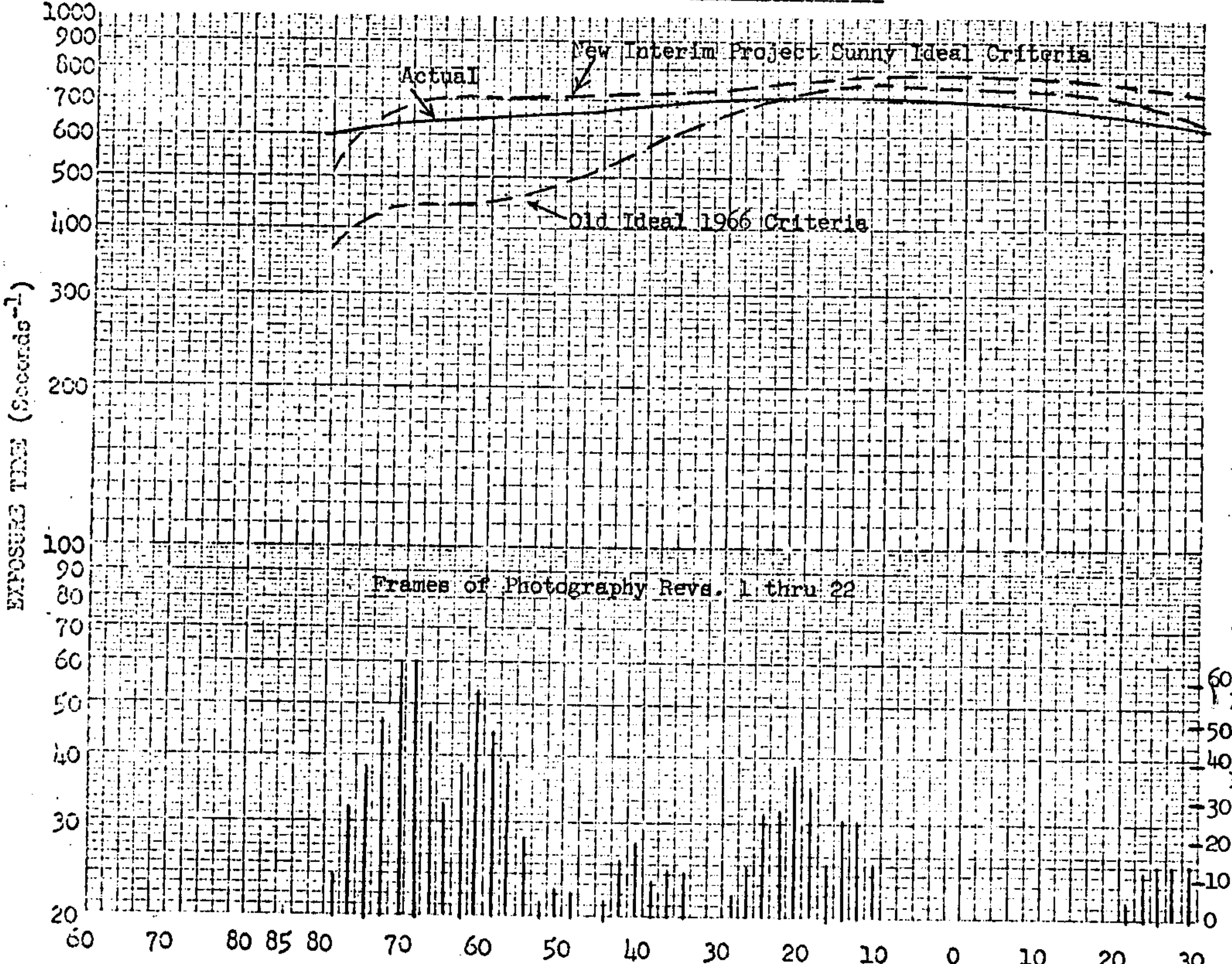
Orbit parameters from Rev. 9, typical of Mission 1050-1, were combined with camera cycle rate, exposure value vs solar elevation data, filter and slit choice to produce a computerized output that includes actual and ideal exposure time versus latitude. Figure 5-1 for the forward looking camera (#210) and Figure 5-2 for the aft looking camera (#211) show the actual vs ideal exposure time vs latitude for Rev. 9.

The actual slit choice for Mission 1050-1 and -2 was made and based upon a preliminary Project Sunny brightness model modified to produce a slight overexposure in flight use as seen in Figures 5-1 and 5-2. A comparison of the actual exposure with the old ideal curve dated 1966 indicates that Mission 1050 was somewhat underexposed.

Superimposed on Figures 5-1 and 5-2 is the frequency of camera operation versus latitude for Rev. 1 thru Rev. 22. Following Rev. 22 the flight vehicle lost attitude control primarily in the yaw direction. As a result exposure plots for Rev. 23 and up are not shown.

FIGURE 5-1

EXPOSURE POINTS

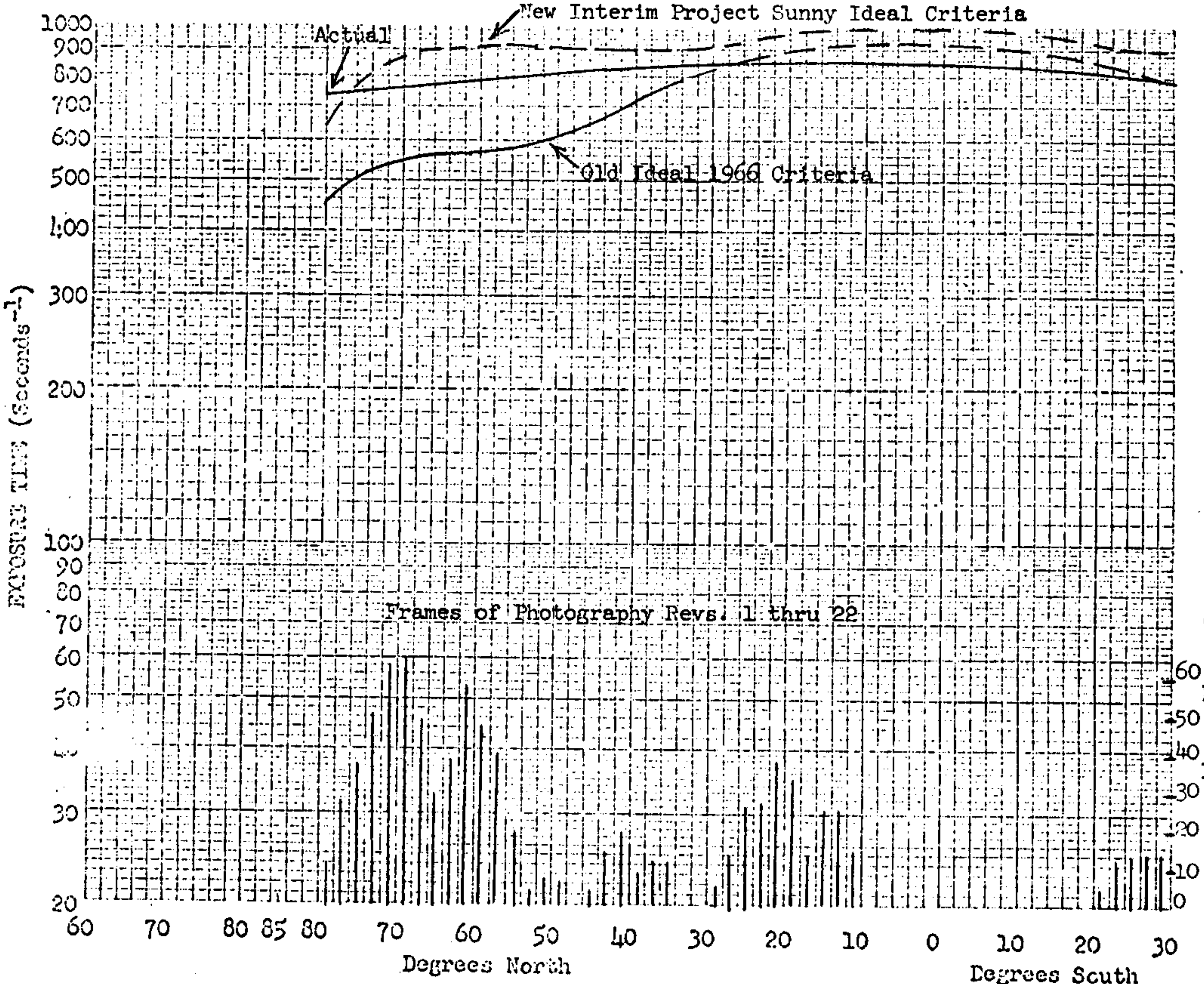


Mission No: 1050-1
Payload No: J-43
Camera No: 210 Fwd Looking
Pass No: 9
Launch Date: 19 March 1969
Launch Time: 21:38Z
Slit Width: 0.100 Inches
Filter Type: Wratten 23
Film Type: SO-230

FORWARD CAMERA EXPOSURE TIME AND OPERATION VS LATITUDE

FIGURE 5-2

EXPOSURE POINTS



Mission No: 1050-1

Payload No: J-43

Camera No: 211 Aft Looking

Pass No: 9

Launch Date: 19 March 1969

Launch Time: 21:38Z

Slit Width: 0.080 Inches

Filter Type: Wratten 21

Film Type: SO-230

AFT CAMERA EXPOSURE TIME AND OPERATION VS LATITUDE

Actual terrain density measurements (D-min) of the original negatives from Rev. 1 thru Rev. 22 demonstrate that little or no underexposure occurred while some overexposure is indicated as shown in Table 5-1.

TABLE 5-1

Terrain Density Analysis of Exposure Revs. 1 Thru 22

Panoramic Camera	Under[1] Exposed	Correct[2] Exposure	Over[3] Exposed
Fwd	0%	73%	27%
Aft	3%	66%	31%

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

Terrain negative density data agree better with the new Project Sunny criteria used for Mission 1050 exposure than with the older 1966 criteria used previous to this flight. The better agreement with the Project Sunny exposure criteria is attributed to the new brightness model based on month to month variations in scene brightness vs solar elevation. The old 1966 brightness model included data summed over a one year period.

Representative terrain D-min, D-max values for Mission 1050-1 thru Rev. 22, fwd and aft cameras, are shown in Figures 5-3 to 5-6.

MISSION * 1050-1 * INSTR * FWD * 3/19/69 PLOT OF D MIN * TERRAIN * PROCESSING * FULL

ARITH MEAN * 0.80 * MEDIAN * 0.81 * STD DEV * 0.19 * RANGE * 0.44 TO 1.29 WITH 83 SAMPLES

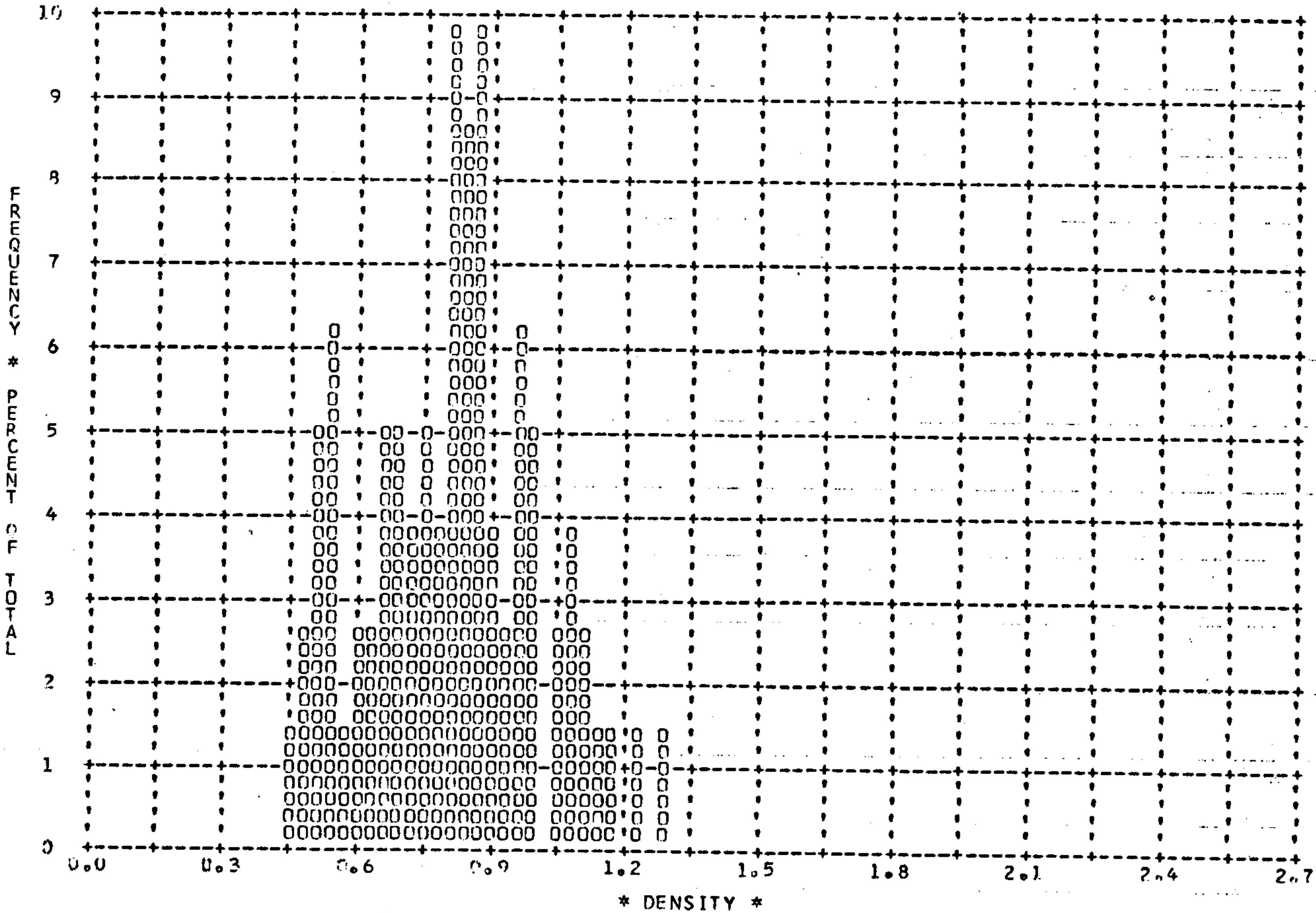


FIGURE 5-3

MISSION * 105[illegible]-1 * INSTR * FWD * 3/19/69 PLOT OF D MAX * TERRAIN * PROCESSING * FULL

ARITH MEAN * 1.51 * MEDIAN * 1.57 * STD DEV * 0.21 * RANGE * 0.86 TO 1.79 WITH 83 SAMPLES

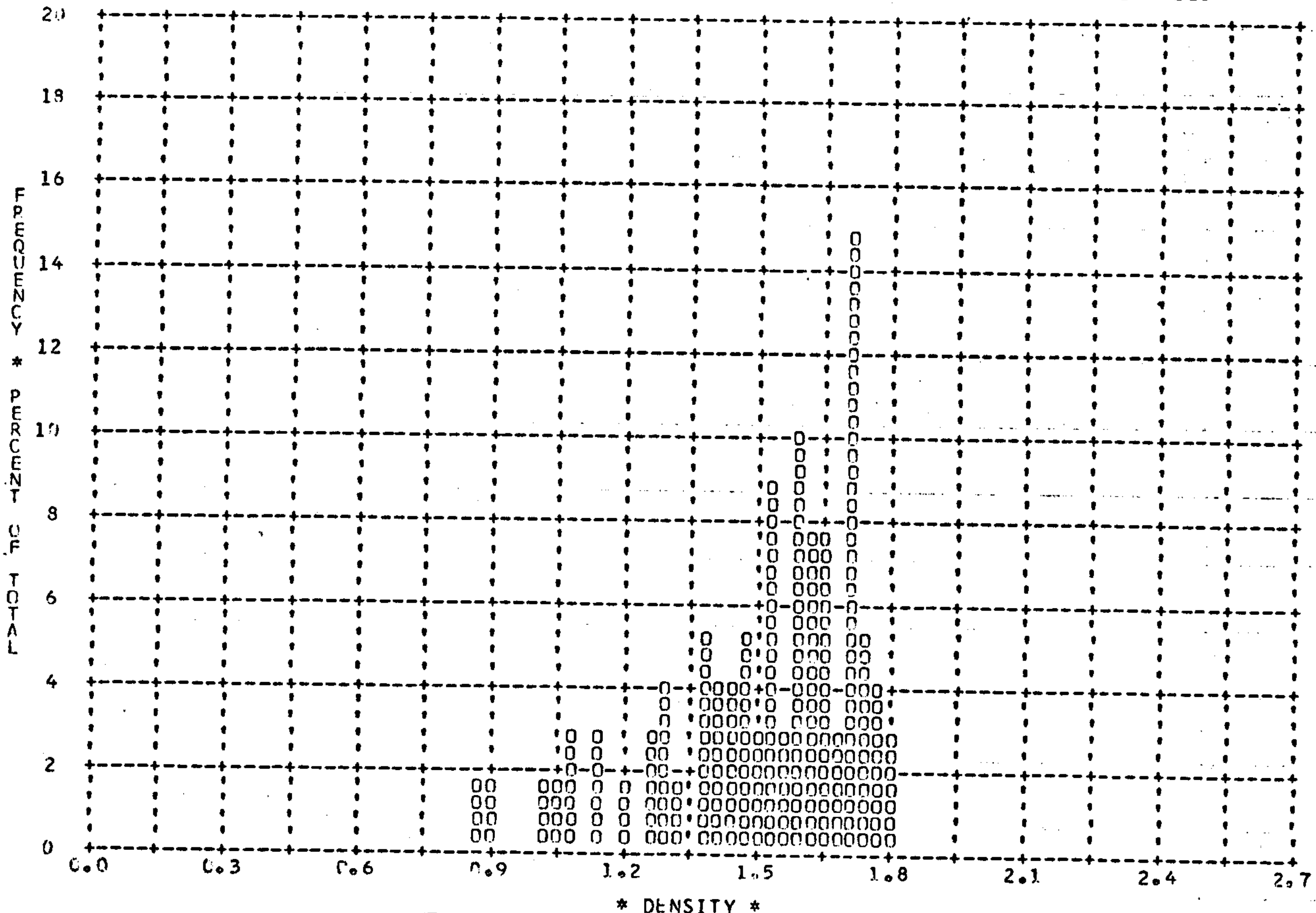


FIGURE 5-4

MISSION * 1050-1 * INSTR * AFT * 3/19/69 PLOT OF D MIN * TERRAIN * PROCESSING * FULL

ARITH MEAN * 0.77 * MEDIAN * 0.76 * STD DEV * 0.26 * RANGE * 0.35 TO 1.40 WITH 90 SAMPLES

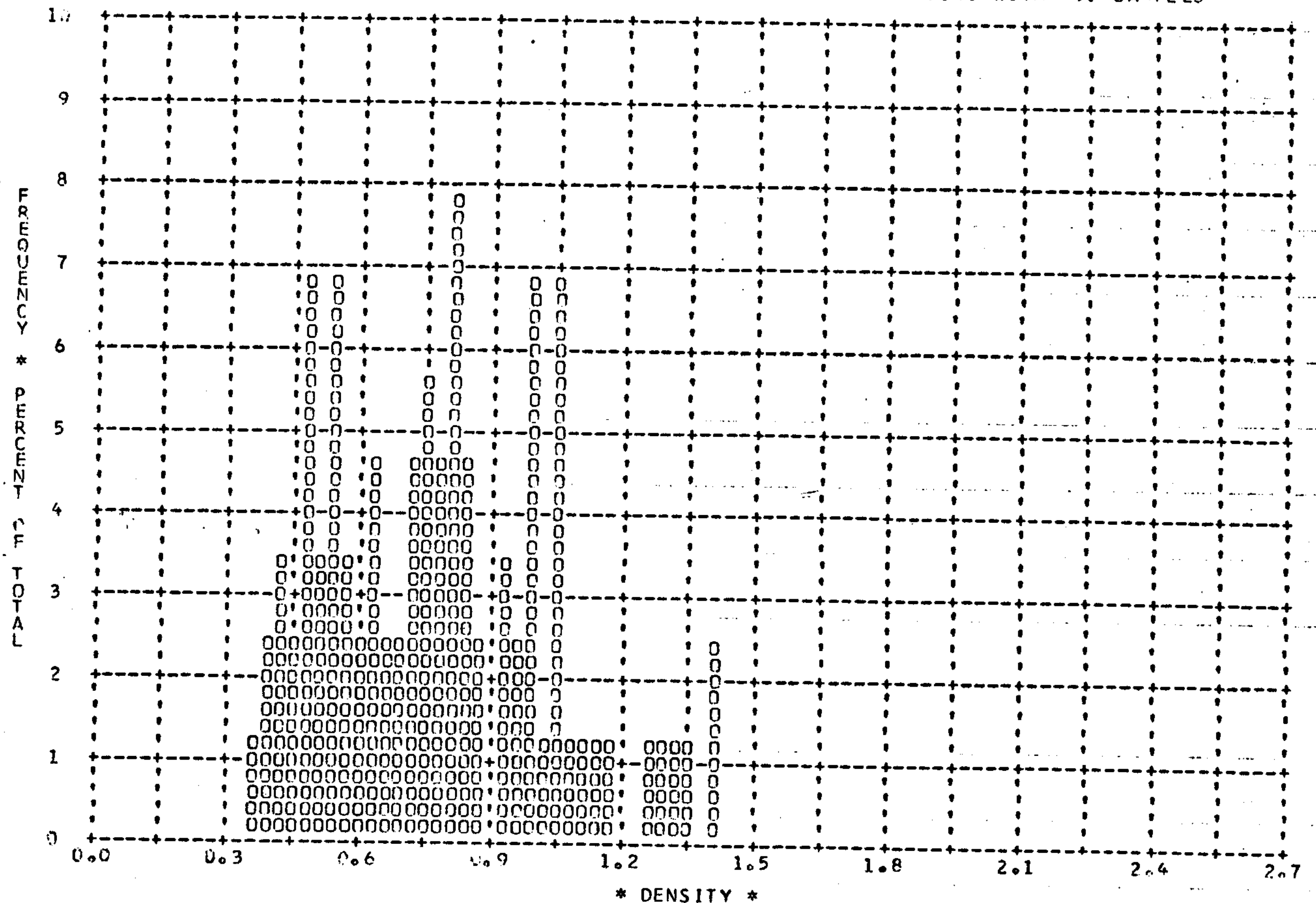


FIGURE 5-5

MISSION * 1050-1 * INSTR * AFT * 3/19/69 PLOT OF D MAX * TERRAIN * PROCESSING * FULL

ARITH MEAN * 1.46 * MEDIAN * 1.49 * STD DEV * 0.19 * RANGE * 1.00 TO 1.83 WITH 90 SAMPLES

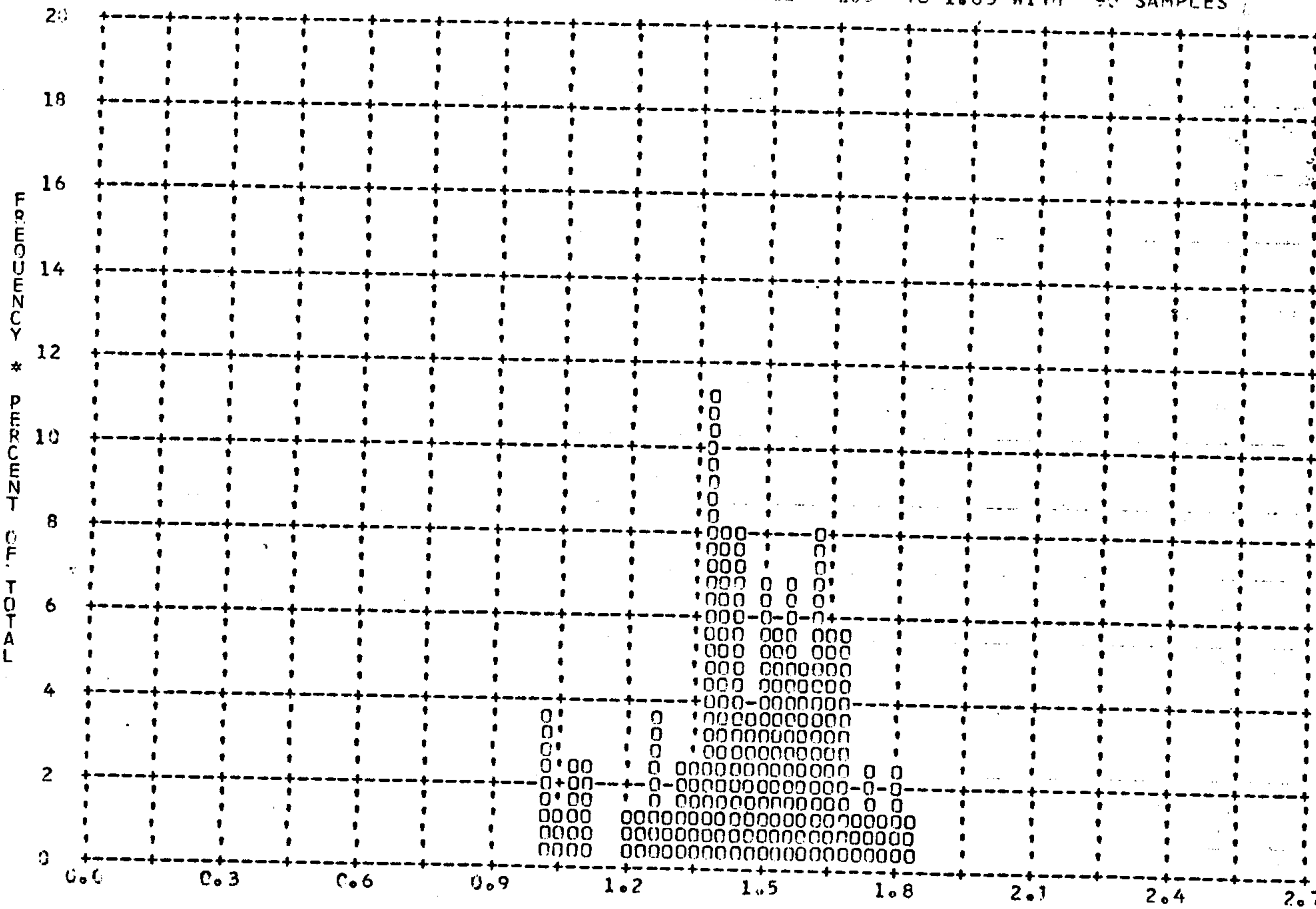
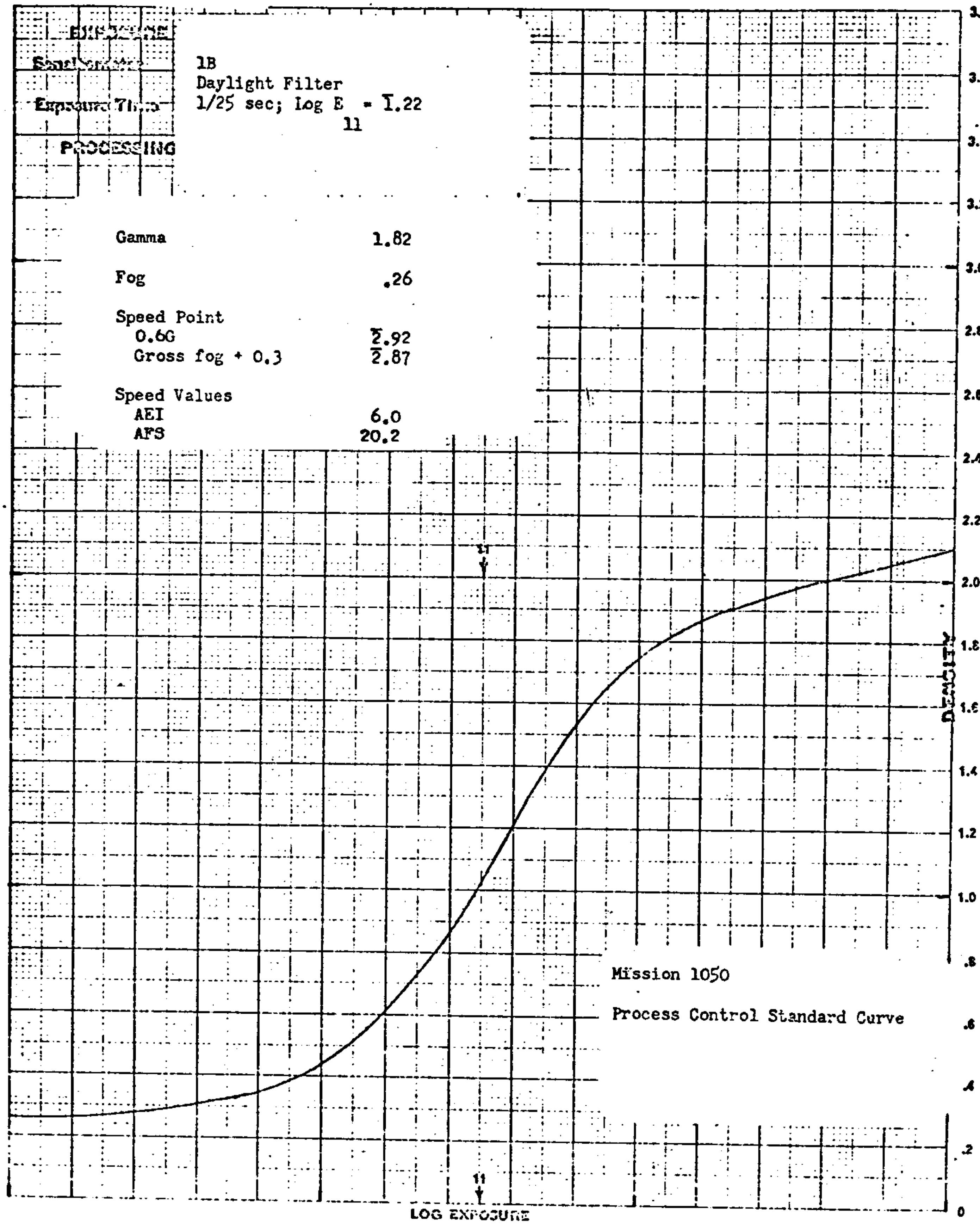


FIGURE 5-6

Both segments of the Main Camera records were processed in the Yardleigh machine employing the single level dual-gamma process. Film type SO-230 was processed to the Process Control Standard curve shown in Figure 5-7. Deviation of the actual processing from the standard curve shown was not significant. Deviation was less than +0.04 log E from the speed point shown for both mission segments.

FIGURE 5-7

Film Type SO-230



SECTION 6

IMAGE SMEAR

A. VEHICLE ATTITUDE

Vehicle attitude performance data were derived from reduction of the stellar photography by NPIC. These data are supplied to A/P, where computer analysis provides charts and tabulations of the distribution of attitude angle and rate deviations.

Performance of the attitude control system appeared normal thru Rev. 21. The table below summarizes both the total range of attitude variation and that experienced during ninety percent of photographic operations thru Rev. 21. Data for all but the first five frames of each forward-looking camera operation are included thru Rev. 21. Data from the aft-looking camera are similar.

	90%	Total Range
Angle Deviation (degrees):		
Pitch	0.37	-1.11 to +0.48
Roll	0.30	-0.50 to +0.32
Yaw	2.5	-2.78 to +0.73
Rate Deviation (degrees/hour):		
Pitch	26	-76 to +76.1
Roll	34	-43.3 to +86
Yaw	24	-72.3 to +66

Attitude performance thru Rev. 21 compares favorably with many recent missions.

An Agena attitude guidance system failure occurred on Rev. 22, causing loss of attitude control mainly in the yaw axis from Rev. 22 and up. Analysis indicated that one gas valve was not responding to the guidance package commands.

While the operational performance of the panoramic cameras was satisfactory throughout Missions 1050-1 and 1050-2, the unstable vehicle attitude beginning on Rev. 22 caused significant image smear throughout the remainder of both mission segments.

Vehicle oscillations in pitch and roll occurred. The vehicle continued to yaw 360° out of control at various rates. Yaw rates to 1 degree/second were observed. Stellar photography from Rev. 22 and up contained no usable stellar imagery due to the attitude problem. Consequently vehicle attitude data, normally derived from the stellar photography, is not available from Rev. 22 and up.

Loss of attitude control is attributed to a gas valve failure in the open position. Most probable failure mechanism is a mechanical failure of the valve plunger assembly caused by workmanship and/or galling of the plunger in the valve cylinder. Subsequent to the 1050 flight all plunger assemblies were reworked to stringent assembly, inspection and test procedures.

B. SMEAR ANALYSIS

Data containing the time word from 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 (FMC) 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. These resolution limits would apply to any camera system, regardless of focal length or other system capabilities.

Total system limits were well within the normal performance envelope thru Rev. 22 of Mission 1050-1. The following tabulation summarizes the system IMC error and resolution limits for Revs. 1 thru 22. The total range of variation and that experienced during 90% of the photographic operations is shown.

		1050-1 Revs. 1 thru 22	
		90%	Total Range
IMC Error, percent:			
	Fwd	3.9	-7.35 to +5.08
	Aft	3.3	-4.55 to +6.85
Resolution Limit, feet:			
Intrack:	Fwd	2.1	00 to 4.02
	Aft	2.0	0.01 to 3.04
Crosstrack:	Fwd	1.1	0 to 3.87
	Aft	0.7	0 to 1.85

Subject to Rev. 22, vehicle attitude was unstable, particularly in yaw, causing severe image smear. Most of the photography following Rev. 22 was degraded by smear with a significant loss of information content. However, most formats contained some usable imagery. The small slit widths associated with SO-230 film reduced the smear component and contributed to the random examples of good imagery.

SECTION 7

SYSTEM RELIABILITY

Payload reliability data are based upon a sample beginning with M-7. Hence, twenty Mural program systems and all of the "J" program to date are included in the calculations. The sample origin is changed only when system modifications or new designs are introduced because reliability was one of the principal reasons for the change, as the Stellar/Index and Horizon cameras. The sample size is consistent with reliability reporting for the vehicle, for primary mission functions.

These reliability estimates deal exclusively with the electrical and mechanical functions of the payload. Vehicle-induced failures, as not achieving orbit, are excluded. Film quality is not considered in the computations. Recoveries prior to completion of a full mission are considered as complete missions, providing that payload operations problems did not cause the early termination.

The reliability data are divided into two categories. The primary section considers those elements which contribute to retrieval of the more significant information, such as panoramic imagery and time data. The secondary section considers auxiliary camera functions, excluding those affecting primary information. The following table summarizes system reliability, estimated to a fifty percent confidence level:

FUNCTIONS:

	Opportunities to Operate	Failures	Estimated Reliability
Primary (M7 and up)			
Panoramic Cameras	238	3	98.5%
Main Doors	140	0	99.5%
Command and Control	14,808 (hrs)	2	97.0%
Clock	14,808 (hrs)	0	99.2%
Total Payload Functions	-	-	97.0%
Recovery System	111	1	98.5%
Secondary (J5 and up)			
Horizon Cameras:			
Single Camera	148,000	0	99.3%
4 Units, parallel redundant	-	-	99.9%
Stellar/Index Camera	33,230	5	93.1%

SECTION 8

SUMMARY DATA

Mission 1050 was considered successful in its photographic results thru Rev. 21 of Mission 1050-1. Subsequent to Rev. 21 loss of vehicle attitude principally in yaw caused a significant amount of image smear and loss of information.

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