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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1048-1 and 1048-2

FTV 1647, J-49

Approved: [redacted]
Advanced Projects

Approved: [redacted] Manager
Program [redacted]

FOREWORD

This report details the performance of the payload system (J-49) during the operational phase of Mission 1048.

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

This document is the final payload test and performance evaluation report for Missions 1048-1 and 1048-2 which was launched on 18 September 1968.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1048-1 and 1048-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the J-49 payload system and to identify the source of in-flight anomalies.

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

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

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

This report contains certain data summarized from [redacted] Processing Summary, and from AFSPPF TERO Report.

SECTION 1

SYSTEM PERFORMANCE

A. MISSION OBJECTIVES

The payload section of Mission 1048, placed into orbit by Flight Test Vehicle #1647 and THORAD Booster #524, consisted of two panoramic cameras, two Stellar-Index cameras, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipment. Figure 1-1 presents an inboard profile of the J-49 payload system. This Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. A 16-day mission was planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 1431 PST on 18 September 1968. Ascent and injection were normal and the achieved orbit was within nominal tolerances. Tracking and command support was effected by the Air Force Satellite Control Facility consisting of tracking and command stations at [redacted] and [redacted] under central control of the Satellite Test Center at Sunnyvale, California.

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

ORBITAL PARAMETERS

Parameter	Predicted	Orbit 9 Actuals
Period (Min.)	90.248	90.263
Perigee (N.M.)	100.	98.02
Apogee (N.M.)	211.10	214.48
Inclination (Deg.)	83.0	83.0
Perigee Latitude (Deg. N.)	22.287	19.938
Eccentricity	0.015439	0.016185

Mission 1048-1 consisted of a 9 day operation and was completed by air recovery on 27 September 1968. Mission 1048-2 was completed with an air recovery on 2 October 1968 following a 5 day photographic operation.

C. PANORAMIC CAMERAS

The Master Panoramic camera indicated normal operation throughout the -1 mission. Telemetry and film analysis indicated the Master camera failed after 1,095 cycles in the -2 mission. The failure appeared to be in the camera motor drive assembly (gear box). The internal camera Operate command remained energized due to the position at which the unit stopped.

The Slave camera functioned properly throughout the -1 and -2 missions. The Slave camera film was depleted on Rev. 216 with frame No. 20 the last active frame.

Photographic results showed a variation in quality ranging from good to that of less than normal quality. Overall interpretability was rated as fair with the aft camera performing better than the forward. An MIP rating of 85 was assigned. Cloud cover was 25% for the -1 mission and 30% for the -2 mission.

D. STELLAR-INDEX CAMERAS

The -1 Stellar/Index camera operated satisfactorily during the -1 mission. The -2 Stellar/Index operated normally through pass 180. The failure of the master Panoramic camera with the Stellar/Index slaved to it, precluded any further operation of the -2 Stellar/Index camera. Prior to the failure, telemetry data indicated the programmer, metering functions, and shutter monitor performed satisfactorily on the observed engineering passes.

E. OTHER SUBSYSTEMS

The clock, pressure make-up, command and thermal control subsystems performed satisfactorily.

The payload instrumentation system performed satisfactorily except for the T/M commutator. The commutator containing status and temperature data, failed to start on Rev. 175 and remained inoperative until after acquisition at the [redacted] Tracking Station on Rev. 224.

F. COMPONENT IDENTIFICATIONS AND SETTINGS

1. MASTER PANORAMIC CAMERA

a. COMPONENT ASSIGNMENT

Component	Serial Number
Main Camera	222
Main Camera Lens	2342243
Supply Horizon Camera	323G6L
Supply Horizon Camera Lens	28515
Take-up Horizon Camera	323G5L
Take-up Horizon Camera Lens	23770
Supply Cassette	SC-39

b. CAMERA DATA AND FLIGHT SETTINGS

Main Camera:

Lens	24" f/3.5
Slit Width	0.200"
Filter Type	Wratten 23A
Film Type	Eastman Type 3404

Supply (Port) Horizon Camera:

Lens	55mm f/6.3
Aperture Setting	f/6.8
Exposure Time	1/100 second
Filter Type	Wratten 25

Take-up (Starboard) Horizon Camera:

Lens	55mm f/6.3
Aperture Setting	f/8.0
Exposure Time	1/100 second
Filter Type	Wratten 25

2. SLAVE PANORAMIC CAMERA

a. COMPONENT ASSIGNMENT

Component	Serial Number
Main Camera	223
Main Camera Lens	223243
Supply Horizon Camera	324G6L
Supply Horizon Camera Lens	23762
Take-Up Horizon Camera	314G5H
Take-Up Horizon Camera Lens	12894
Supply Cassette	SC-59

b. CAMERA DATA AND FLIGHT SETTINGS

Main Camera:

Lens	24" f/3.5
Slit Width	0.150"
Filter Type	Wratten 21
Film Type	Eastman Type 3404

Supply (Starboard) Horizon Camera:

Lens	55mm f/6.3
Aperture Setting	f/8.0
Exposure Time	1/100 second
Filter Type	Wratten 25

Take-Up (Port) Horizon Camera:

Lens	55mm f/6.3
Aperture Setting	f/6.8
Exposure Time	1/100 second
Filter Type	Wratten 25

3. MISSION 1044-1 STELLAR-INDEX CAMERA

a. COMPONENT ASSIGNMENT

Component	Serial Number
Camera	D/121
Index Reseau	155
Stellar Reseau	160

b. CAMERA DATA AND FLIGHT SETTINGS

Stellar Camera:

Lens	85mm f/1.8
Exposure Time	2.0 second
Filter Type	None
Film Type	Eastman Type 3401

Index Camera:

Lens	38mm f/4.5
Exposure Time	1/500 second
Filter Type	Wratten 21
Film Type	Eastman Type 3400

4. MISSION 1044-2 STELLAR-INDEX CAMERA

a. COMPONENT ASSIGNMENT

Component	Serial Number
Camera	D116
Index Reseau	147
Stellar Reseau	136

b. CAMERA DATA AND FLIGHT SETTINGS

Stellar Camera:

Lens	85mm f/1.8
Exposure Time	2.0 second
Filter Type	None
Film Type	Eastman Type 3401

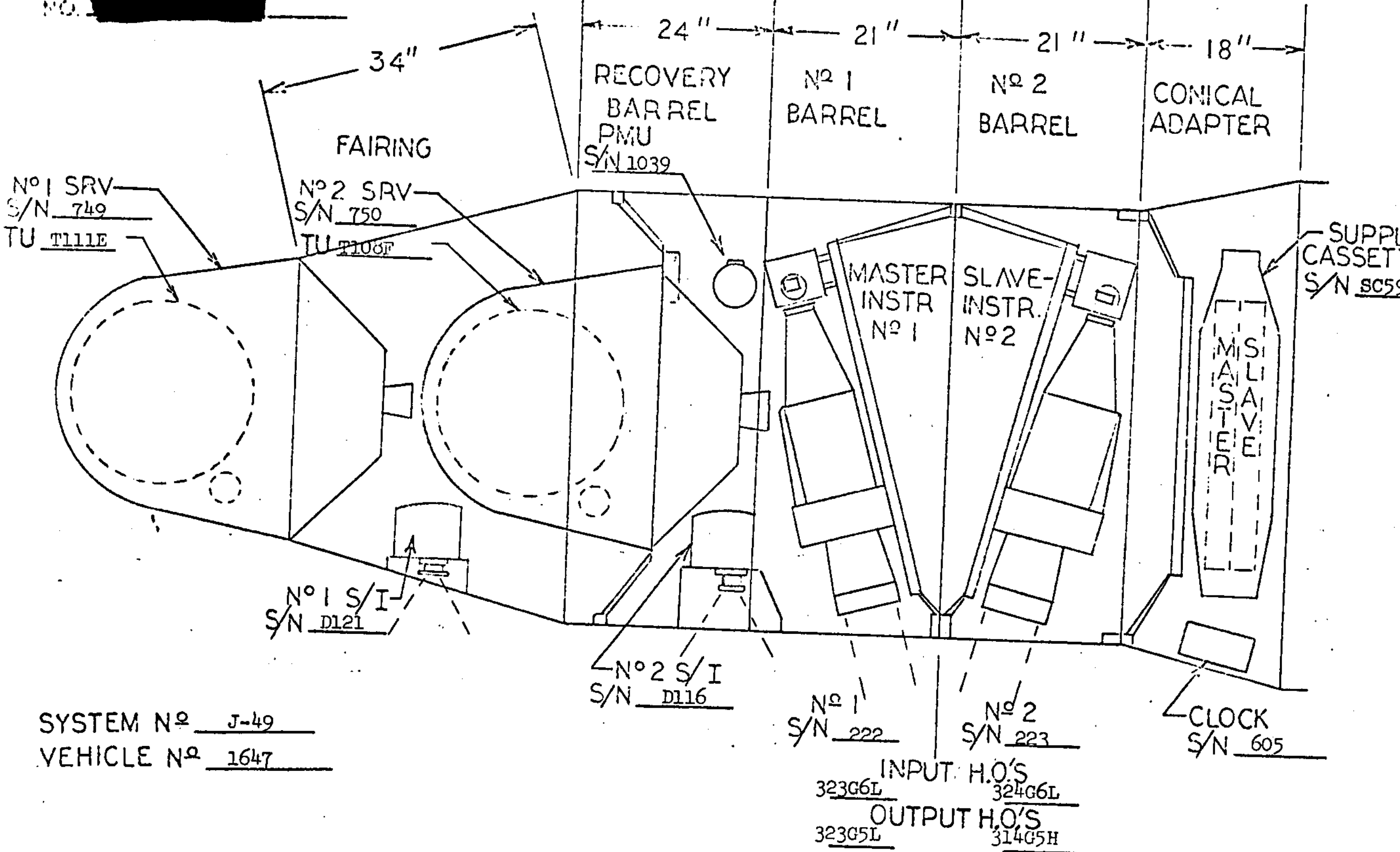
Index Camera:

Lens	38mm f/4.5
Exposure Time	1/500 second
Filter Type	Wratten 21
Film Type	Eastman Type 3400

TOP SECRET [redacted]

NO. [redacted]

CORONA J PROFILE



TOP SECRET [redacted]

NO. ______ ______

FIGURE 1-1

SECTION 2

PRE-FLIGHT SYSTEMS TESTS

As a standard procedure, the J payload systems are subjected to a series of tests which demonstrates a satisfactory level of confidence that the systems will indeed perform as required in their respective missions. The tests include an operational-type exposure to simulate thermal/altitude environment, a light-leak evaluation, and a dynamic measure of the photographic performance capabilities.

A. ENVIRONMENTAL TEST

HIVOS test of the J-49 system commenced on February 20, 1968.

Panoramic operations through Rev. 7 were characterized by weak or missing H/O fiducials, serial and index lamps on both instruments. No significant corona was noted for the encountered pressure range of 2.3 microns to 60.0 microns.

At the start of Rev. 8 on February 22, a 19 percent difference in cycle rate between forward and aft instruments was observed and the test was terminated. Investigation disclosed a faulty tachometer on the master instrument. This was corrected and the system returned to HIVOS on February 26.

During the time the system was out of the chamber the master received 1482 cycles and the slave 959.

After pump down and a short confidence run, the test was continued with the program starting at Rev. 9, Op. 1.

Through the balance of the test, pressure ranged from 0.5 microns to 55.0 microns. No significant corona marks were found on the panoramic film.

No H/O shutter failures were found. Serial number, index, and fiducials were acceptable after replacing the console's regulated power supply at Rev. 7.

Most of the binary words were quite acceptable. Only 3 were missing: 2 on the slave and 1 on the master. On some occasions the master bit "10" was quite weak.

The 200 PPS track was acceptable in both cameras. An extra pip appeared in some frames of the slave but was clearly distinguishable from the true pips.

The start-of-pass mark was entirely absent on the master after return to HIVOS, but this failure was not considered to be chamber related.

Cut/wrap associated film appeared normal for both panoramic cameras.

Both index cameras performed well. No significant corona could be found.

Both stellar cameras produced corona marking. The "A" stellar contained approximately 457 frames. Nineteen frames contained corona type marks in the format. The corona marking produced by this was 4.1%, with a maximum density of +.14D above reference level, well within established specifications.

The "B" stellar contained approximately 450 frames, 76 frames of which contained corona marking in the active format. This amounts to 17 percent and was outside specifications as to quantity of marking. However, only eight frames exceeded the specified maximum density of +.4D above base plus fog.

Although this stellar camera exceeded both quantity and density specifications, the nature of these marks indicated that no significant degradation of operational photography should be expected. A waiver of these specifications was recommended and was granted by the customer representative.

B. RESOLUTION TEST

Resolution and theodolite tests were performed on 12 March 1968. Results of the thru-focus resolution tests of pan instruments 222 and 223 show the following characteristics:

Master Pan Instrument No. 222

Maximum high contrast resolution 174 lines/mm at -0.002 focal position.

Maximum low contrast resolution 123 lines/mm at -0.002 focal position.

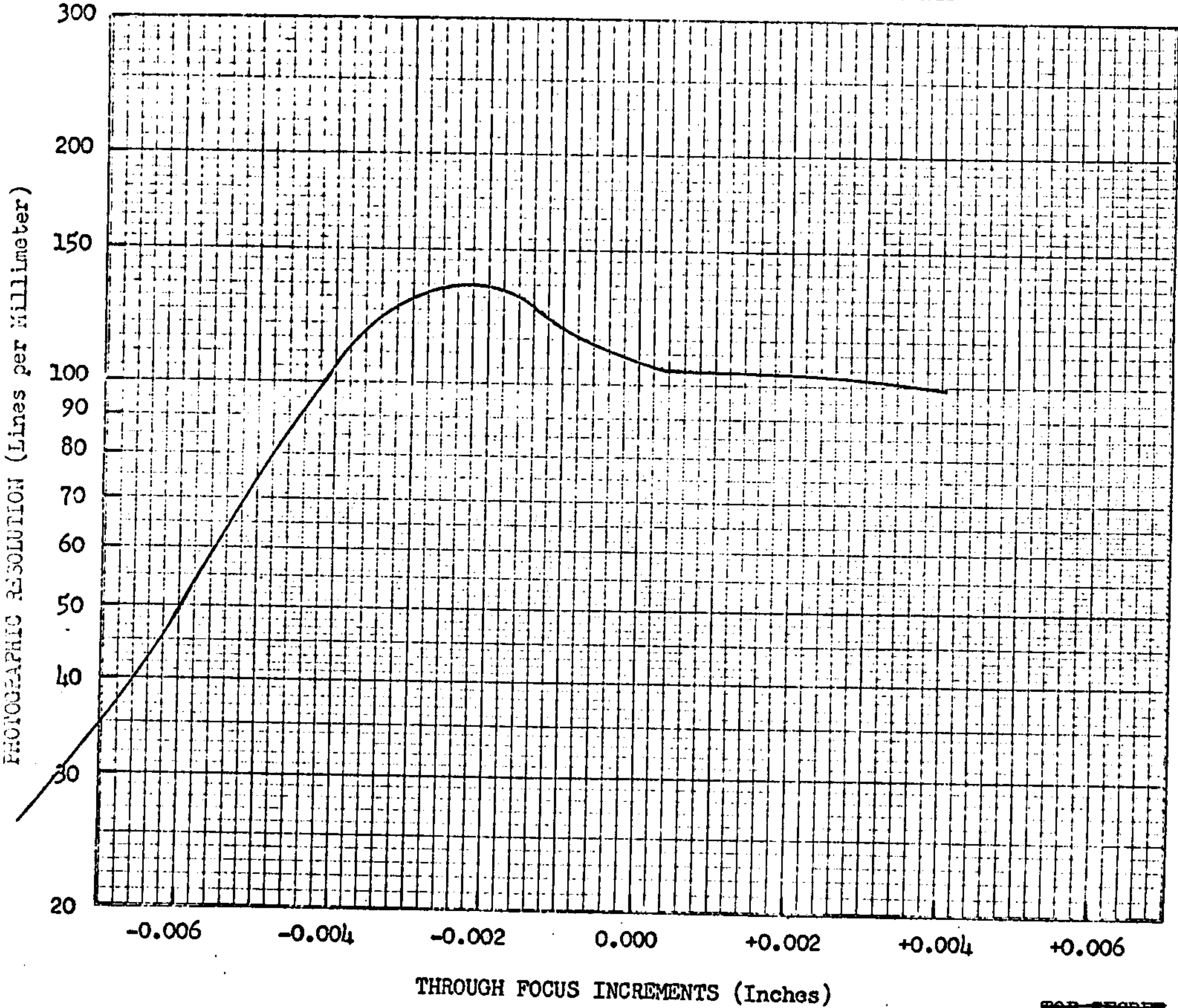
Slave Instrument No. 223

Maximum high contrast resolution 187 lines/mm at -0.003 focal position.

Maximum low contrast resolution 131 lines/mm at -0.002 focal position.

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

PRE-FLIGHT DYNA[redacted]SOLUTION



Camera No: 222

Payload No: J-49

Resolution (1/mm)

High Contrast: ____

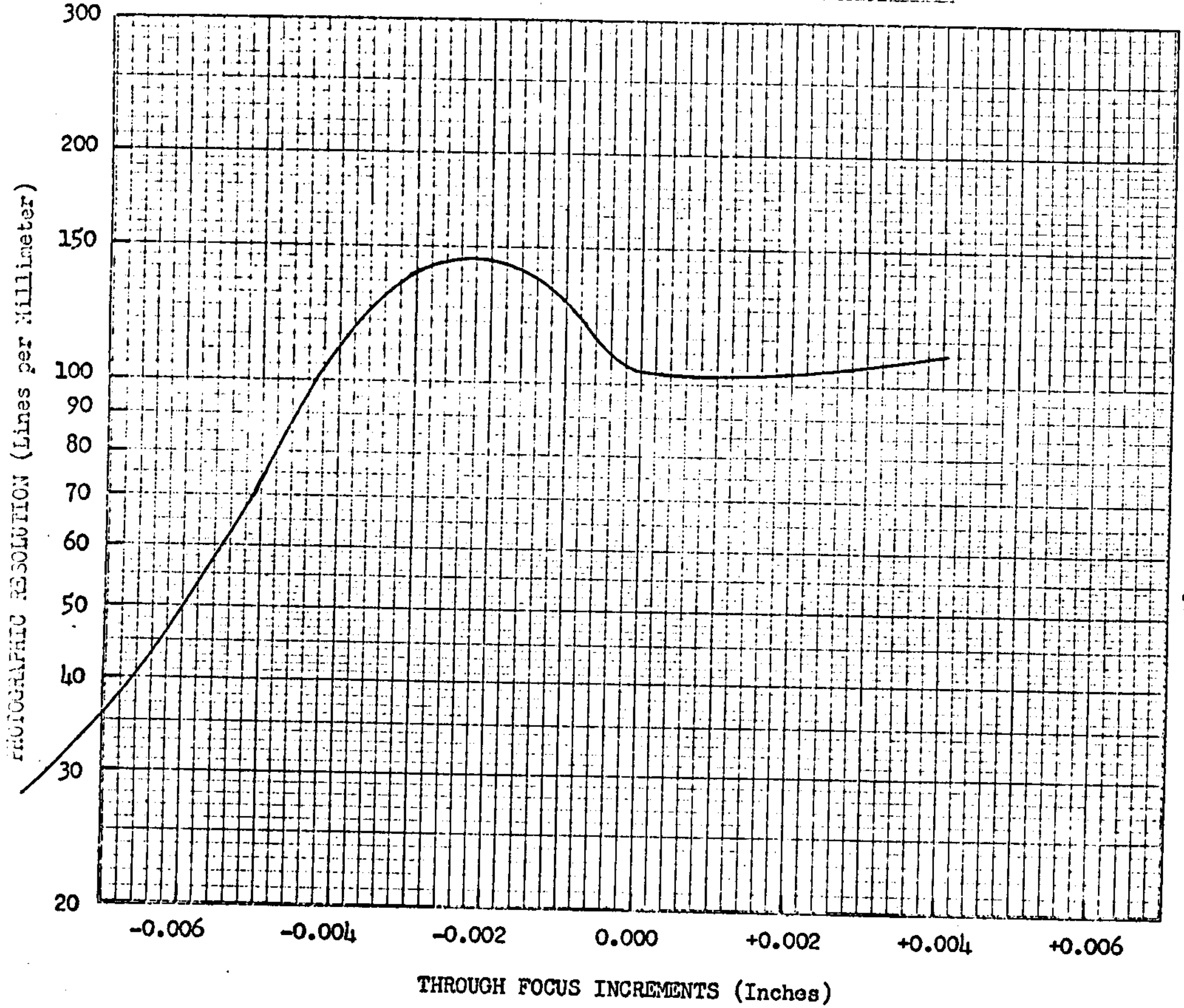
Low Contrast: 134

Film Type: 3404

Test Date: 3-12-68

FIGURE 2-1

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 223

Payload No: J-49

Resolution (1/mm)

High Contrast: ______

Low Contrast: 145

Film Type: 3404

Test Date: 3-12-68

FIGURE 2-2

C. LIGHT LEAK TEST

The J-49 system was tested for light leaks on 5 February 1968, revealing minor leaks in the corners of the drum seal in each camera. Because of the impracticality of repairing these leaks, and the relatively minor level of fogging experienced, corrective action was waived. Additional fogging was just preceptible on both films in the area corresponding to the SRV cover interface, but because of the apparently non-objectionable level no corrective action was taken.

D. FLIGHT LOADING AND CERTIFICATION

Flight loading of supply cassette #SC-59 commenced on 9 September 1968. One supply spool was found to have capscrews in the flange mount instead of flatheads. These were replaced with the proper screws removed from an empty spool on hand. Loading was completed without further incident.

Post-loading operation for proper tracking was performed on 11 September 1968. Although this test and the light leak search was entirely satisfactory, the test was nullified by subsequent demate of the "A" SRV. This was made necessary by the decision to replace the "A" thrust cone programmer.

Confidence operations were re-performed on 13 September 1968. Some moderate rail scratching occurred on the slave camera with occasional emulsion particle clumps passing into the bucket. The usual "brush marks" were found on the backing. The flow of film thru both cameras was not quite as smooth as most systems but was deemed acceptable by the customer representative. Operation of the H/O and S/I shutters was verified (index by T/M).

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

All ascent and injection events were nominal. Event times were close to the predicted and a hard Agena shutdown by velocity-meter were observed. The resultant orbit parameters were within three (3) sigma dispersions.

The Master instrument failed after 1095 cycles in the -2 mission and caused the internal camera Operate command to be on continuously for the remainder of the -2 mission. This resulted in early termination of the -2 mission because of excessive current drain on the vehicle batteries.

The Slave Pan camera operated satisfactorily throughout the -1 and -2 missions.

The -2 Stellar/Index camera Operate command remained slaved to the master camera after failure, precluding further Stellar/Index camera operation.

The payload T/M commutator failed to start on Rev. 175 and remained inoperative until Rev. 224 where it was restarted at the time the arm command was initiated.

The command system, clock system, pressure make-up system, recovery systems, and the yaw function generator performed satisfactorily throughout the flight.

KIK-ZORRO 38 (early -1 to -2 recovery) was performed on Rev. 136[redacted] and all transfer functions occurred normally.

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

DMU firings were made on Revs. 4, 56, and 136 during the mission. Additional firings were made following event -2 recovery on Revs. 225, 229, 233, and 238. The Rev. 4 firing was mainly required to raise the perigee height approximately 10 N.M. since the launch plan specified the use of a DMU rocket to assist the launch vehicle in achieving a nominal orbit.

The firings on Revs. 56, 136, and 225 were made for period control. The firings on Revs. 229, 233, and 238 were made to test the Thiokol rockets carried on board for experimental purposes.

Rocket No.	Pass	Seconds	Velocity Change FPS	Impulse Lb./Sec.
1	4	10.55	16.5	2075
2	56	10.8	16.8	2102
3	136	10.45	16.3	2039
4	225	13.8	21.3	2111
5 *	229	-13.1	-20.2	2035
6 *	233	-19.2	-29.7	2964
7 *	238	-20.2	-30.8	3072

* = DEBOOST

Figure 3 depicts the orbit history of Mission 1048.

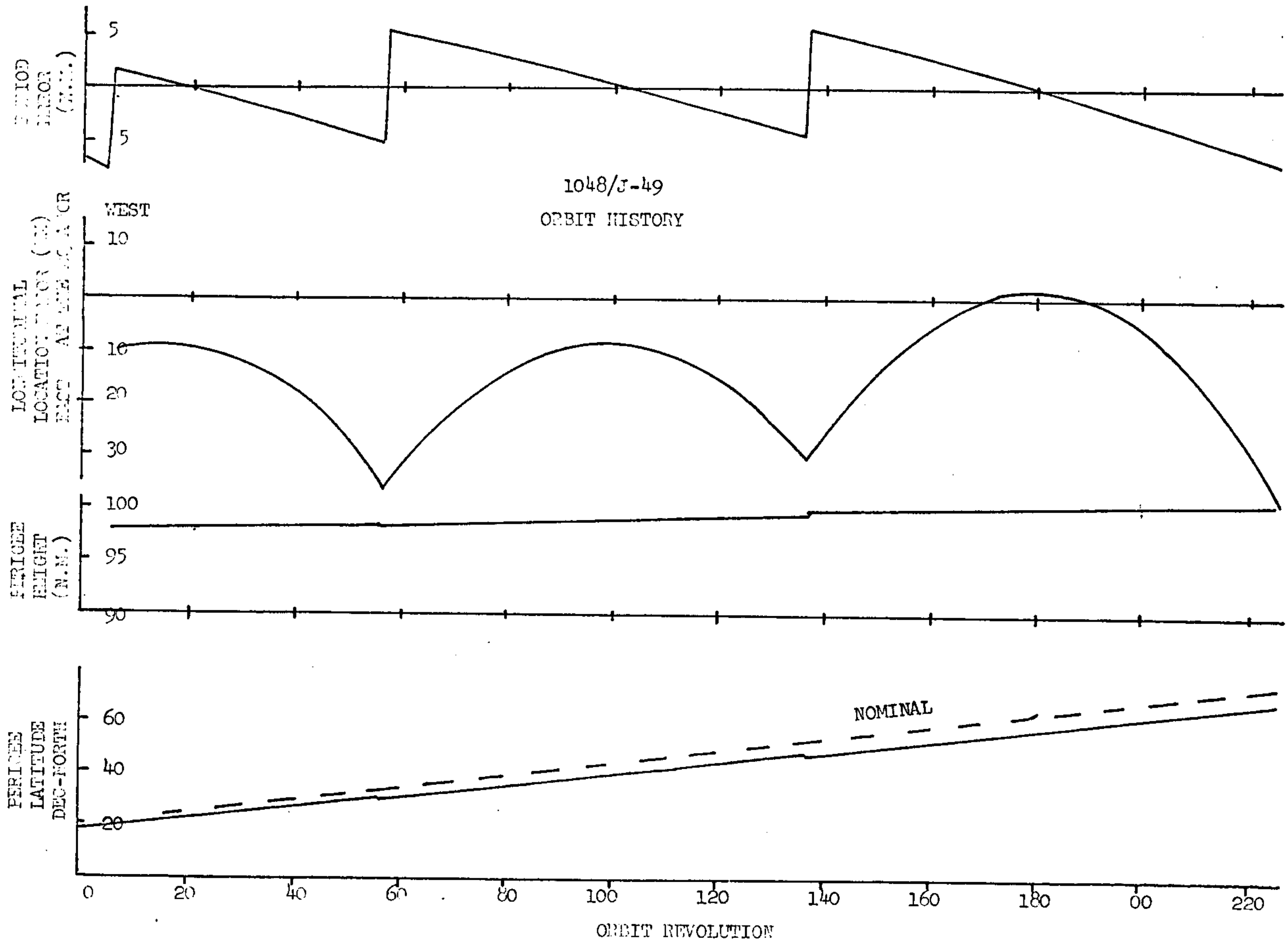

1048/J-49
ORBIT HISTORY
5
5
WEST
10
10
20
30
EAST
100
95
90
PERIGEE HEIGHT (N.M.)
60
40
20
PERIGEE LATITUDE DEG-NORTH
NOMINAL
0
20
40
60
80
100
120
140
160
180
00
220
ORBIT REVOLUTION

FIGURE 3-1

B. PANORAMIC CAMERA PERFORMANCE

The Master Panoramic camera indicated normal operation throughout the -1 mission. Telemetry and film analysis indicated the Master camera failed after 1,095 cycles in the -2 mission. The failure appeared to be in the camera motor drive assembly (gear box). The internal camera Operate command remained energized due to the position at which the unit stopped.

An investigation was conducted to determine the cause(s) of the Master camera failure and the results reported below.

GROUND TEST SUMMARY

Master camera S/N 222 completed normal ground tests at Boston and A/P. The only major anomaly experienced was the failure of the tachometer in the Environmental test and resulted in a 19% overspeed condition (ref. Section 2). The tachometer was replaced and the Environmental test was resumed with no further camera anomalies.

TELEMETRY ANALYSIS SUMMARY

All telemetry monitors indicated normal camera operation through Rev. 180. The master camera failed on Rev. 181 and prevented the removal of the electrical Operate command.

The payload telemetry commutator failed to start on Rev. 175 thru Rev. 223. The camera diagnostic monitors such as the drive motor, tachometer, and cycle counter were not available at the time of the camera failure. However, telemetry data on Rev. 224 indicated the main drive motor and the tachometer were functioning properly after the failure. The tachometer responded normally to all eleven V/H amplitude changes that were commanded. The master camera cycle counter indicated the control linkage had stopped after the center of format switch (S105) on the 71st frame of Rev. 181. The loss of S107 shutdown switch and the position of the lens rotation monitor indicated the unit had stopped in the last 2/3 of the metering portion of the cycle of Frame 71.

Vehicle current monitors indicated the camera system electrical load was 1.2 amps regulated power and 3.5 amps unregulated power. The electrical load plus the tachometer response indicated that the master camera fuses were intact.

The dynamic camera telemetry monitor indicated the input metering/control linkage and the lens drive linkage were inoperative after Rev. 181. The camera input metering control stopped in the 99% position, indicating the film shuttle had been on the output side at the last control change.

The vehicle attitude data on Rev. 181 indicated a smooth normal instrument coastdown at the time of the failure. No vehicle perturbations were observed when a manufacturing splice passed through the system on Rev. 180.

The telemetry data indicated the supply spool was not rotating after the camera failure.

FILM ANALYSIS SUMMARY

Analysis of the tail end of the film on the master camera revealed it was torn, not cut, and contained approximately 6 inches of the format for Frame 70 of Rev. 181. The rail outlines and definition indicated the film was in-the-rails and under proper tension at the time of exposure of Frame 70 of Rev. 181. Microscopic examination of the film tear indicated the possibility of a partial cut followed by a tearing.

The binary time words indicated a consistent cycle period up to the time of the failure.

A manufacturing splice, located on Frame 23 of Rev. 180, contained evidence of adhesive bleeding.

During film retrieval it was determined that the film from both the master and slave camera film were entangled around the mechanical components within the bucket. The master and slave take-up spools were jammed with loops of film around both and 89 feet of the slave film was wrapped on the master take-up.

There were no abraded film particles in the recovery bucket or indications of excessive puck arm roll marks as would be expected if the take-up spool had rotated continuously for three days.

The film prior to the failure did not indicate any anomaly in the camera system.

SUMMARY OF CONCLUSIONS

A mechanical failure in the main drive assembly possibly from a sheared or lost pin caused the master camera failure. The film tear occurred after the master unit stopped rotating and was torn between the air twist from the shuttle and the intermediate roller assembly. The disarray of film within the take-up spool was considered to be an effect of the master camera failure.

Panoramic Film Consumption - Frames

	Actual	
	Master	Slave
Pre-Launch	125	124
-1 Mission	3,005	2,991
-2 Mission	1,095	3,046
Total	4,225	6,161

C. RAMP-TO-ORBIT MATCH

A satisfactory Ramp-to-Orbit match was maintained during both missions of the flight. Flight data indicated that the system was operating slower than the pre-flight calibrations. Thus, the system calibration was biased one percent for Ramp selection.

The following settings of RTC 6, 8, and 10 were utilized to obtain the optimum FMC match during the flight.

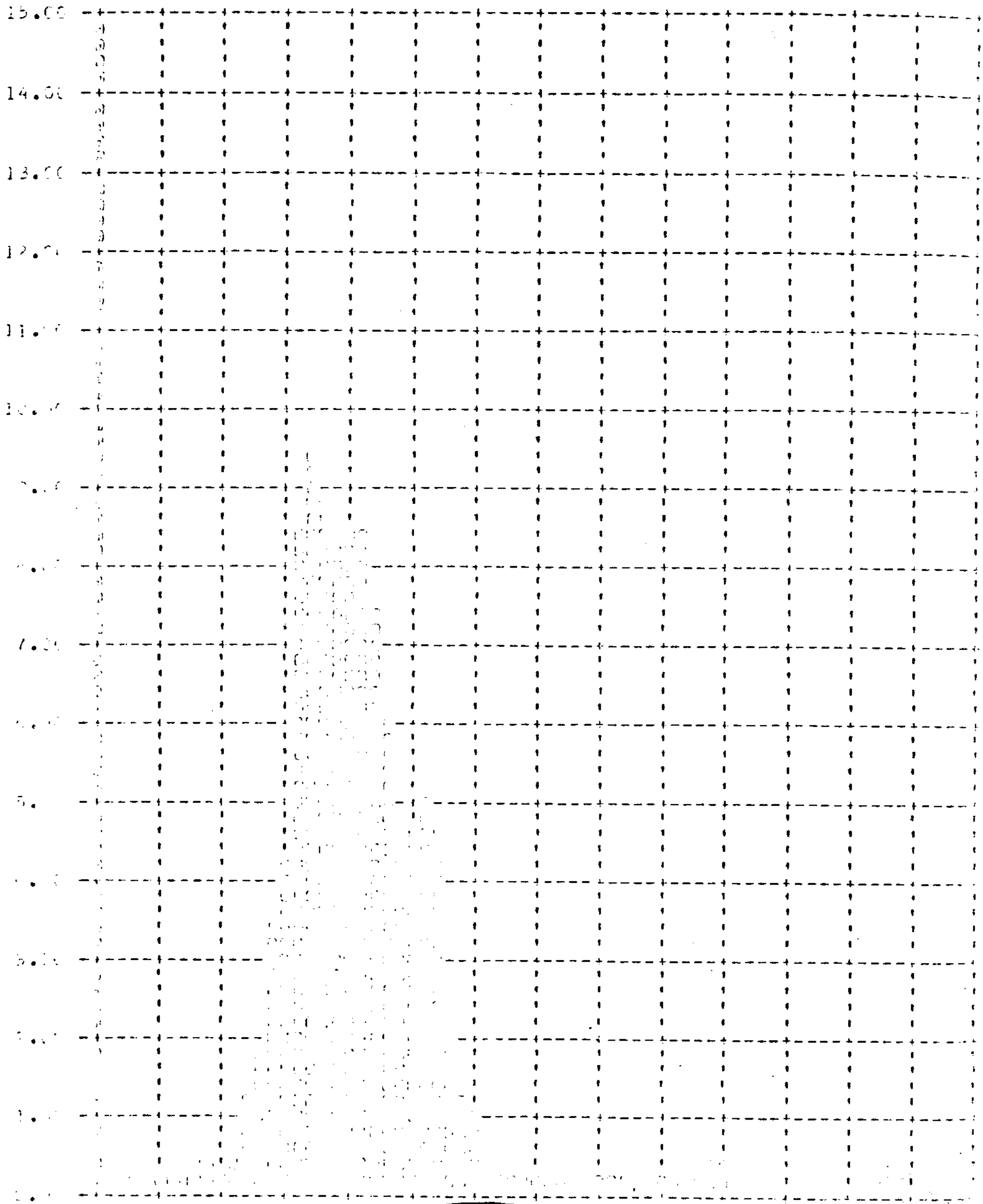
	RTC			
Rev	6	8	10	Comments
L/O	7	4	6	Settings for nominal orbit.
6	7	3	8	Changed to compensate for orbit dispersions.
14	7	4	7	To compensate for orbit changes following DMU firing.
141	7	4	8	To compensate for normal perigee shift.
188	7	4	9	To compensate for normal perigee shift.

The resulting performance of the overall V/H match is statistically summarized in Figures 3-2 through 3-5.

MISSION 1048A1 TOP SECRET C[redacted] - CUTTING NO. [redacted]

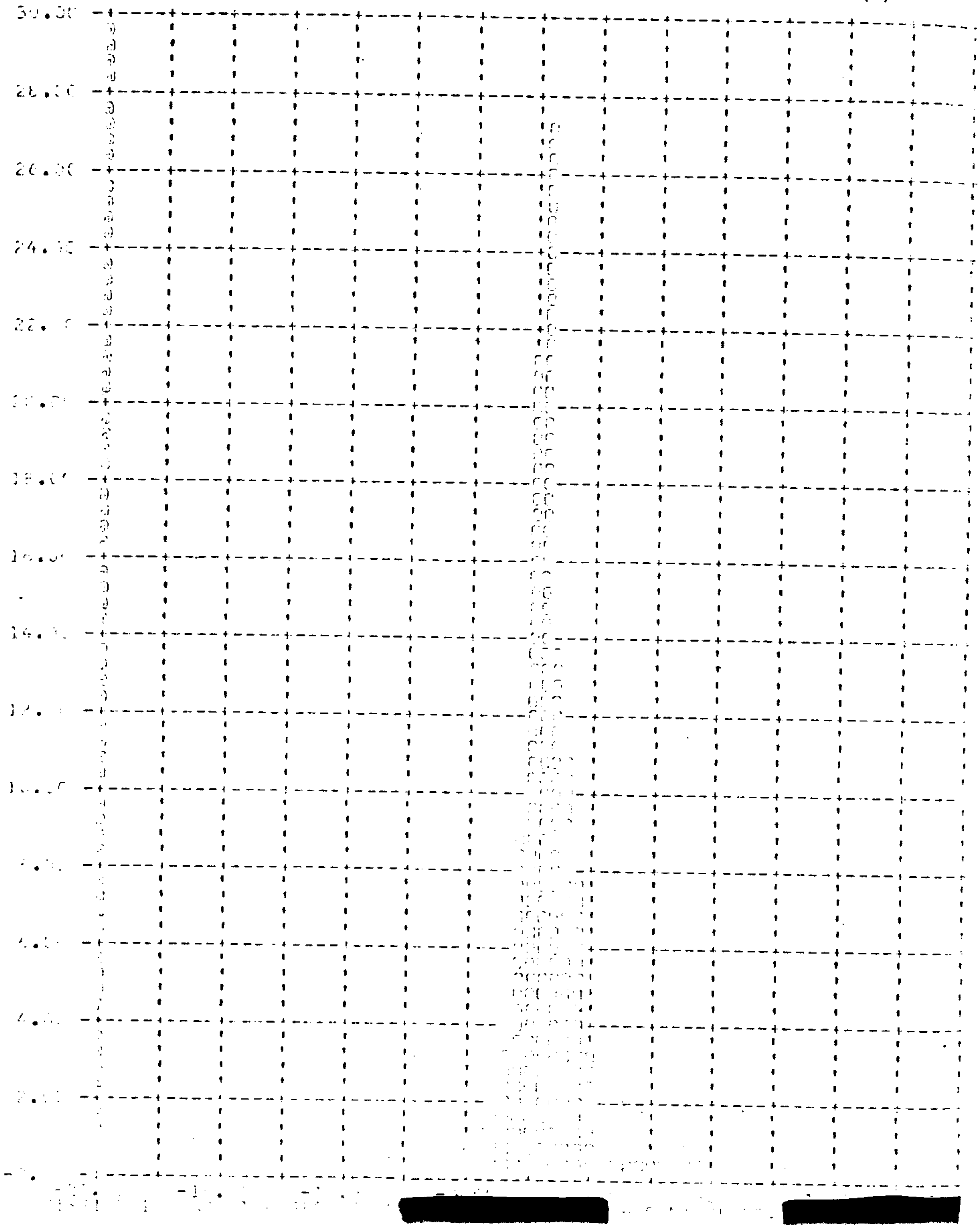
Forward Looking Camera FRAMES 1-5 OF EACH OF ... PERCENT =

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



MISSION 1044A2 ~~TOP SECRET~~ C[redacted] - CONTROL NO. [redacted]
Aft Looking Camera FRAMES ... EACH ... OMITTED ... OF PERIOD = ...

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

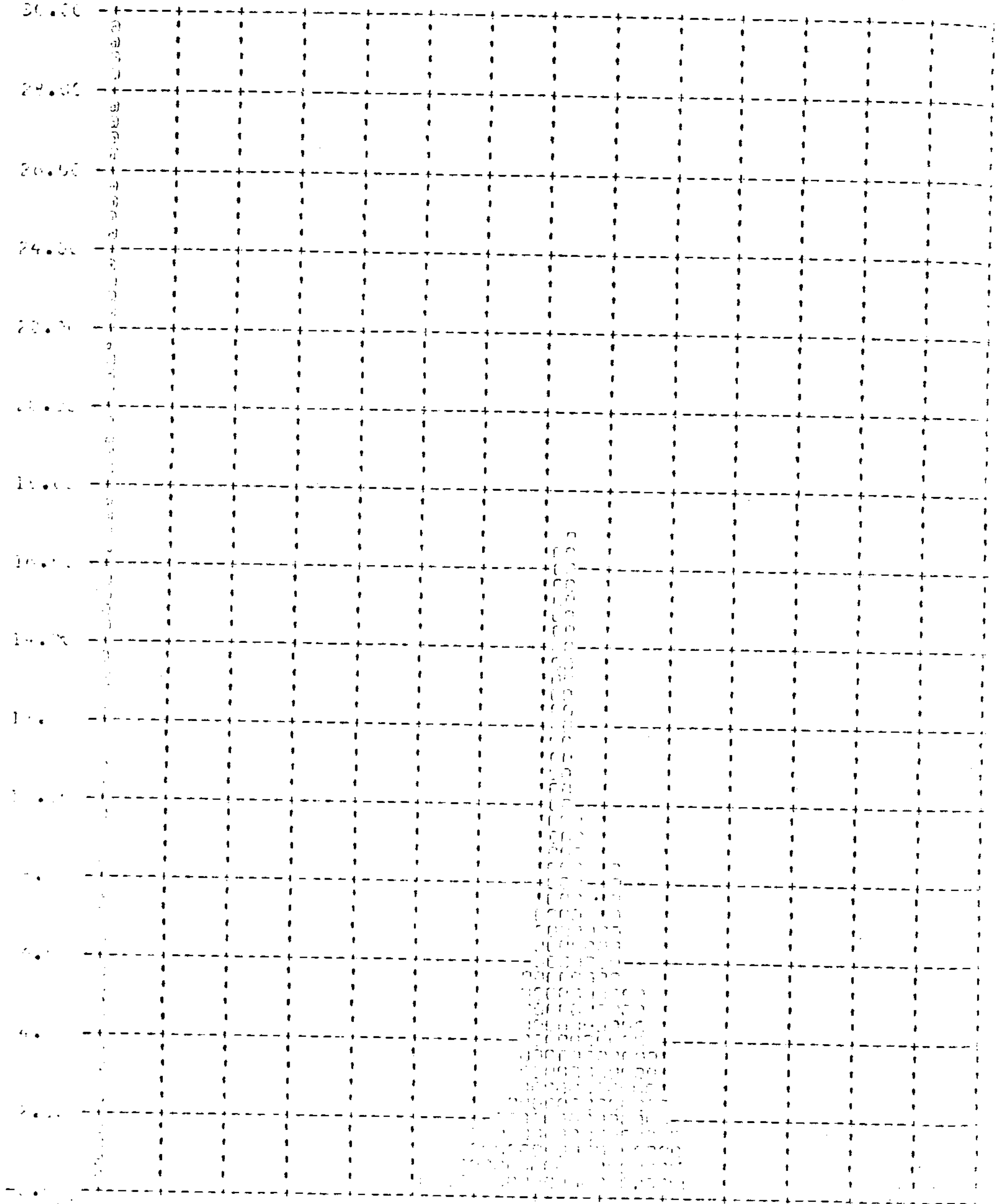


[redacted] [redacted]

MISSION 1048-1 [redacted] - CONTROL NO. [redacted]

Forward Looking Camera

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



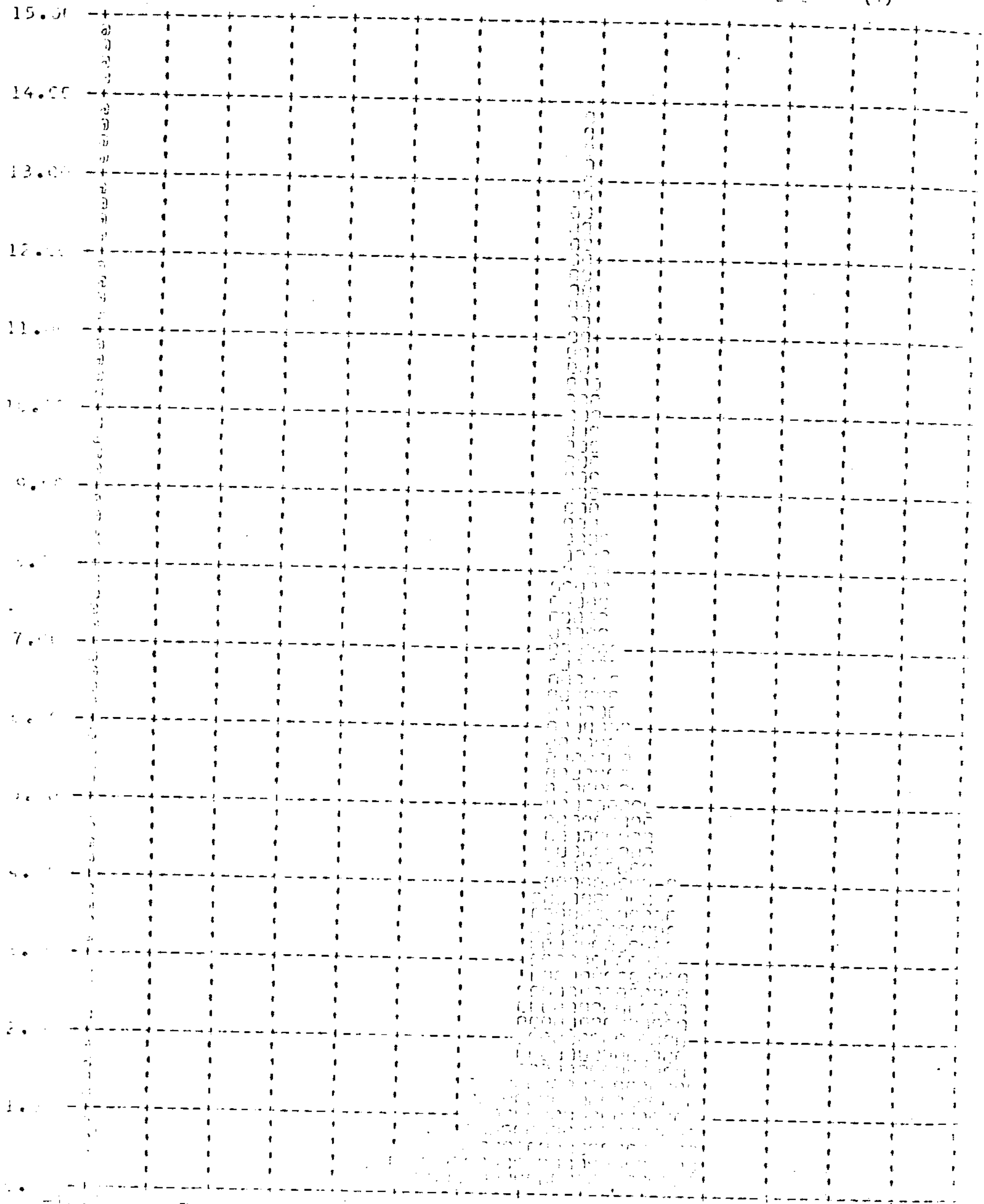
[redacted] [redacted]

MISSION 1143-2 [redacted] - CONTROL NO. [redacted]

Aft Looking Camera

FRAMES 1-5 OF EACH ... OMITTED ... PERCENT =

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



[redacted] [redacted]

D. STELLAR/INDEX CAMERA PERFORMANCE

The -1 Stellar/Index camera operated satisfactorily during the -1 mission. The -2 Stellar/Index operated normally through pass 180. The failure of the master Panoramic camera with the Stellar/Index slaved to it, precluded any further operation of the -2 Stellar/Index camera. Prior to the failure, telemetry data indicated the programmer, metering functions, and shutter monitor performed satisfactorily on the observed engineering passes.

E. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

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

The payload instrumentation system performed satisfactorily except for the T/M commutator. The commutator containing status and temperature data, failed to start on Rev. 175 and continued to not start until after acquisition at the [redacted] Tracking Station on Rev. 224. The commutator started at the -2 recovery "ARM" command and was presumed to be a result of the mechanical jolt of the water seal closing.

The failure mode appears to have been a drive motor problem and past history has shown this to be caused by oxidation of the armature and brushes.

Loss of the commutator did not present an operational control problem, therefore no corrective action is recommended for the four remaining commutators of this type.

F. CLOCK SYSTEM PERFORMANCE

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

G. PRESSURE MAKE-UP SYSTEM PERFORMANCE

The pressure make-up system (PMU) operated satisfactorily through Rev. 180. The failure of the Master camera prevented the removal of the PMU Operate command and the gas supply was subsequently depleted during the next rev. The total operate time was approximately 160 minutes with 102 camera operates. The PMU flow rate was near the flow rate that was experienced during the HIVOS environmental test.

H. THERMAL ENVIRONMENT

The thermal environment achieved with this system was near the pre-flight predictions. A temperature range of 81°F to 66°F was predicted for the beginning of the -1 mission and the actual system temperatures were 79°F to 73°F and 76°F to 71°F for the Master and Slave cameras respectively. The predicted temperature range for the beginning of the -2 mission was 72°F to 55°F and the actual system temperatures were 66°F to 60°F and 65°F to 60°F for the Master and Slave cameras respectively.

I. RECOVERY SYSTEM PERFORMANCE

-1 Mission

The -1 recovery capsule was successfully recovered by air-catch on Rev. 145 at 1715 PDT on 27 September 1968. Capsule impact and all re-entry events occurred within tolerance.

	Latitude	Longitude
Predicted	23° 58.5'N	169° 04.7'W
Actual	23° 38'N	169° 07'W

-2 Mission

The -2 recovery capsule was recovered by air-catch on Rev. 224 at

1605 PDT on 02 October 1968. Capsule impact and all re-entry events occurred within tolerance.

	Latitude	Longitude
Predicted	17° 30.97'N	160° 40.46'W
Actual	17° 34'N	160° 49'W

SECTION 4

PHOTOGRAPHIC PERFORMANCE

The photographic imagery obtained from Missions 1048-1 and 1048-2 was considered to show a variation in quality ranging from good to that of less than normal quality. Imagery from the aft-looking camera was consistently superior to that from the forward-looking camera with some imagery equal to the best obtained from the J-1 systems. For photographic interpretation purposes, the overall interpretability was considered fair. The aft-looking material was generally good for information content. The forward-looking material was rated poor to fair with the loss of stereo after Rev. 181 as a contributing factor to the fair rating.

A. PANORAMIC INSTRUMENTS

The forward-looking camera produced 3005 frames (7935 feet) of photography during Mission 1048-1, and 1095 frames (2909 feet) during Mission 1048-2. The shortened second mission was due to the camera failure discussed in Section 3. The aft-looking camera produced 2991 frames (7895 feet) during Mission 1048-1 and 3046 frames (8056 feet) during Mission 1048-2.

Image quality from the forward-looking camera was quite variable, not only throughout the mission, but differences were detectable within individual frames. Out-of-focus areas were evident near the bonus area at the end of the frame and extended inward as much as 3 inches. Imagery near the center of format was the best of each frame but was not equal to the best from the aft-looking camera.

Image quality from the aft-looking camera was not as good for Mission 1048-2 as was Mission 1048-1, but was superior to the forward camera imagery from either mission. On the basis of the aft camera performance an MIP rating of 85 was assigned.

Several fixed resolution targets were photographed during the mission. The best of these was judged to be resolved to 8.7 feet.

In spite of the foregoing general comments, specific objects of much smaller dimensions were readily detected. The 36 inch suspension cables of the Golden Gate bridge were quite distinct on both forward and aft photographs, even though located less than 1-1/4 inches from the end of the format. However, painted lines on blacktop parking lots and streets were detectable in the aft, but they were not in forward. Also cars, trucks and busses had a more rectangular aspect in the aft photos. These observations were derived from Rev. 16 and confirm the superiority of the aft-looking camera, even early in the mission.

B. STELLAR/INDEX CAMERAS

The Stellar/Index film recovered consisted of 463 frames of each from Mission 1048-1, and 159 frames each from Mission 1048-2. The lower quantity from the second mission was due to failure of the master Panoramic camera (ref. Section 3) which supplies the signal to operate the S/I cameras.

Both cameras operated satisfactorily up to failure of the master. Double exposures occurred on Frame 363 of the -1 mission and Frame 3 of the -2 mission. Also in -2, a triple exposure occurred on Frame 1 and Frame 102 contained 5 exposures. The Index camera's operation correlated with the Stellar's in each case.

No corona fog of the type experienced in the HIVOS test was found on the Stellar film (ref. Section 2). Only traces of dendritic type edge static were detected.

More than 25 well distributed stellar images were detectable on most frames. The images were slightly smeared and short dumbbell in form. Flare affected 60% of every format of the -1 stellar formats but stars were detectable within the flare. Only minor flare was found in the -2 material with 20% of each format affected.

The reseaus were sharp and well defined on all frames from both S/I cameras.

C. PERFORMANCE MEASUREMENTS

A summary of MTF/AIM resolution values measured by SPPF is tabulated below. The microdensitometer slit used was 1 micron by 80 microns.

Camera	Cycles/mm	Avg	Ground Resolution
Fwd	102	103	11'
Aft	96	110	11½'

The details of the measurement and computing techniques, targets measured and target locations are fully reported in the evaluation report published by AFSPPF and are not included in this report. These values were determined by using the "Interim MTF/AIM Program" technique.

SECTION 5

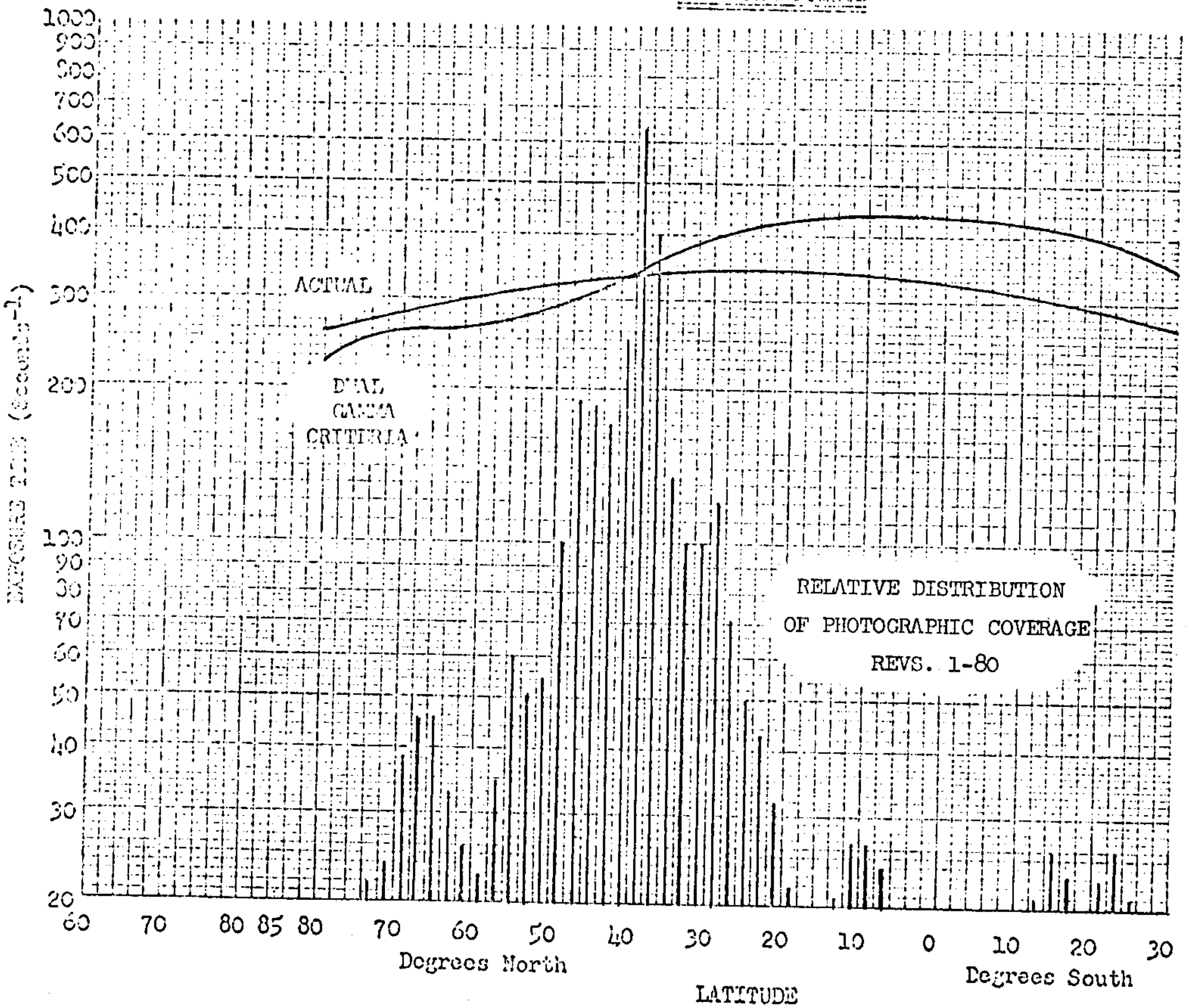
PANORAMIC CAMERA EXPOSURE

The forward-looking camera contained a Wratten 23A filter with a slit width of .200". The aft-looking camera utilized a Wratten 21 filter with a .150" slit width.

The nominal exposure times of the Panoramic cameras are shown as a function of latitude for Revs. 40, 120, and 200 in Figures 5-1 through 5-6. Superimposed on these plots are relative distributions of camera operations for the portion of the mission represented by each plot.

As on Mission 1104, the desired exposure profile, based on Project Sunny recommendations, was to maintain average exposure levels 1/4 to 1/3 stop less than that indicated for the nominal diffuse density based criteria. This latter criteria is the curve shown in Figures 5-1 through 5-6.

EXPOSURE POINTS



Mission No: 1048

Payload No: J-49

Camera No: 222

Pass No: 40

Launch Date: 9-18-68

Launch Time: 2131Z

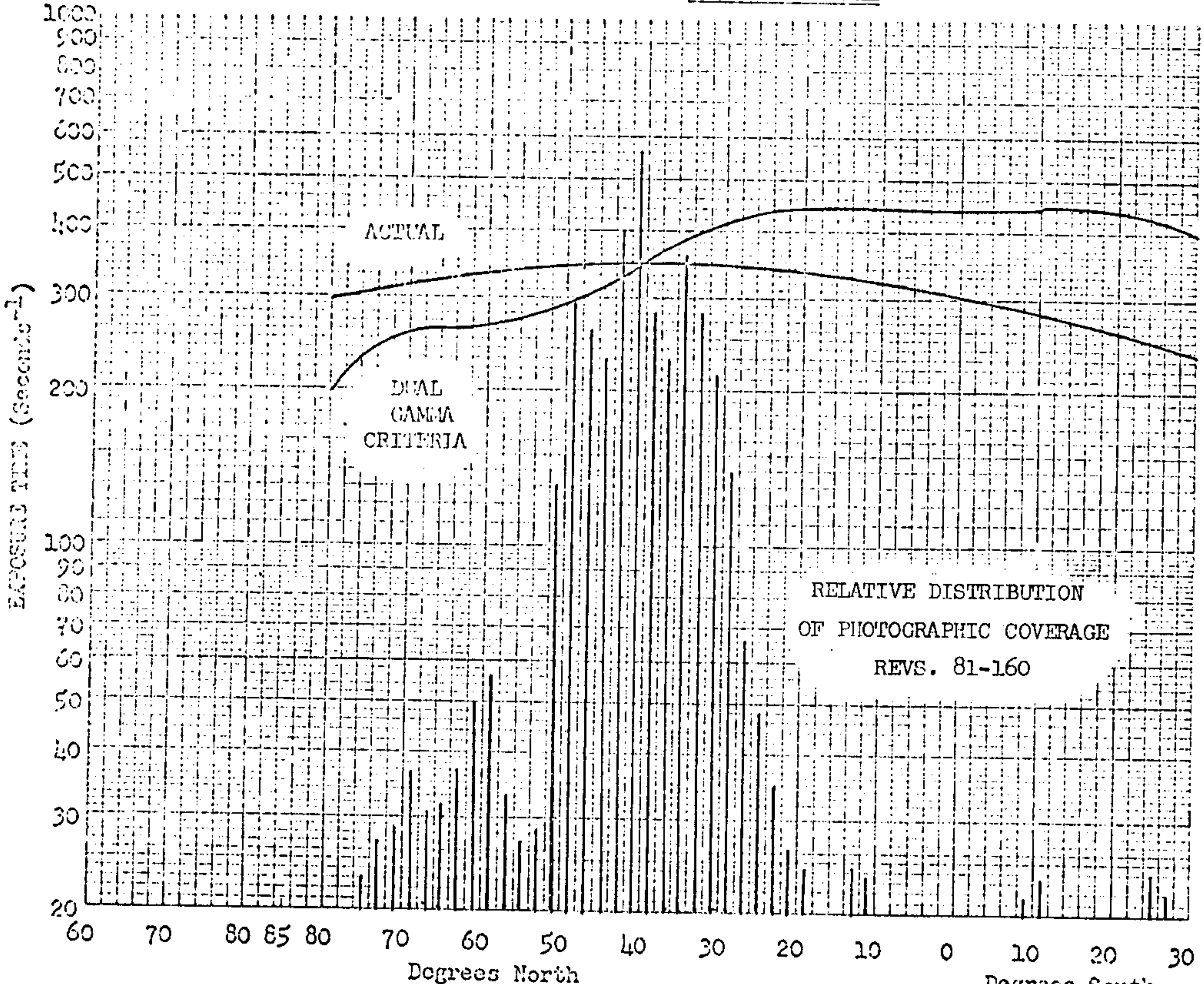
Slit Width: .200"

Filter Type: W/23A

Film Type: 3404

FIGURE 5-1

EXPOSURE POINTS



Mission No: 1048

Payload No: J-49

Camera No: 222

Pass No: 120

Launch Date: 9-18-68

Launch Time: 2131Z

Slit Width: .200"

Filter Type: W-23A

Film Type: 3404

FIGURE 5-2

EXPOSURE POINTS

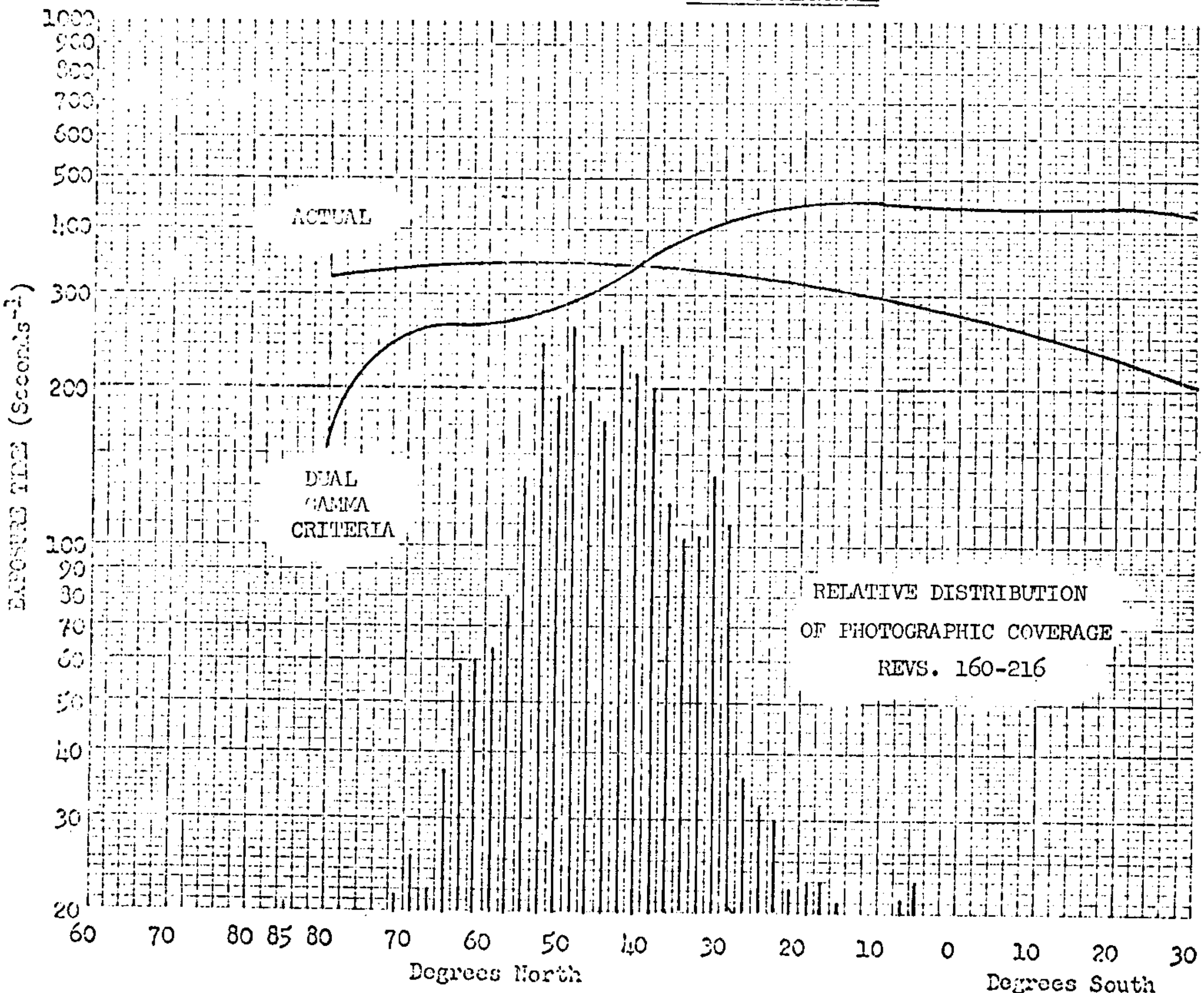


FIGURE 5-3

Mission No: 1048

Payload No: J-49

Camera No: 222

Pass No: 200

Launch Date: 9-18-68

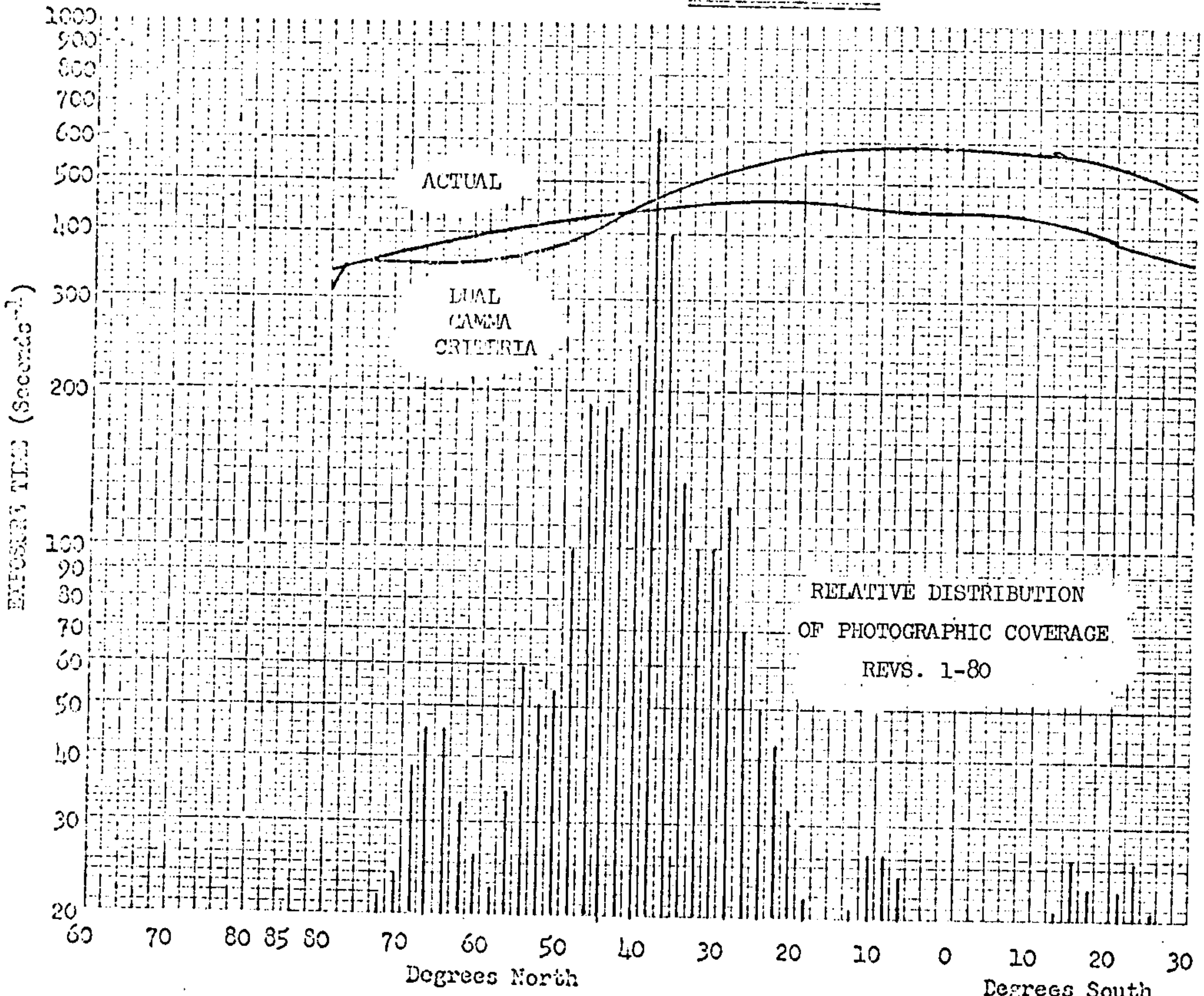
Launch Time: 2131Z

Slit Width: .200"

Filter Type: W/23A

Film Type: 3404

EXPOSURE POINTS



Mission No: 1048

Payload No: J-49

Camera No: 223

Pass No: 40

Launch Date: 9-18-68

Launch Time: 2131Z

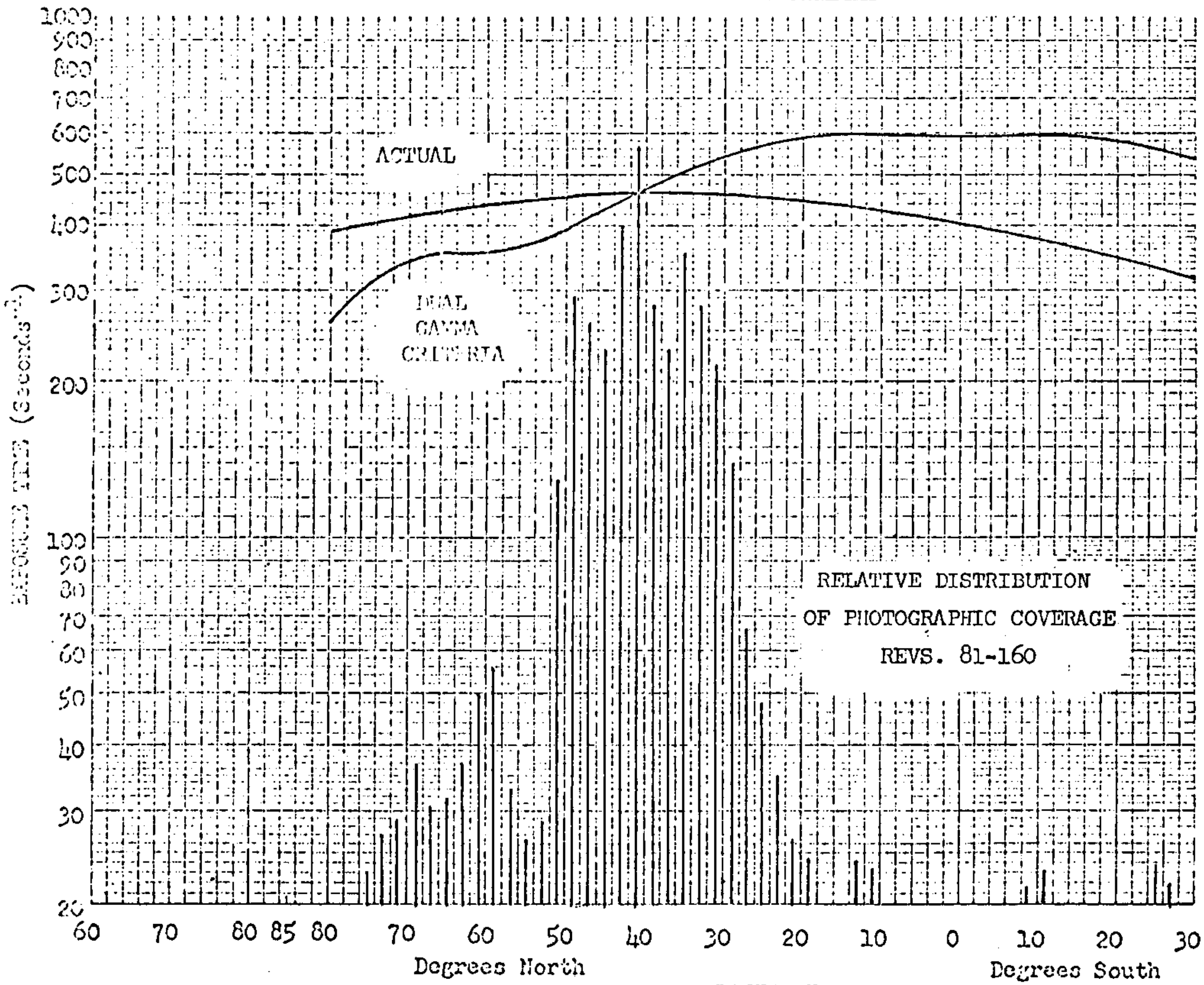
Slit Width: .150"

Filter Type: W/21

Film Type: 3404

FIGURE 5-4

EXPOSURE POINTS



Mission No: 1048

Payload No: J-49

Camera No: 223

Pass No: 120

Launch Date: 9-18-68

Launch Time: 2131Z

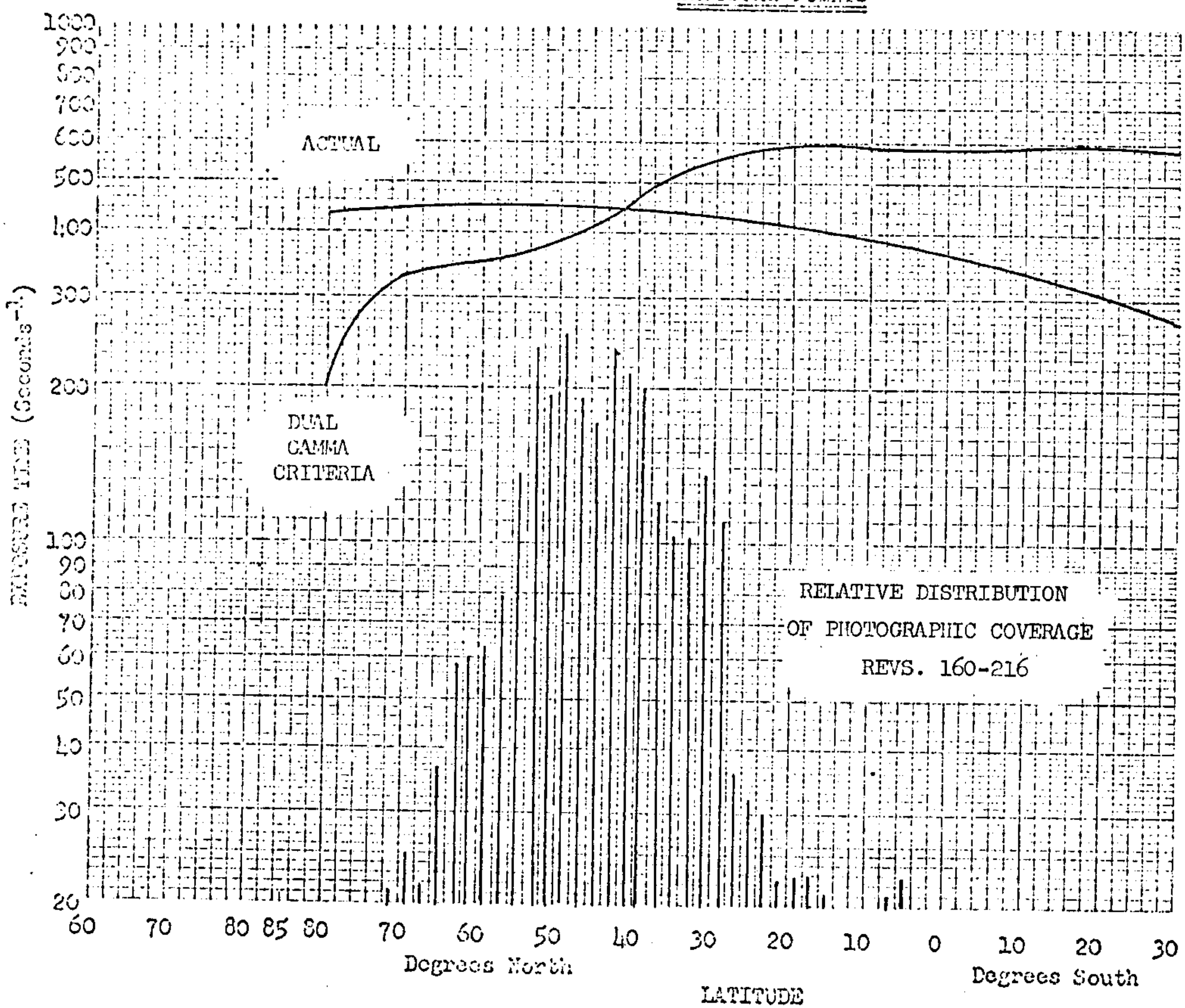
Slit Width: .150"

Filter Type: W/21

Film Type: 3404

FIGURE 5-5

EXPOSURE POINTS



Mission No:	1048
Payload No:	J-49
Camera No:	223
Pass No:	200
Launch Date:	9-18-68
Launch Time:	2131Z
Slit Width:	150
Filter Type:	W/21
Film Type:	3404

FIGURE 5-6

SECTION 6

DENSITY MEASUREMENTS

Mission 1048 was the second flight in which the viscous, single level, dual gamma processing was employed on an operational basis. Coincident with Mission 1104, the processing agency discontinued reporting of terrain diffuse densities, and instituted a procedure for systematic reporting of select target microdensitometer readings. The AFSPPF will continue to compile terrain diffuse density measurements, which will be summarized in these final reports.

The differences between the previously used full processing characteristics and the new dual gamma process is graphically depicted in Figure 6-1. The lowered levels of D_{max} values for terrain and cloud densities resulting from these differences is evident from the frequency distributions presented in Figures 6-3 through 6-14.

As illustrated in Section 5, the actual exposure achieved was very close to the nominal desired criteria used for Mission 1048. A sample of twenty microdensitometer measurements of specific targets indicated that the exposure performance was well controlled at proper levels. The target density analysis is summarized in Table 6-1.

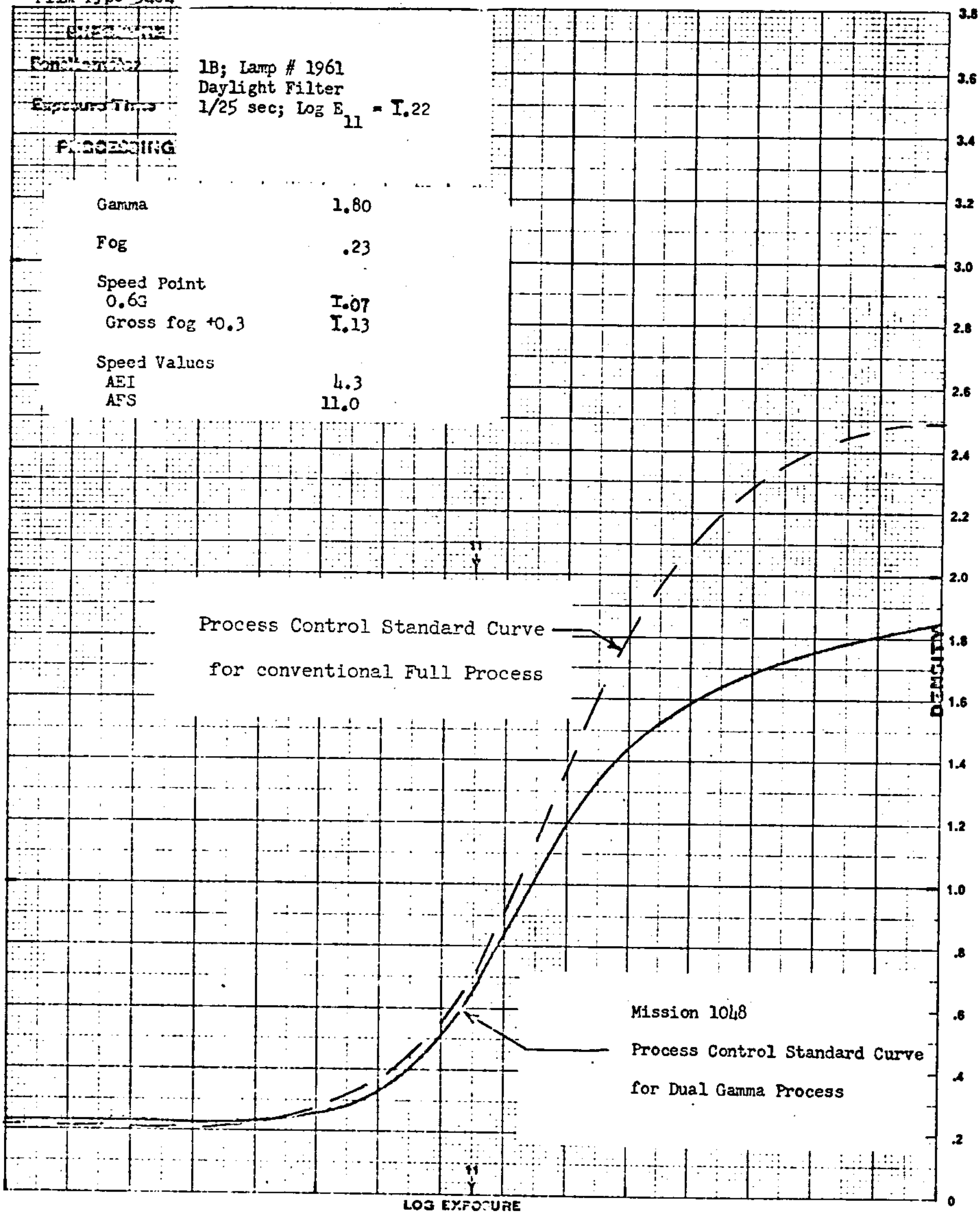
The terrain density measurements summarized in Table 6-2 and in Figures 6-3 through 6-14 illustrate the expected results of the exposure profile differences, as well as providing an example of the disparity between terrain-density based criteria and Project Sunny type performance results.

The curves illustrated in Figure 6-2 describe an apparent disparity in the dual-gamma process first noted on Mission 1104. Comparison of these curves with those in Figure 6-1 indicates that the mission material indeed exhibited sensitometric properties very close to the control standard; however, the R-2 samples show significant deviations. It is anticipated that these undesirable performance and control characteristics will be corrected as the operational application of this new process is further developed.

The last 17 frames from the forward camera and the last 33 frames of aft camera film were severely damaged as one result of the forward camera failure (ref. Section 3). These frames were removed from the rest of the load and processed separately on the Trenton processor. No density measurements or other performance evaluation was performed on these frames.

FIGURE 6-1

Film Type 3404



[redacted]

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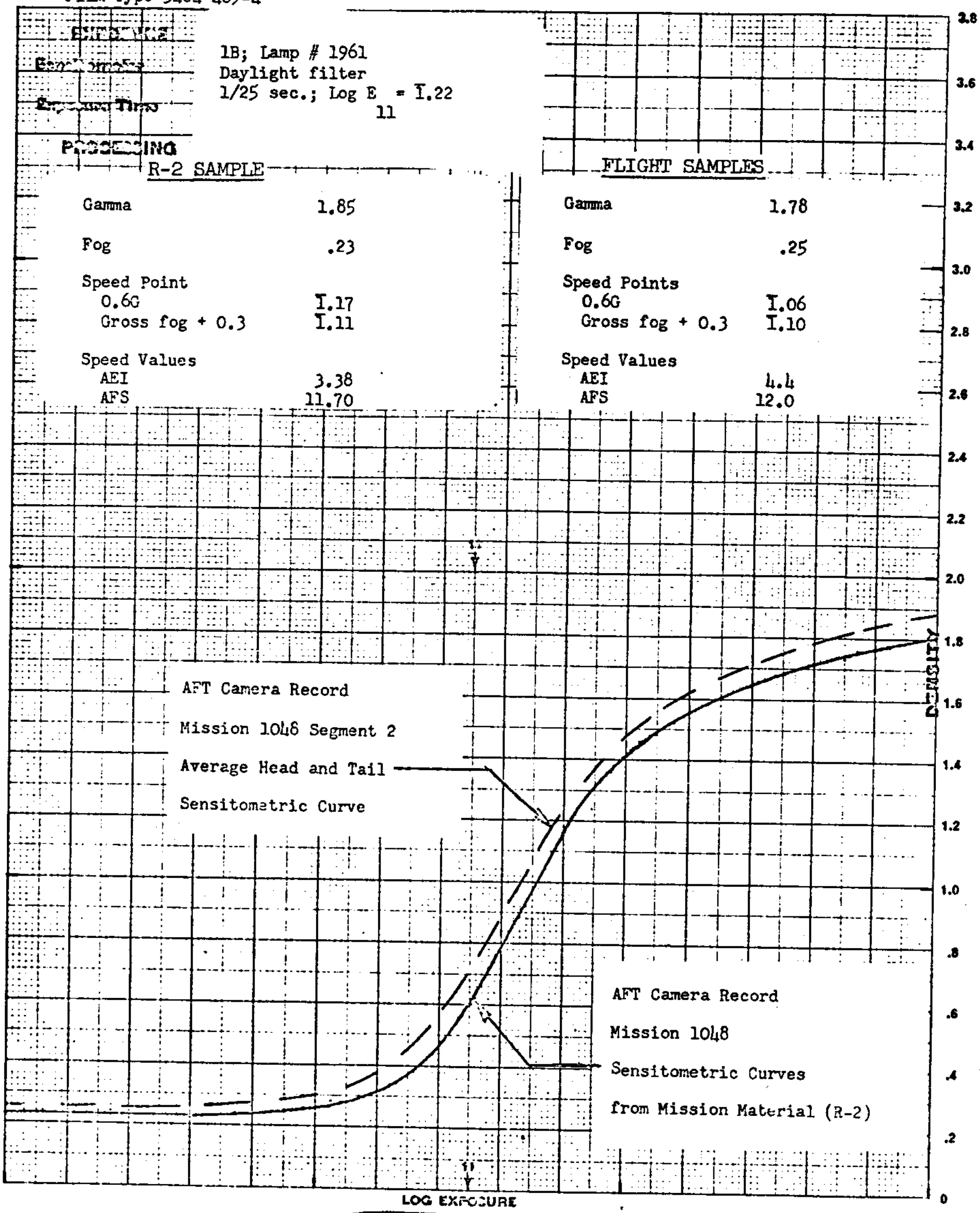
[redacted]

Film Type 3404-409-4

FIGURE 6-2



[redacted]

TARGET	DAY	OBJECT	TARGET D_{max}	TARGET D_{max}	TARGET* D_{nom}	RECOMMENDED* E_v	COMMENTS
A	4 F	Ships	.28	.68	.36	+1	Subjectively underexposed
A	4 A	Ships	.32	.86	.47	+2/3	
B	13 A	RR Cars	.30	.67	.38	+1	Near edge of frame
C	10 F	Conveyor-like	.34	1.04	.56	0	
C	10 A	structure	.37	1.23	.72	0	
D	4 F	RR Cars	.53	1.09	.79	0	
D	4 A	"	.56	1.15	.86	0	
D	11 F	"	.37	1.27	.53	+1/3	
D	11 F	"	.41	1.19	.54	+1/3	
E	6 F	Structure complex	.46	1.61	1.08	-2/3	Subjectively overexposed
E	6 F		.46	1.65	1.06	-2/3	" "
E	14 A	"	.41	1.72	1.09	-2/3	
F	6 F	Buildings	.39	1.65	.89	0	
F	6 A	"	.33	1.23	.41	+2/3	
F	13 A	Stockpiles	.37	1.38	.63	0	Near end of frame
F	14 A	"	.37	1.41	.56	0	
G	6 F	Ships	.32	1.20	.58	0	
G	6 A	"	.31	1.03	.46	+2/3	
G	13 A	"	.30	1.12	.73	0	Near end of frame
G	14 A	"	.30	1.12	.61	0	

* The "nominal" target densities and exposure recommendations are subjective values provided by the processing agency, and do not necessarily represent the consensus of the community.

TABLE 6-1

TERRAIN DENSITY ANALYSIS OF EXPOSURE

INSTRUMENT		SAMPLE SIZE	PERCENT UNDEREXPOSED (D_{min} 0.4)	CORRECT EXPOSURE	PERCENT OVEREXPOSED (D_{min} 0.9)
1048-1	Fwd	308	17	71	12
1048-1	Aft	296	15	69	16
1048-2	Fwd	111	36	59	5
1048-2	Aft	277	23	65	12

TABLE 6-2

~~TOP SECRET~~ C/ [redacted]

MISSION * 1048-1 * INSTR * FWD * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.59 * MEDIAN * 0.52 * STD DEV * 0.22 * RANGE * 0.31 TO 1.25 WITH 308 SAMPLES

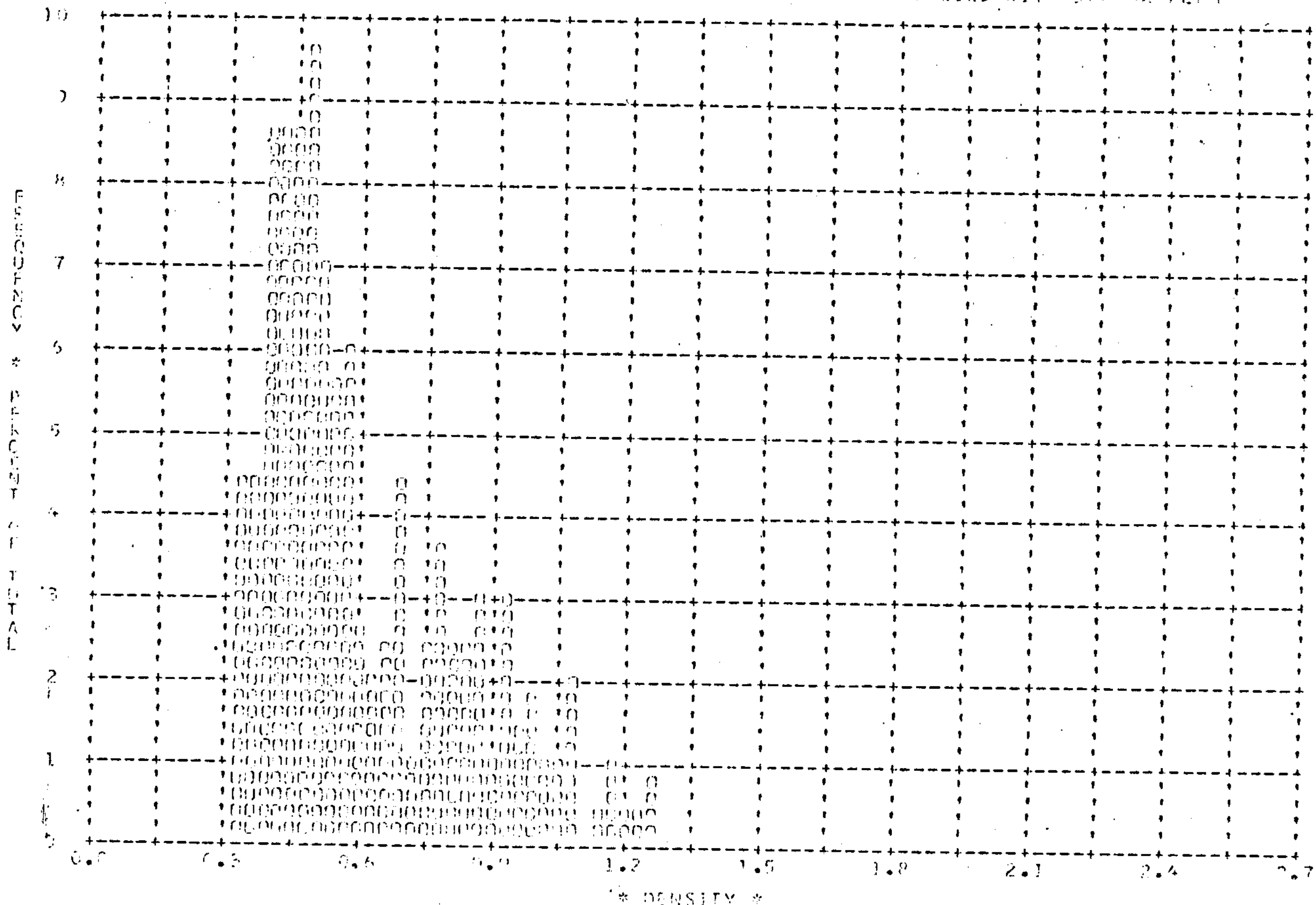


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FIGURE 6-3

MISSION * 1048-1 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.31 * MEDIAN * 1.37 * STD DEV * 0.25 * RANGE * 0.54 TO 1.70 WITH 300 SAMPLES

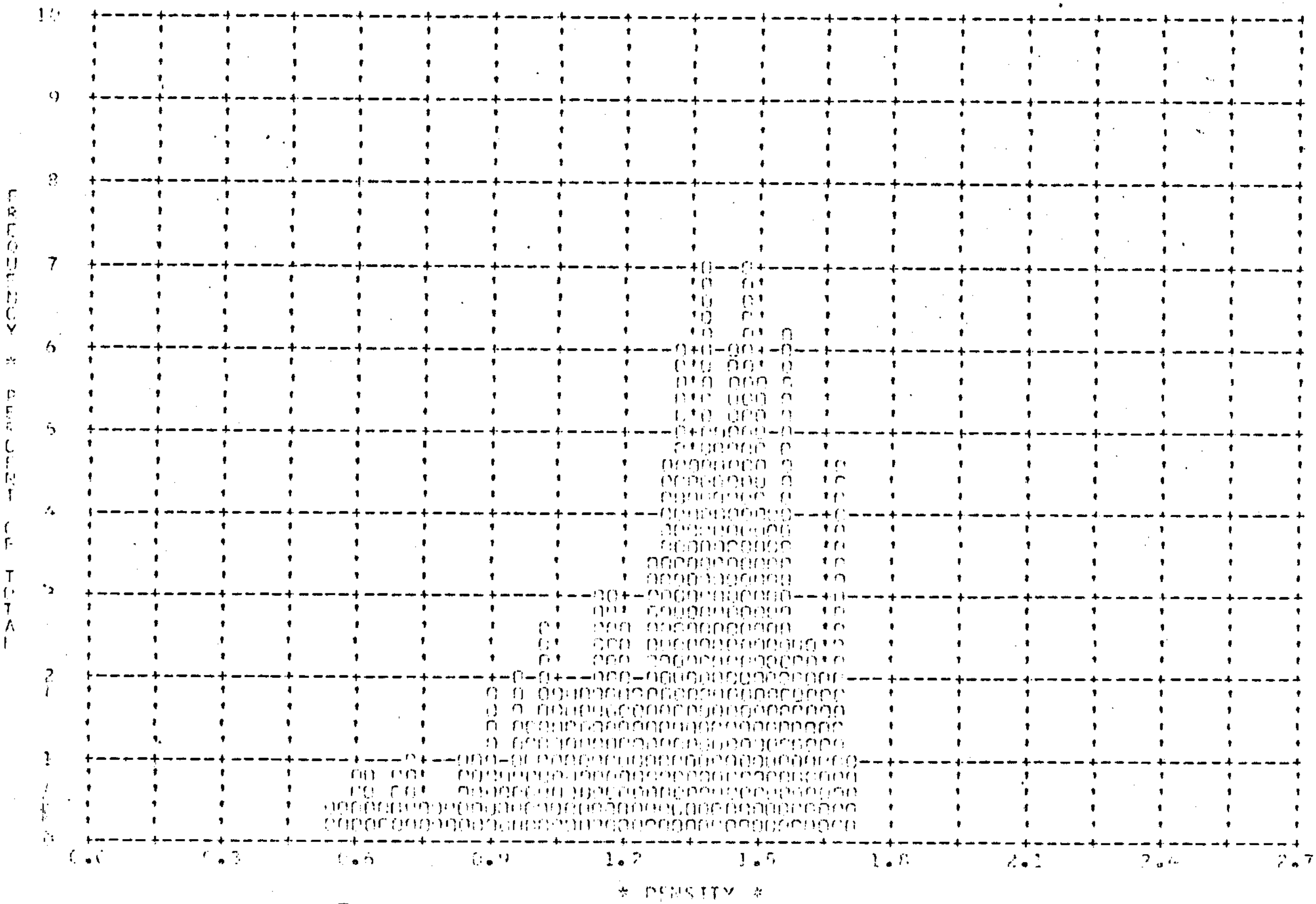

FIGURE 6-4

MISSION * 1040-1 * INSTR * FWD * . . . PLOT OF D MAX * CLOUD * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.62 * MEDIAN * 1.64 * STD DEV * 0.13 * RANGE * 1.[illegible] TO 1.75 WITH 159 SAMPLES

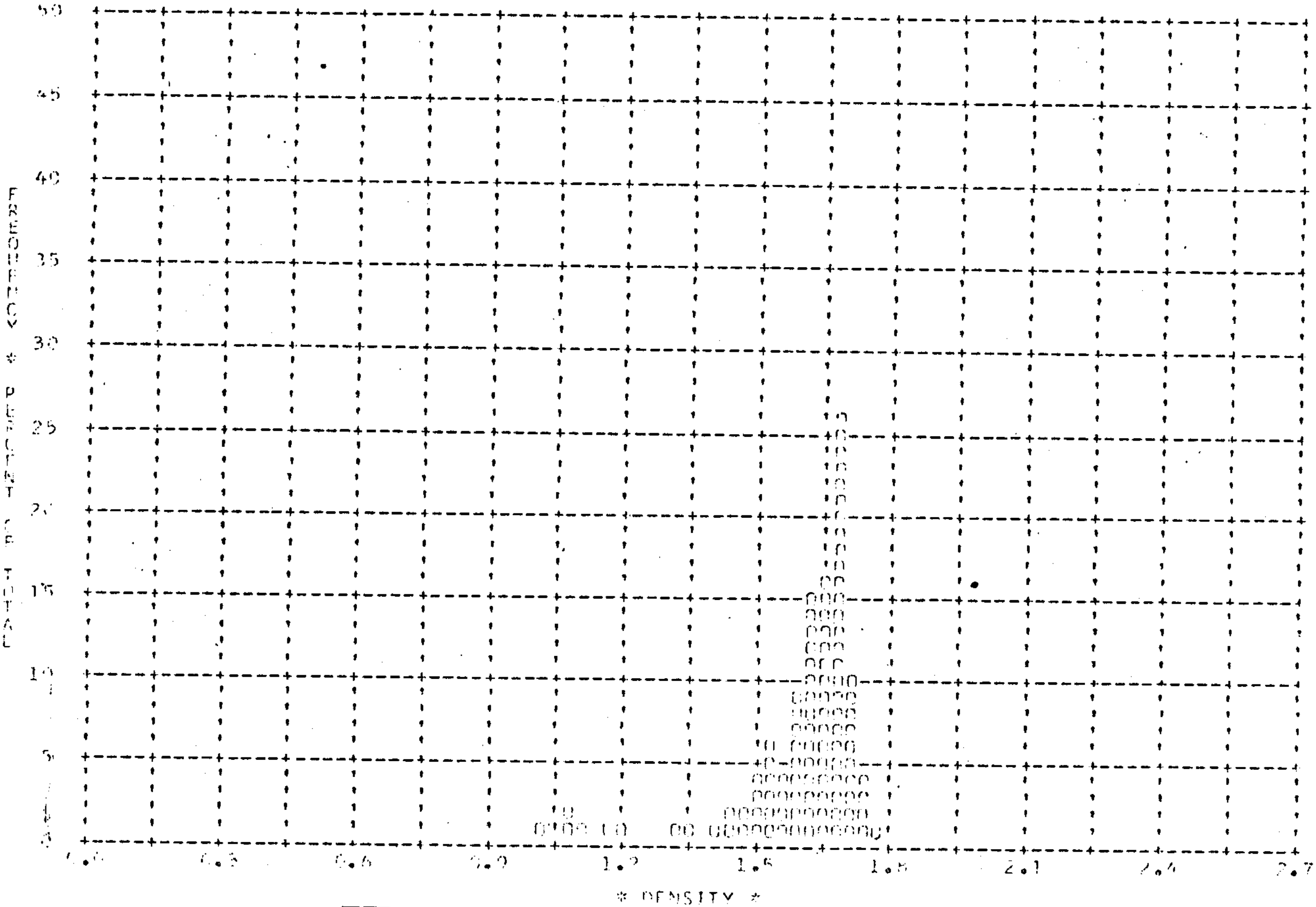

FIGURE 6-5

MISSION * 1048-1 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.62 * MEDIAN * 0.56 * STD DEV * 0.24 * RANGE * 0.31 TO 1.39 WITH 296 SAMPLES

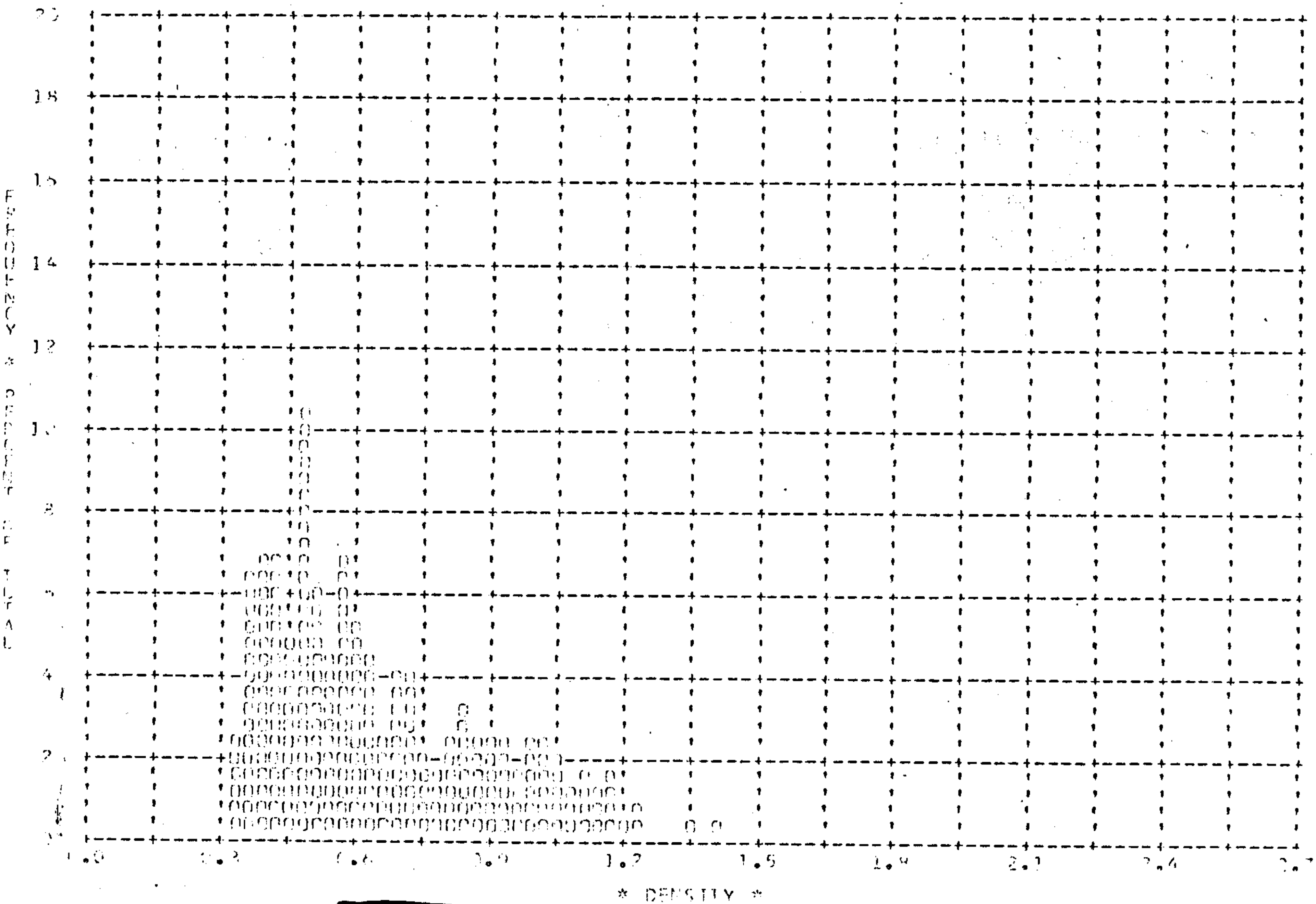

FIGURE 6-6

MISSION * 1048-1 * INSTR * AFT * . PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.33 * MEDIAN * 1.35 * STD DEV * 0.24 * RANGE * 0.61 TO 1.67 WITH 296 SAMPLES

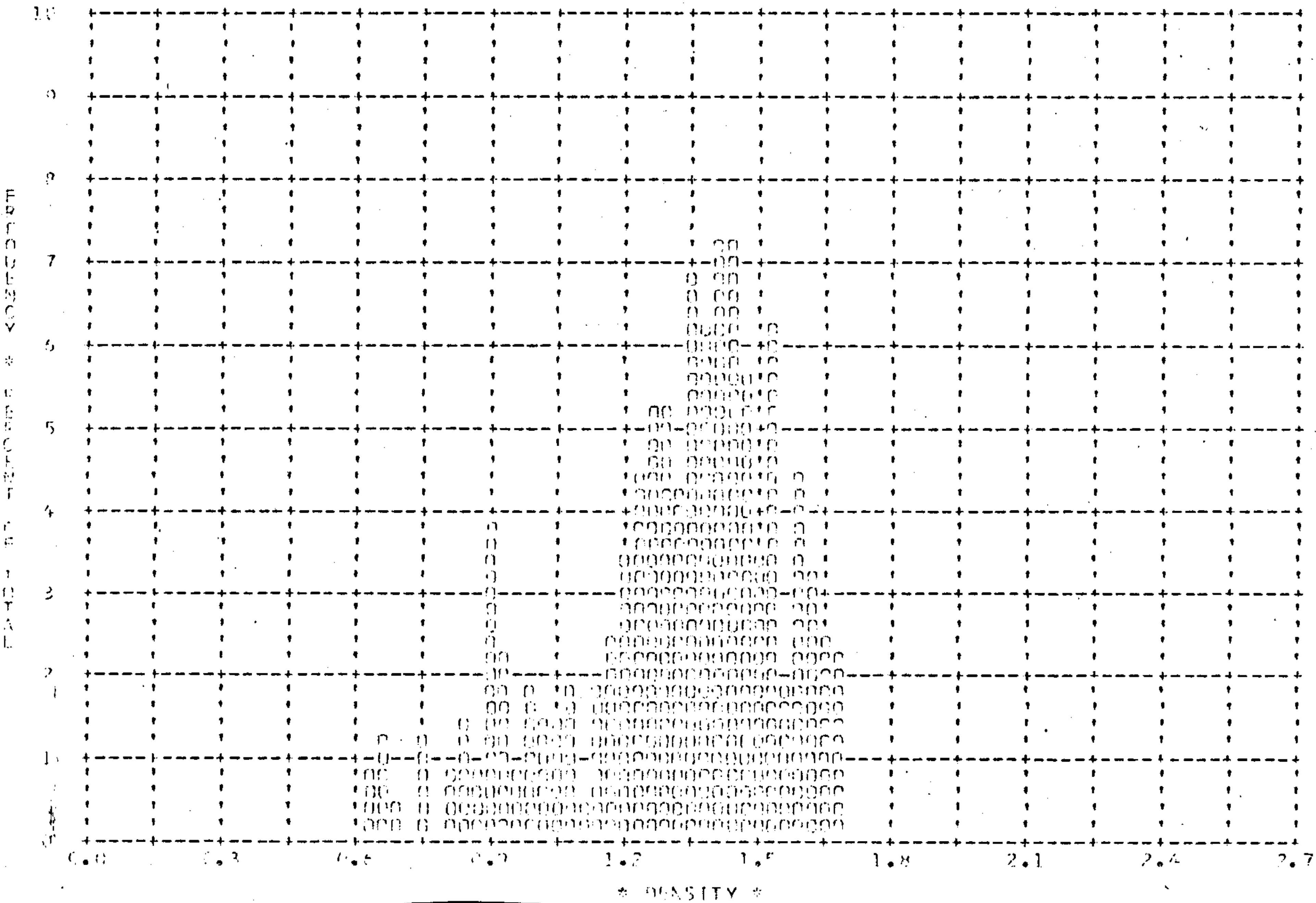

FIGURE 6-7

MISSION * 1048-1 * INSTR * AFT * PLOT OF 0 MAY * CLOUD * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.59 * MEDIAN * 1.61 * STD DEV * 0.12 * RANGE * 0.94 TO 1.72 WITH 160 SAMPLES

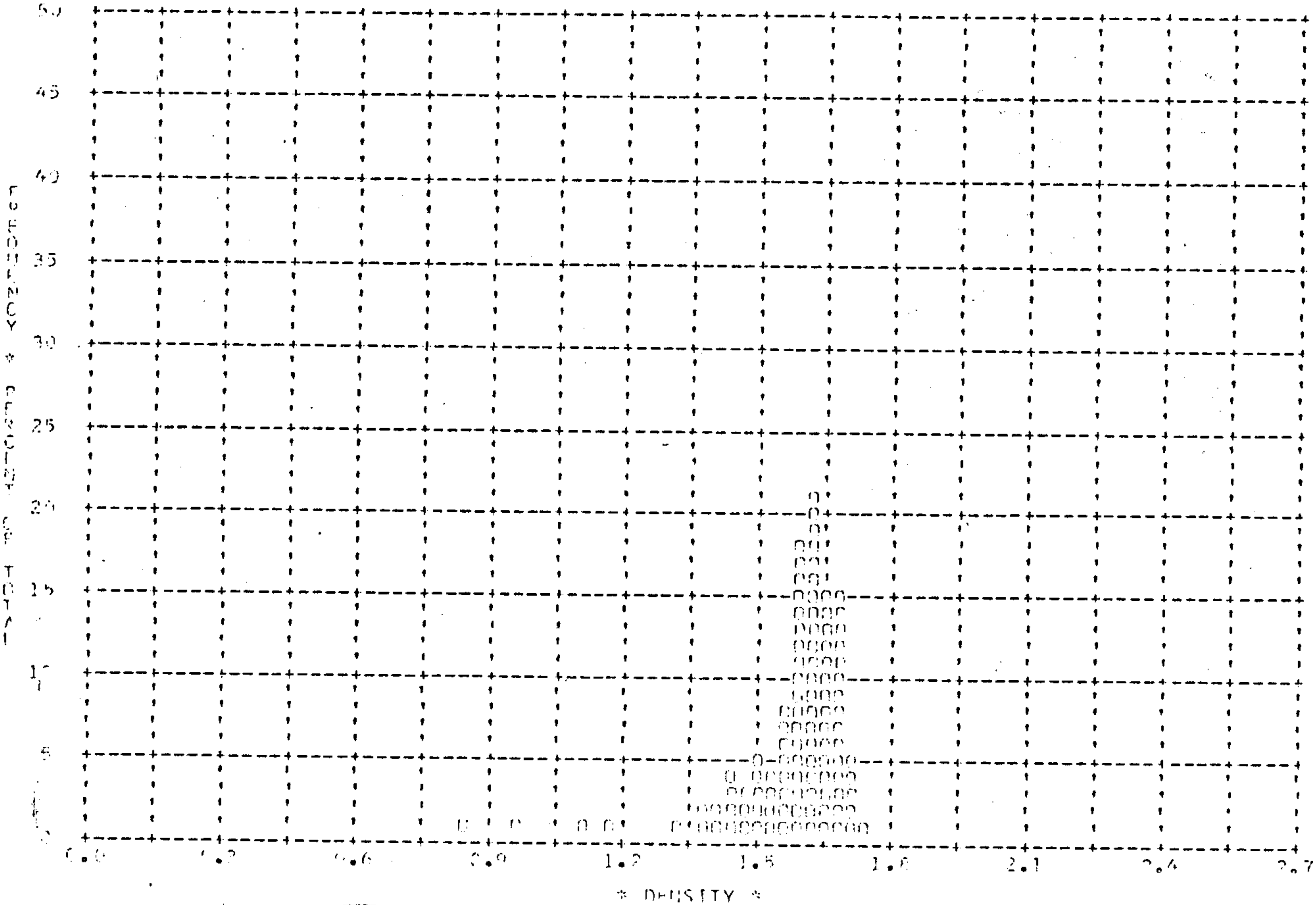

FIGURE 6-8

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MISSION * 1048-2 * INSTR * FWD * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.49 * MEDIAN * 0.43 * STD DEV * 0.17 * RANGE * 0.30 TO 1.12 WITH 111 SAMPLES

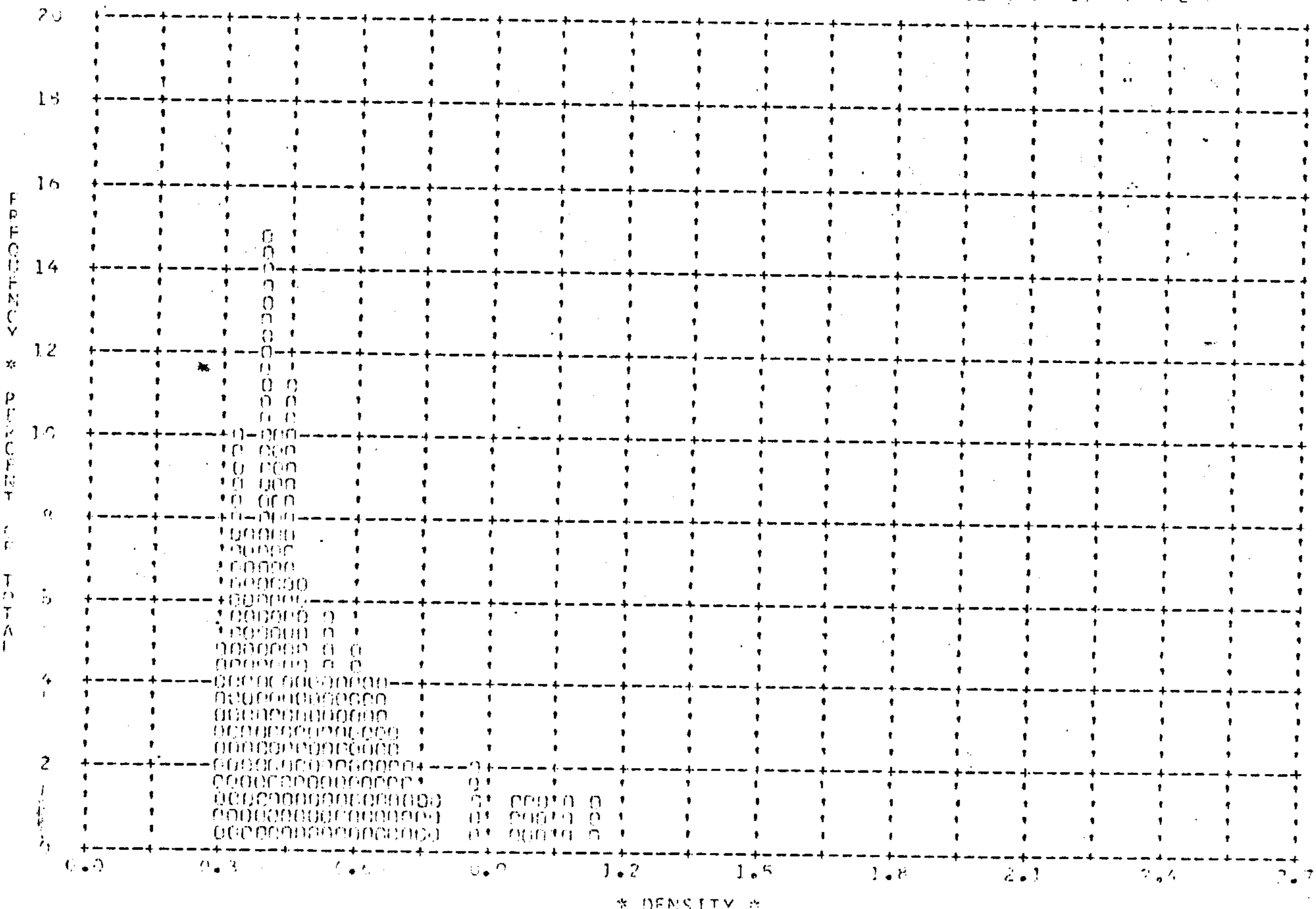

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FIGURE 6-9

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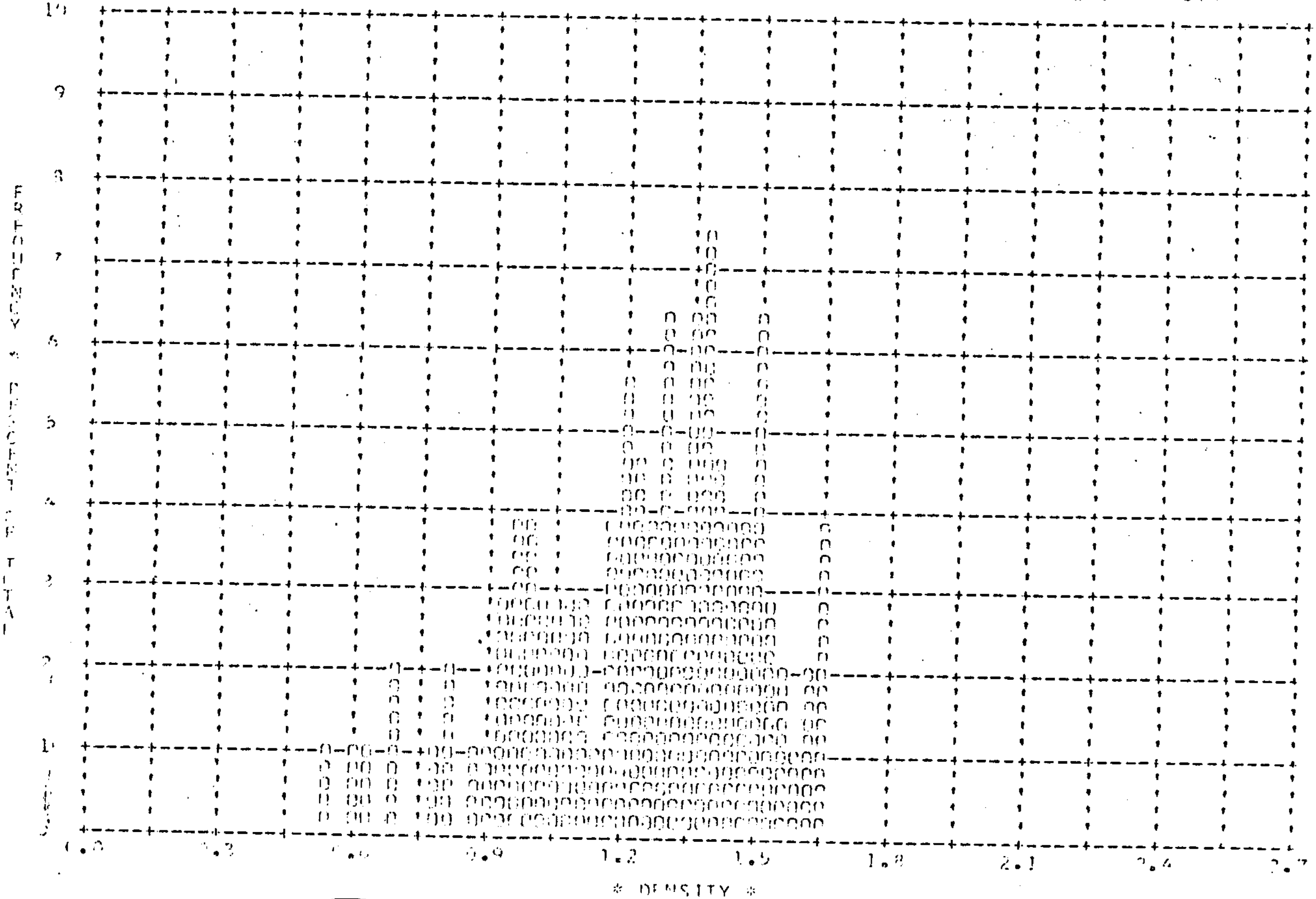
MISSION * 1048-2 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.23 * MEDIAN * 1.27 * STD DEV * 0.25 * RANGE * 0.54 TO 1.65 WITH 111 SAMPLES



~~TOP SECRET~~ C[redacted]

MISSION * 1048-2 * INSTR * FWD * ; PLOT OF D MAX * CLOUD * PROCESSING * DUAL GAMMA
ARITH MEAN * 1.53 * MEDIAN * 1.55 * STD DEV * 0.11 * RANGE * 1.11 TO 1.69 WITH 64 SAMPLES

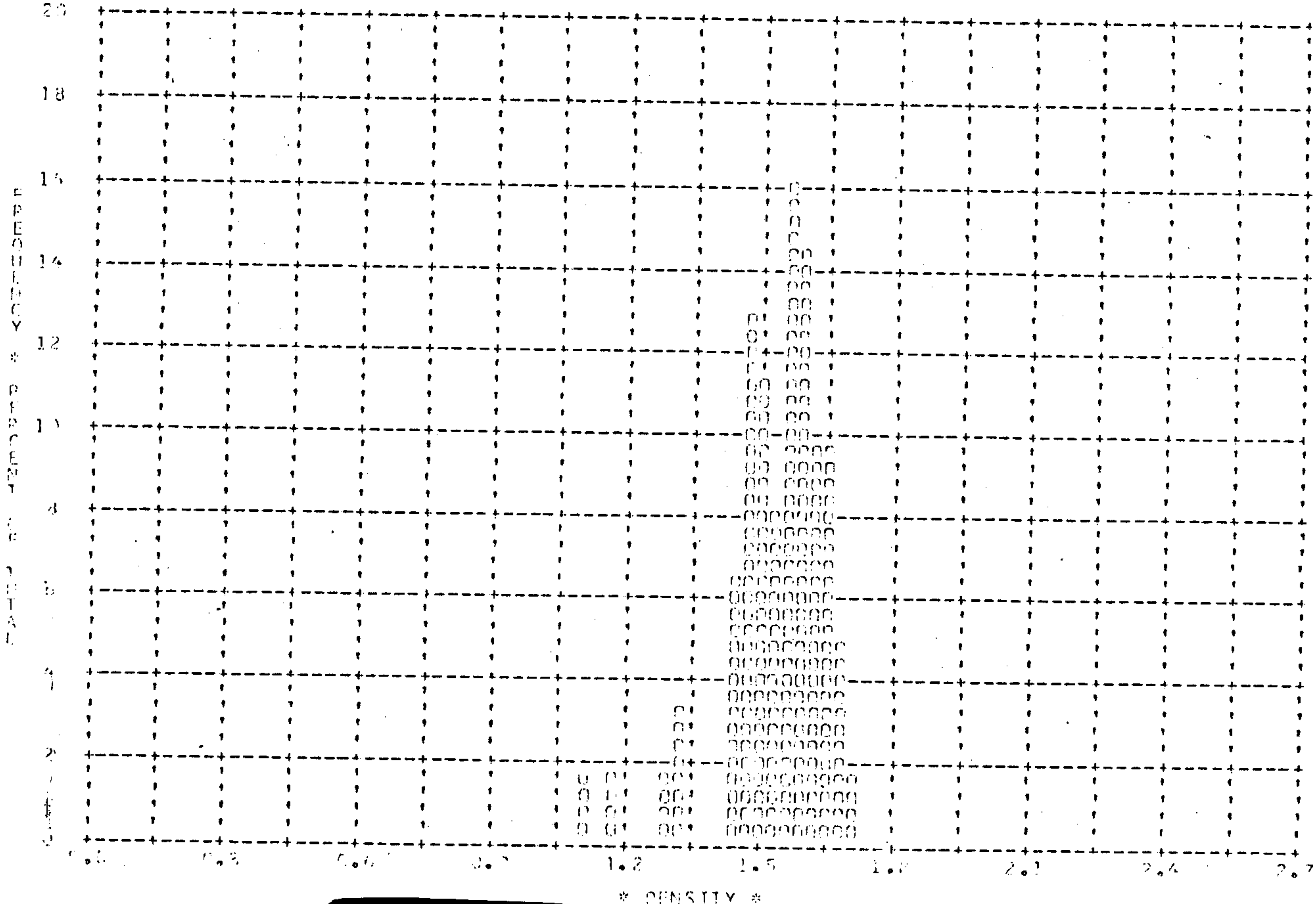


FIGURE 6-11

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MISSION * 1048-2 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.52 * MEDIAN * 0.51 * STD DEV * 0.23 * RANGE * 0.29 TO 1.35 WITH 277 SAMPLES

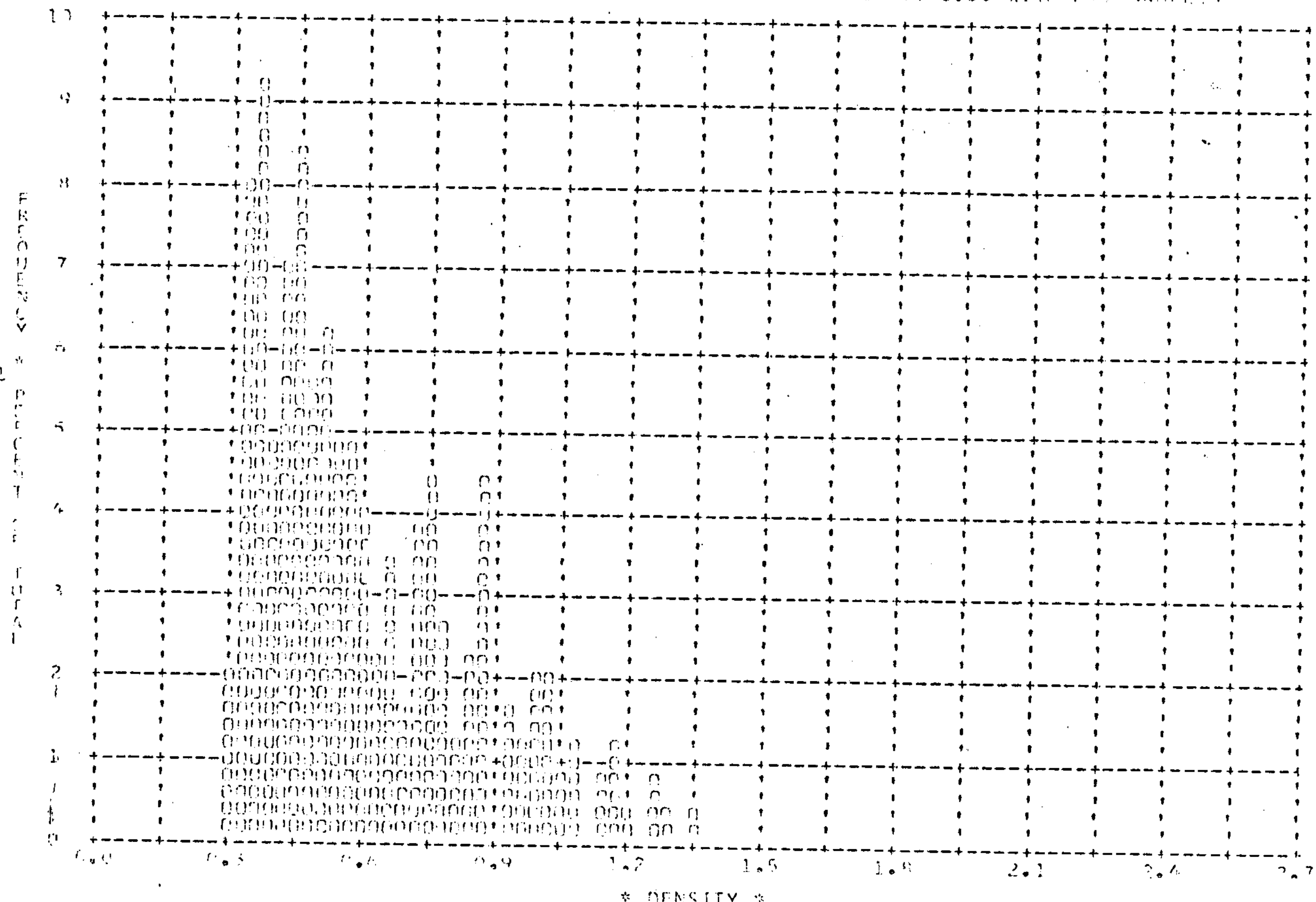

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FIGURE 6-12

MISSION * 1048-2 * INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * **DUAL GAMMA**

ARITH MEAN * 1.21 * MEDIAN * 1.20 * STD DEV * 0.30 * RANGE * 0.52 TO 1.74 WITH 277 SAMPLES

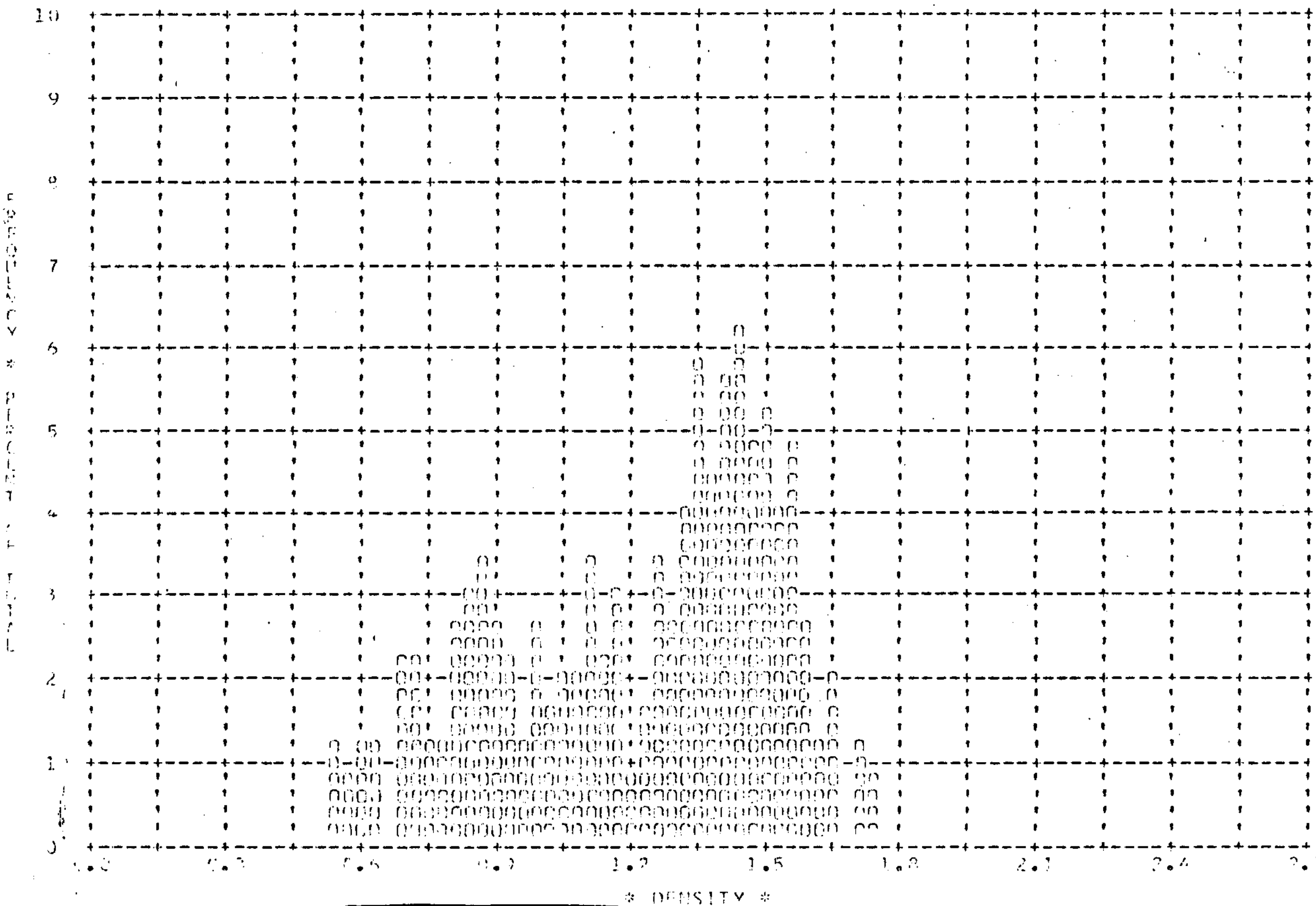
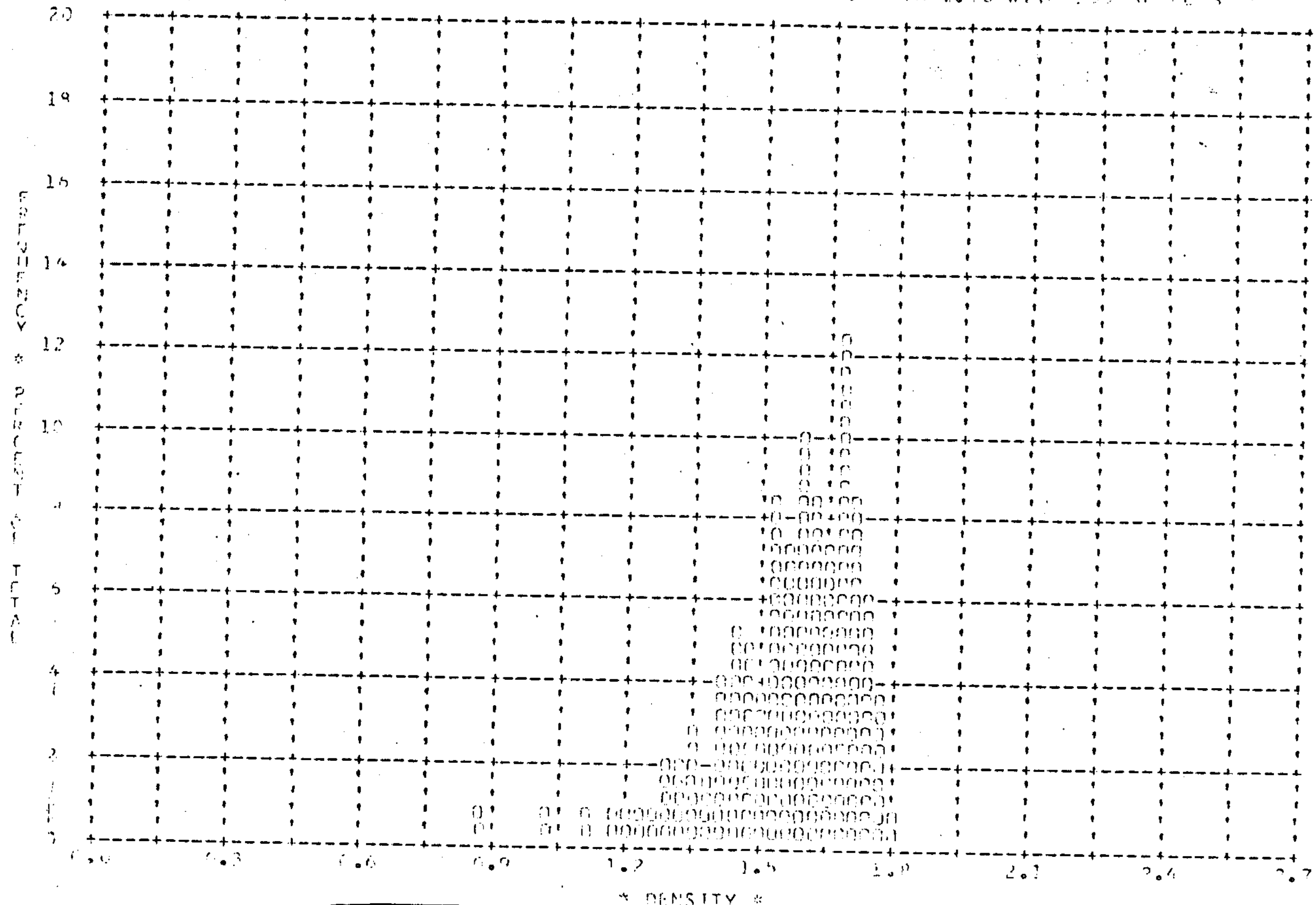


FIGURE 6-13

~~TOP SECRET~~ C[redacted]

MISSION * 1048-2 * INSTR * AFT * PLOT OF D MAX * CLOUD * PROCESSING * **DUAL GAMMA**

ARITH MEAN * 1.55 * MEDIAN * 1.59 * STD DEV * 0.15 * RANGE * 0.96 TO 1.76 WITH 155 SAMPLES



[redacted]

FIGURE 6-14

SECTION 7

VEHICLE ATTITUDE

The vehicle attitude errors for both Mission 1048-1 and 1048-2 were derived from the reduction of the Stellar camera photography. This attitude data is supplied to A/P by NPIC.

The attitude errors for each frame and the attitude control rates are calculated at the A/P computer facility. The computer also plots the frequency distribution of the rates and errors. These plots are no longer included as a part of this report, but are maintained at A/P and are available for reference as desired.

The summary table below lists the maximum attitude errors and rates that were experienced during 90 percent of the forward camera photographic operations, excluding the first six frames of each operation, and the total range of the errors and rates.

	Mission 1104-1		Mission 1104-2	
Value	90%	Range	90%	Range
Pitch Error (°)	0.28	-0.52 to +0.12	0.16	-0.14 to +0.28
Roll Error (°)	0.22	-0.42 to +0.32	0.24	-0.40 to +0.30
Yaw Error (°)	0.28	-0.45 to +0.85	0.30	-0.45 to +0.40
Pitch Rate (°/hr.)	14.94	-34 to +36	15.52	-48 to +26
Roll Rate (°/hr.)	28.75	-60 to +90	28.38	-72 to +56
Yaw Rate (°/hr.)	20.36	-50 to +90	16.65	-36 to +40

The yaw angle error represents the difference between the actual vehicle yaw attitude and the ideal yaw angle that would provide correct ground image motion.

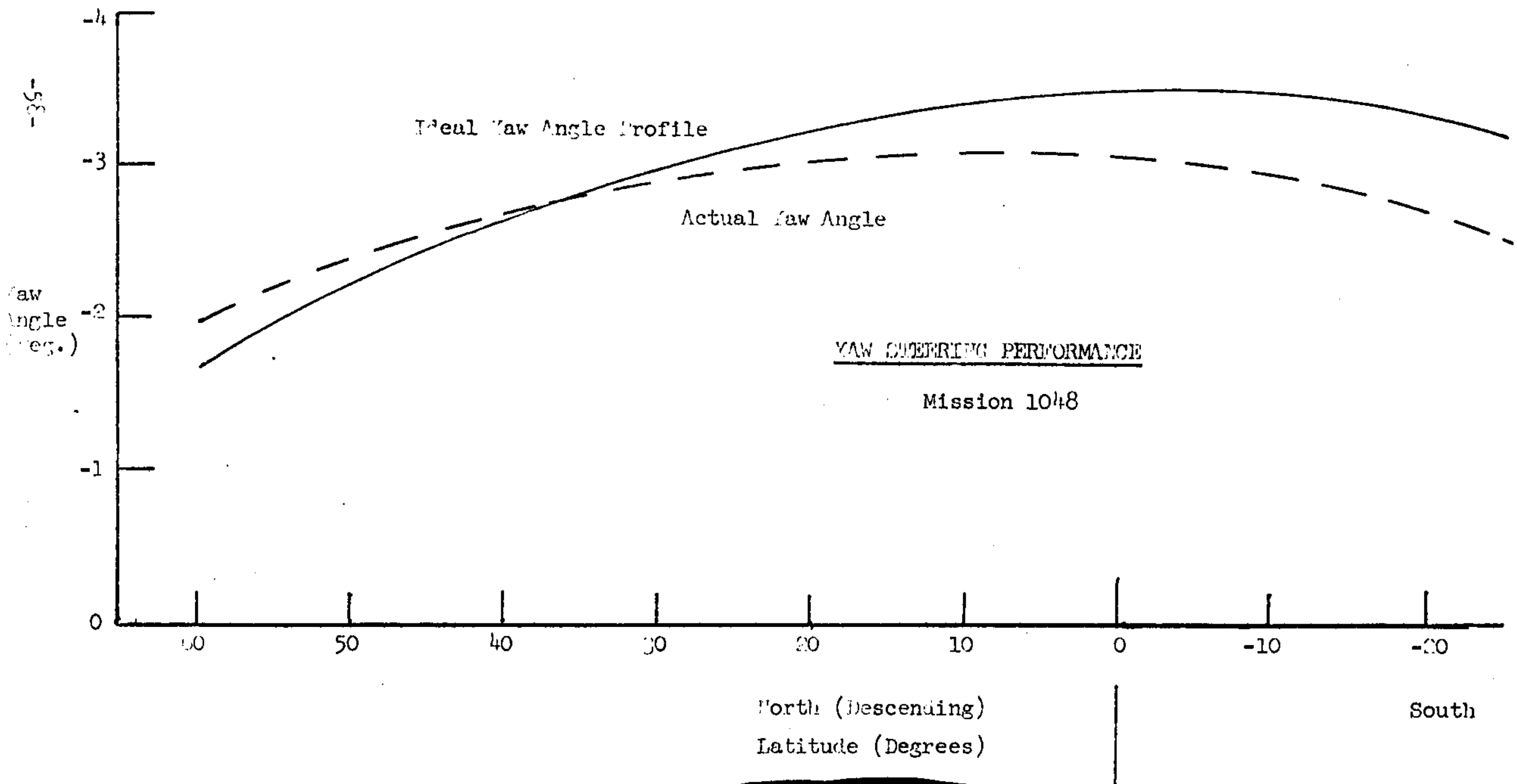


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FIGURE 7-1

SECTION 8

IMAGE SMEAR ANALYSIS

The frame correlation tape supplied to A/P by NPIC contains the binary time word of each frame of photography. A computer program has been assembled at A/P which calculates the exposure time of each frame and compares the camera cycle rate with the ephemeris to calculate the V/H mismatch (Section 3), which is then combined with the vehicle attitude error and rate values of each frame and the crab error caused by earth rotation at the latitude of each frame. The program outputs the net IMC error and the total along track and cross track limit of ground resolution that can be acquired by a camera regardless of focal length and system capabilities.

The computer rejects the first six frames of all operations as the large V/H error induced by camera start-up is not representative of the overall system operations. The computer plotted frequency distributions of IMC errors and resolution limits are no longer included in this report, but are maintained at A/P for reference, as desired.

The summary table 8-1 presents the maximum IMC errors and resolution limits that existed during 90% of the photographic operations and the total range of values during all operations that were computed. The relatively high range of cross track resolution for Mission 1048-2 was contributed by 15 frames on Rev. 143 when the yaw programmer was turned off. When these frames are discounted, the upper limit of cross track resolution range becomes 1.4 feet for the forward camera and 1.2 feet for the aft.

MISSION 1048

IMC RATIO AND RESOLUTION LIMITS

VALUE	UNITS	CAMERA	MISSION 1048-1 90%	MISSION 1048-1 RANGE	MISSION 1048-2 90%	MISSION 1048-2 RANGE
IMC Ratio Error	%	Fwd	3.35	-5.4 to +4.4	3.14	-4.6 to +0.4
		Aft	3.24	-5.5 to +4.5	3.05	-5.0 to 0.0
Along Track Resolution Limit	Feet	Fwd	3.68	0.2 to 7.0	3.37	0.6 to 5.0
		Aft	2.71	0.2 to 7.5	2.45	0.2 to 4.2
Cross Track Resolution Limit	Feet	Fwd	0.80	0.2 to 2.8	0.87	0.2 to 5.6
		Aft	0.54	0.2 to 1.8	0.80	0.2 to 4.6

TABLE 8-1

SECTION 9

SYSTEM RELIABILITY

Reliability calculations for the payload are based on a sample beginning with M-7. Hence both the major part of the Mural program and the "J" program are covered in the calculation. For certain auxiliaries, i.e., the Stellar/ Index camera and the horizon cameras, the sample size is changed to recognize incorporation of modified equipment or new designs where reliability was one of the principal reasons for the modification. However, for primary mission function, the sample size is consistent with reliability reporting for the vehicle.

The reliability estimates of this section deal exclusively with the payload. Failures to achieve orbit or vehicle induced failures are thereby excluded. Recoveries before a mission has been completed are considered as full missions providing that early termination was caused by reasons not connected with payload operation. Film quality is not considered in the reliability estimate calculation. Hence, only electrical and mechanical functioning are considered.

The reliability estimate is also divided into primary and secondary functions. The primary functions are operation of the panoramic cameras, main camera door operation, operation of the payload clock, and recovery operations. The secondary mission functions are horizon camera operation excluding catastrophic open shutter failure mode, auxiliary data recording, and Stellar/Index camera operation.

Panoramic Camera Reliability

Sample Size - 223 opportunities to operate.

Three failures - S/I Programmer on System J-19

Film Transport on System J-42

Film Transport on System J-49

Assume - 3000 cycles per camera per mission.

Estimated Reliability - 98.3% at 50% confidence level.

Main Camera Door Reliability

Sample Size - 70 vehicles x 2 doors - 140 opportunities to operate.

Estimated Reliability - 99.5% at 50% confidence level.

Payload Command and Control

Sample Size - 13,848 hours operation in sample.

Two failures

Estimated Reliability - 96.8% at 50% confidence level.

Payload Clock Reliability

Sample Size - 13,848 hours operation in sample.

No failures

Estimated Reliability - 99.2% at 50% confidence level.

Estimated Reliability of Payload Functioning on orbit - 96.5% at 50% confidence level.

Recovery System Reliability

103 opportunities to recover.

1 failure - improper separation due to water seal - cutter failure.

Estimated Reliability - 98.4% at 50% confidence level.

Stellar/Index Camera Reliability

Sample begins with J5 (does not include DISIC units in 1100 series systems).

Sample size - 31,530 cycles

Four failures

Estimated Reliability - 92.6% at 50% confidence level.

Horizon Camera Reliability

Sample begins with J5 - 136,000

Estimated Reliability of Single Camera - 99.2% at 50% confidence level.

Estimated Reliability of Four Horizon cameras at a Parallel Redundant System - 99.9% at 50% confidence level.

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