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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1047-1 and 1047-2

FTV 1645, J-47

Approved[redacted] Manager
[redacted] Advanced Projects

Approved:[redacted] Manager
Program [redacted]

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FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1645.

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 1047 which was launched on 20 June 1968.

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INTRODUCTION

This report presents the final performance evaluation of Corona Mission 1047. The purpose of this report is to define the performance characteristics of the J-47 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 cognizent 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 1047 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 over 6,000 panoramic frames, each 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 realtime 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 sub-systems for each mission segment.

The flight system was launched into orbit from Vandenburg AFB during the afternoon of 20 June, 1968. The THORAD booster failed to produce sufficient thrust to place the flight system into the planned orbit with a period of 90.44 minutes. The actual period was 89.66 minutes measured on Rev. 1. Photographic operations were programmed throughout the orbit that was achieved during Mission 1047-1 and -2. Telemetry and film analysis indicated that the slave camera experienced an uneven film wrap on the take-up cassette of Mission 1047-2. The master camera demonstrated acceptable performance throughout the cut and wrap operation and throughout Mission 1047-2. The first mission segment was successfully completed, after nine days of flight, with an air catch of the recovery capsule. The second segment was similarly terminated after the fifteenth day.

Photographic performance of the Panoramic cameras was good. Imagery from the panoramic records was considered to be average for the J-1 system. With the exception of the cut and wrap malfunction experienced by the Aft camera, anomalies noted in the flight films were either minor, or of a characteristic nature.

B. FLIGHT CONFIGURATION

VEHICLES:	THORAD Booster (SLV-2G)		517
	AGENA Satellite (SS-01B)		1645
	RECOVERY (SRV-MK5): 1047-1	USE -	745
	1047-2	USE -	746

PANORAMIC CAMERAS: Assembly No.	218(Master)	219 (Slave)
MAIN: Look Direction	Forward	Aft
Slit (inches)	0.150	0.130
Filter (Wratten Type)	23A	21
Aperture (T/number)	4.0	4.0
Focal length (inches) (Vacuum)	24.0011	24.0011
Lens No.	1460	1750

		Forward Looking		Aft Looking	
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
	Lens No.	19102	12869	12892	23760
	Assembly No.	311G6	317G5	321G6	324G5
FILM	Kodak Type		3404		3404
	Length (feet)		16300		16300
	Emulsion No., date		409,4/68		409/4/68
	No. Splices		2		3

STELLAR/INDEX CAMERAS		1047-1	1047-2
ASSEMBLY NO.		D-117	D-118
STELLAR:	Reseau No.	146	154
	Exposure Time (seconds)	2.0	2.0
	Aperture (F/number)	1.8	1.8
	Focal Length (millimeters)	85	85
	Lens No.	11642	11399
	Film (Kodak Type)	3401	3401
	Emulsion No., Date	231,09/67	231,09/67
INDEX:	Reseau No.	149	150
	Exposure Time (seconds)	1/500	1/500
	Filter (Wratten Type)	21	21

INDEX (Continued)

	1047-1	1047-2
Aperture (F/number)	4.5	4.5
Focal Length (millimeters)	38.48	38.56
Lens No.	825509	825510
Film (Kodak Type)	3400	3400
Emulsion No. Date	139,01/67	139,01/67

COMPONENTS

Clock		604
Film Cassettes:	Supply	57
	1047-1 Takeup	T109E
	1047-2 Takeup	T106F
Pressure Makeup System		1033
Orbit Sine Function Generator		632

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-47 system successfully passed all phases of the testing operations providing acceptable performance and a high degree of operational confidence.

B. ENVIRONMENTAL TEST

The J-47 system was subjected to the thermal/environment test from 24 August to 31 August 1967. During this period panoramic instrument #218 operated for 5856 cycles and panoramic instrument #219 produced 5849 cycles. The film was subsequently processed to the intermediate standard level prior to photographic evaluation.

The primary purpose of the environmental test was to determine the corona discharge marking characteristics of the panoramic and stellar/index cameras with flight type film during operation at altitude.

Corona marking occurred on film from both panoramic cameras. Corona marking was produced by the input metering roller at camera start up. Corona marking was heaviest at internal system pressures below 7 microns. Above 7 microns the corona marking decreased until at 30 microns and above no corona marks were observed in the film exhibit. Film type 3404 was used for all panoramic camera tests performed. Although corona marking occurred it affected less than 5 frames at camera start up and was acceptable per the J-1 requirement specification.

The frame metering roller of panoramic instrument 218 produced small spots of very low density corona in some operations at internal pressures between 7 and 25 microns. This marking was not acceptable as more than 5 frames were affected in some operations. A waiver was recommended and granted because the fog level of the corona marks were less than 0.05 density above the base fog level of the processed film. The corona fog marks were also small, being approximately 0.25 inches in diameter.

The stellar/index cameras demonstrated acceptable corona marking performance throughout the environmental test.

Auxiliary data recording imagery produced by both panoramic cameras was not entirely acceptable.

Panoramic instrument #218 produced horizon fiducials that were weak or missing, the PG rail hole imagery was not present on the data block edge of the format and the serial number and binary index lamp imagery was sometimes missing. Imagery of the time track, start of pass mark, PG traces, and binary time word was acceptable. Both horizon cameras were operational throughout the environmental test.

The horizon fiducial images on the take-up side of Panoramic camera #219 were missing. Imagery of the PG traces, time track, binary time word, start of pass mark, and camera serial number were acceptable. The shutter of the take-up horizon camera (Serial #314) failed to open in the last two frames of Revs 4-4 and 4-7. Horizon camera #314 failed in a subsequent bench test and was replaced in J-47 system by horizon camera #324.

All panoramic camera data recording anomolies were corrected to an acceptable level as evidenced by post environmental film tests completed on 26 September 1967.

Stellar/index camera No. D-117 produced 442 frames of 35 mm and 70 mm photography respectively during the "A" portion of the environmental test. Two stellar frames were affected by minor pressure marks. The fiducials, correlation lamp and grid imagery of the stellar camera were all satisfactory. The correlation lamp, serial number and grid imagery of the index camera were acceptable.

Similiary, all data recording imagery produced by Stellar/Index camera No. D-118 during the "B" portion of the environmental test was acceptable. Stellar/index camera No. D-118 produced 449 frames of 35 mm and 70 mm photography respectively during the "B" portion of the environmental test. Minor dendritic static affected five frames of the stellar record.

Operational performance was generally acceptable.

The command system performed satisfactorily throughout the altitude test.

Cycle rates were examined. The computed results indicated that the No. 1 instrument was running 2% to 6% slow and the cycle periods of the two instruments were 3% to 5% apart. The system was corrected to an acceptable condition by the replacement of the camera's magnetic amplifier.

Stellar/index cameras No. D-117 and D-118 operated satisfactorily throughout the test. The pressure make-up system operated normally. Internal pressure stabilized between 48 and 55 microns during panoramic camera operation with the pressure make-up system on.

The cycle counter readings agreed with the actual count. Cycle count and footage pot correlation was satisfactory.

Clock accuracy was acceptable.

Early "A" to "B" transfer was accomplished by real time command. All transfer functions occurred normally.

The Yaw Programmer operation was normal throughout the environmental test.

C. LIGHT LEAK TESTING

The J-47 system was evaluated for light leaks on 7 September 1967.

The light leak test film revealed heavy fog marks in the vicinity of the horizon camera boot areas of both panoramic cameras. Visual examination of the flight system demonstrated that all four horizon camera boot interfaces permitted light to enter the system. The horizon camera boot leaks were sealed and subsequently inspected to verify that the light leaks were eliminated.

D. RESOLUTION TESTING

Evaluation of the resolution material from the initial test, in November 1967, indicated acceptable results for both panoramic cameras. The data demonstrated normal performance at all focal positions, with the usual minor difference between values in the FMC and scan directions. Resolution peaked at approximately 120 lines/millimeter, low contrast, for both cameras at the zero focal position. This was well above the ninety-lines-at-zero minimum criterion effective at that time.

After the above November test, additional information became available to the ITEK Company that indicated the focal shift in vacuum for certain lens systems was less than had been previously computed. It became desirable to shim the scan heads of systems at A/P, with subsequent resolution retesting required to verify focus. The assumed vacuum shift was 0.016 inch.

Data from the second test, in May 1968, indicated approximately 129 lines/millimeter for both cameras. Peak focus on both the master and slave unit occurred at -0.002 inches focal position. This was recommended as acceptable by ITEK; no further adjustments were performed.

E. FLIGHT READINESS AND CERTIFICATION

A combined Baseline and Readiness test was conducted on 5 June 1968. Approximately 20 to 30 stereo cycles of 3404 film were produced, processed, and evaluated.

All auxiliary data recording imagery was acceptable. No camera scratches were present. Film tracking appeared acceptable.

Imagery of the format edges from both panoramic cameras #218 and 219 were irregular, particularly on the binary word side, suggesting emulsion particle buildup on the rails. The rails were subsequently cleaned and a second Readiness test was completed. The format edges from the second Readiness test were straight and relatively clean looking. The second Readiness test was accepted as proof that the J-47 camera system was ready for flight loading.

J-47 flight loading occurred on 11 and 12 June 1968. Spool loading and film tracking were acceptable. Lens rotation appeared acceptable. Auxiliary optics and Stellar/Index camera shutter action was normal. No scratches were present in either the Master or Slave supply film. Sensitometric measurements of the flight films indicated normal quality.

The J-47 system was considered acceptable for flight.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Mission 1047 was launched normally without incident. During ascent the THORAD booster did not impart sufficient velocity to the flight system. As a result, the flight system achieved an orbit that was significantly low in period. The actual period attained was 89.66 minutes for Rev. 1. The planned period was 90.44 minutes.

The payload system functioned in an acceptable manner during Mission 1047-1. The Slave camera system experienced an uneven film wrap at the beginning of Mission 1047-2, following a normal KZ-38 command and film cut. The uneven film wrap caused extensive degradation to the Slave camera panoramic imagery for the first 13 frames of photography at the core of the take-up spool. The Slave camera recovered from the uneven film wrap with the result that good photographic results were obtained to the end of the mission. The Master camera produced good photography during Mission 1047-1 and 1047-2.

B. LAUNCH

The flight was launched at 2146 Z from Satellite Launch complex 1-east at Vandenberg AFB.

Ascent was abnormal due to a THORAD booster malfunction. During ascent the THORAD booster failed to impart the necessary velocity to the Agena. The Agena engine burned to fuel oxidizer depletion but could only make up approximately 208 feet per second (FPS) of the required 281 FPS.

Launch was within the specified 2145 Z to 2245 Z launch window. This window, in conjunction with the camera settings, had been chosen to maximize useful panoramic coverage of northern latitudes throughout the flight.

C. ORBIT

As a result of the short burn of the Thorad booster the orbital period was 47 seconds less than the predicted and outside the three sigma dispersions. Drag make-up rockets (DMU) were fired by ground command on day 1 during revs number 2, 3, 9, 11, and 14 to raise the orbit period to nominal. The orbit parameters and the DMU rocket effects are shown in Table 3-1.

TABLE 3-1 ORBIT PARAMETERS AND DMU EFFECTS

Parameter	Predicted	Actual Rev. 1
Period (min.)	90.44	89.66
Perigee (N.M.)	99.6	100.6
Apogee (N.M.)	222.0	178.3
Eccentricity	.0170	.0111
Inclination (Deg.)	85.00	84.99
Argument of Perigee (Deg.)	161	164.3

DMU Rocket Performance

Rocket No.	Pass	Period Seconds	Velocity Ft/Sec.	Impulse Lb/Sec.
1	2	7.9	12.4	1558
2	3	10.4	16.25	2030
3	9	10.0	15.65	2053
4	11	10.2	15.95	1973
5	14	10.5	16.4	2023

The Period Error, Ground Track Error, and Perigee Location vs. Rev NO. for Mission 1047 are shown in Table 3-2.

TABLE 3-2 ORBIT ERRORS AND PERIGEE LOCATION

Rev. No.	Period Error (Seconds)	Ground Track Location Error (N.M. East of Predicted)		Perigee Location (North Latitude)
		Lat 30N	Lat 60N	
1	-46.62	7.77	4.49	14.916
50	- 3.24	89.07	51.51	30.270
100	- 9.83	159.40	12.19	43.092
150	-16.41	301.32	174.26	55.855
200	-23.00	514.83	297.74	68.486
238	-28.00	724.97	419.27	77.774

D. PHOTOGRAPHIC OPERATIONS

The first photographic operation occurred during the Rev. 1 [redacted] acquisition. This was a short stereo confidence run. Reconnaissance operations began on Rev. 5.

There were 64 inflight photographic operations including 2 daytime engineering checks programmed over the continental United States. Daytime engineering operations were implemented on Revs 16, 32, 63, and 95. One nighttime engineering operation occurred on Rev. 8. Reconnaissance operations during Mission 1047-1 were terminated on Rev. 120.

The photographic operations for Mission 1047-2 began on Rev. 121 with an abnormal film wrap at the core of the Slave camera take-up spool. The uneven film wrap produced an out of round film roll that persisted throughout the mission.

The first operation in Mission 1047-2 occurred during Rev. 121. The operation was a 4-cycle engineering run programmed at night as part of the cut and film wrap sequence.

Reconnaissance photography began with the second operation of Rev. 121. There were 71 inflight photographic operations during Mission 1047-2 including 6 daytime engineering operations programmed domestically. Domestic engineering operations occurred during Revs. 127, 157, 159, 206, 221, and 238.

E. PANORAMIC CAMERAS

Master and Slave camera performance throughout Mission 1047-1 was acceptable The Master camera produced 2956 frames of photography while the Slave produced 2953 frames during Mission 1047-1.

Telemetry and film analysis indicated that the slave camera experienced an uneven film wrap at the beginning of Mission 1047-2 during the cut and film wrap following the KZ-38 (early -1 to -2 switchover) operation. The last seven (7) frames of the -1 mission, the cut and wrap operation, and the first six (6) frames of the -2 mission were badly crinkled. The uneven film wrap at the core of the slave take-up spool caused the formation of a hump in the otherwise round film roll. This hump caused the film to exceed the spool flanges and jam against a component within the bucket.

This jammed condition caused the slave camera film transport to fail during the last camera operation of the -2 mission. This operation occurred on Rev. 231 with frame number 35 being the last recovered. It is estimated that approximately 50 frames of film remained in the slave camera system at the time of failure.

The master camera performed satisfactorily during the cut and wrap and throughout the -2 mission. The master camera film was depleted on Rev. 231, frame number 64.

The Master and Slave cameras produced 3101 and 3052 frames of photography respectively during Mission 1047-2.

A satisfactory FMC control (ramp to orbit match) was maintained throughout the entire flight. Changes to the settings of Analog 6, 8 and 10 were made to compensate for orbit dispersions at launch and for the DMU firings required during Day 1 to raise the orbit period to nominal.

F. STELLAR/INDEX CAMERAS

The -1 and -2 Stellar/Index cameras operated satisfactorily on the observed engineering passes. Telemetry data indicated the programmer, metering functions, and shutter monitor performed satisfactorily. However, the film analysis revealed the -2 mission stellar shutter was operating slow from pass 151 to the end of the -2 mission. Both the stellar and index cameras contained film at the end of the -2 mission.

G. INSTRUMENTATION AND COMMAND SYSTEM

The payload instrumentation and command systems performed satisfactorily throughout the flight. Numerous commanding problems were encountered while utilizing the Uncle command system. The backup analog (S-band) command system was utilized to maintain operational control. These problems were attributed to hardware and software problems within the tracking stations.

H. 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 1.00000018040:1.

I. PRESSURE MAKE-UP SYSTEM

The pressure make-up system operated satisfactorily throughout the flight. Average supply gas pressure drop was approximately 7.3 PSI/min. of camera operation. The total operate time was 236 minutes with 135 camera operates. A surplus of 400 lbs. of gas supply existed at the end of the flight.

J. THERMAL ENVIRONMENT

The loss of telemetry readout of the temperature commutator precluded real time temperature monitoring. All payload system temperatures were obtained from the vehicle tape recorder on a single pass per day basis throughout the flight. Due to tape recorder "wow", the accuracy of the temperature data is believed to be slightly less than normal.

The thermal environment achieved with this system was near the preflight predictions. A temperature range of 62°F to 77°F was predicted for the beginning of the -1 mission and the actual temperatures were 76°F and 73°F for the master and slave cameras respectively. The predicted temperature range for the end of the -2 mission was 57°F to 71°F and the actual temperatures were 65°F and 63°F for the master and slave cameras respectively.

K. RECOVERY SYSTEM

Mission 1047-1 recovery capsule was successfully recovered by air catch on Rev. 129 at 1734 PDT on 29 June 1968. Capsule impact was approximately 10 n.m. north of the predicted point and was within tolerance. All re-entry events occurred as programmed.

IMPACT POINT

	Latitude	Longitude
Predicted	26° 58.4'N	167° 11.6'W
Actual	27° 08.0'N	167° 19.0'W

Mission 1047-2 recovery capsule was successfully recovered by air catch on Rev. 240 at 1622 PDT on 05 July 1968. Capsule impact was essentially the same as the predicted point. All re-entry events occurred as programmed.

Impact Point

	Latitude	Longitude
Predicted	24° 54.7'N	160° 54.9'W
Actual	24° 55.0'N	161° 06.0'W

L. YAW PROGRAMMER

The Yaw Programmer operated properly throughout Mission 1047-1. The difference between the actual yaw angle experienced in flight and the desired angle was within 0.4 degrees near tangency and within 0.6 degrees at the equator as determined by post flight analysis of stellar data. The Yaw Programmer was set prior to flight to produce a nominal maximum yaw deviation of 3.368 degrees at the equator, southbound.

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 IMSC 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.

Emulsion	Mission 1047-1 B + F Density	Mission 1047-1 Radiation	Mission 1047-2 B + F Density	Mission 1047-2 Radiation
Type 3401	0.15	0.4R	0.16	0.5R
Royal X Pan	0.27	0.5R	0.28	0.5R

These levels are below that which will degrade the photography.

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

Panoramic camera photography from Missions 1047-1 and -2 is considered to be of average quality for the corona J-1 Program. An MIP rating of 85 was awarded to both mission segments.

Stellar/Index camera photography from Mission 1047-1 was considered to be good. Stellar photography from Mission 1047-2, starting with frame number 79 near the beginning of the mission, was grossly over-exposed due to a shutter failure in the open position. Star images from Mission 1047-2 were difficult to detect. Terrain image quality from Mission 1047-2 was good.

B. PANORAMIC CAMERAS

1. Image Quality

Imagery produced by the Aft Looking camera was noticeably better than the forward looking camera where weather permitted a clear assessment of cultural objects throughout Mission 1047-1 and -2. Weather coverage was rated 70% clear.

The MIP frames were selected from the Aft Looking camera for both mission segments. Frame #74 from pass D-120 and Frame #7 from pass D-231 Aft camera were given an MIP rating of 85. These frames were relatively free from weather degredation.

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.

Engineering photography was examined in detail at the A/P facility to determine the degree of fine detail recorded by the panoramic system.

Duplicate positive material from pass D-95, Forward and Aft cameras, revealed small aircraft and vehicular traffic at March AFB, California. Both panoramic cameras produced resolvable imagery as fine as aircraft nacelles on bomber type aircraft. Imagery from both cameras was good enough to distinguish between various sized vehicles such as trucks and cars travelling along interstate highway systems. Imagery recorded by the Aft camera was better defined than that recorded by the forward camera in all examples where a comparison was made and weather did not interfere with the analysis.

Engineering pass D-63, D-127, D-157, and D-206 revealed image quality similar to pass D-95 where weather was not a degrading factor. Pass D-129 was entirely cloud covered. The duplicate positive of pass D-221 is degraded by an overall plus density fog that appears to originate from post flight printing and/or processing.

Fixed resolution bar targets from the controlled range network (CORN) were photographed to assess image quality. Resolution targets were photographed on passes D-095 and D-157. Original negative bar target resolution readings are shown in Table 4-1.

TABLE 4-1

ORIGINAL NEGATIVE RESOLUTION BAR TARGET READINGS

Pass	Frame	Camera	Target Contrast	Reading (Feet) Along Track	Reading (Feet) Across Track	Target Location
D-095	5	FWD	Med.	Not Readable		Indian
	4	AFT	Med.	Not Readable		Springs
D-095	7	FWD	High	12.2	12.2	PAHRUMP
		AFT	High	12.2	12.2	
D-095	16	FWD	Low	22.6	14.2	Edwards
	15	AFT	Low	14.2	14.2	AFB
D-157		FWD	Cloud	Covered		Wright Pat
	17	AFT	High	11.3	-	AFT

1. 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.

The image of the 200 pulse per second time track produced by the Forward Looking camera was erratic and missing for approximately 35% of

Mission 1047-1 and -2. In most instances the slur pulse initiated a restart of the timing track. The density of the timing track was very low making detection difficult. More lamp current is expected to correct this problem.

The Aft looking camera produced a timing track image on the first frame of several passes that was up to 18 inches short. Preflight certification of both panoramic cameras demonstrated that time track performance was acceptable and complete.

Although J-47 system was built with a PG capability it is not to be fully utilized. The PG concept is not applicable to Mission 1047-1 and -2. PG rail holes are present at the beginning of Mission 1047-1 but approximately 40% of the images disappear by the end of Mission 1047-2. The photography had little utility for P.G. measurements. The requirements for PG capability have been removed for the remaining J-1 systems so equipped.

3. 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 1047 -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 of both instrument number 218 and number 219 from both segments 1 and 2. A minus density streak is present intermittently on several frames of instrument number 219 throughout the mission. The minus density streak is attributed to a foreign particle in the scan head assembly.

The erratic and discontinuous 200 pulse per second time track imagery that occurred during operation of both cameras has been described in the Data Recording Section of this report.

An out-of-focus area up to six inches long extends from the supply end of the Forward camera into the format and up to one inch into the format from the titled edge of the frame, throughout Mission 1047-1 and -2. The soft area usually appears after the fifth frame after camera start-up and continues through the pass.

A similar out-of-focus or soft area up to four inches long was present in film from the Aft Looking camera occurring intermittently throughout Mission 1047-1 and -2.

The exact cause of the out-of-focus condition is thought to be associated with a film tracking bias. A similar cause was assigned to soft imagery present in photography from Missions 1028 (J-26), 1036 (J-32), 1041 (J-40) and 1042 (J-37).

The first 13 frames (approximately 35 feet) of photography at the core of the Aft Camera "B" take-up spool, Mission 1047-2, following the cut and wrap function, contained extensive physical damage.

Examination of the damaged film revealed two sets of plus density set screw hole imprints in the film that correspond to the new set screw hole pattern around the core of the take-up cassette.

One set of imprints approximately $7\frac{1}{2}$ feet from the "A" bucket water seal cut indicates that the "B" take-up spool of the Aft camera cinched up the film with the "B" take-up spool turning in the normal direction. The second set of imprints which are approximately 6 feet from the "A" water seal cut may have been created by film slippage of up to approximately $1\frac{1}{2}$ feet at the take-up core during the initial film wrap. However, the second set of set screw hole imprints in the film match the core pattern of holes when the take-up spool is turned in a direction opposite from normal. A check of the original negative from Mission 1046 revealed a normal cut and wrap with only one set of plus density set screw hole imprints approximately 7½ feet from the "A" bucket water seal cut.

Examination of the last two feet of film next to the "A" bucket water seal cut revealed extensive film fold over marks. These fold over marks indicate that the tail of film at the core of the "B" take-up spool was crumpled under successive film wraps and initiated the formation of the egg-shaped roll that was reported by telemetry and reported again during the post-flight despooling operation at [redacted]

Multiple plus density creases are present in the 13 frames of photography following cut and wrap. Creasing is at right angles to the long axis of the film. The pitch of the creasing is frequently quite regular and generally ranges between 0.1 inches apart to 0.5 inches apart. Adjacent creases are indented in the same direction as opposed to an accordian effect. The pattern of creasing on the 7 feet of film next to the "A" bucket water seal cut match a corresponding pattern of creases in the next section of the film. This appears to indicate that the multiple creasing occurred when the film was in intimate contact on the core of the take-up cassette. Creasing apparently occurred when adjacent film wraps on the take-up core slipped as the roll made adjustments for the interwrap spaces created by film fold over observed in the film exhibit. Additional film folds were present approximately 13 to 15 feet from the cut film end.

Evaluation of the electrical circuitry associated with the film take-up revealed that no electrical failure mode could be found that would cause the take-up spool to turn in a direction opposite from normal and then reverse to the normal direction for the balance of the Mission 1047-2.

A continuous minus density streak is present in the active format of the forward camera throughout Mission 1047-1 and -2. The minus density streak is located approximately 0.1 inches from the time track edge of each frame. Degradation to imagery was very minimal.

A minus density streak, generally aligned with the major axis of the film, is present intermittently on several frames throughout the mission. Degradation to imagery is minimal.

Emulsion scratches, oriented parallel to the major axis of the film are present throughout the mission. The number, up to 16, is not restricted to the frame boundaries.

C. HORIZON

All four horizon cameras demonstrated acceptable performance throughout Mission 1047-1 and -2. Veiling was not present during Mission 1047-1 and -2. The horizon line was well defined throughout the format. Slight vignetting was observed at the ends of all horizon images.

Horizon image veiling usually occurs at beta angles greater than minus 30 degrees. The maximum beta angle that occurred during Mission 1047-1 and -2 was minus 27 degrees, hense horizon veiling was not present.

Horizon fiducials were present throughout both mission segments.

D. STELLAR-INDEX CAMERAS

1. First Mission

Stellar-Index camera number D-117 was operational during Mission 1047-1 with the exception of two consecutive frames (#229 and #230) which were not exposed. Approximately 12-18 stellar images are detectable on most frames. The reseau is sharp and imaged on all frames. Stellar fiducials are present. The Index camera operated satisfactorily throughout Mission 1047-1. The reseau is imaged sharply on all frames. The image quality of both the stellar and index cameras was good. Most star images are the point type. Minor fog patterns appear on two frames at the end of the mission. Star density was adequate for the detection of many images. Stellar film recovery consisted of 450 frames (53 feet). The index camera film recovered contained 450 frames (100 feet).

2. Second Mission

The Stellar-Index camera operated throughout the first 78 frames. After stellar frame #78 the stellar shutter failed in the open position causing all remaining frames to be grossly over exposed. Stellar images were difficult to detect. The stellar reseau is sharp and imaged properly on all frames, except frame #479, the last frame.

Approximately 12-16 stellar images are detectable on the properly exposed frames prior to frame 79. Stellar image quality was good on frames 1-78. The star images on frames 79 and up were elongated.

The index camera was operational throughout Mission 1047-2. The index reseau was uniformly sharp. Index imagery was rated good.

SECTION 5

PANORAMIC EXPOSURE

Exposure on the panoramic camera system is a function of the slit width used, the filter attenuation, and the scan rate. As scan rate depends upon 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 0.150 inch slit and Wratten 23A filter were selected for the forward looking camera, with a 0.130 inch slit and Wratten 21 filter for the aft. These selections were made to place exposure near the full processing level for northern operations, passing thru the intermediate and primary levels on southernly operations. These settings are approximately one-third stop less exposure than recent flights during summer months, and represent the best compromise obtainable among the many considerations.

Solar elevations encountered during photographic operations are summarized below. While distribution within these ranges is non-Gaussian, most frames were taken between 10 and 40 degrees elevation during both segments. This represents a general latitude band between 30 and 60 degrees north.

Solar direction, relative to system flight direction, was on the starboard side of the ground track. The ranges, below, represent normal dispersions for a summer mission.

RANGES OF EXPOSURE PARAMETERS

Sun Elevation:	1047-1		37° - 76°
	1047-2		7° - 74°
		Northern	Southern
Sun Direction:	1047-1	22° - 104°	145° - 151°
	1047-2	10° - 80°	110° - 150°
		Master	Slave
Exposure Time:	1047-1	1/364-1/451	
	1047-2	1/290-1/315	1/370-1/405

The recovered film was processed using the Trenton equipment, which provides three levels of development depending upon the exposure the material has received, the gross density range indicated by an intermediate stage infrared scanning station, and the judgement of the operators:

REPORTED PROCESSING LEVEL

	Primary	Inter.	Full	Transition	#Changes
1047-1	1%	8%	81%	10%	42
1047-2	1%	3%	90%	6%	32

Measurements of optical density of selected frames were taken at AFSPPF. The consensus of the data is that the material was generally correctly processed, but there existed a significant tendency towards underexposure as shown in Table 5-1.

MISSION 1047-1 INSTR - FWD 8/14/68 PROCESSING AND EXPOSURE ANALYSIS

PROCESS LEVEL	SAMPLE SIZE	UNDER EXPOSED	UNDER PROCESSED	CORRECT EXP&PROC	OVER PROCESSED	OVER EXPOSED
PRIMARY	0	0 PC	0 PC	0 PC	0 PC	0 PC
INTERMEDIATE	38	0 PC	37 PC	61 PC	3 PC	0 PC
FULL	262	40 PC	0 PC	55 PC	5 PC	0 PC
ALL LEVELS	300	35 PC	5 PC	56 PC	4 PC	0 PC

MISSION 1047-1 INSTR - AFT 8/14/68 PROCESSING AND EXPOSURE ANALYSIS

PROCESS LEVEL	SAMPLE SIZE	UNDER EXPOSED	UNDER PROCESSED	CORRECT EXP&PROC	OVER PROCESSED	OVER EXPOSED
PRIMARY	0	0 PC	0 PC	0 PC	0 PC	0 PC
INTERMEDIATE	33	0 PC	27 PC	61 PC	12 PC	0 PC
FULL	261	21 PC	0 PC	69 PC	10 PC	0 PC
ALL LEVELS	294	18 PC	3 PC	69 PC	10 PC	0 PC

MISSION 1047-2 INSTR - FWD 8/14/68 PROCESSING AND EXPOSURE ANALYSIS

PROCESS LEVEL	SAMPLE SIZE	UNDER EXPOSED	UNDER PROCESSED	CORRECT EXP&PROC	OVER PROCESSED	OVER EXPOSED
PRIMARY	0	0 PC	0 PC	0 PC	0 PC	0 PC
INTERMEDIATE	15	0 PC	20 PC	67 PC	13 PC	0 PC
FULL	299	58 PC	0 PC	37 PC	4 PC	0 PC
ALL LEVELS	314	55 PC	1 PC	39 PC	5 PC	0 PC

MISSION 1047-2 INSTR - AFT 8/14/68 PROCESSING AND EXPOSURE ANALYSIS

PROCESS LEVEL	SAMPLE SIZE	UNDER EXPOSED	UNDER PROCESSED	CORRECT EXP&PROC	OVER PROCESSED	OVER EXPOSED
PRIMARY	0	0 PC	0 PC	0 PC	0 PC	0 PC
INTERMEDIATE	16	0 PC	6 PC	69 PC	25 PC	0 PC
FULL	291	43 PC	0 PC	51 PC	6 PC	0 PC
ALL LEVELS	307	41 PC	0 PC	52 PC	7 PC	0 PC

PROCESS LEVEL	BASE & FOG	UNDER EXPOSED	UNDER PROCESSED	CORRECT EXP&PROC	OVER PROCESSED	OVER EXPOSED
PRIMARY	0.01-0.09	0.01-0.13	0.14-0.39	0.40-0.90	---------	0.91 AND UP
INTERMED	0.10-0.17	0.01-0.20	0.21-0.39	0.40-0.90	0.91-1.34	1.35 AND UP
FULL	0.18 AND UP	0.01-0.39	---------	0.40-0.90	0.91-1.69	1.70 AND UP

TABLE 5-1

Processing and Exposure Analysis Mission 1047

The normal criterion used to determine proper exposure and processing is that minimum image density should range between 0.4 and 0.9. The area of the scene to be measured is selected subjectively and is not necessarily the absolute minimum image density. This criterion has been found to be an inadequate indicator of optimum target exposure. This is because information content is largely based upon density variations at or near the resolution threshold of cultural targets only, as the photograph is utilized by the photointerpreter. The density measurements are indescriminantly made of relatively gross natural and cultural areas.

Maximum intelligence is generally derived from specific cultural target densities meetingthe 0.4 to 0.9 criterion. This will usually result in minimum gross scene densities below 0.4, as the reflectance value range for natural areas tends to be lower than that for cultural areas. It becomes apparent that missions with the more desirable information will probably be reported as significantly underexposed, using current evaluation techniques.

Figures 5-1 to 5-8 show the freqency distribution of the minimum image density taken from Mission 1047-1 and -2 photography, forward and aft looking panoramic cameras. Minimum image density shown in Figures 5-1 thru 5-8 is for all levels of processing.

The nominal exposure times of the forward and aft looking cameras are shown as a function of latitude for passes D-1, D-112, and D-224 in Figures 5-9 to 5-14. Superimposed on these plots are relative distributions of camera operations for the portion of the mission represented by each plot.

MISSION * 1047-1 * INSTR * FWD * 8/14/68 PLOT OF D MIN * TERRAIN * PROCESSING * ALL LEVELS

ARITH MEAN * 0.50 * MEDIAN * 0.43 * STD DEV * 0.18 * RANGE * 0.26 TO 1.27 WITH 300 SAMPLES

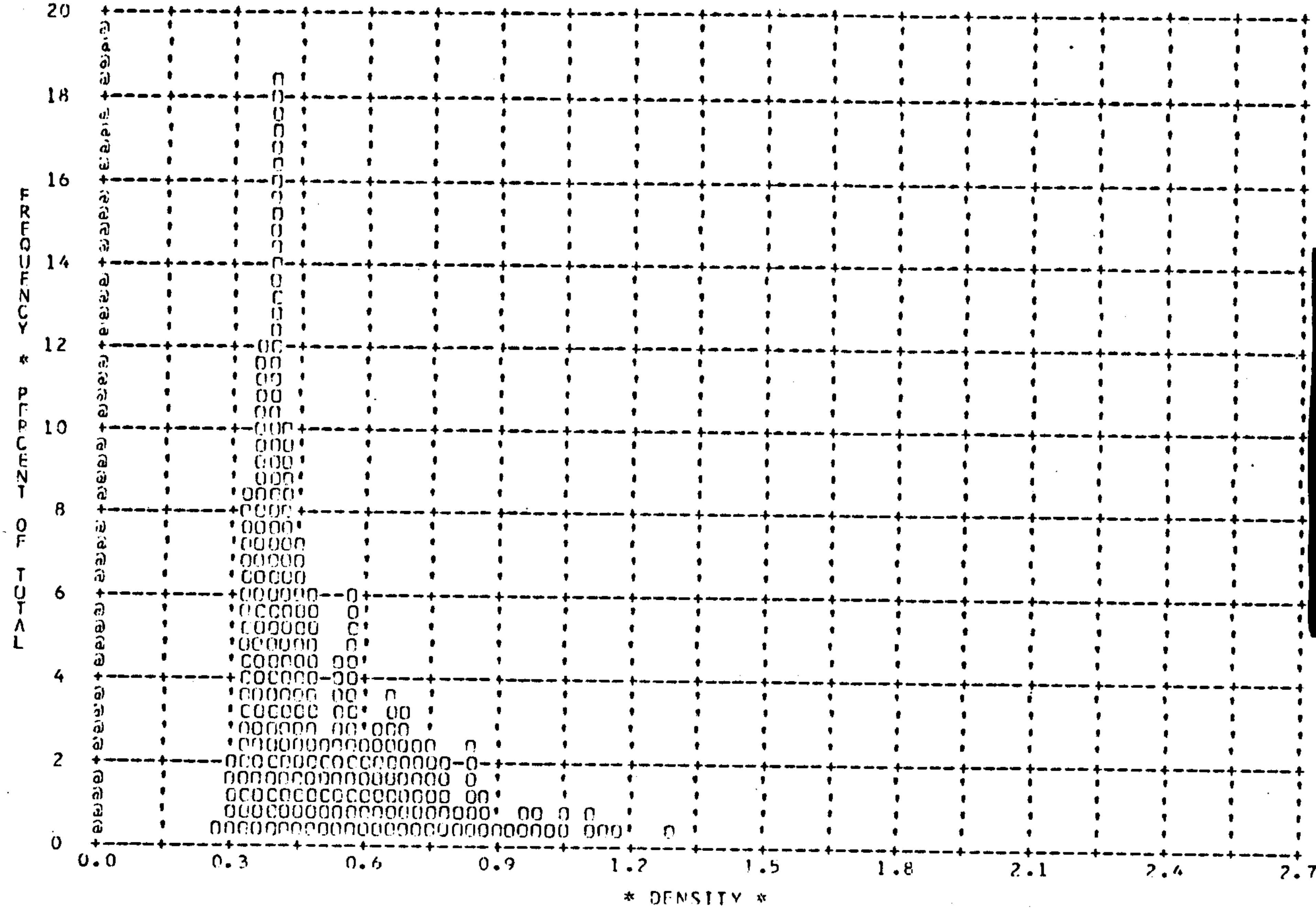


Figure 5-1

~~TOP SECRET~~ C[redacted]

MISSION * 1047-1 * INSTR * FWD * 8/14/68 PLOT OF D MAX * TERRAIN * PROCESSING * ALL LEVELS

ARITH MEAN * 1.38 * MEDIAN * 1.40 * STD DEV * 0.36 * RANGE * 0.53 TO 2.41 WITH 300 SAMPLES

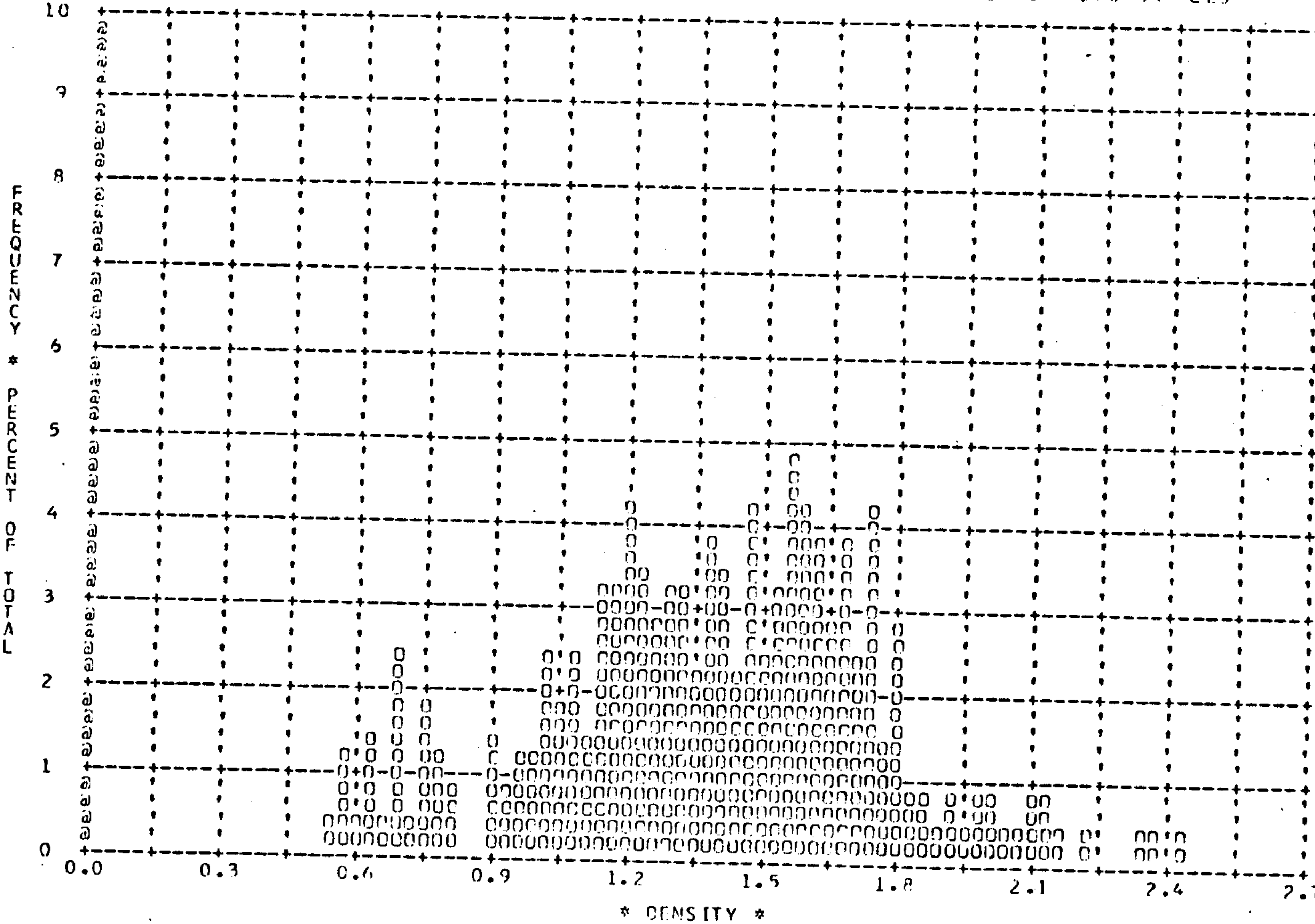


Figure 5-2

MISSION * 1047-1 * INSTR * AFT * 8/14/68 PLOT OF D MIN * TERRAIN * PROCESSING * ALL LEVELS

ARITH MEAN * 0.57 * MEDIAN * 0.50 * STD DEV * 0.22 * RANGE * 0.29 TC 1.32 WITH 294 SAMPLES

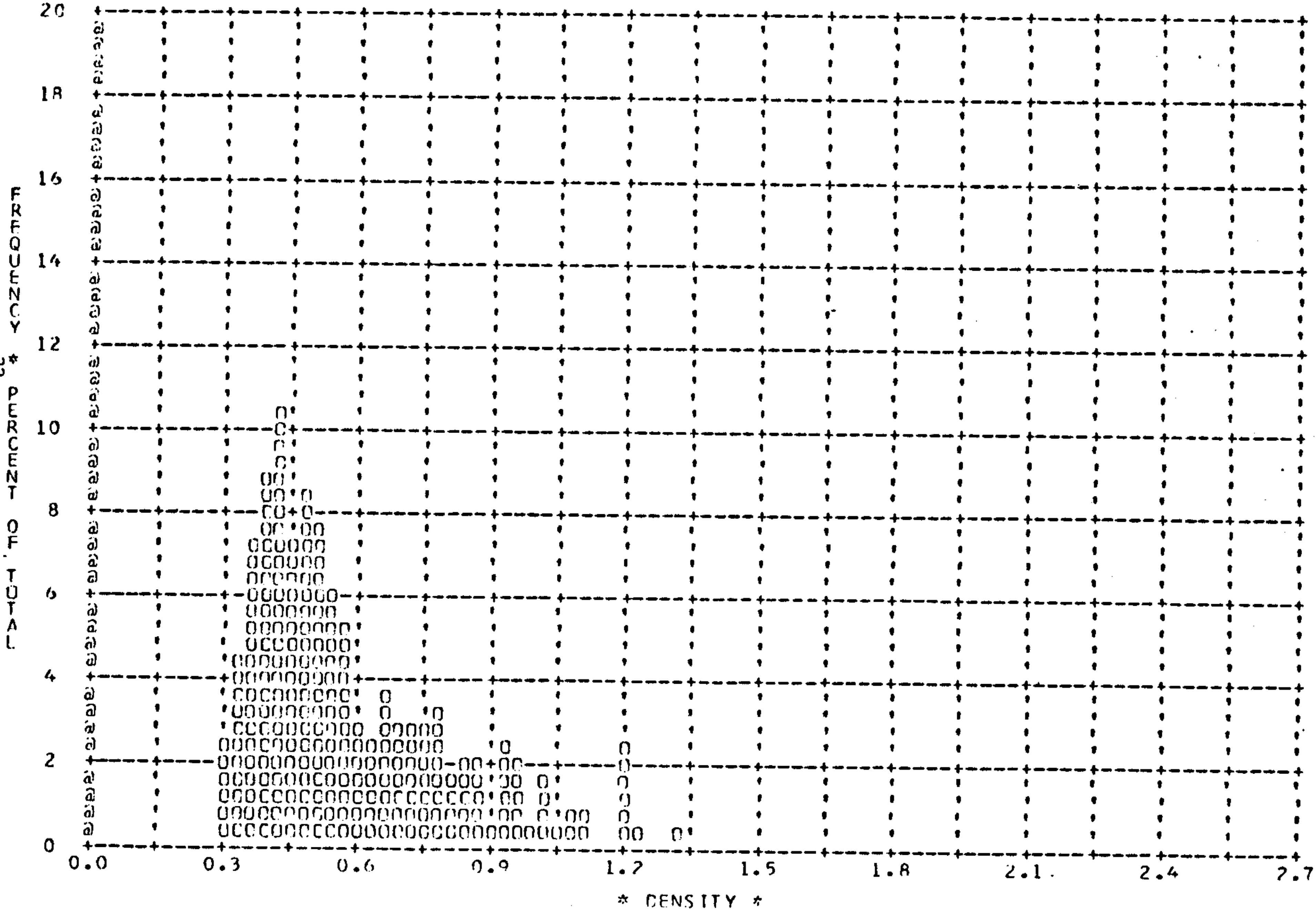


Figure 5-3

MISSION * 1047-1 * INSTR * AFT * 8/14/68 PLOT OF D MAX * TERRAIN * PROCESSING * ALL LEVELS

ARITH MEAN * 1.41 * MEDIAN * 1.44 * STD DEV * 0.35 * RANGE * 0.48 TO 2.27 WITH 294 SAMPLES

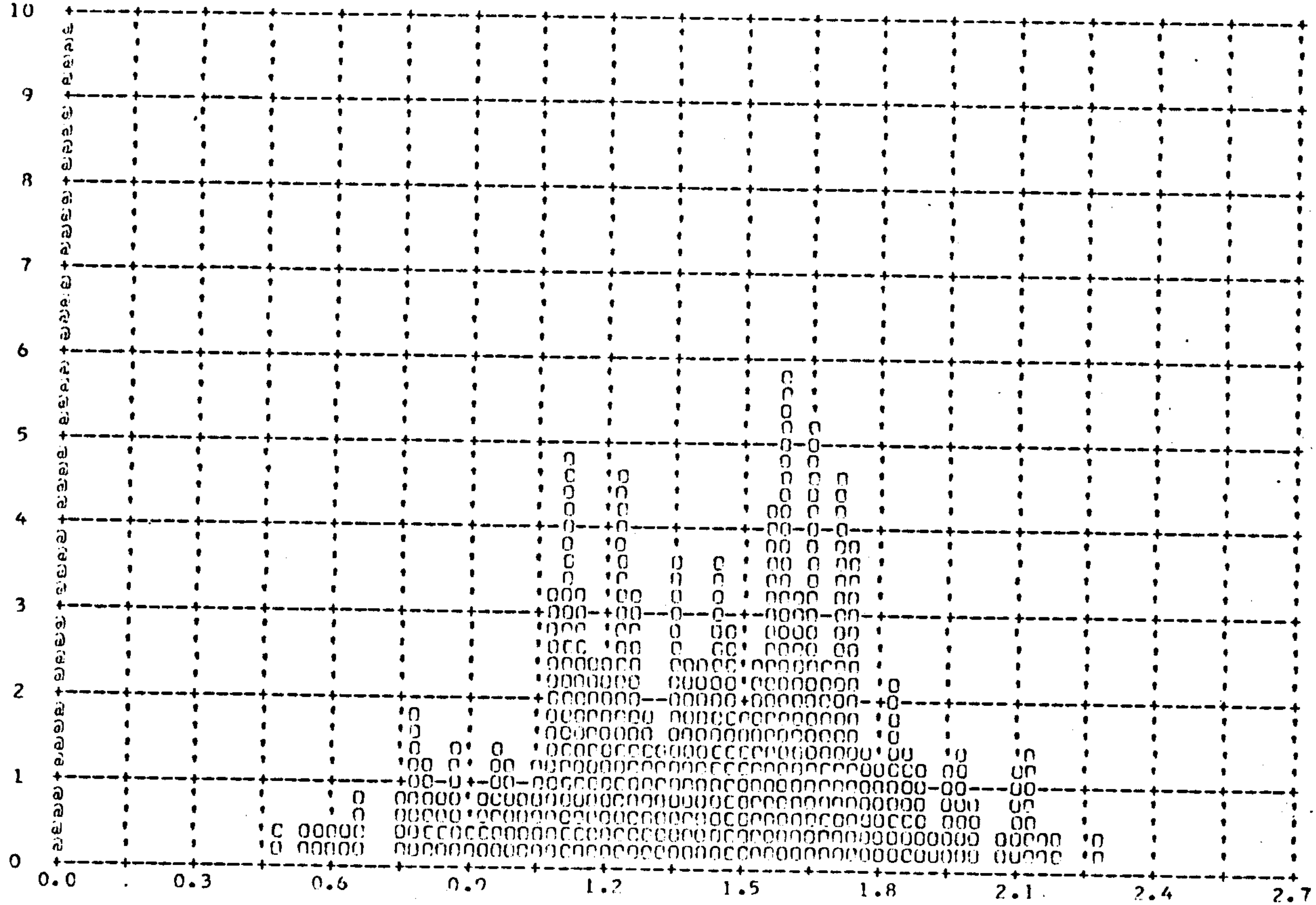
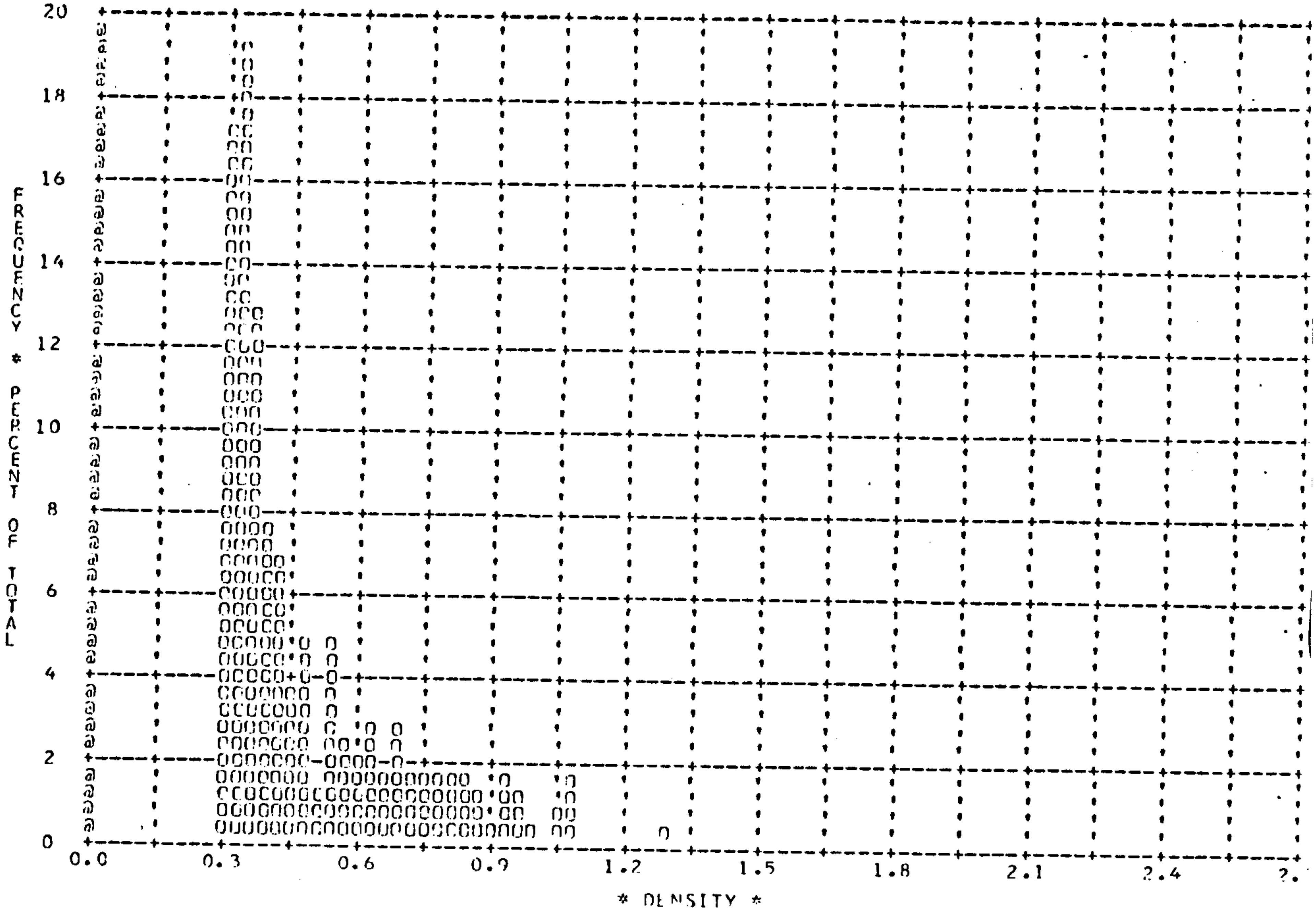


Figure 5-4

MISSION * 1047-2 * INSTR * FWD * 8/14/68 PLOT OF D MIN * TERRAIN * PROCESSING * ALL LEVELS
ARITH MEAN * 0.45 * MEDIAN * 0.37 * STD DEV * 0.20 * RANGE * 0.30 TO 1.29 WITH 314 SAMPLES



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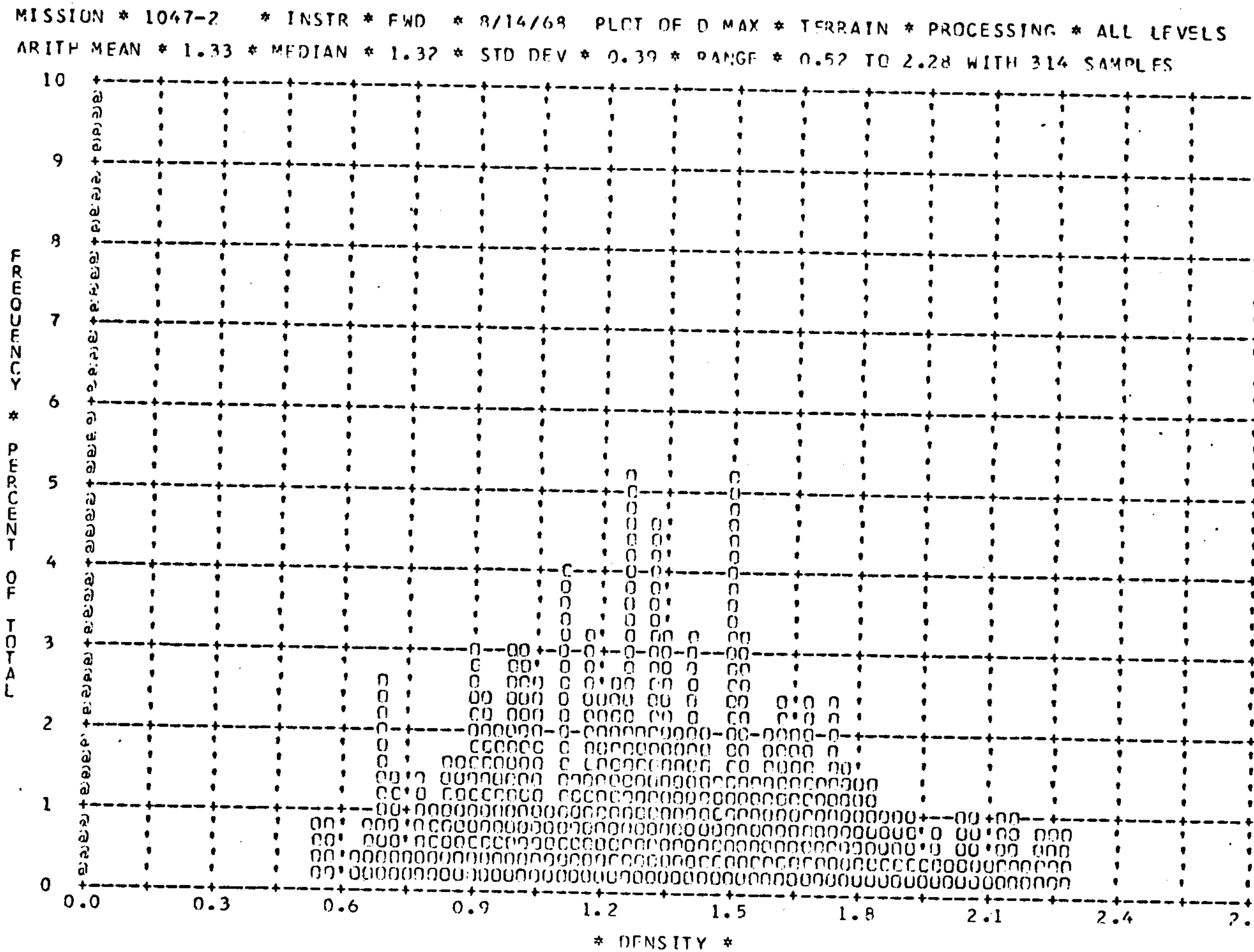

Figure 5-6

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MISSION * 1047-2 * INSTR * AFT * 9/14/68 PLOT OF D MIN * TERRAIN * PROCESSING * ALL LEVELS
ARITH MEAN * 0.50 * MEDIAN * 0.42 * STD DEV * 0.21 * RANGE * 0.27 TO 1.41 WITH 307 SAMPLES

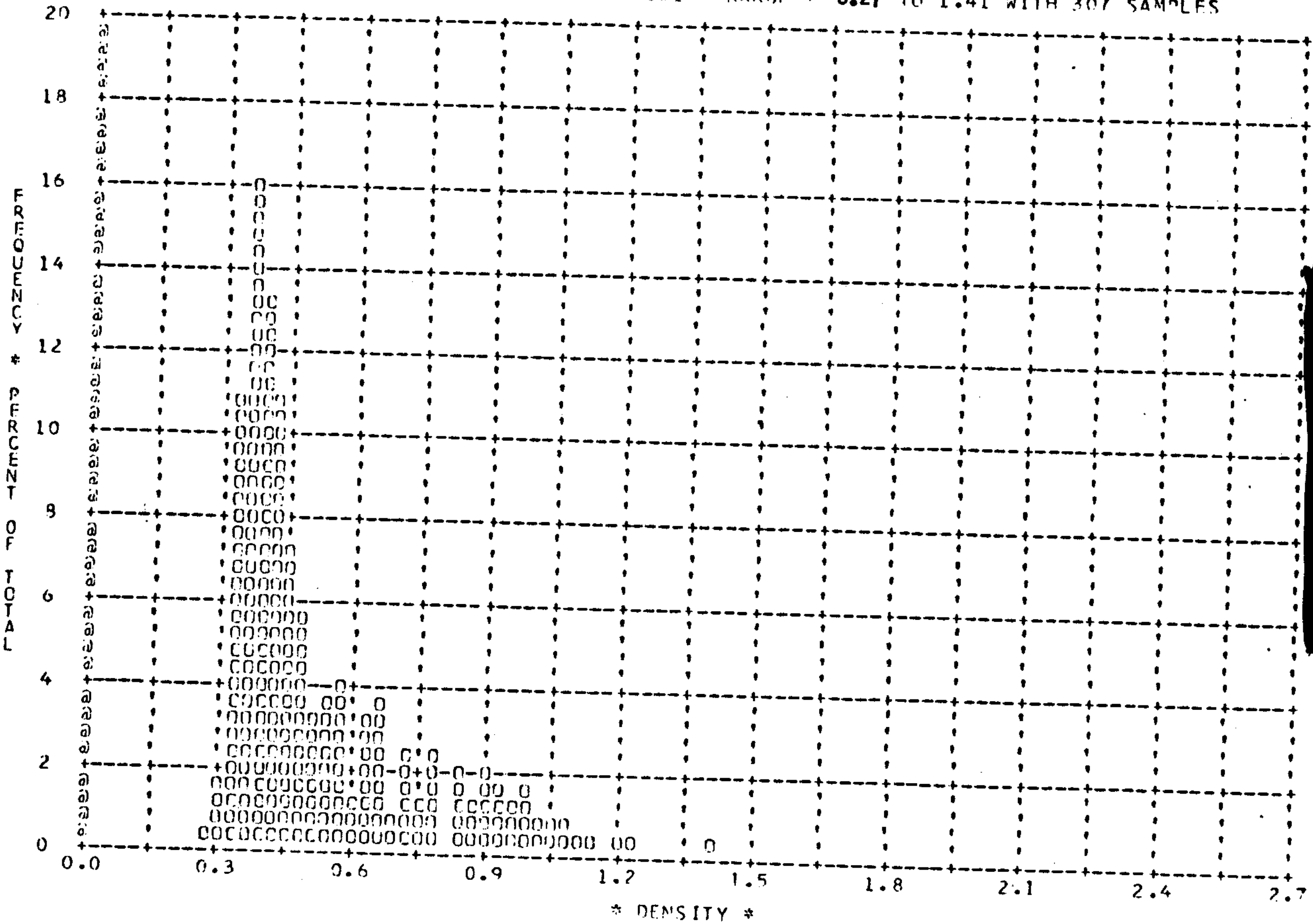


Figure 5-7

MISSION * 1047-2 * INSTR * AFT * 9/14/68 PLOT OF D MAX * TERRAIN * PROCESSING * ALL LEVELS

ARITH MEAN * 1.36 * MEDIAN * 1.34 * STD DEV * 0.35 * RANGE * 0.55 TO 2.23 WITH 307 SAMPLES

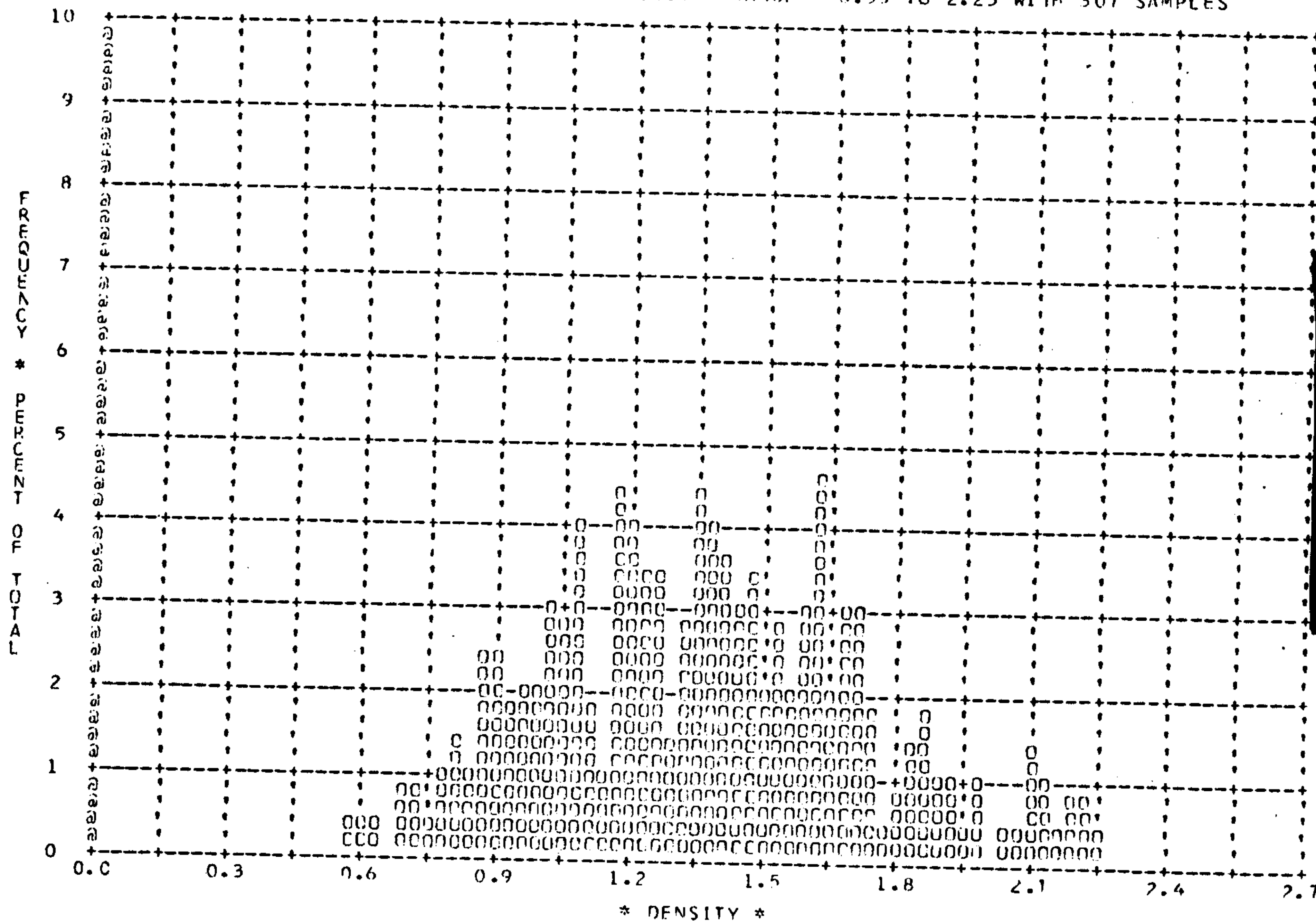
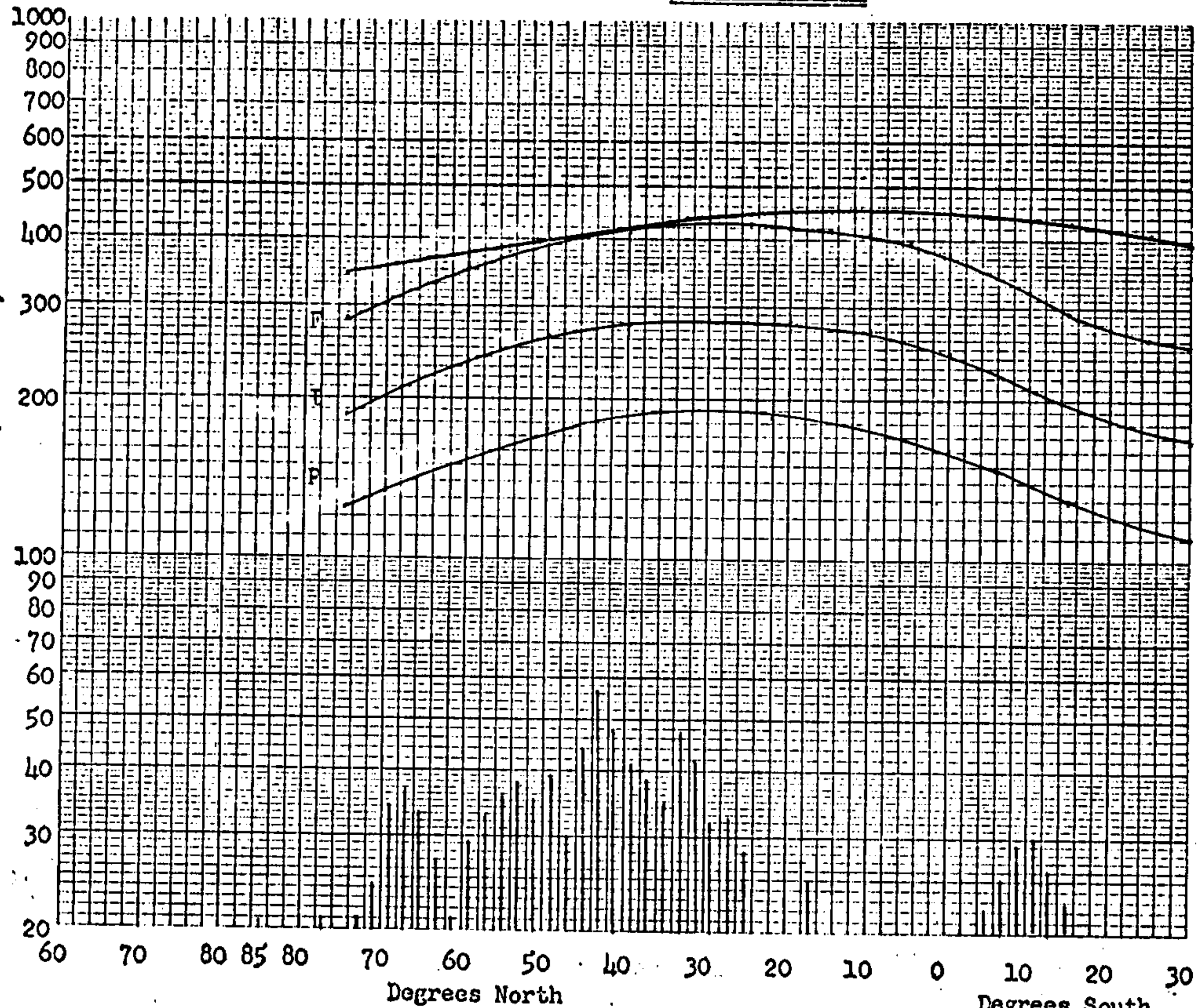


Figure 5-8

EXPOSURE POINTS



Mission No: 1047

Payload No: J-47

Camera No: 218

Pass No: 1

Launch Date: June 20, 196[redacted]

Launch Time: 21:46 Z

Slit Width: .150

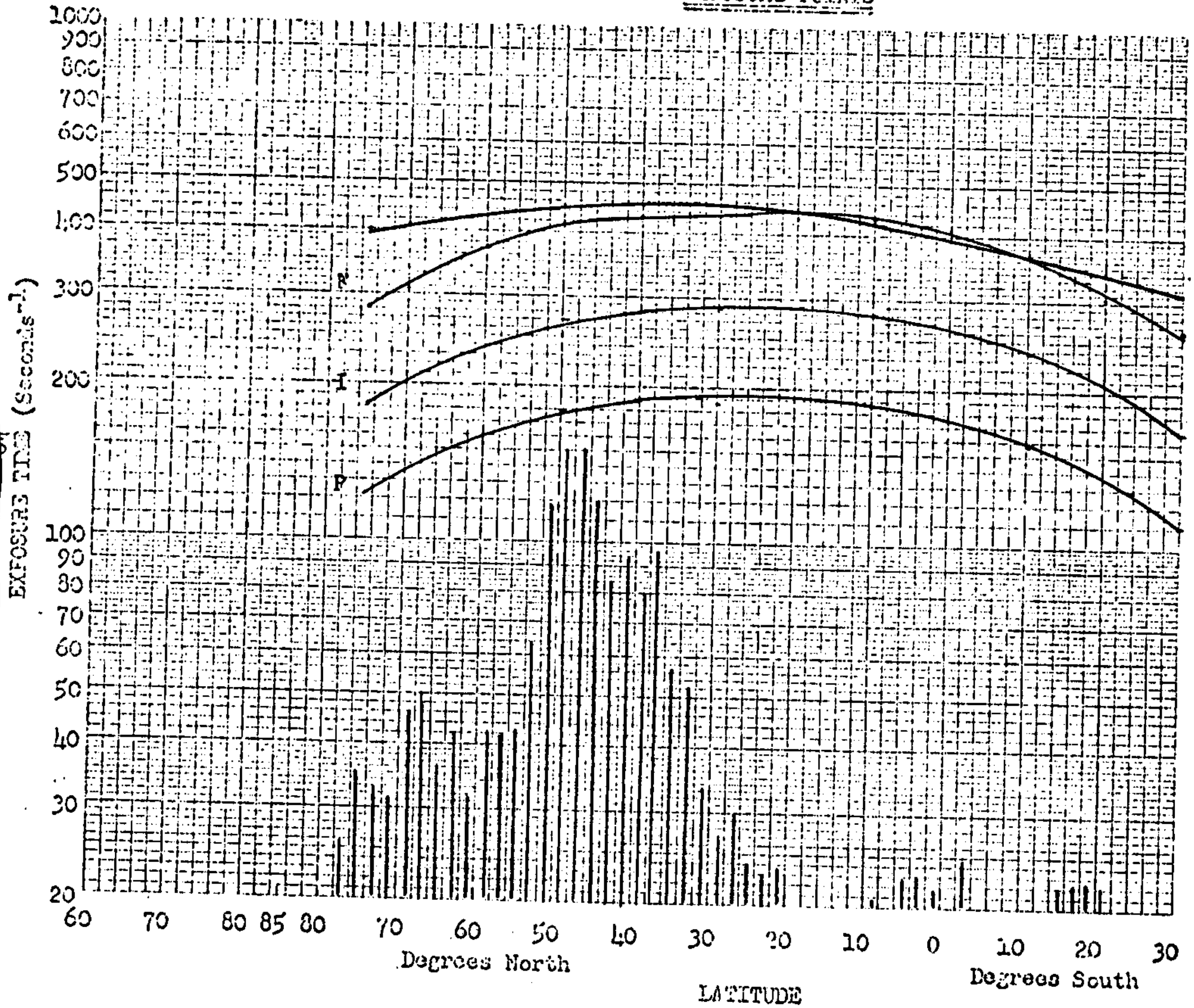
Filter Type: W23A

Film Type: 3404

FIGURE 5-9

[redacted]

EXPOSURE POINTS



Mission No: 1047

Payload No: J-47

Camera No: 218

Pass No: 112

Launch Date: June 20, 1968

Launch Time: 21:46 Z

Slit Width: .150

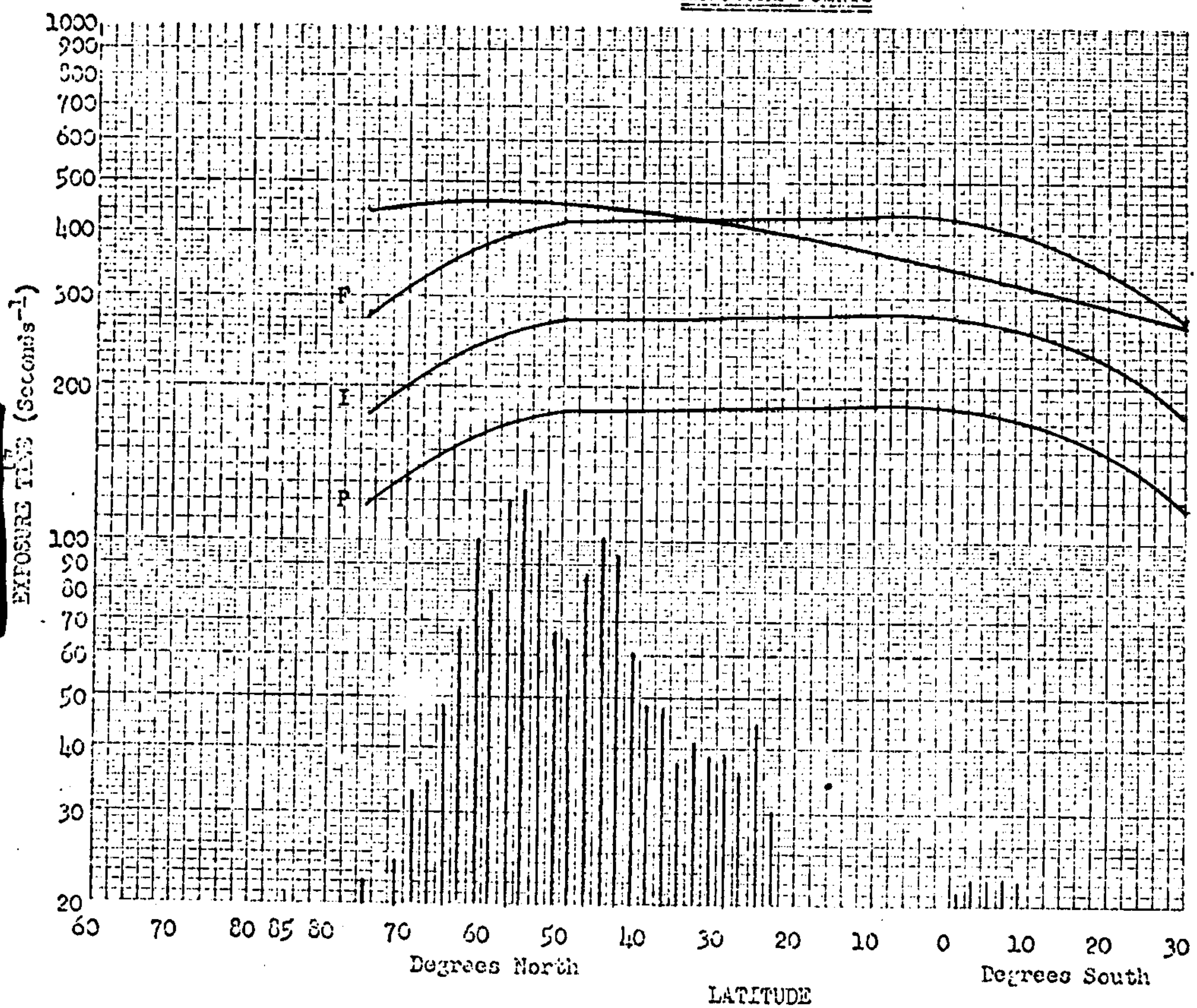
Filter Type: W23A

Film Type: 3404

FIGURE 5-10

[redacted]

EXPOSURE POINTS



Mission No: 1047

Payload No: J-47

Camera No: 218

Pass No: 224

Launch Date: June 20, 1968

Launch Time: 21:46 Z

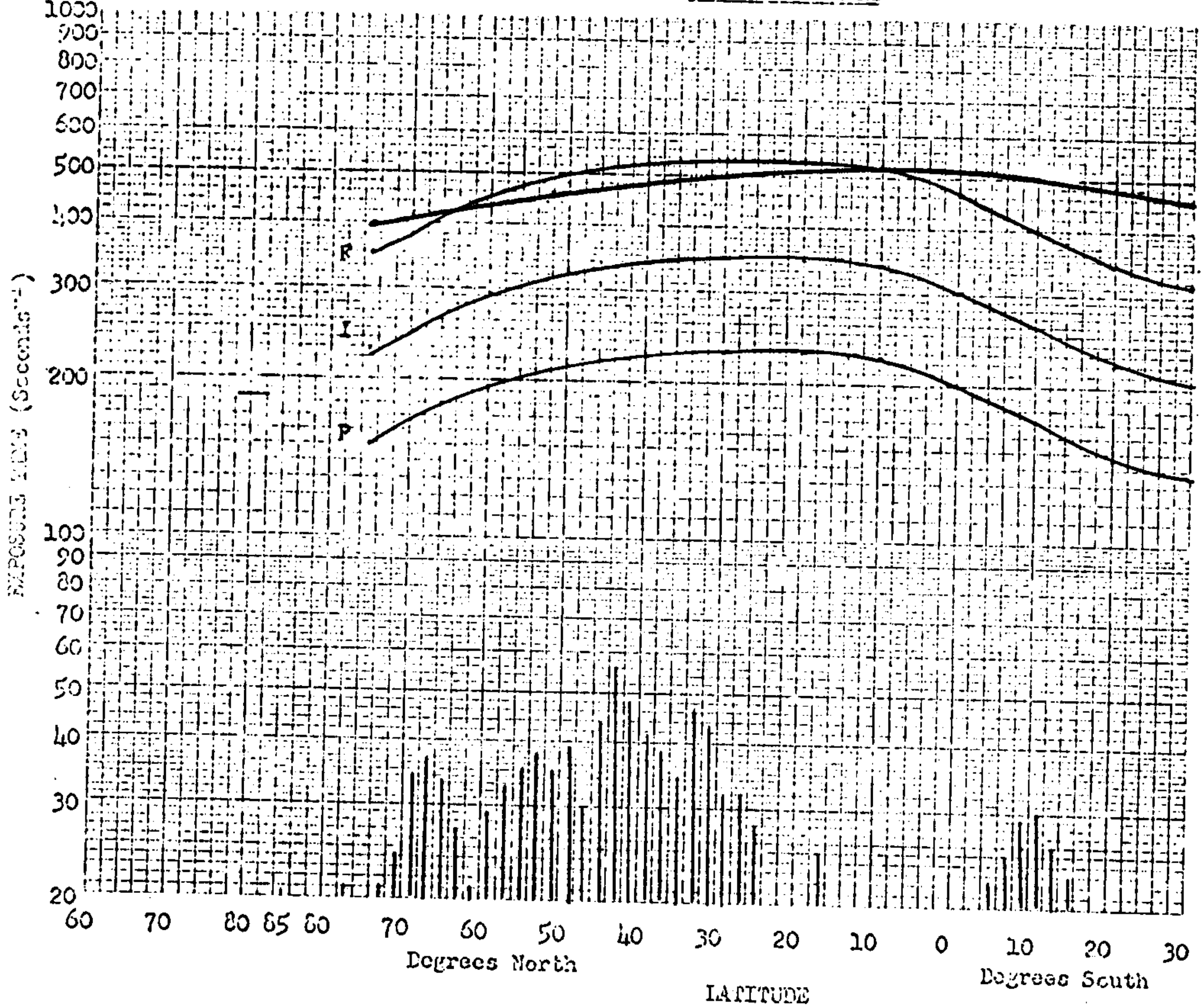
Slit Width: .150

Filter Type: W23A

Film Type: 3404

FIGURE 5-11

EXPOSURE POINTS



Mission No: 1047

Payload No: J-47

Camera No: 219

Pass No: 1

Launch Date: June 20, 1968

Launch Time: 21:46 Z

Slit Width: .130

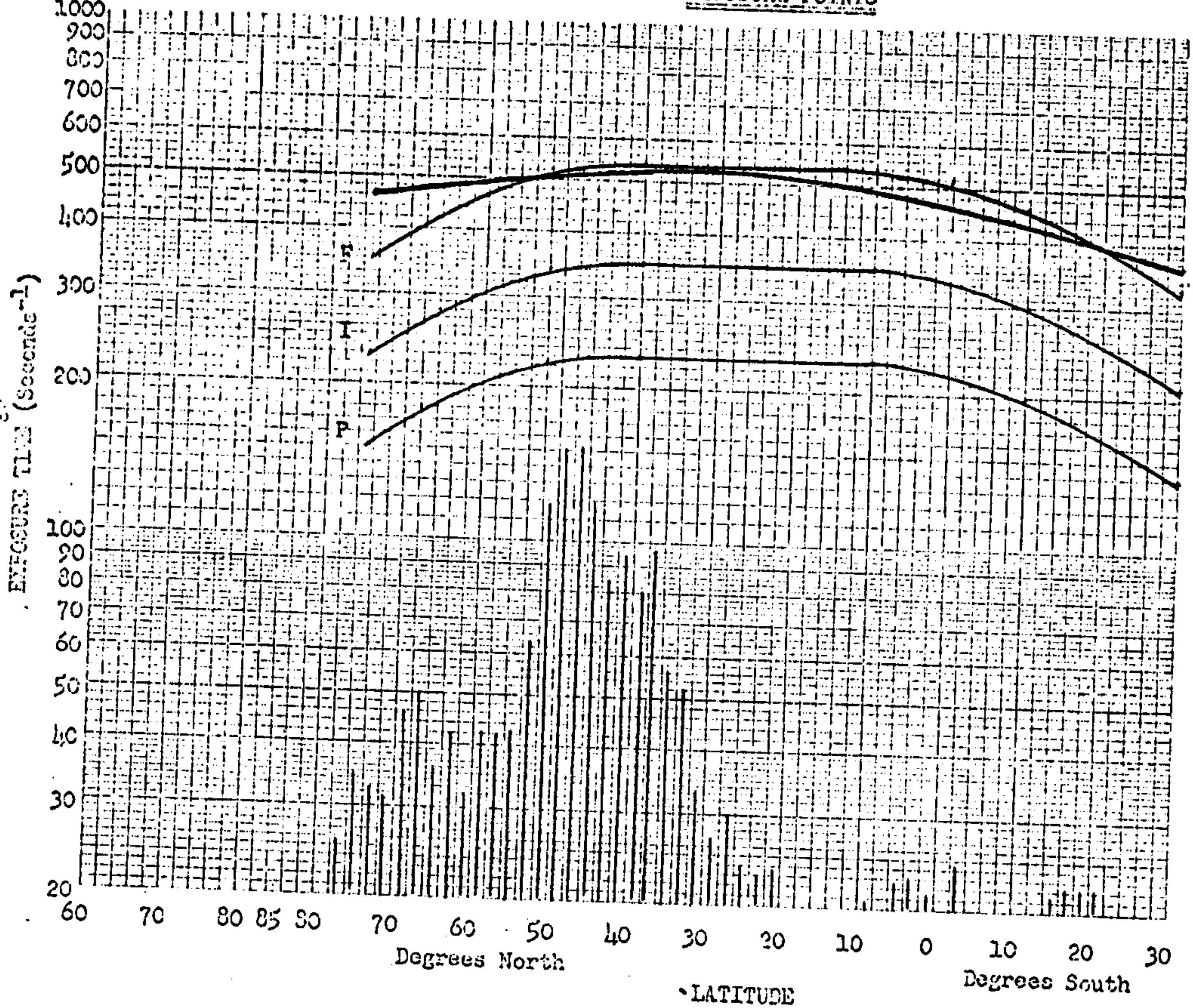
Filter Type: W21

Film Type: 3404

TOP SECRET C [redacted]

FIGURE 5-10

EXPOSURE POINTS



Mission No: 1047

Payload No: J-47

Camera No: 219

Pass No: 112

Launch Date: June 20, 1968

Launch Time: 21:46 Z

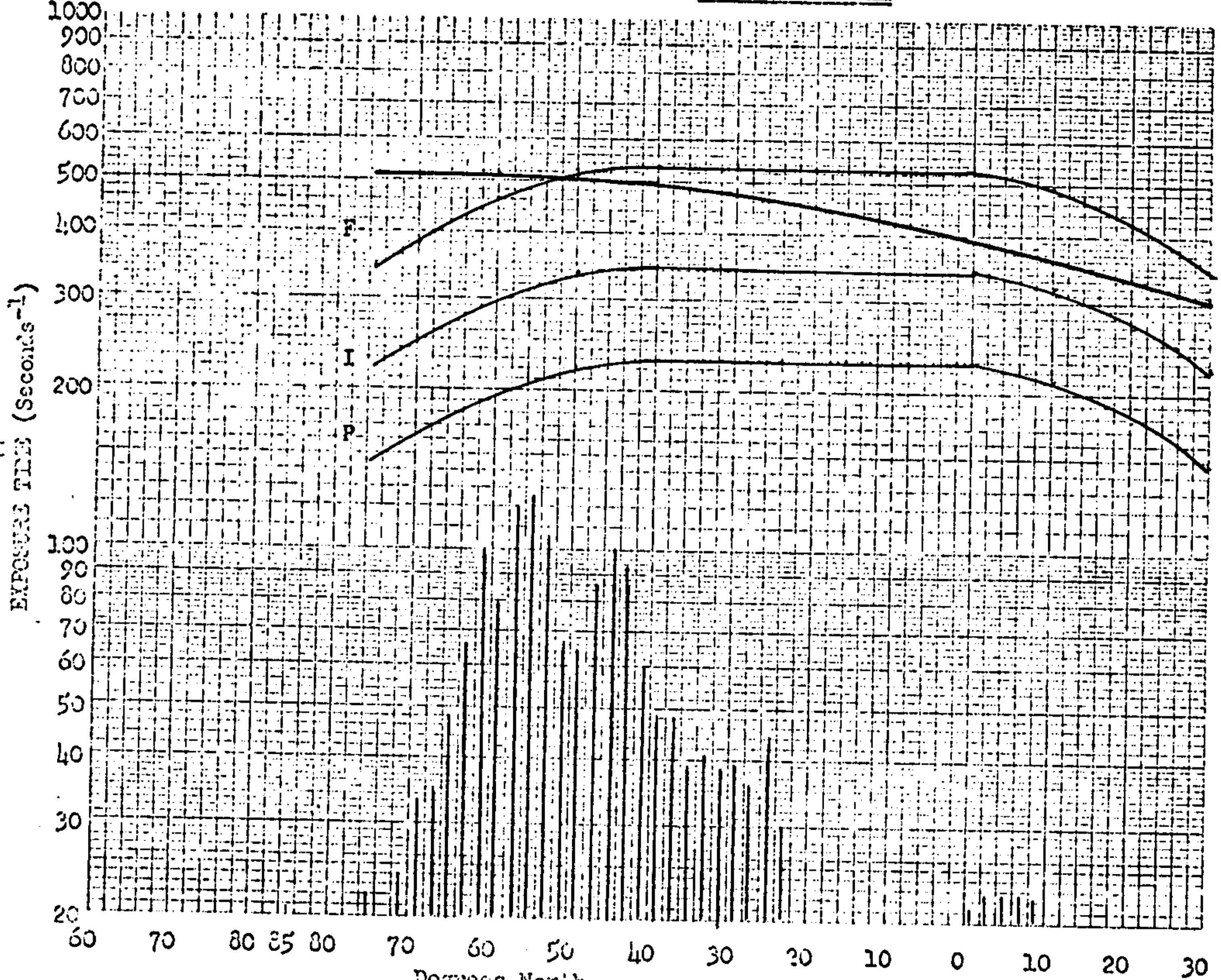
Slit Width: .130

Filter Type: W21

Film Type: 3404

FIGURE 5-13

EXPOSURE POINTS



Mission No: 1047

Payload No: J-47

Camera No: 219

Pass No: 224

Launch Date: June 20, 1968

Launch Time: 21:46 Z

Slit Width: .130

Filter Type: W 21

Film Type: 3404

FIGURE 5-14

SECTION 6

IMAGE SMEAR

A. VEHICLE ATTITUDE

Vehicle attitude performance data were derived from reduction of the S ellar 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 was normal, and comparable to recent missions. While any angular deviation will cause geometric variation in the photography and any rate deviation will tend to cause relative image motion, the deviations for this mission are not considered degrading to the panoramic photography. The table, below, summarizes both the total range of attitude variation and that experienced during ninety percent of photographic operations:

	1047-1		1047-2	
	90%	Total Range	90%	Total Range
Angle Deviation (degrees):				
Pitch	0.18	-0.56 to +0.28	0.23	-0.38 to +0.5[illegible]
Roll	0.23	-0.42 to +0.28	0.27	-0.38 to +0.7[illegible]
Yaw	0.52	0.00 to +1.35	No Data	
Rate Deviation (degrees/hour):				
Pitch	24.17	-64 to +60	34.83	-85 to +100
Roll	23.79	-90 to +80	27.74	-90 to +85
Yaw	23.08	-64 to +42	No Data	

(NOTE:) Above data are for all but the first six frames of each forward-looking camera operation. Data from the aft-looking camera are similar).

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 IMSC Precision Fit ephemeris to produce an analysis of 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. The following tabulation summarizes the system error and resolution limits:

		1047-1		1047-2	
		90%	Total Range	90%	Total Range
IMC Error, percent:					
	FWD	2.10	-5.0 to +3.6	4.06	-7.0 to +0.4
	AFT	1.78	-5.0 to +4.4	3.01	-7.5 to +2.0
Resolution Limit, feet:					
Intrack:	FWD	1.74	0 to 4.8	3.30	0 to 7.0
	AFT	1.28	0 to 4.2	2.09	0 to 6.4
Crosstrack:	FWD	0.92	0 to 2.15	4.49	0 to 7.4
	AFT	0.63	0 to 2.0	3.83	0 to 6.0

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 consistant 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:

Primary (M7 and up)	Opportunities To Operate	Failures	Estimated Reliability
Panoramic Cameras	215	2	98.8%
Main Doors	134	0	99.5%
Command and Control	13,130 (hrs)	2	96.6%
Clock	13,130 (hrs)	0	99.1
Total Payload Functions	-	-	97.0%
Recovery System	99	1	98.3%
Secondary (J5 and up)			
Horizon Cameras:			
Single Camera	130,000	0	99.2%
4 Units, parallel redundant	-	-	99.9%
Stellar-Index Camera	30,680	5	92.5%

SUMMARY

Mission 1047 was considered successful in its photographic results; good imagery was made available to the intelligence and cartographic communities. Few significant photographic anomalies were noted.

DISTRIBUTION:

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