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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1112-1 and 1112-2

FTV 1658, QR-2R

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Advanced Projects

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FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1658.

Lockheed Missiles and Space Company has a contractual responsibility for evaluating payload performance. This document constitutes the final payload test and performance evaluation report for Mission 1112, which was launched 18 November 1970.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1112-1 and 1112-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the QR-2R payload system and to identify the sources of in-flight anomalies.

The designation, QR-2R, refers to the Corona J-3 program flight qualification system, QR-2, as refurbished by Itek Corporation. The refurbishment includes replacement of the main lenses with "third generation" lenses, and incorporation of substantially all system modifications effective on the flight date. System configuration data and test history in this report refer only to the refurbished system.

Quantitative data used in this report is obtained from several sources. Some noteworthy changes in these sources are effective with this report. In the past, the Air Force Special Projects Production Facility provided both macro and microdensitometer data with related analyses of exposure performance. They have also provided a variety of resolution performance measures and some mission summary data in mission-oriented technical evaluation reports referred to as TEROs. Because of other commitments, these contributions are being terminated. No TERO was prepared on Mission 1112. No density data (micro or macro) is to be provided after Mission 1112. An examination of diffuse macrodensity data collected by [redacted] for printing control indicates that this existing data will be a useful substitute for the AFSPPF macrodensity data. Machine plotted frequency distributions and summary statistical properties of both data sets are included in this report. Continued use is made of data in the mission processing summary report published by [redacted]

The vehicle attitude error values and frame correlation times are determined by NPIC from DISIC camera data and tape recorder information. Because of failure of both units on the 1112-2 mission, some analyses can be made only on the 1112-1 mission.

SECTION 1

MISSION SUMMARY

A. MISSION OBJECTIVES

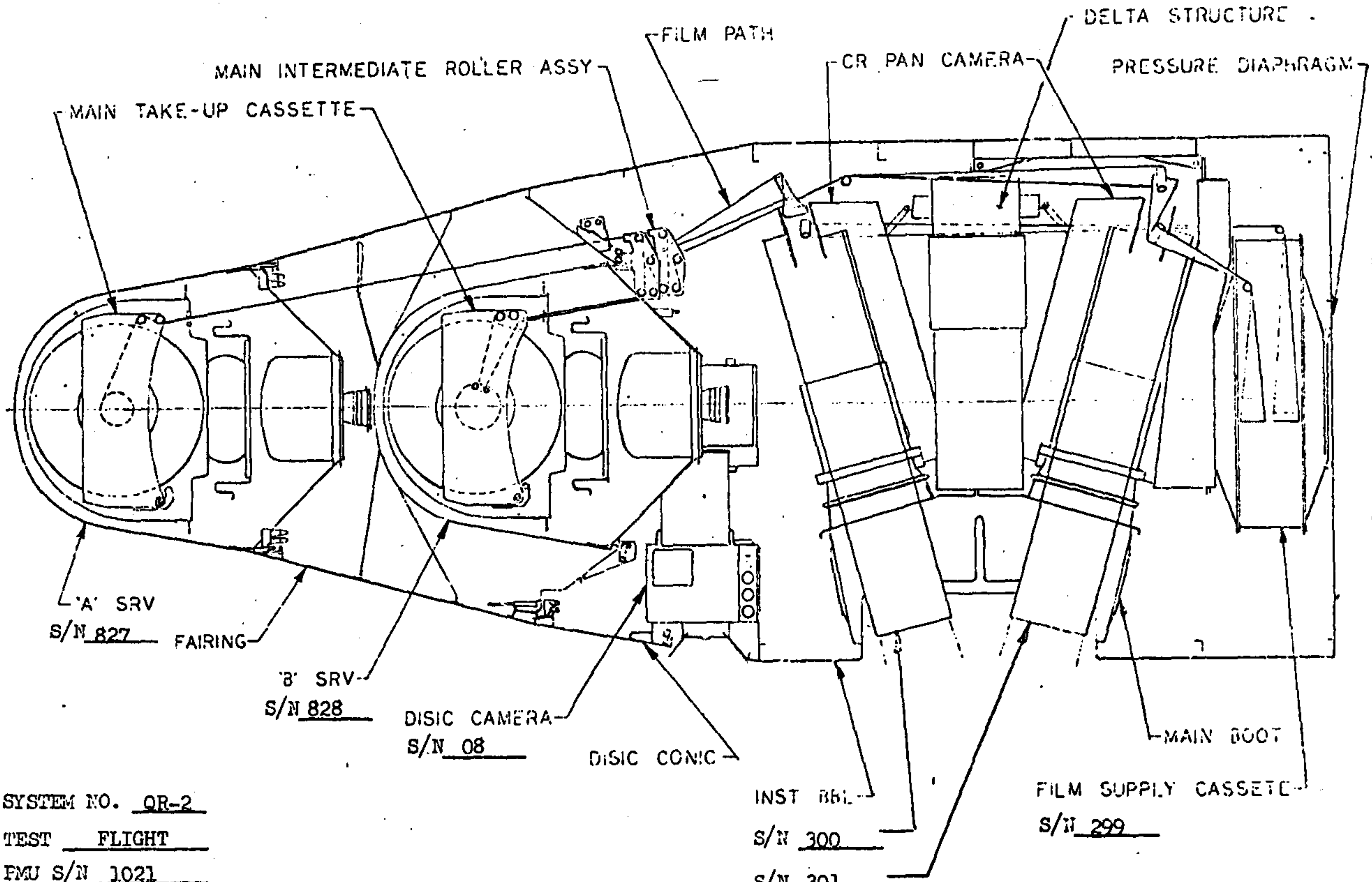
The payload section of Mission 1112, placed into orbit by Flight Test Vehicle 1658 and THORAD Booster (SLV-2H) S/N 552, consisted of two panoramic cameras, one DISIC camera, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipment. Figure 1-1 presents an inboard profile of the QR-2R payload system. The Corona "J" system was designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. A nine day -1 mission and a ten day -2 mission was planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2128:00Z (1328:00 PST) on 18 November 1970. 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] under central control of the Satellite Test Center at Sunnyvale, California. Mission 1112-1 consisted of a 9-day operation and was completed by air recovery on 27 November 1970. Mission 1112-2 was completed with an air recovery on 7 December 1970 following a 10-day photographic operation.

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

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. QR-2
TEST FLIGHT
FMU S/N 1021
SLOPE PROGRAMMER S/N 213
CLOCK S/N 613
SWITCH PROGRAMMER S/N 200

FIG. 1-1

ORBITAL PARAMETERS

Parameter	Planned	Orbit 2 Actuals
Period (Min.)	88.61	88.56
Perigee (N.M.)	99.7	97.2
Apogee (N.M.)	128.2	122.6
Inclination (Deg.)	83.0	83.0
Perigee Latitude (Deg. N)	238.0	311.3
Eccentricity	0.0043	.0036

Seven drag make-up rockets were fired during the flight to maintain track and period control throughout the mission. The eighth DMU rocket was fired after the -2 mission.

C. PANORAMIC CAMERAS

The aft panoramic camera functioned properly throughout the flight with the exception of an abnormal shut-down on Rev. 3. Telemetry indicated that a premature loss of internal operate command resulted in loss of take-up tension. The resultant misphasing of the 99/101 metering clutch required 20 cycles of camera operation before achieving normal, stabilized operation.

The camera exhausted its 16,300 feet of standard base film, composed of type 3404 and 3414 material. All of the film passed into the recovery system without a wrap-up.

The forward panoramic camera film footage T/M indicated a greater consumption than actual. The erroneous T/M has been attributed to out-of-round take-up in the -1 recovery system. Film scratching, related to the out-of-round anomaly, was present throughout the -1 mission, as well.

On Rev. 6, Frame 135, the forward panoramic camera failed to stow properly with the perturbation probably resulting in a slack loop. Missing center-of-format signals, as indicated by the SRV tape recorder indicate the possibility of defective center of format switches. This anomaly repeated itself on Frame 17 of Rev. 7. Concomitant with the missing center-of-format signal, those functions generated by the switch closure, were absent or degraded.

The forward camera failed during the first frame of the -2 mission. Although the cut and cinch appeared to be normal, from telemetry data, a slowing down of the frame metering function indicated a binding or jamming failure mechanism in the camera drive system.

Only one full frame and two partial frames were recovered from the -2 SRV.

D. DISIC CAMERA

The DISIC camera performed normally during the -1 mission. After a normal A to B transfer sequence, the terrain cycle counter indicated 33 cycles instead of the programmed 71 cycles indicating a stalled condition. Attempts to operate the DISIC in the independent mode failed three times. A loss of terrain take-up is the most probable cause of the DISIC failure.

E. OTHER SUBSYSTEMS

The pressure make-up unit, the clock, exposure control and thermal control subsystems performed satisfactorily as did the Digital Shift register portion of the command system. Satisfactory operation for the SRV tape recorder was achieved only during the -1 mission. The recorder failed early during the -2 mission and subsequent analysis indicated a drive belt failure as the cause.

The slope programmer performance was satisfactory with good ramp matches after the fifth rev. Large perigee dispersions accounted for initial errors.

F. COMPONENT IDENTIFICATIONS AND SETTINGS

1. Forward Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	301
Main Camera Lens	I224
Supply Horizon Camera Lens	E40775
Take-up Horizon Camera Lens	E40786

b. Camera Data and Flight Settings

Main Camera:	
Lens	24"f/3.5
Slit Widths	
S_1	0.154"
S_2	0.189"
S_3	0.250"
S_4	0.320"
F/S	0.259"
Filter Types	
Primary	Wratten 23A Glass (0.037")
Secondary	Wratten 23A Glass (0.040")
Film Data	

Split Load	Eastman Type 3414	15,300 feet
	Eastman Type 3404	1,000 feet
	Total	16,300 feet

Supply (Port) Horizon Camera:

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

Take-up (Starboard) Horizon Camera:

Lens	55 mm f/6.3
Aperture Setting	f/8.0
Exposure Time	1.100 second
Filter Type	Wratten 25

2. Aft Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	300
Main Camera Lens	I223
Supply Horizon Camera Lens	E28516
Take-up Horizon Camera Lens	E23756

b. Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Width	
S_1	0.125"
S_2	0.160"
S_3	0.225"
S_4	0.267"
F/S	0.219"

Filter Types

Primary	Wratten 25 Glass (0.037")
Secondary	Wratten 25 Glass (0.040")

Film Data

Split Load	Eastman Type 3414	15,300 feet
	Eastman Type 3404	1,000 feet
	Total	16,300 feet

Supply (Starboard) Horizon Camera:

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

Take-up (Port) Horizon Camera:

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

3. DISIC Camera

a. Component Assignment

Component	Serial Number
Camera	008
Index Reseau	108
Stellar Reseaus	
Port	12P
Starboard	11

b. Camera Data and Flight Settings

Stellar Cameras:

Lens	3.0 in. f/2.8
Exposure Time	1.5 seconds
Filter Type	None
Film Type	Eastman Type 3401 (2000 ft.)

Index Camera:

Lens	3 in. f/6.3
Exposure Time	1/500 second
Filter Type	Wratten 12
Film Type	Eastman Type 3400 (2200 ft.)

SECTION 2

PRE-FLIGHT SYSTEMS TEST

The CR payload systems are subjected to a sequential series of tests required to demonstrate a satisfactory confidence level in the flightworthiness of the systems. These tests include static verification, dynamic performance, operation in simulated thermal-altitude environment, light leak evaluation and dynamic photographic performance measurements. Significant baseline levels and anomalies experienced on QR-2 during pre-flight testing are as follows:

A. ENVIRONMENTAL TESTING

The QR-2R payload system was tested in the environmental HIVOS chamber in standard configuration from May 6, 1970 through May 13, 1970. Both cameras used a split load consisting of types 3404 and 3414 film, permitting testing the panoramic cameras with both film types. The DISIC camera used film types 3400 and 3401 for the Terrain and Stellar cameras, respectively.

The processing chemistry was revised to Versamat 641 to more closely match the processing used on flight materials. The QR-2R environmental test was the first Corona System test to utilize this revised chemistry.

1. <u>Pan Instruments</u>

   a. Aft Panoramic Camera, S/N 300

   Some start-up corona marking in the 1.6 to 8.0 pressure range, but was found to be within acceptable limits.

   An intermittent scratch of undetermined origin was found throughout the test.

The transition from 3404 to 3414 type of film was accompanied by some film edge damage although the splice appeared to be normal.

b. Forward Panoramic Camera, S/N 301

Some start-up corona marking was evidenced in the 1.0 to 2.3μ range. The marking was confined to the 3414 film solely. All of the corona marking was within acceptable levels, except in one instance, which was waived.

2. <u>DISIC Camera</u>

DISIC Camera S/N 8 which was part of the QR-2 flight configuration did not undergo thermal-altitude testing with the QR-2 payload system. DISIC S/N 8 was environmentally tested in the HIVOS chamber as part of the CR-13 test configuration. Two consecutive HIVOS tests were performed because of panoramic instrument corona marking.

a. <u>HIVOS Test #1</u> (8 April - 15 April 1970)

No anomalous camera operation was noted. Test results showed that the processed Terrain film evidenced some dendritic corona along the film edges, but these were found to be within acceptable levels. The Stellar film showed some corona marking caused by rollers and the reseau grid.

b. <u>HIVOS Test #2</u> (15 April - 20 April 1970)

Again normal camera operation was experienced. Processing results showed the Terrain film to have a flow type of corona along one or both edges. Since the marking exceeded the 10% limit specification, only a small part of the active format was affected, the condition was waived. The Stellar film was marked by dense and extensive corona throughout. This marking was caused by the S.L.P. head being improperly shimmed. This condition was corrected prior to the DISIC camera being installed in the QR-2 flight configuration.

3. Subsystem Performance

a. Command System

b. Exposure Control

c. V/h Programmer

d. Clock

All of the above subsystems operated normally throughout the test.

e. Pressure Make-up

Normal operation occurred, however, the alternate PMU level was greater than the desired 16 microns differential pressure at the instrument "ON" command.

f. Status Telemetry

The temperature sensor and status commutator failed during Rev. 9A and remained inoperative until Rev. 10A. The commutator continued to work for the remainder of the test.

g. SRV Tape Recorder

The -1 SRV tape recorder indicated dual C.F. pulses on most operations slower than 2.0/sec/cycle. The -2 tape recorder system failed to record after the end of track 1 resulting in the loss of data after Rev. 1B.

B. RESOLUTION TEST

A series of resolution tests were conducted with the QR-2R system during July 1970, to verify resolution performance with glass filters and check focal shift with different thicknesses of glass. All tests were with 3414 film.

A final test, using primary flight filters was made on 1 October 1970. Aft looking camera #300, using a 0.037 inch thick Wratten 23A glass filter, produced high and low contrast peak resolution values of 294 and 167 lines per millimeter respectively at the -0.0005 inch focal position (based on a 0.0140 inch vacuum focal shift). Forward looking camera #301, using a 0.037 inch thick Wratten 25 glass filter, produced high and low contrast peak resolution values of 303 and 206 lines per millimeter respectively at the focal position. The through-focus resolution values are shown in Figures 2-1 and 2-2.

PRE-FLIGHT DYNAMIC RESOLUTION

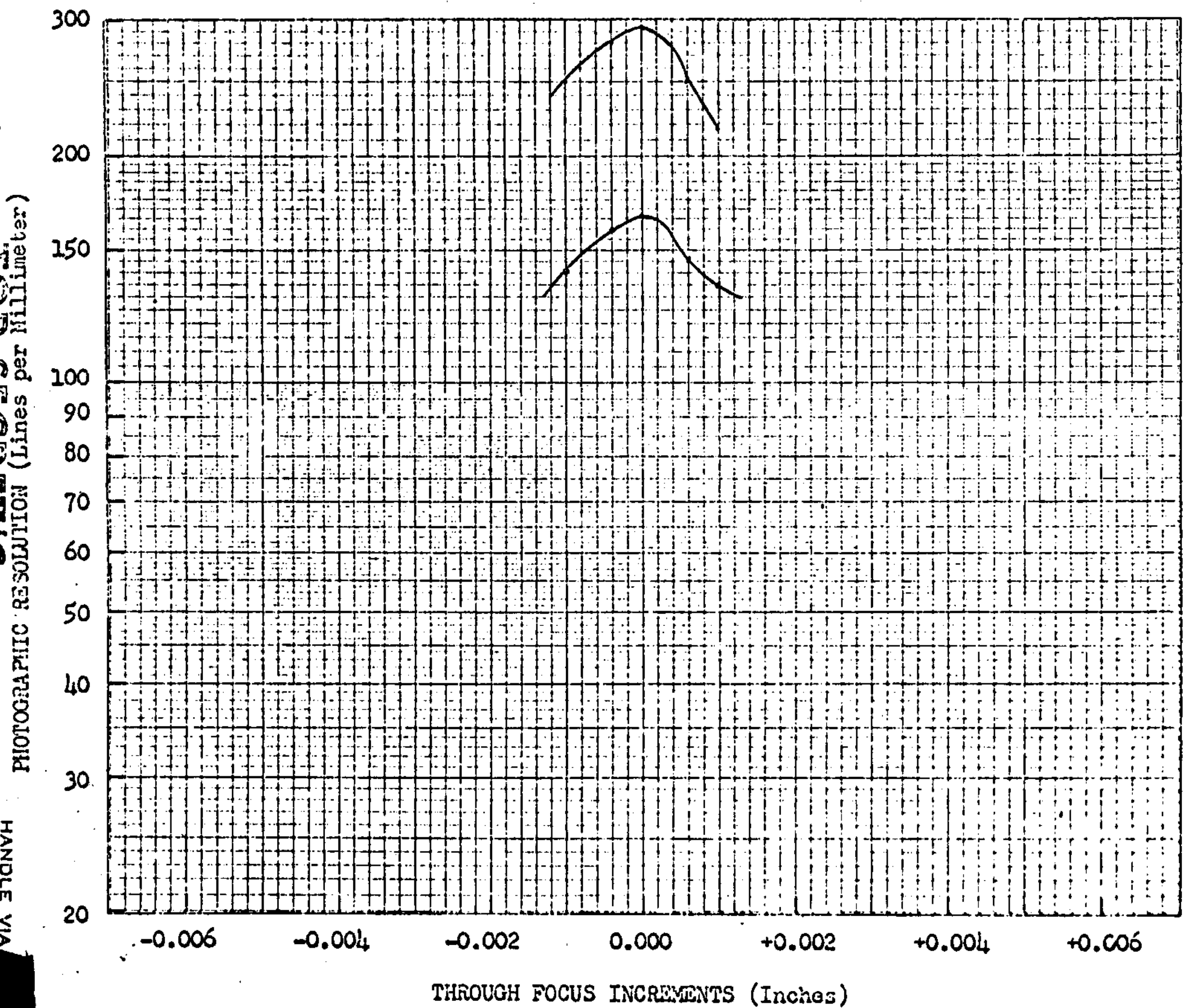


FIG. 2-1

Camera No: 300

Payload No: QR-2

Resolution (1/mm)

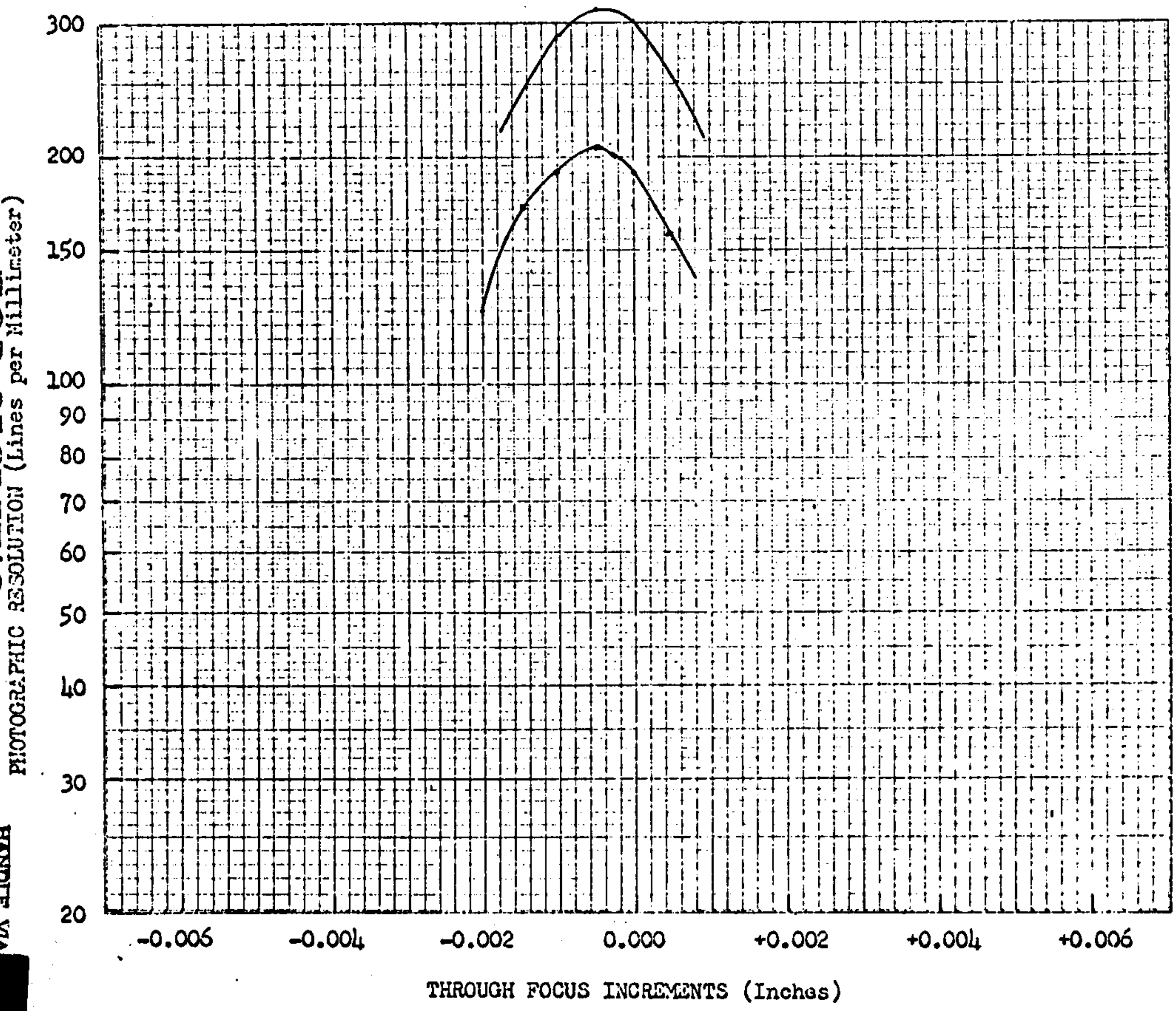
High Contrast: 293

Low Contrast: 167

Film Type: 3414

Test Date: 10-1-70

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 301

Payload No: QR-2

Resolution (1/mm)

High Contrast: 315

Low Contrast: 205

Film Type: 3414

Test Date: 10-1-70

FIG. 2-2

C. LIGHT LEAK TEST

A simulated four orbit light soak was performed on 5 May 1970, using type 3401 film. Very minor low density spots were found on the test films from both cameras in the vicinity of the output horizon cameras. These spots appeared to be caused by internal sources that would represent no problem in flight. Two large areas of medium and high density fog were found on the forward looking camera #301, third frame from end of pass. These major leaks were attributed to the aft looking camera #300 drum and/or boot. Corrective action was deferred until the flight readiness sequence of tests.

The flight readiness photometer search on 9 November 1970, revealed major light leaks in the regions previously noted. The leaks at the camera boot/ skirt interface were eliminated. However, the photometer record showed that significant leakage occurred at the forward camera drum. No corrective action is available for this condition and some flight marking was expected. Additionally, it was noted that light-tightness at the fairing access could not be verified with the available test cover. However, no problem was apparent with the flight cover used in the 5 May 1970 test.

D. FLIGHT READINESS, LOADING AND CERTIFICATION

A series of DISIC Readiness Tests were conducted from 23 to 30 October 1970, on DISIC #8. Some minor anomalies were observed in stellar and terrain binary bit density, but from consultation with the user organization it was concluded that the condition would not be an operational problem. A stellar metering anomaly was indicated by variable format spacing. The condition was corrected by increasing take-up tension from 0.4 pounds to 0.6 pounds. The final DISIC readiness test was conducted on 30 October. Fogging density of the stellar formats was satisfactory . A minus density mark was noted in terrain formats due to a defect in the reseau plate. This condition was accepted by the Customer. DISIC #8 was considered acceptable for flight loading. Film loading of DISIC #8 was performed on 2 November 1970. Technical evaluation of film from both camera units demonstrated acceptable characteristics.

A series of four strobe tests were conducted on the panoramic cameras to establish and verify required exposure slitwidths. A Flight Readiness Test on 31 October 1970, demonstrated acceptable data recording, format fogging, and freedom from mechanical marking. The panoramic camera was loaded on 8 November. Technical evaluation of both films demonstrated acceptable characteristics.

The system was certified for flight on 9 November 1970.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Lift off occurred at 1328:00 PST on 18 November 1970, from Vandenberg Air Force Base pad SLC-3 West. All payload launch, ascent, and injection events occurred as programmed. The orbit achieved was within the 3-sigma predicted dispersions.

Aft looking panoramic camera #300 operated satisfactorily throughout the flight except for one abnormal shutdown on rev three. The film supply was exhausted on rev 298.

Forward looking panoramic camera #301 operated normally throughout the -1 mission. However, a telemetry indication of an out of round takeup spool led to a decision to make the A-to-B transfer about one thousand feet earlier in the film supply than would normally be done. The telemetry indication was due to a gouge in the film base that occurred during revs 5 to 35. The forward camera then failed during the A-to-B transfer operation on rev 104.

The DISIC system operated normally during the -1 mission. The A-to-B transfer was made during rev 107. Immediately thereafter, during a dependent/independent operation, the system failed.

The clock system, command system, instrumentation system, exposure control system, FMC system, pressure make-up (PMU) system, and thermal environment were normal throughout the flight. The tape recorder in the -1 SRV functioned normally, however the recorder in the -2 SRV failed after 13 seconds of operation.

A modified PMU was used for the first time to suppress marking on DISIC independent operations.

Recovery of the -1 SRV was deferred to rev 147 because of weather and to allow time to analyze the pan camera and DISIC failure conditions. Both SRV's were successfully recovered by air catch and all recovery events were normal.

B. ORBITAL PARAMETERS

The following tabulation show actual and predicted values (with 3-sigma tolerances) of principal orbit parameters for rev two.

Parameter	Predicted	Actual
Period (min.)	88.61 (+0.33,-0.34)	88.56
Perigee (naut. mi.)	99.7 (+13, -14)	97.2
Apogee (naut. mi.)	128.2 (+17, -18)	122.6
Eccentricity	0.0043(+0.0029,-0.0030)	0.0036
Inclination (deg.)	83.0 (+0.14, -0.12)	83.00
Regression rate (deg./rev.)	22.28	22.23
Argument of Perigee (deg.)	142 (+102, -88)	191
Perigee location (quad/lat.)	238	311.3

C. DMU OPERATION

Ground track and period control were maintained during the flight by firing seven of the eight available DMU rockets.

The following tabulation summarized the DMU rocket firings:

Rocket No.	Rev No.	System Time Seconds	Period Change Seconds	Velocity Change Ft/Sec.	Period at Firing Minutes	Impulse Lb.-Sec.
1	29	58189	15.36	24.55	88.48	3140
2	70	17044	10.58	17.03	88.54	2140
3	120	25218	14.73	23.61	88.46	2963
4	152	22585	11.28	18.08	88.51	2022
5	204	38499	16.87	26.81	88.44	2973
6	254	45992	17.45	27.87	88.43	3069
7	279	06157	17.21	28.15	88.56	3081
8	Fired after -2 recovery					

The ground track errors at the ascending node ranged from 41.6 naut. mi. west of nominal to 38.6 naut. mi. east of nominal. The seventh DMU rocket was fired to move the ground track west of nominal to acquire a priority target on rev 284. Refer to Figures 3-1 and 3-2 for orbit history data. Figure 3-3 shows the latitude and altitude frequencies of pan camera operation.

D. PANORAMIC CAMERA PERFORMANCE

Aft looking panoramic camera #300 experienced an abnormal shutdown on rev 3. Analysis of telemetry and tape recorder data indicated the camera system lost its internal operate command prematurely, precluding normal shutdown. The camera system coasted without takeup tension which permitted film slack. A film loop was drawn into the input metering roller and pressure roller assembly forming a crease. Tension from the constant tension assembly negator spring and application of the supply cassette brake freed the film from the input metering roller. When power was applied with the next operate command the take-up pulled the slack film out of the system. However the 99/101 clutch shuttle was moved to the end of its travel and required about 20 pan camera cycles to achieve stabilized operation.


ORBIT HISTORY
1112/QR-2
PERIGEE ALTITUDE (NM)
102
100
98
96
94
92
90
PERIGEE LATITUDE (DEG. NORTH)
50
30
10
0
-10
ORBIT REVOLUTION
40
80
120
160
200
240
280
320

Fig. 3-1

QR-2R/1112 ORBIT HISTORY

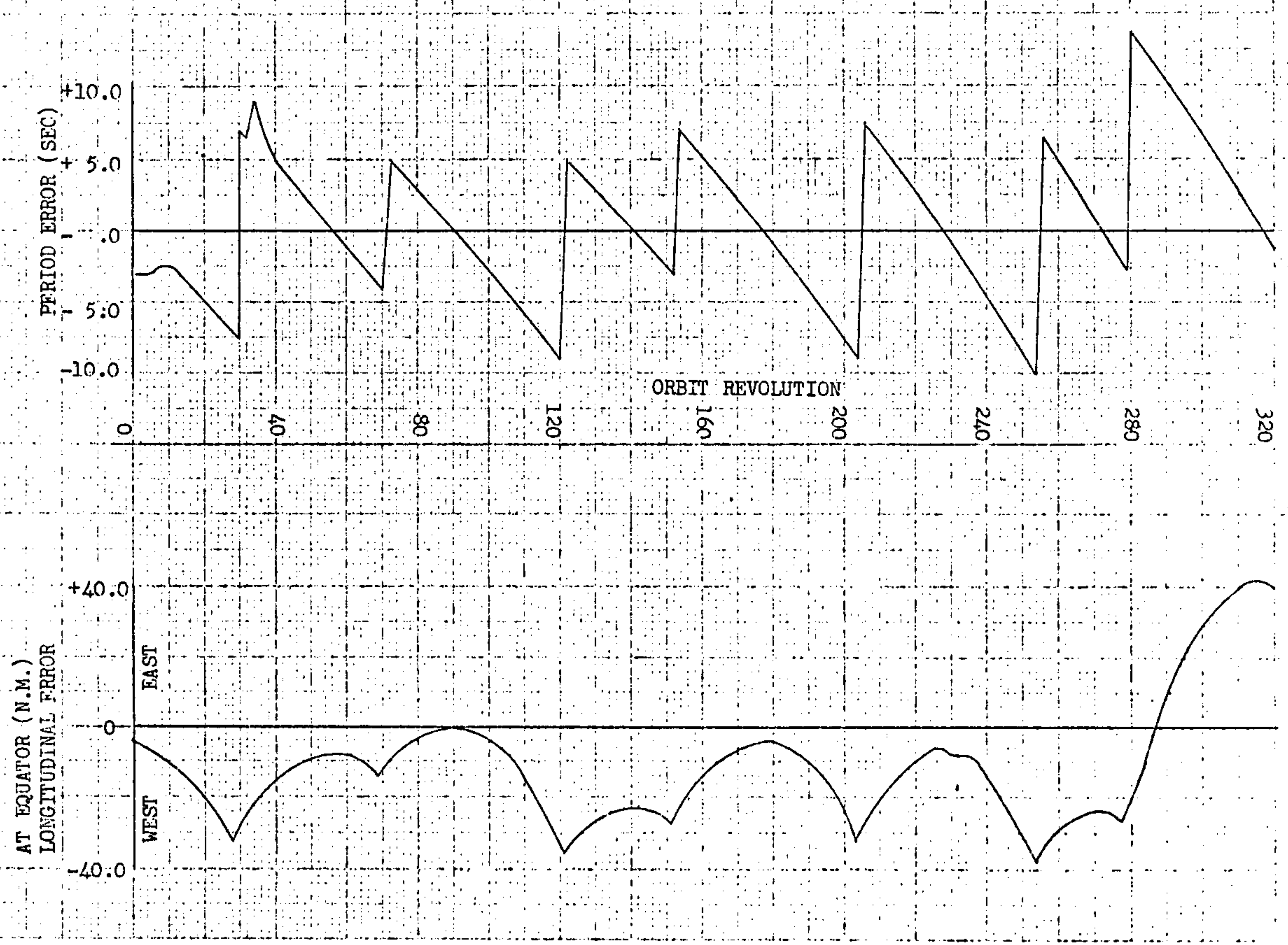


FIG. 3-2

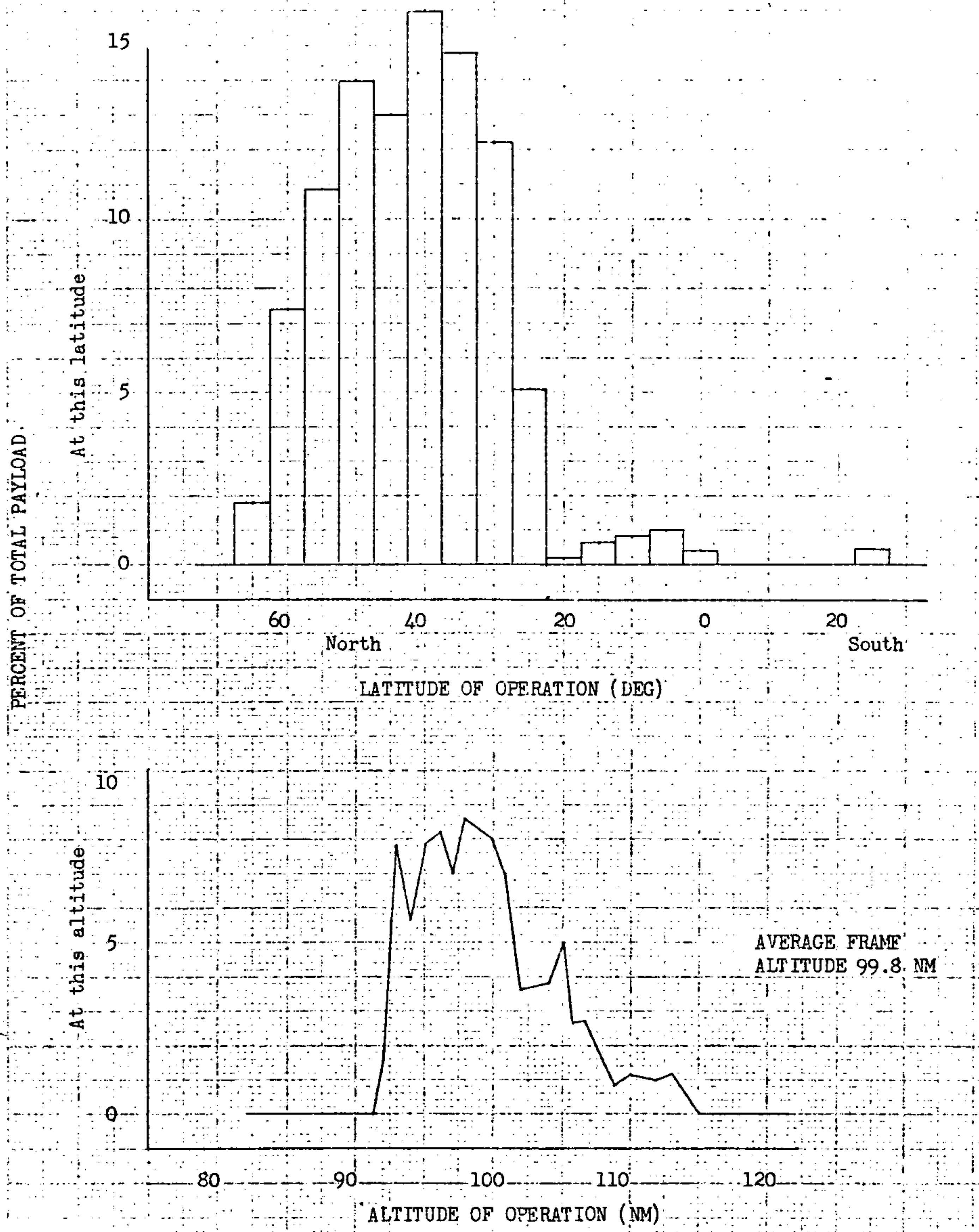

PERCENT OF TOTAL PAYLOAD
At this latitude
15
10
5
0
60
40
20
0
20
North
South
LATITUDE OF OPERATION (DEG)
At this altitude
10
5
0
AVERAGE FRAME
ALTITUDE 99.8 NM
80
90
100
110
120
ALTITUDE OF OPERATION (NM)

FIG. 3-3

The most probable cause of the premature removal of the operate command was a drop out in the twenty second delay power relay. However, the cause of the 20-second timer anomaly could not be determined. Since the malfunction would generally result in catastrophic failure, a modification was performed on all remaining systems (except CR-13) to hold takeup power on for seven seconds after removal of the internal operate command.

Forward looking panoramic camera #301 film footage pot telemetry monitor indicated one hundred to two hundred cycles higher count than the cycle counters from rev 6 to the end of the -1 mission. Post flight de-spooling indicated the film on the takeup was out-of-round and the telemetry monitor was correctly indicating an abnormal film condition. It was this condition that led to recovery of the -1 mission SRV with about 1000 feet less film than usual.

The film on the takeup spool had a ridge parallel to the major axis of the film. This ridge was found to be caused by a gouge in the base. It was about 0.007 inches wide and 0.8 inches from the time track edge. The gouge was preceeded by a 0.1 inch triangular pressure mark at 6.25 inch intervals, indicating a small particle of unknown origin had lodged in the input metering pressure roller. The particle was detached and carried by the film to a narrow opening between a roller and guide resulting in continuous gouging from frame 62 of rev 5, through a manufacturer's splice, and ending on frame 1 of rev 35. Minor base rubs were apparent at about the same distance from the film edge through the remainder of the -1 mission apparently from a reorientation of the particle. Corresponding rubs were not found in the six feet of film recovered from the forward camera in the -2 mission.

Forward looking camera #301 did not stow properly at the end of an operation on rev 6. Real time telemetry data also indicated a perturbation occurred in the constant tension assembly, probably resulting in a slack loop. Analysis of recovered film and the SRV tape recorder telemetry data showed that the center-of-format signals were missing on frames 133, 134, and 135. Frame 134 should have been the normal stow frame. However, due to the loss of center-of-format signal, the camera operated an extra cycle during the 20 second power-off delay period, resulting in the stow and film slack loop anomaly. Another center-of-format signal was missing on frame 17 of rev 7. The missing center-of-format signals also resulted in lost time words, camera serial numbers, slurred time pulses on four frames and a missing horizon optic exposure on one frame. The most likely cause of the center-of-format anomaly was either an intermittent failure of the center-of-format switch or a marginal adjustment of the switch travel.

Forward looking camera #301 experienced a catastrophic failure while metering during the A to B transfer sequence. The flight cut in the 6 feet of film recovered from the -2 mission was normal. Telemetry data indicated the film cut and take-up cinch were normal and camera functions were normal for more than half of the first cycle. A film metering anomaly occurred when the scan head was within 15 degrees of the platen area as revealed by a slow down in the frame metering function, increase in forward drive motor voltage and an increase in unregulated current. Camera drive functions on the input side of the drive mechanism continued while all output functions ceased, indicating a mechanical failure, jamming or sheared pin in the metering drive mechanism. The camera system remained in the stalled condition throughout the -2 mission and all post event 2 testing. The most probable cause of the camera failure is a mechanical failure, binding, or jamming of the gear train or star wheel drive mechanism by an object of unknown origin.

E. DISIC PERFORMANCE

The terrain camera was loaded with 2200 feet of type 3400 film and the stellar camera was loaded with 2000 feet of type 3401 film. The DISIC unit performed normally throughout the -1 mission.

The DISIC camera system operated during the panoramic camera A to B transfer sequence through a sneak circuit in the pressure make-up (PMU) control circuitry. This condition resulted in four frames of unprogrammed index and accompanying stellar photography. The sneak circuit was erroneously added when modifying the transfer and command boxes for PMU operation with the DISIC camera independent mode operation.

The DISIC camera system operated properly during the engineering pass on rev 106. The DISIC camera A to B transfer sequence was performed on rev 107 with all transfer functions occurring properly. However, on rev 108, only 33 cycles were registered on the terrain cycle counter instead of the programmed 71 cycles. The DISIC camera was stalled in the metering portion of the cycle. The DISIC camera was turned on in the independent mode three times during the -2 mission, however, the camera system failed to operate. Post flight material analysis indicated no flight terrain material was present and only 28 frames of stellar material. The most probable cause of the DISIC camera failure was the loss of the -2 mission terrain take-up. The flight take-up was tested at Fairchild for thermal altitude testing resulting in a failure after four minutes of operation.

F. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

The instrumentation system performed satisfactorily throughout the flight. The panoramic camera #301 filter change selector appeared as an open T/M point during the engineering operation on rev 307. This condition lasted for approximately 20 seconds and then for the remainder of the pass the selector indicated position 4 instead of position 3. On rev 309, the selector varied between position 3 to position 5 and remained in position 4. Nine RTC commands were issued to correct the selector to position 3. However, the selector stopped in position 10 and remained there thru fade. On rev 311, the selector monitor again appeared as an open T/M point. Two commands were issued and the selector indicated position 2. No other commanding was attempted.

The camera system had failed with the scan head approximately 25 degrees prior to the center-of-format. The physical condition of the scan head, film through the platen area, and the filter selection components are unknown. However, the slit width telemetry monitor also changed slightly on rev 307 indicating that the scan head suffered damage, probably by a film obstruction from the failure of the panoramic camera. It is therefore assumed that the filter change anomaly resulted from the camera failure and was not a separate failure.

The ascent pyro current sensor was inoperative due to an unknown cause. All remaining systems have been verified to be in proper operating condition. Circuit analysis of QR-2R indicates no wiring discrepancies. It is therefore postulated that the most probable cause was a failure of the sensor mechanism.

The real time command (RTC) system operation was satisfactory throughout the flight.

G. FORWARD MOTION COMPENSATION PERFORMANCE

A large perigee dispersion at launch produced a mismatch error between three and six percent during the first five revs. However, a satisfactory ramp to orbit match was maintained throughout the remainder of the flight. The mismatch error was within plus or minus one percent for 88.4 percent of the operations during the -1 mission and within the same limits for 89.6 percent of the operations in the -2 mission.

H. EXPOSURE CONTROL SYSTEM PERFORMANCE

This slit width control programmer was the first to utilize the new Autronic timers. Approximately 90% of all the camera operations were in the automatic mode. The slit width control programmer performed satisfactorily throughout the -1 and -2 missions.

I. CLOCK SYSTEM PERFORMANCE

The clock system performance was normal throughout the flight and resulted in satisfactory clock/system time correlation. The correlation equation and constants are as follows:

<u>First Order Fit</u>

System Time = $A_0 + A_1$ (Clock Time)

A_0 = -0.1433609439203687 D 06

A_1 = 0.9999998356734852 D 00

Sigma = 0.00458252

Number of Points = 372

Second Order Fit

System Time = $A_0 + A_1$ (Clock Time) + A_2 (Clock Time)^2

A_0 = -0.1433609597502632 D 06

A_1 = 0.9999998783187686 D 00

A_2 = -0.2180828742766736 D -13

Sigma = 0.00068056

Number of Points = 372

J. PMU SYSTEM OPERATION

The pressure make-up system (PMU) operated properly throughout the flight. The PMU was modified to operate in the low pressure range when the DISIC was operated in the independent mode. There were 116 panoramic camera operates for a total of 213 minutes which resulted in a gas consumption rate of 4.18 lbs/min of operate time. There were 352 DISIC camera operates for a total of 851 minutes for an alternate level gas consumption rate of 1.12 lbs/min of operate time. The large amount of DISIC operate time was due to the command logic (S324-DISIC Independent) and the sneak circuit in the PMU control unit which allowed the PMU to operate with every SPC Brush 48 from rev 241 through rev 307.

K. THERMAL ENVIRONMENT

The temperature data obtained during this flight indicated the temperature environment was within the pre-flight predictions for the duration of the flight. The averages of the panoramic camera temperatures ranged from 58°F to 62°F for S/N 300 and 59°F to 64°F for S/N 301 during the -1 mission and 58°F to 63°F for S/N 300 and 58°F to 62°F for S/N 301 during the -2 mission. Refer to Figure 3-4.

QR-2 FLIGHT VS. PREDICTED
TEMPERATURE

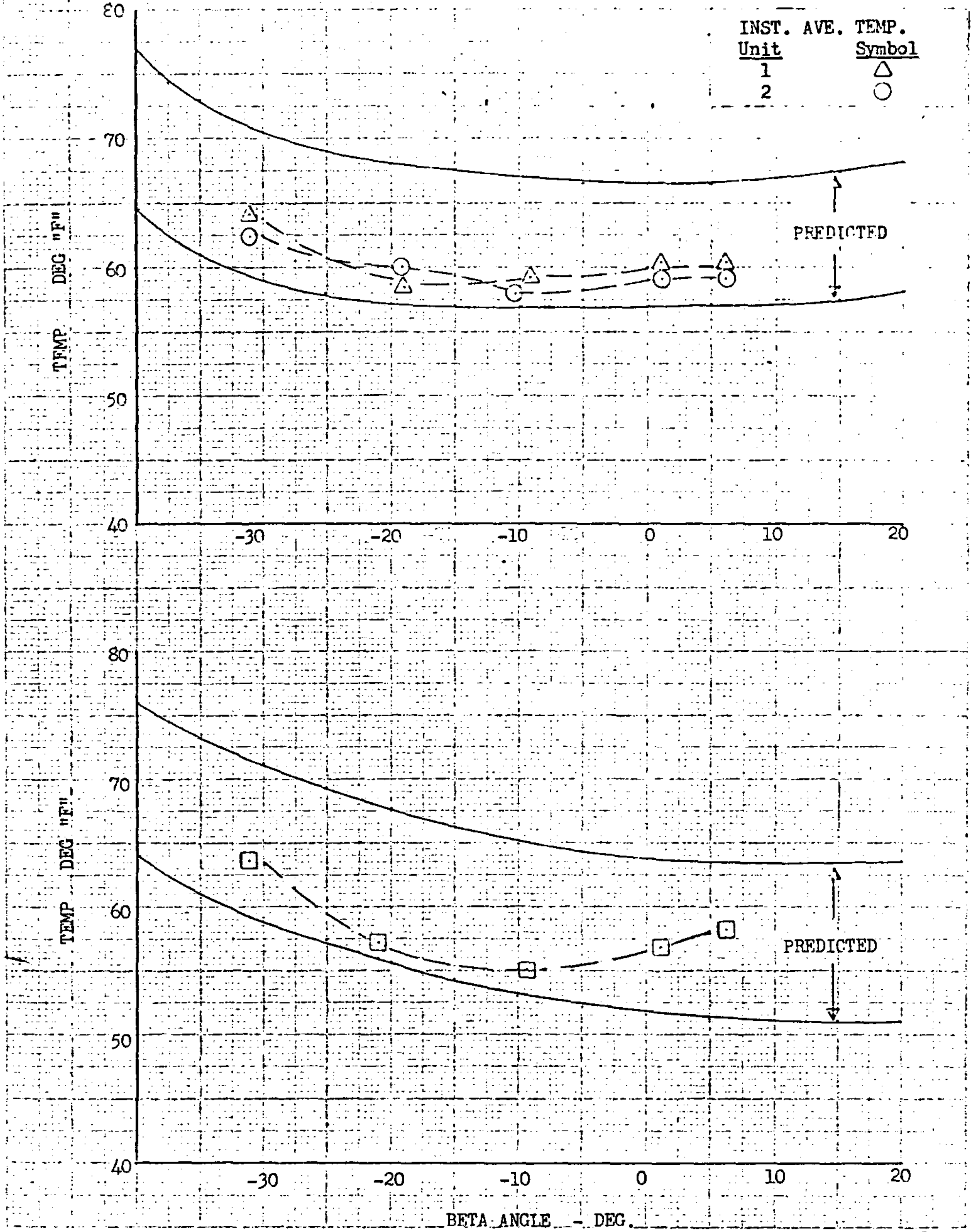


FIG. 3-4

L. RECOVERY SYSTEM PERFORMANCE

The -1 recovery capsule was successfully recovered by air catch on rev 147 at 1509 PST on November 27, 1970. All re-entry events were within tolerance with the impact approximately 17 miles north of the predicted.

	Actual	Predicted
Impact Location	18° 10'N/153° 45W	18° 0.1'N/153° 52.5W

The -2 recovery capsule was successfully recovered by air catch on rev 309 at 1424 PST on December 7, 1970. All re-entry events were within tolerance with the impact occurring approximately 20 miles north of the predicted.

	Actual	Predicted
Impact Location	29° 15'N/164° 59'W	28° 59'N/165° 12'W

M. SRV TAPE RECORDER SYSTEM

The SRV tape recorder for the -1 mission operated normally recording 109 minutes of data. The SRV tape recorder for the -2 mission failed after 13 seconds of the first instrument operation. Post flight ground tests revealed the recorder would not operate in the record mode on the initial test. The reverse mode of operation performed satisfactorily. Several subsequent forward playbacks functioned normally. The recorder then failed at or near the forward playback start position. The recorder was then sent to the vendor and investigation revealed that the iso-drive belt was broken causing loss of tension. The break apparently was caused from a puncture by a sharp object. Manufacturer disassembly revealed loose flakes of glyptol. A glyptol chip apparently lodged between the iso-belt drive and the transport case jamming the transport mechanism. The drive belt was apparently torn through during the operations performed after recovery.

N. POST EVENT 2 TESTING

Both panoramic cameras were enabled on rev 328 in the emergency mode. The film tag end on aft camera # 300 had wrapped up during film exhaustion on rev 298, causing the camera system to remain in a stalled condition. Forward panoramic camera # 301 had failed on rev 104 and had remained in a stalled condition. Telemetry data indicated that the drive motors on both cameras had 18 volts on the plus side of the motor and 3½ volts on the minus side of the motor, 20 amps on the A/P unregulated current monitor. On rev 329, approximately 69 minutes later, the voltage on the minus side of the motor was reduced to almost zero volts, probably due to heating and resistance change.

At fade on rev 330 at the [redacted] Tracking Station, approximately 148 minutes since turn on, the telemetry monitors remained unchanged. Approximately 5 minutes later at the [redacted] Tracking Station acquisition, both instruments indicated 18 volts on both sides of the motor. This condition indicates that there is no current through the motor with increased resistance between the minus side of the motor and ground. This could have been caused by the failure of forward drive transistor. During the first 24 seconds of the acquisition, the voltage on both sides of the motor on camera #301 decreased to zero volts. The most probable cause of this anomaly was a failure and opening of complementary drive transistor. The A/P unregulated current during this time period decreased from 20.0 to 7.5 amps. Telemetry data remained unchanged through the last recorded rev (rev 352).

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

The quality of the photography produced by both panoramic cameras was the best of the entire Corona program. Although an MIP number of 115 was assigned to both mission segments, the image quality produced by both cameras was superior to that produced by the forward-looking camera of Mission 1104, the only previous unit to produce a rating of 115. The MIP frame of Mission 1112-1 was rev D-16, Aft frame 17, and of Mission 1112-2, it was rev D-242, Aft frame 12.

The DISIC camera produced very good stellar and terrain photography throughout the 1112-1 mission, but failed to take up film during the 1112-2 mission.

The following flight film was recovered from the QR-2R system:

Mission	Camera	Film	Footage	Frames
1112-1	Forward Pan	3414	7155	2715
	Leader		492	
	Aft Pan	3414	7254	2754
		3404	214	81
	Leader	3414	484	---
	Stellar	3401	726	2434 Stbd.
				2430 Port
	Leader	3401	19	
	Terrain	3400	1028	2441
	Leader	3400	44	---
1112-2	Forward Pan	3414	6	3
	Aft Pan	3404	785	298
		3414	7473	2836
	Stellar	3401	7	23 Stbd.
				25 Port
	Terrain	3400	0	0

B. PANORAMIC CAMERAS

1. Image Quality

Both the peak image quality and the overall image quality of Mission 1112 were the best thus far acquired in the Corona Program. Imagery from both pan cameras consistently retains its sharpness when magnified fifty times. The outstanding quality achieved is attributed to several factors in addition to the high peak resolution of the third generation lenses. These factors are listed in the order of probable significance.

1) Dynamic stability of the camera-film system.

2) Improved focus setting.

3) Use of glass filters.

4) Quality of 3414 film.

Although the photographic performance of both pan cameras is judged to be excellent, the photographic interpretation suitability was judged by user interpreters (of Priority One targets) to range from "poor" to "good", with the largest portion falling in the "fair" category. This inconsistency between quality and suitability was examined by the Performance Evaluation Team and was found to be rather directly related to two factors: stereo coverage and scale.

A comparison of the suitability ratings of the 1112-1 and 1112-2 mission segments showed a significant reduction in good ratings for the latter segment - 10 percent versus 4 percent. This change is consistent with the loss of stereo coverage because of failure of the forward-looking instrument at the end of the 1112-1 mission.

The significance of scale (inversely proportional to altitude) was considered through an examination of the interpretation suitability ratings of all past J-3 missions. It was found that the average of "good" suitability ratings for missions with perigee lower than 90 nautical miles was 20 percent, while the corresponding average for missions with higher perigee heights was 9.5 percent. Additionally, the four lowest perigee missions had the four highest percentages of "good" interpretor ratings for an average of 23 percent. It was clear that at least for the Corona system, a direct relationship exists between scale and photo interpretation suitability.

A problem that had been anticipated, low scene luminance, did not result in significant image degradation. The time of year that this mission was flown is associated with the lowest scene luminances that are encountered in the usual target areas. With the sun at near maximum south declination, the maximum solar elevations in target areas are near their annual minimums, yet these areas generally have not received enough snow to significantly increase the scene luminances. It is therefore necessary to increase exposure times and accept increased image smear. Fortunately, snow coverage predictions indicated that the most northerly targets (lowest solar elevations) generally were snow covered and maximum exposure was not required. Examination of both original negatives and duplicate positive indicates that coverage from both cameras was remarkably free of detectable smear. The shorter exposure times of the aft-looking cameras with Wratten 23A filters (compared to the forward looking camera with Wratten 25 filters) is probably a factor in the MIP frames being selected from the aft camera film.

The stability of the film in the focal plane as it was exposed appears to have been exceptionally good. There are small areas along the rail edges, particularly the serial edge near the start of scan, that are detectably out of focus. However, both cameras show a consistency of good focus unmatched by previous systems.

Controlled Range Network (CORN) targets at five sites were acquired on two operations during the 1112-1 mission. No CORN targets were acquired on Mission 1112-2. Original negative ground resolution values were read with particular care because of the focal position tests described in following paragraphs. The 8.4 foot average ground resolution is equivalent to better than 125 lines per millimeter at the film for the average altitude of over 101 nautical miles. At the same time the original negative resolution targets were read, the corresponding targets on duplicate prints were also read. Both sets of data are summarized in Table 4-1, Visual Evaluation of Bar Target Imagery. It is apparent that in going to the prints (which are used by photo interpreters) there was a 17 percent loss in resolution. This loss is a factor in the variance between image quality and interpretation suitability mentioned earlier. It is probable that the percentage loss in resolution is greater with the higher resolution original negatives of this mission. However, there are other image quality factors that would limit any direct comparison.

2. <u>Focal Position Tests</u>

A special test for optimum focus adjustment was conducted by use of glass filters of different thicknesses which cause small shifts in the focal position. The primary filters were 0.037 inch thick glass.

Alternate filters providing the same filtration as the primary filters in each camera were 0.040 inch thick. The 0.003 inch increase in filter thickness caused a 0.001 inch increase in focal position. In order to

TABLE 4-1 VISUAL EVALUATION OF BAR TARGET IMAGERY

Rev/Frame	Geographic Location	Target type, contrast / Camera filter position		Ground Resolution (feet) Original Negative Forward FMC				Duplicate Positive Forward FMC			
				Original Negative				Duplicate Positive			
				Forward		Aft		Forward		Aft	
				FMC	SCAN	FMC	SCAN	FMC	SCAN	FMC	SCAN
16D 003	Edwards AFB, Ca.	B-1, 4:1	P	7.6	9.9			9.7	11.3		
16D 009			P			7.7	9.6			9.2	10.8
16D 003		B-2, 11:1	P	8.0	10.9			8.8	11.3		
16D 009			P			6.8	8.6			8.7	7.5
16D 012	Aguanga, Ca.	51/51 T-Bar, 5:1	A	8.5	8.7			10.0	10.7		
16D 018			A			6.5	9.9			11.4	11.7
16D 012		Vernier, 5:1	A	7.3	7.5			8.1	8.5		
16D 018			A			8.6	9.3			9.3	9.7
48D 006	Safford, Az.	51/51 T-Bar, 5:1	P	6.2	6.1			10.0	7.7		
48D 012			P			8.8	9.2			10.2	10.6
48D 016		Vernier, 5:1	P	7.0	7.1			7.5	8.5		
48D 012			P			7.2	7.0			8.2	7.7
48D 014	Ft. Huachuca, Az.	Leg B, 1.3:1	A	7.1	8.2			7.9	8.2		
48D 020			A			8.5	10.5			10.7	13.2
48D 014		Leg C, 15:1	A	7.3	8.8			8.5	10.0		
48D 020			A			6.9	10.3			8.1	11.5
48D 015	Douglas, Bisbee, Az.	51/51 T-Bar, 5:1	A	6.9	10.3			12.0	11.4		
48D 021			A			9.3	12.6			12.0	10.3
	Average component ground resolution			7.32	8.61	7.81	9.67	9.17	9.73	9.76	10.33
	Average camera resolution			7.96		8.74		9.45		10.05	
	Average system resolution			8.35				9.75			

compare the performance as directly as possible, mobile resolution targets were arranged in pairs for use on two domestic passes. Each pair of targets was sufficiently separated in latitude to allow a filter change, with corresponding focal length shift, during a single photographic operation. The tests were conducted on revs 16 and 48. A third filter change was made on rev 79 without ground resolution targets. No analysis of this rev was attempted because of complete cloud cover. Test results on revs 16 and 48 were inconclusive. The data in Table 4-1 shows no systematic variation that can be attributed to the focal length shift. Note that there was also a mobile target array at Lucerne Valley, Ca., which included both the 51-51 T-Bar and Vernier arrays. (Forward frame 6 and aft frame 12 of rev D-16). Original negative material was not available for this target reading but duplicate positive material (third generation) is comparable to the other targets listed in Table 4-1. Both from examination of the various target arrays and from detailed examination of cultural imagery, it is not possible to reach an unequivocal conclusion about the better focal position. The subjective analysis does suggest that the primary filter position may provide slightly better results.

A very slight change in camera performance is consistent with preflight test results. The primary filters provided a focal position that was very slightly on the minus side (about -0.0002 to -0.0004 inches) of the peak focal positions of the lenses. The alternate filters increased these focal positions by about 0.001 inch, shifting the positions to the opposite sides of the thru-focus curves with only small changes in the resolution levels.

3. Data Recording

The forward and aft looking cameras produced complete and normal auxiliary data throughout the recovered photography, except for two instances. Imagery of the PG rail holes, scan lines, 200 cycle time marks, slur pulses, camera serial numbers, time words, start of pass marks and horizon fiducial marks were present and acceptable. One instance of missing data was associated with a shut down anomaly of the forward looking camera on rev D-06. The other instance was associated with a different kind of shut down anomaly of the aft looking camera on rev D-03. These anomalies are summarized in the following paragraphs.

4. Anomalies

On the forward camera film, a 0.1 inch triangular plus density mark was present at 6.25 inch intervals beginning on frame 26of rev D-04 and continuing through frame 61 of rev D-05. In frame 62, 6.25 inches from the last plus density mark, a gouge in the film base started and continued to frame 1 of rev 35. The gouge affected 907 frames comprising a distance of about 2400 feet. After the gouge ended, minor base rubs were detected at the same location to the end of the -1 mission. No rubbing or marking was detected on the approximately 70 inches of forward camera film recovered from the -2 SRV. The gouge caused a bulge in the take-up roll which necessitated an early recovery of the -1 mission. An analysis of this anomaly is given in Section 3D, Panoramic Camera Performance.

On the forward camera film a related group of anomalies affected the last three frames (133-135) of rev D-06. These three frames had no time word, no camera serial number, and no center-of-format slur pulse time mark. The horizon images that should have been exposed on frame 134 were missing. Frames 134 and 135 were both creep frames. A separate but probably related anomaly was the missing center-of-format switch functions on frame 17 of rev 7. These anomalies were most likely caused by either a defective center-of-format switch with an intermittent failure mode or a marginal adjustment of the switch travel.

The forward camera film had a back-to-back crease perpendicular to the major axis on frame 114 of rev D-05. Investigation of the film and telemetry records did not indicate a system anomaly. The location of the crease with respect to the end-of-pass mark placed it in the output shuttle assembly at shutdown. The rollers and subassemblies in this area do not provide a reasonable source for this anomaly. The tape recorder data for the period of time that this section passed through the system did not show any anomalies. It was concluded that the crease probably occurred during post flight handling.

The forward camera experienced a catastrophic failure during A to B transfer. This condition is described and analyzed in Section 3D, Panoramic Camera Performance.

The aft camera had the following related anomalies on the last frame of rev D-03 and the first frame of D-04: smeared output horizon fiducials; horizon format superimposed on frame one; emulsion digs along both edges of the film; frame 21 (last of D-03) was one inch longer than normal; there is dense fog near the center of frame 21 due to an open capping shutter at lens stow; and finally, frame 1 contains a sharp emulsion to emulsion crease perpendicular to the major axis. These conditions occurred from an abnormal loss of power on shut-down which would generally result in catastrophic failure. Analysis and disposition of this problem is given in Section 3D, Panoramic Camera Performance.

A 2.5 inch crease parallel to the major axis of the aft camera film is present on frame 1 of pass D-103. The creasing was barely detectable. There was no physical damage associated with this crease and an obvious system failure could not be found. Tape recorder data indicated normal system operation. The characteristics of this crease indicate that it probably occurred during post mission handling.

Two groups of light leak fog patterns were found on both pan camera films. One group, on the ninth and seventh frames from the end of an operate of the forward and aft cameras respectively, was caused by light leakage at the fairing access door.. As noted in Section 2, this location could not be verified in final photometer checks, but did not leak in the live film test. A second group of light leaks was indicated by fog patterns and equipment shadows on formats close to the cameras during sit periods. These marks were caused by leakage at the camera drums. This condition was detected in preflight test but no corrective action was available. All light leak fog was judged by users to be minor.

Random intermittent plus density spots are present on most frames of the aft camera from pass D-147 (recovery rev) to the end of the mission. These spots are similar to those noted on Missions 1110-2 and 1111-2 and generally appear on the last eight inches of the supply end of the frame. The size of the spots vary, with the largest approximately five then thousandths of an inch. Action concerning this anomaly is under continuing investigation.

C. HORIZON CAMERAS

Both horizon cameras on each of the panoramic cameras functioned normally throughout the recovered film.

D. DISIC STELLAR/TERRAIN CAMERAS

1. <u>Stellar Cameras</u>

The stellar cameras functioned properly until the DISIC failure on rev 107. Only 83.75 inches of stellar film was recovered from the 1112-2 SRV. Point-type stellar images were recorded by each camera. Approximately 25 star images were on port formats, and 5 to 10 star images were on starboard formats. The stellar film was relatively free of corona and other degrading marks.

Some difficulty was encountered by NPIC personnel in reading the binary time words when the 19th bit was off. Apparently, an extremely faint repeatitive mark was read by the automatic reader as an "ON" condition. Examination of both the original negative and the print used on the reader demonstrated that the condition was well within Mil-Standard 782-C requirements. NPIC personnel concurred that so far as the DISIC system is concerned, no corrective action was indicated.

The stellar film was relatively free of degrading corona or electrostatic marking.

2. <u>Terrain Camera</u>

The terrain camera functioned properly until the DISIC failure on rev 107. No terrain film was recovered from the Mission 1112-2 SRV.

Corona and dendritic static marking was present continuously from rev 37 to the beginning of rev 48. There was no such marking either before an after this segment. The dendritic marking appeared to be characteristic of retrieval handling and some minor electrostatic discharge was reported at that time. The corona type marking however appeared to be of a type that would have occurred on orbit. This may have been due to slight rubbing caused by lack of adequate take-up tension. Lack of such tension appeared to be cause of ultimate failure.

Adequate photographic exposure had been a matter of particular concern. This terrain unit had an f6.3 lens with a 1/500th second shutter exposure. Although some previous DISIC terrain units had this smaller aperture and shorter exposure time, two factors made the situation more critical. First, the seasonal conditions of the launch date provided about the lowest scene luminances of the entire year. Second, although previous units used only a nominal 1/500th second exposure time, the effective exposure times had been about 1/325th second. The present flight unit had an effective exposure time of 1/500th second. These two factors combined to create the possibility of serious underexposure for northern targets without snow cover. The processing facility was alerted to the potential problem to assure that it would not be aggravated by processing tolerances.

Examination of the processed film showed that while there was frequent underexposure at solar elevations under 10 degrees, there was no place where image density was as low as the base fog level of the film. It was concluded that the single exposure level used was adequate for program objectives.

It was found that there was also extensive overexposure. Because of the conditions noted above, this was a surprise. It was found that all of the serious overexposure was due to extensive cloud cover on DISIC independent operations over equatorial regions (i.e., high solar elevations). For this condition, no corrective action is possible. The dual gamma chemistry used to process the terrain film provides the best known accommodation of these extreme luninance conditions.

SECTION 5

PANORAMIC EXPOSURE

A. INTRODUCTION

Panoramic camera exposure is determined by the scan rate, slit width, filter, and scene luminance. Scan rate is adjusted continuously in flight to compensate for forward motion. The patterns of adjustment depend on orbit geometry. Primary and alternate filters are installed before the flight. Four fixed slit widths plus a failsafe slit width are also established in each camera before the flight. The four slit widths may be operated by a preflight adjusted automatic sequence control, or fixed on command in flight. Although scene luminance is a complex variable, criteria based on time of year and/or presence or absence of snow are used to provide exposure values as functions of solar elevation.

Depending on the particular operational and photographic requirements of the mission, orbits, launch date and time, and film and filters are selected. From these data, slit widths and automatic sequencing relationships are established to provide the most nearly optimum exposure that can be predicted.

B. SPECIAL OBJECTIVES

1. Focal Position Tests

While not directly an exposure requirement, the use of single filter types of different thicknesses on each camera limited the amount of exposure control available. The Wratten 25 filters on the forward looking camera, combined with the low seasonal luminances resulted in the lowest amounts of luminous energy ever available at the film for normal target coverage. This condition was substantially compensated by the increased speed of 3414 film used for most of the mission, when compared with the 3404 film previously used.

2. Plus Density Spot Reduction

The random and intermittent groups of plus density spots detected on recent missions with 3414 film occur less detectably on 3404 film. Since the frequency and severity of these spots appears to be greater after the "A" SRV recovery, the insertion of a 1000 foot segment of 3404 film at the corresponding location in the supply roll was directed to reduce the degradations. The use of the 3404 film aggravated the exposure problems noted in the preceding paragraph. However, it was also directed by the customer that no special exposure compensation would be required for the 3404 film. The postflight exposure analysis demonstrates that, as anticipated, there was underexposure of 3404 film judged to be serious but not catastrophic.

3. Change of Density Data Source

The systematic sampling of density data from panoramic camera original negative material has been performed throughout the Corona "J" Program by the Air Force Special Projects Production Facility (AFSPPF) at Westover Air Force Base, Massachusetts. Because of other commitments, this service for the Corona Program is terminated with this mission.

As a possible substitute, the printing density data routinely collected by [redacted] has been analyzed in parallel with the AFSPPF data for Mission 1112. While there are some differences between these two data sets that are not understood, it appears that the [redacted] data will be sufficient for present program exposure control requirements.

C. OPERATIONAL EXPOSURE

The preliminary analysis of exposure requirements showed that exposure patterns would have only minor changes through a twenty day mission. Almost all of the changes in the required exposure patterns would occur in the first few days of the mission. This stability of the patterns, combined with availability for the first time of longer exposure control timer intervals, permitted the use of new techniques in system exposure control.

Rather than establish exposure control sequences based on a single seasonal criterion including the combined average of snow and no-snow conditions, separate criteria for each of these conditions were used. The automatic timing steps were related primarily to the no-snow conditions which were expected to predominate. The increased variable timer interval (800 second from 400 seconds) permitted at least one slit change to be made with snow conditions if desired. However, the predominant mode for snow conditions was planned to be fixed slits.

Examination of exposure conditions with 3404 film (one-half stop slower than 3414 film) indicated that significant underexposure would occur at the more northern latitudes. The condition was more serious with the forward looking camera equipped with Wratten 25 filters. Because of the forward camera failure, no 3404 film was recovered from that camera. The 3404 film from the aft camera did contain the lowest terrain minimum densities of the mission acquired with that camera.

In making slit transitions, the amount of acceptable underexposure was treated more conservatively than on previous missions. Although the 3414 film has fully one-half stop more photographic speed than 3404 film, the amount of exposure at peak film resolution is about the same for the two films. When possible, the amount of underexposure indicated by the appropriate snow or no-snow criterion was held to about two tenths of a stop (or EV number).

The exposure conditions for Mission 1112 are summarized in Figures 5-1 through 5-4. Figure 5-1 illustrates forward looking camera exposure for the total time it operated on Mission 1112-1. Figure 5-2 illustrates aft looking camera exposure of 3414 film on Mission 1112-1. Figure 5-3 summarizes aft camera exposure of 3404 film on both mission segments. Figure 5-4 summarizes aft looking camera exposure of 3414 film on Mission 1112-2. Comparison of Figures 5-2 and 5-4 indicates the very small change of exposure conditions throughout the entire mission. The data on all five figures is based on actual orbit parameters and measured slit values.

In comparing photographic performance among missions, it is useful to summarize the frequencies of various solar elevations and azimuths. These data are in Tables 5-1 and 5-2.

D. PROCESS CONTROL

All of the recovered Mission 1112 flight films were processed to program standard values. The panoramic camera film and the terrain camera film received single-level dual-gamma processes. The stellar film received a single level viscous process of conventional characteristics.

The sensitometric characteristics of film from each flight roll are evaluated prior to arrival of the exposed mission film at the processing facility. Processing conditions are adjusted if necessary, to attain maximum photographic speed with reasonable fog for the particular batch of film involved. The mission film is then processed under the adjusted conditions with additional flight roll sensitometric strips attached to the head of the mission film. Sensitometric curves

FIGURE 5-1 , EXPOSURE PROFILE, Mission 1112, Payload QR-2R

Forward - Looking Camera #301 , Pass # 88

Launched 18 November 1970

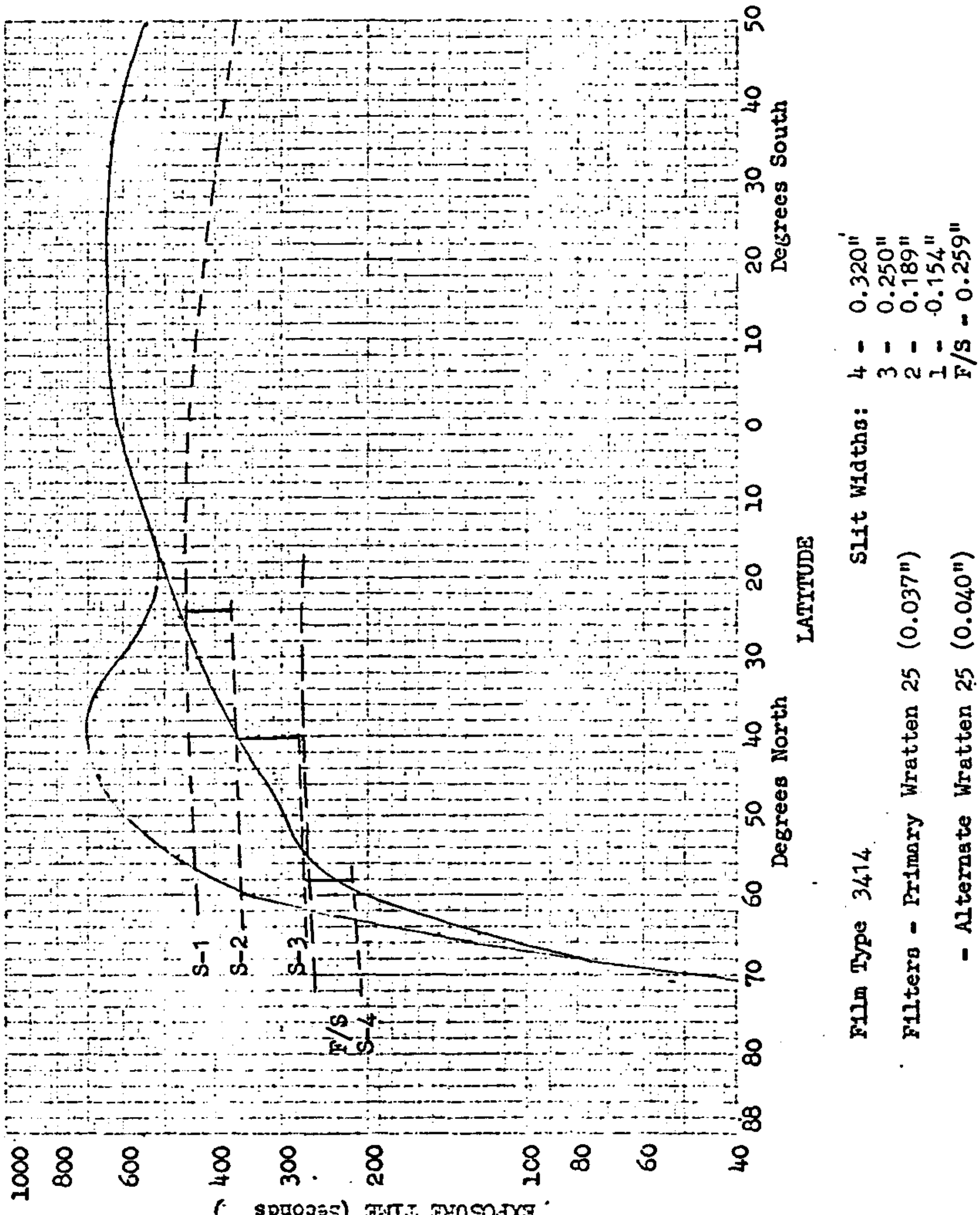
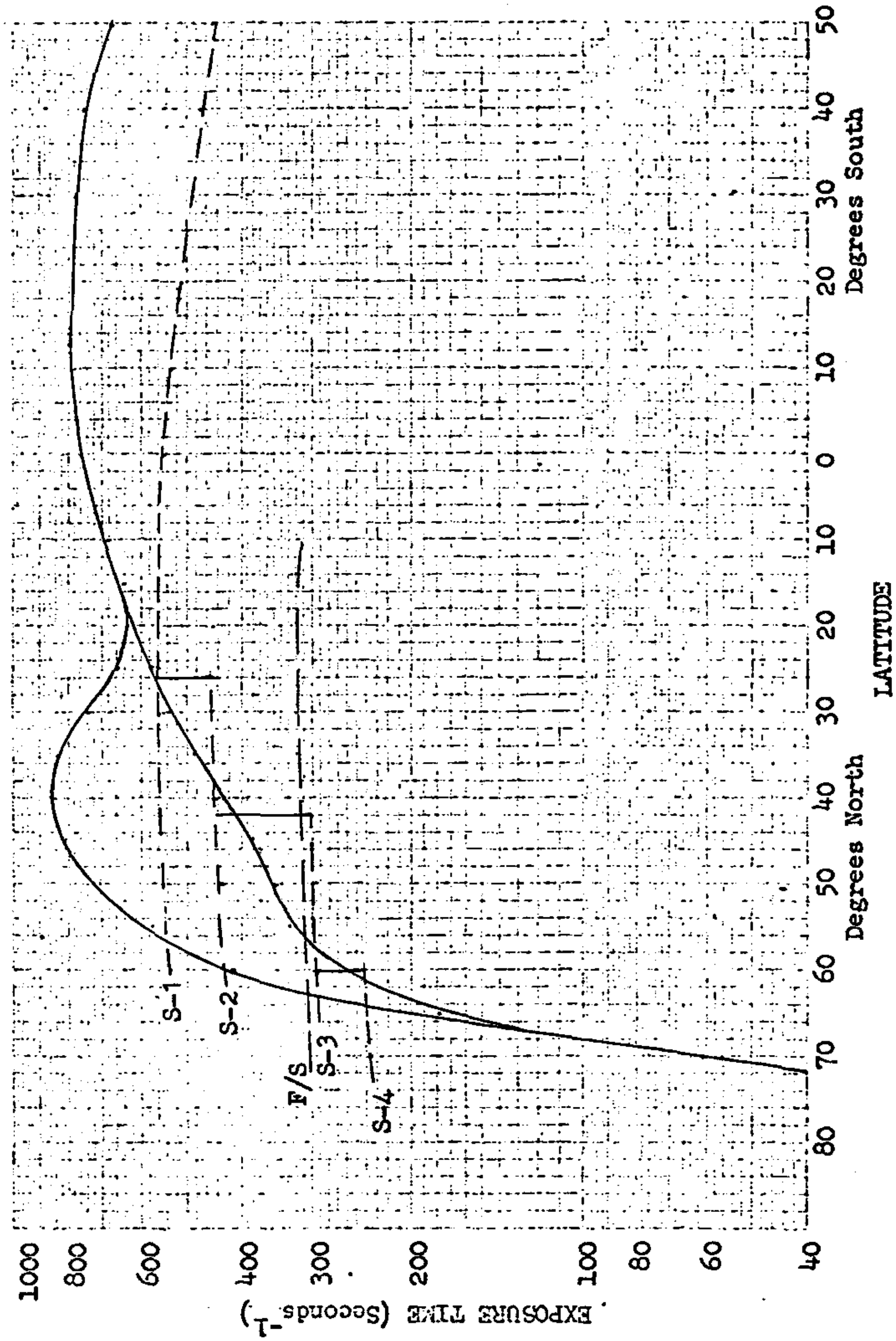


FIGURE 5-2 , EXPOSURE PROFILE, Mission 1112, Payload QR-2R

Aft - Looking Camera #300 , Pass # 88

Launched 18 November 1970



Slit Widths: 4 - 0.267"
3 - 0.225"
2 - 0.160"
1 - 0.125"
F/S - 0.219"

Film Type 3414

Filters - Primary Wratten 23A (0.037")

- Alternate Wratten 23A (0.040")

FIGURE 5-3 , EXPOSURE PROFILE, Mission 1112, Payload QR-2R

Aft - Looking Camera # 300 , Pass # 88

Launched 18 November 1970

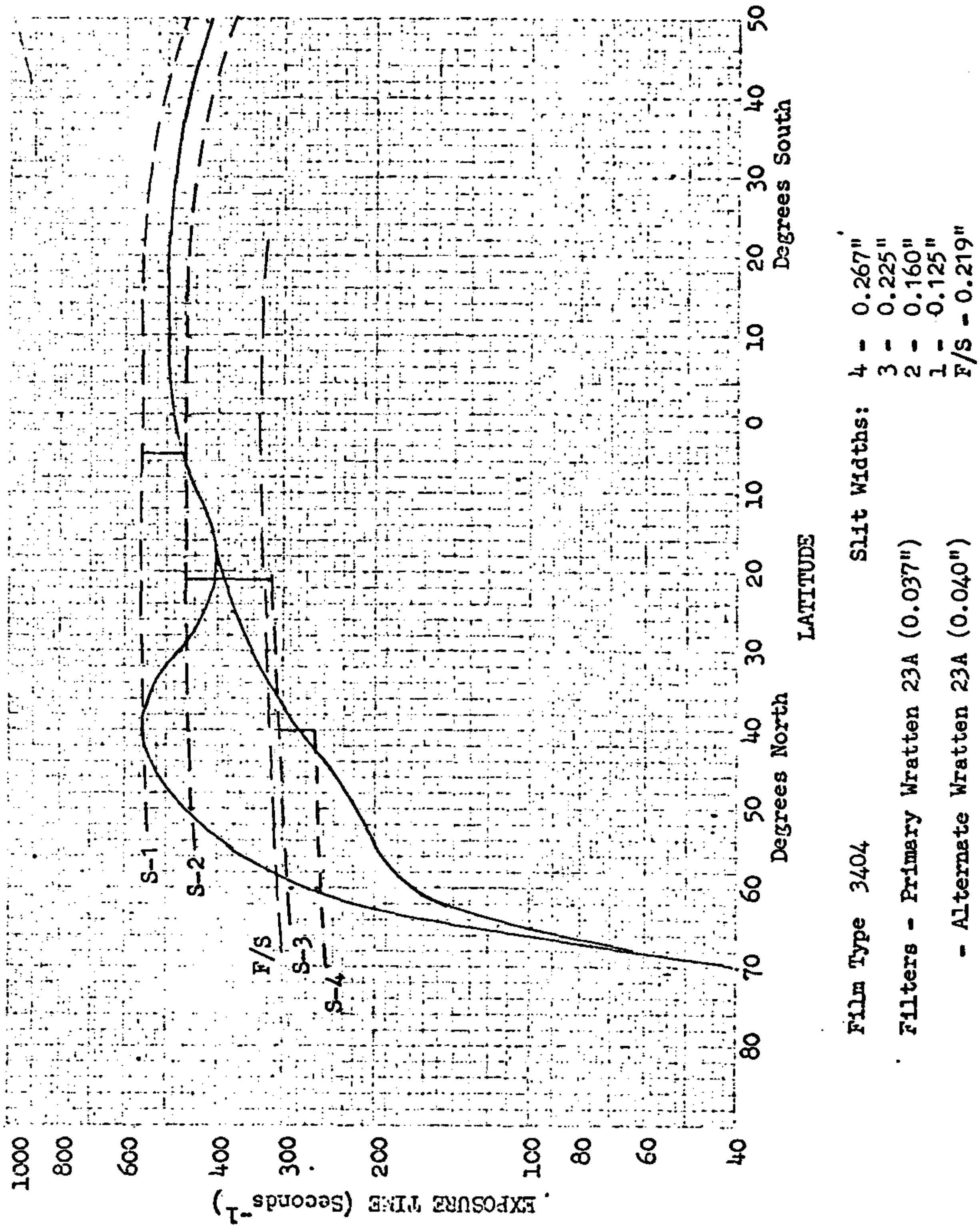


FIGURE 5-4 , EXPOSURE PROFILE, Mission 1112, Payload QR-2R

AFT - Looking Camera # 300 , Pass # 203

Launched 18 November 1970

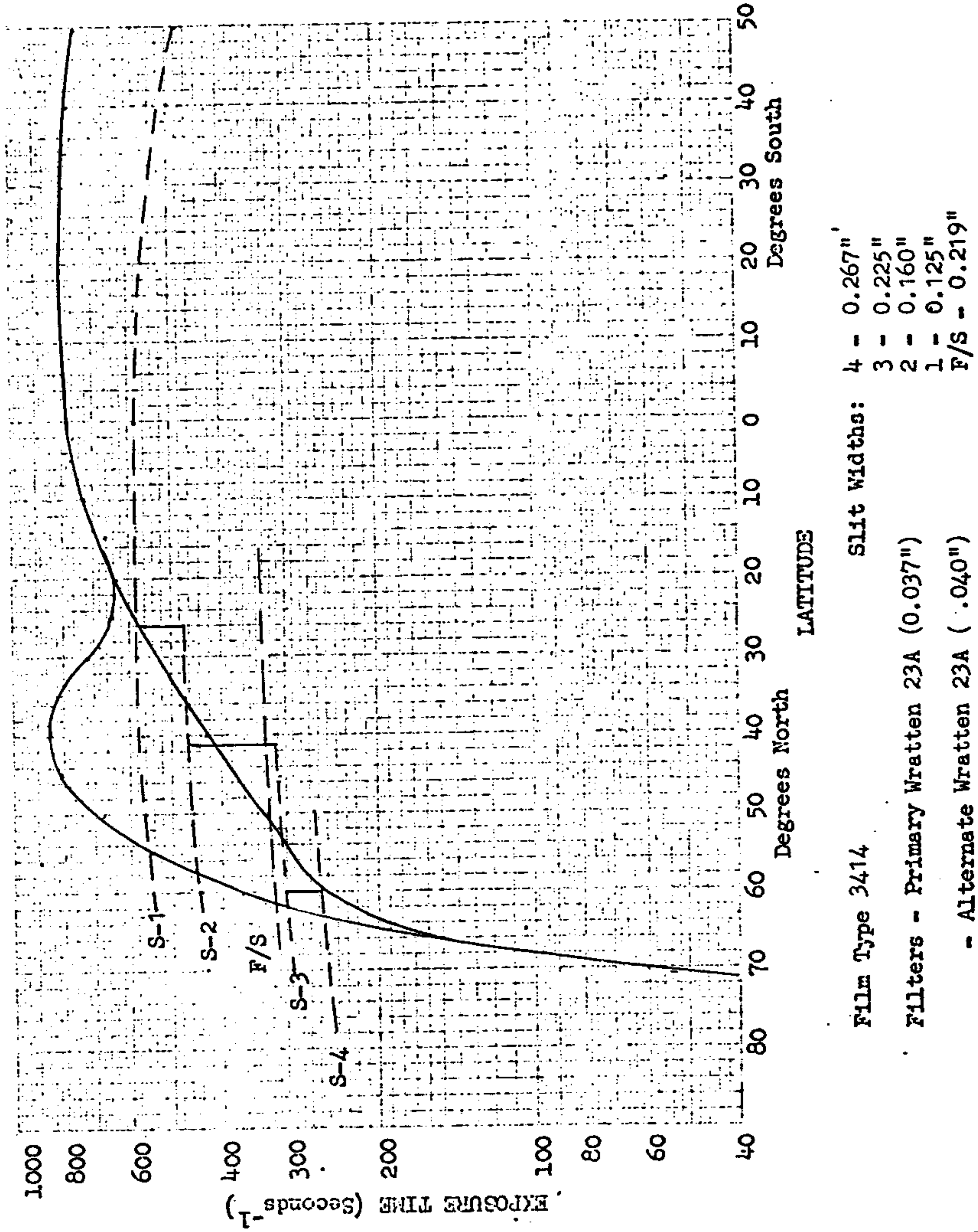


TABLE 5-1

SOLAR ELEVATION DISTRIBUTION OF PAN CAMERA OPERATIONS

	Mission 1112-1		Mission 1112-2	
Solar Elevation Interval	Percent	Cumulative	Percent	Cumulative
1 to 5 degrees	0.32	0.32	7.46	7.46
5 to 10 degrees	10.66	10.98	11.80	19.26
10 to 15 degrees	10.39	21.37	13.77	33.03
15 to 20 degrees	15.60	36.97	12.94	45.97
20 to 25 degrees	16.07	53.04	16.09	62.06
25 to 30 degrees	20.10	73.14	18.53	80.59
30 to 35 degrees	10.72	83.86	14.31	94.90
35 to 40 degrees	6.30	90.16	4.22	99.12
40 to 45 degrees	3.43	93.54	0.12	99.24
45 to 50 degrees	2.17	95.71		
50 to 55 degrees	3.36	99.14		
55 to 60 degrees	0.88	100.00		
over 80 degrees			0.76	100.00

TABLE 5-2

SOLAR AZIMUTH DISTRIBUTION OF PAN CAMERA OPERATIONS

Solar Azimuth Interval	Mission 1112-1 Percent	Mission 1112-1 Cumulative	Mission 1122-1 Percent	Mission 1122-1 Cumulative
-10 to -5 degrees			11.21	11.21
- 5 to 0 degrees			23.78	34.99
0 to 5 degrees			21.88	56.87
5 to 10 degrees			21.53	78.40
10 to 15 degrees			13.58	91.98
15 to 20 degrees	1.84	1.84	7.25	99.24
20 to 25 degrees	18.34	20.18		
25 to 30 degrees	38.23	58.41		
30 to 35 degrees	29.81	88.22		
35 to 40 degrees	6.26	94.48		
40 to 45 degrees	0.84	95.32		
45 to 50 degrees	1.24	96.56		
50 to 55 degrees	1.40	97.96		
55 to 60 degrees	1.36	99.32		
60 to 65 degrees	0.68	100.00		
over 125 degrees			0.76	100.00

from these strips are regarded by the processing facility as the most representative of the sensitometry of the flight film. These curves are included as Figures 5-5 through 5-13.

E. MACRO DENSITY MEASUREMENTS

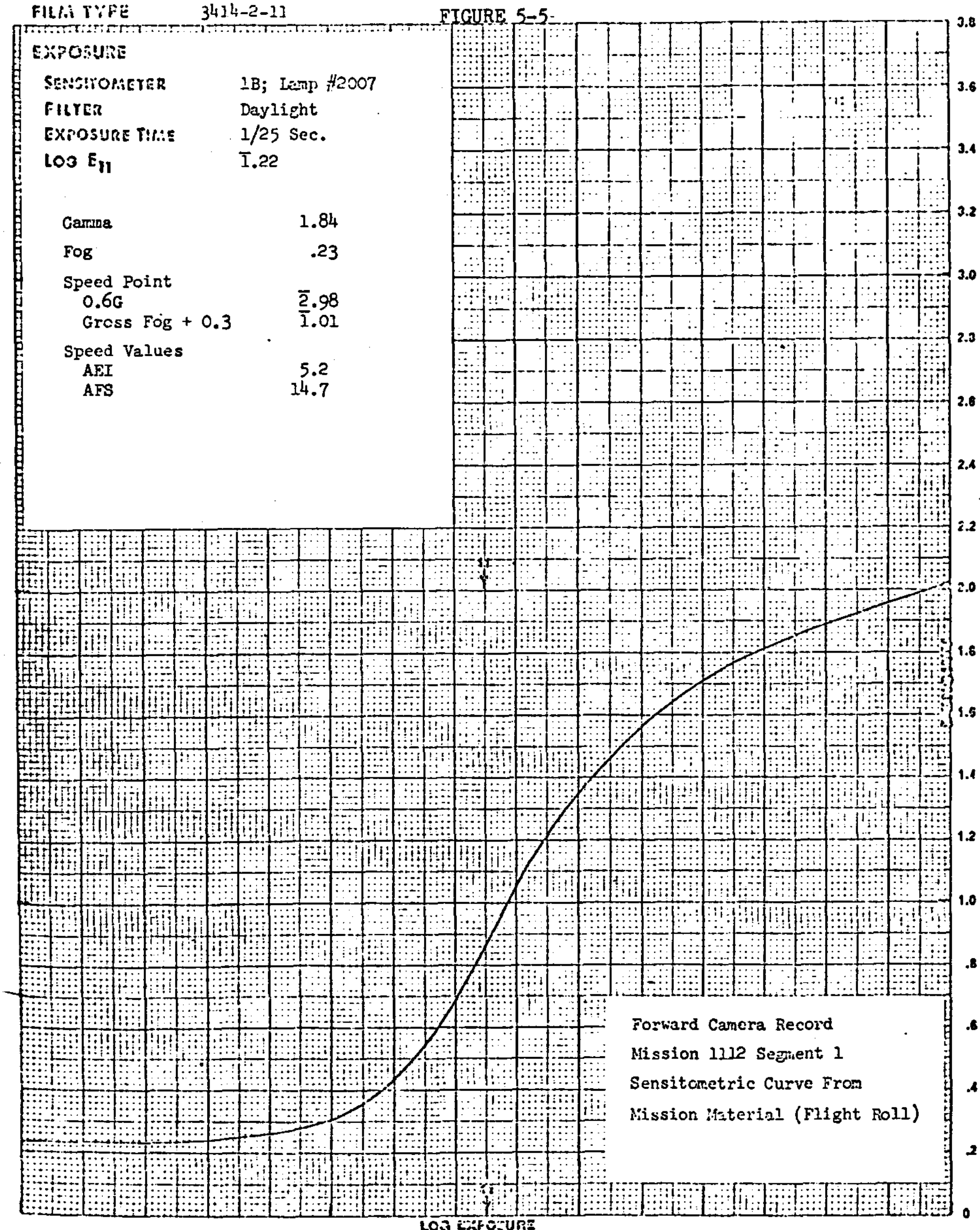
Representative diffuse density measurements are supplied by AFSPPF. These values, along with target microdensity measurements, also supplied by AFSPPF, are used by Advanced Projects to evaluate exposure performance and improve criteria for future missions.

Because of other commitments, it is planned that Mission 1112 will be the last Corona mission for which AFSPPF will supply this data. As a possible substitute for the AFSPPF macrodensity data, the [redacted] processing density data for this mission has been evaluated in parallel with the AFSPPF data.

The SPPF macrodensity data is summarized in the frequency distribution plots, Figures 5-14 through 5-22. Figures 5-14 through 5-16 are the minimum, maximum, and delta (range) densities for the forward camera on Mission 1112-1. Figures 5-17 through 5-22 are the corresponding values of the aft camera for Missions 1112-1 and -2. The -2 mission aft camera data includes 26 frames of 3404 film along with 274 frames of 3414 film. There was no 3404 film in the Mission 1112-1 sample.

The [redacted] printing density data is summarized in Figures 5-23 through 5-31, frequency distribution plots with formats and content identical with those of the AFSPPF data. The -1 mission aft camera data includes 9 frames of 3404 film and 268 frames of 3414 film; the -2 mission aft camera data includes 55 frames of 3404 film and 523 frames of 3414 film.

FIGURE 5-5

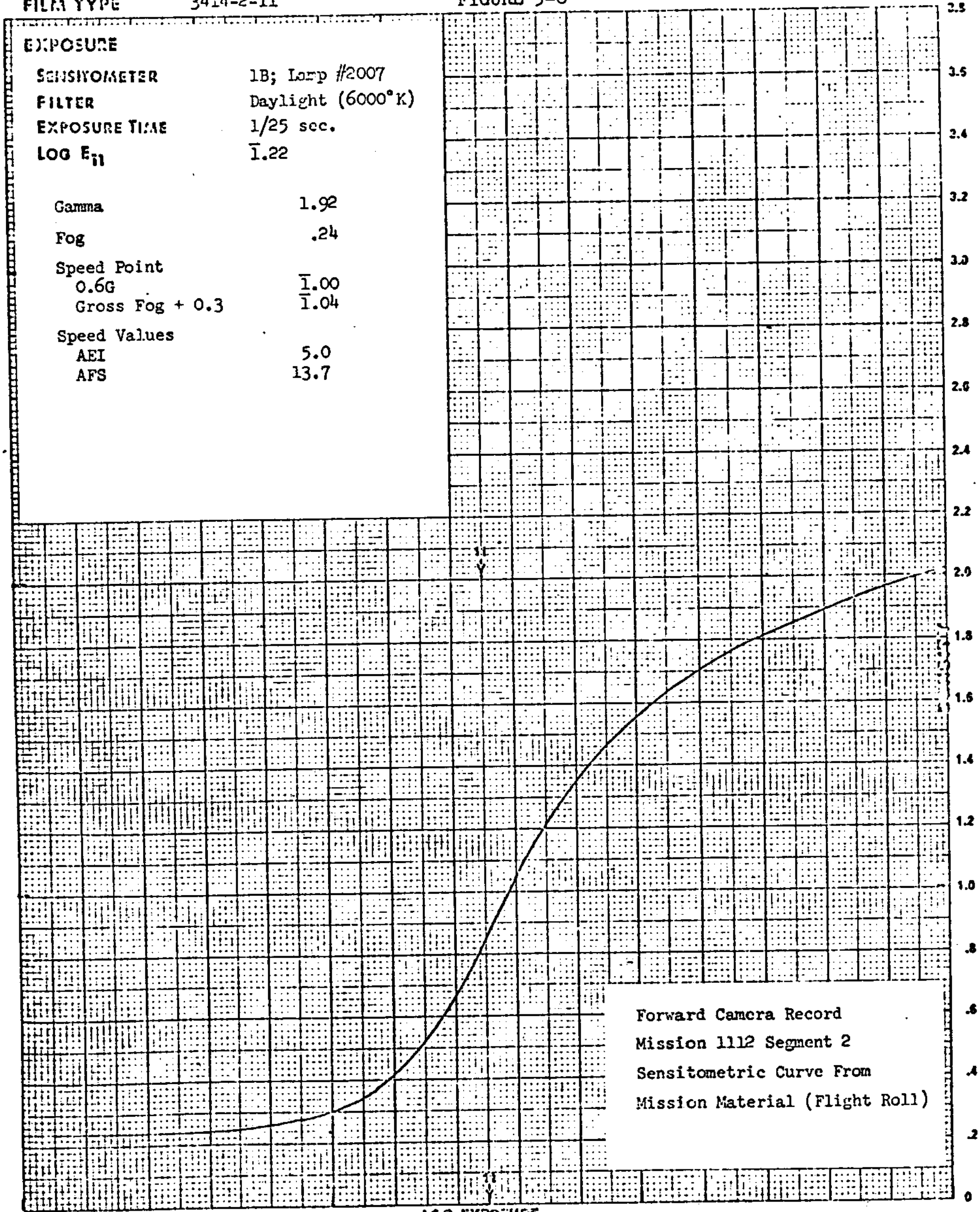

FILM TYPE 3414-2-11
EXPOSURE
SENSITOMETER 1B; Lamp #2007
FILTER Daylight
EXPOSURE TIME 1/25 Sec.
LOG E_{11} $\bar{1}.22$
Gamma 1.84
Fog .23
Speed Point
0.6G $\bar{2}.98$
Gross Fog + 0.3 $\bar{1}.01$
Speed Values
AEI 5.2
AFS 14.7
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
LOG EXPOSURE
Forward Camera Record
Mission 1112 Segment 1
Sensitometric Curve From
Mission Material (Flight Roll)

FILM TYPE 3414-2-11

FIGURE 5-6

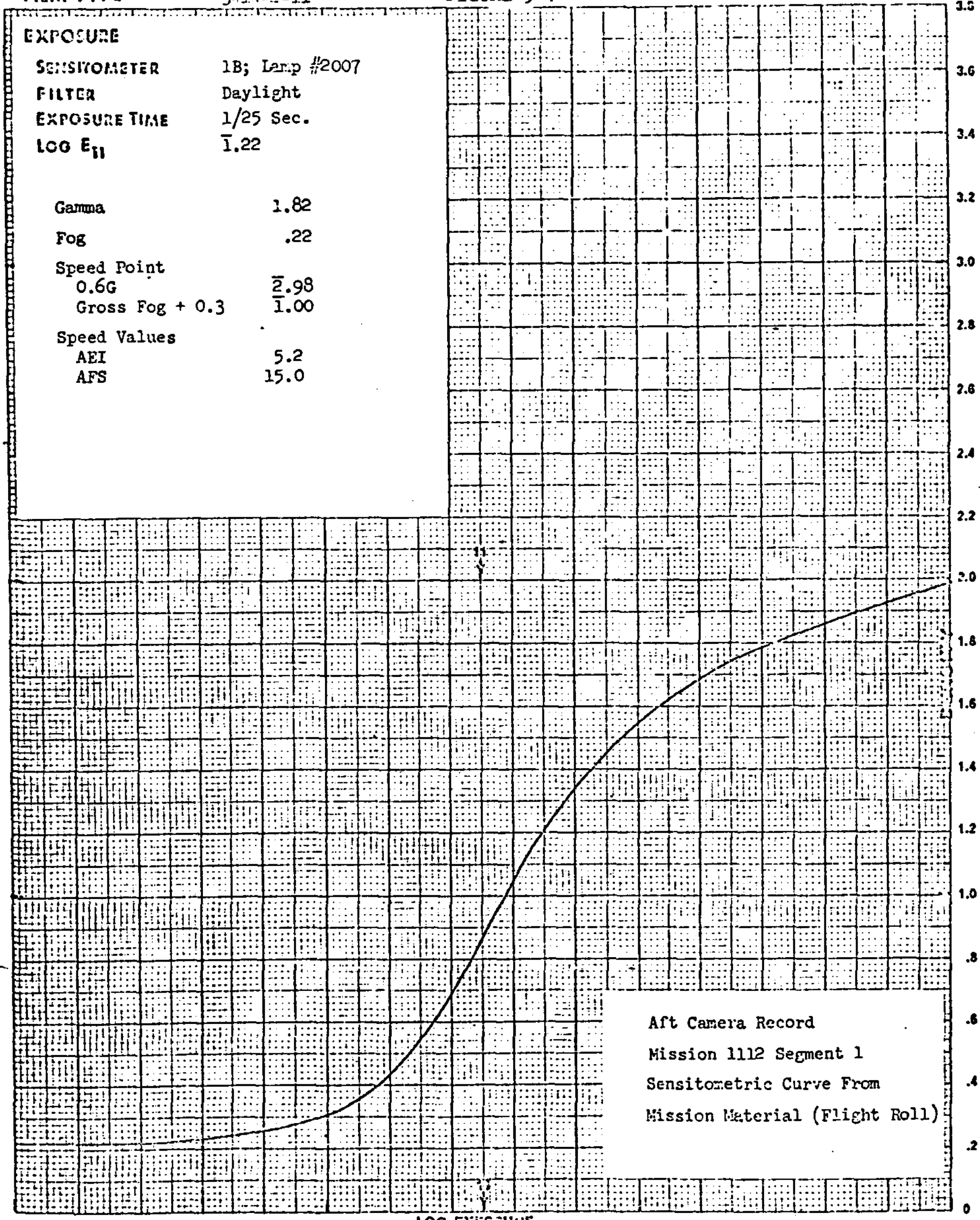
EXPOSURE

SENSITOMETER	1B; Lamp #2007
FILTER	Daylight (6000°K)
EXPOSURE TIME	1/25 sec.
LOG E_{11}	$\bar{1}.22$
Gamma	1.92
Fog	.24
Speed Point	
0.6G	$\bar{1}.00$
Gross Fog + 0.3	$\bar{1}.04$
Speed Values	
AEI	5.0
AFS	13.7



Forward Camera Record
Mission 1112 Segment 2
Sensitometric Curve From
Mission Material (Flight Roll)

FILM TYPE 3414-2-11 FIGURE 5-7



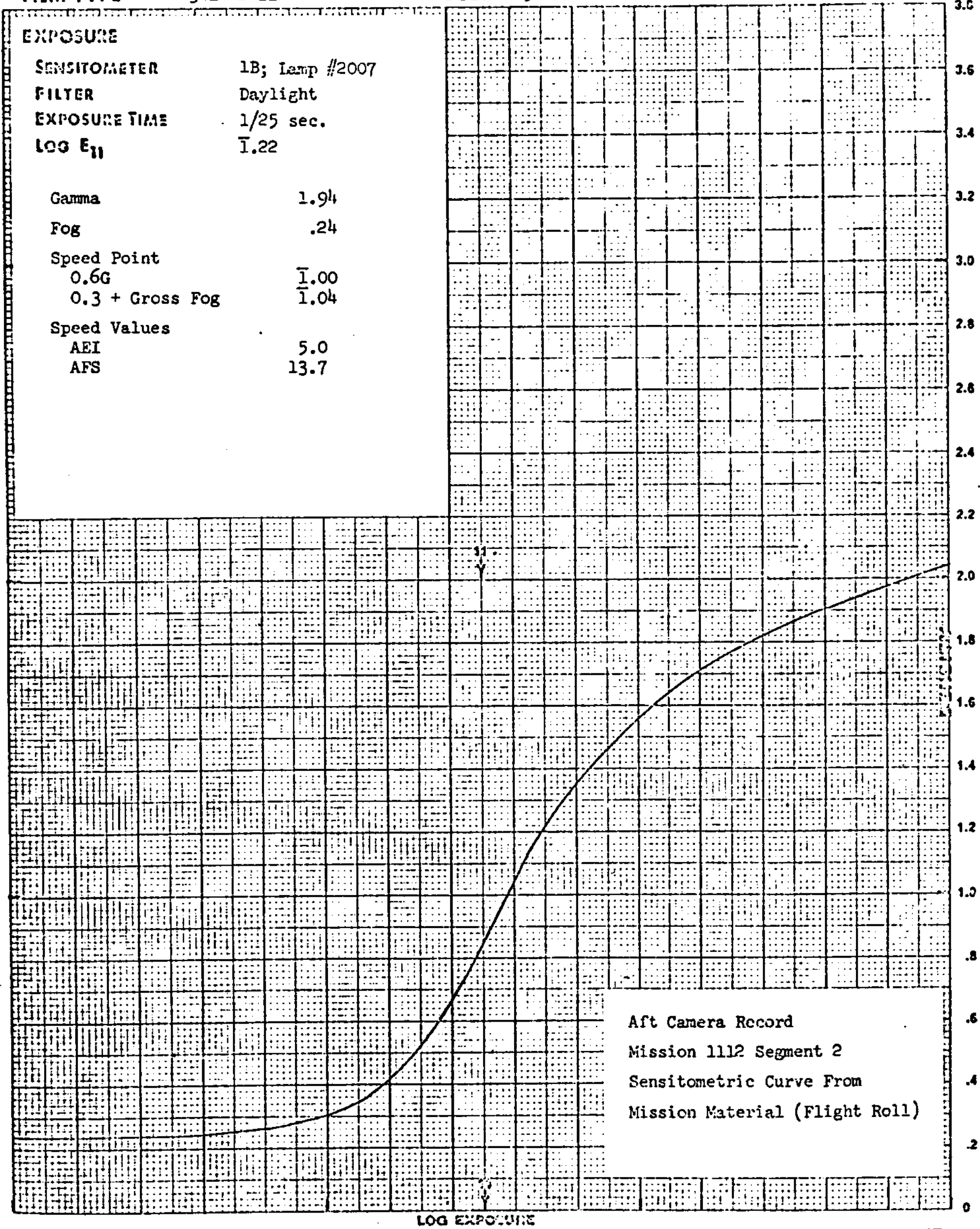
FILM TYPE 3414-2-11

FIGURE 5-8

EXPOSURE

SENSITOMETER	1B; Lamp #2007
FILTER	Daylight
EXPOSURE TIME	1/25 sec.
LOG E_{11}	$\bar{1}.22$

Gamma	1.94
Fog	.24
Speed Point	
0.6G	$\bar{1}.00$
0.3 + Gross Fog	$\bar{1}.04$
Speed Values	
AEI	5.0
AFS	13.7



Aft Camera Record
Mission 1112 Segment 2
Sensitometric Curve From
Mission Material (Flight Roll)

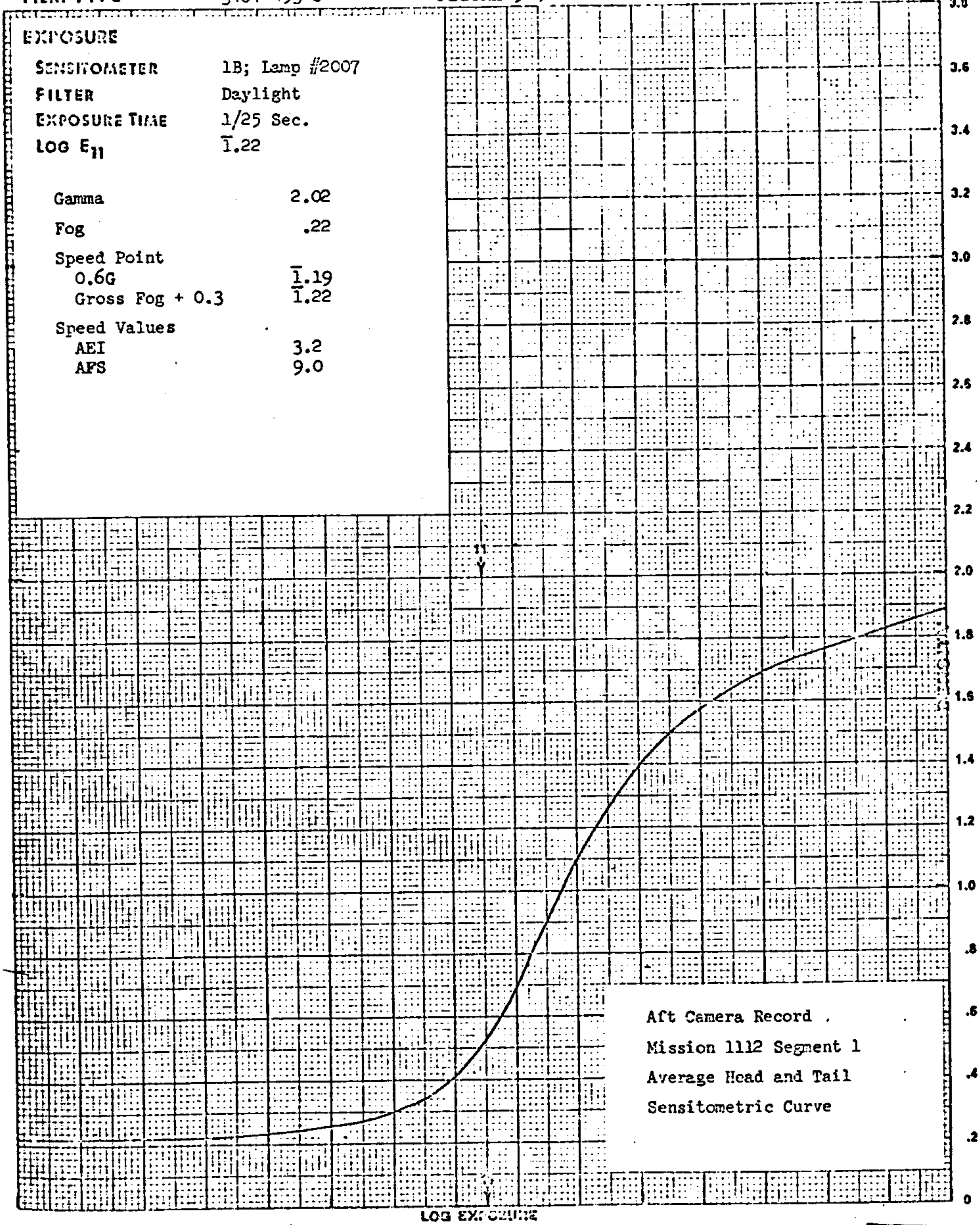
FILM TYPE 3404-453-8

FIGURE 5-9

EXPOSURE

SENSITOMETER	1B; Lamp #2007
FILTER	Daylight
EXPOSURE TIME	1/25 Sec.
LOG E_{11}	$\bar{1}.22$

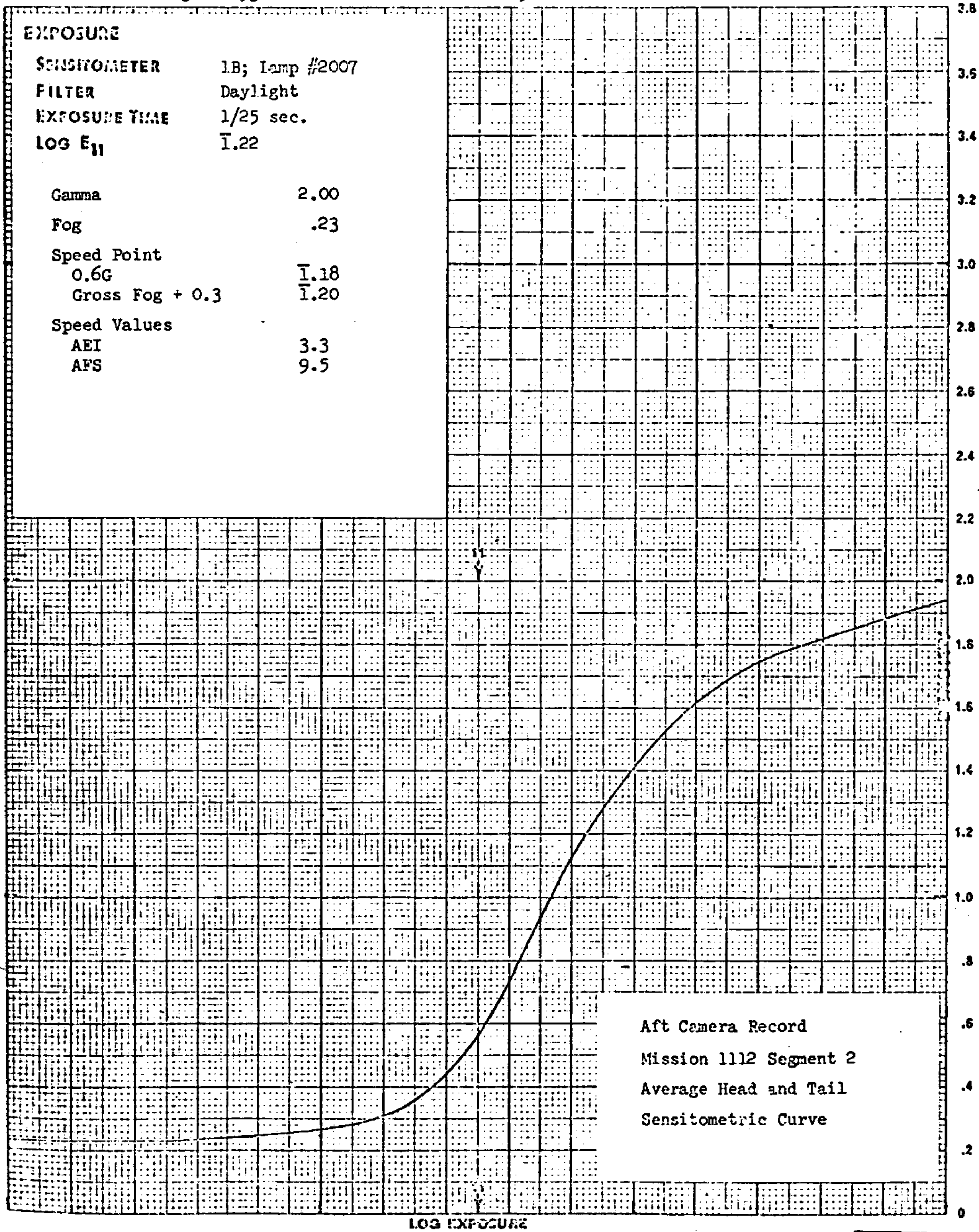
Gamma	2.02
Fog	.22
Speed Point	
0.6G	$\bar{1}.19$
Gross Fog + 0.3	$\bar{1}.22$
Speed Values	
AEI	3.2
AFS	9.0



Aft Camera Record
Mission 1112 Segment 1
Average Head and Tail
Sensitometric Curve

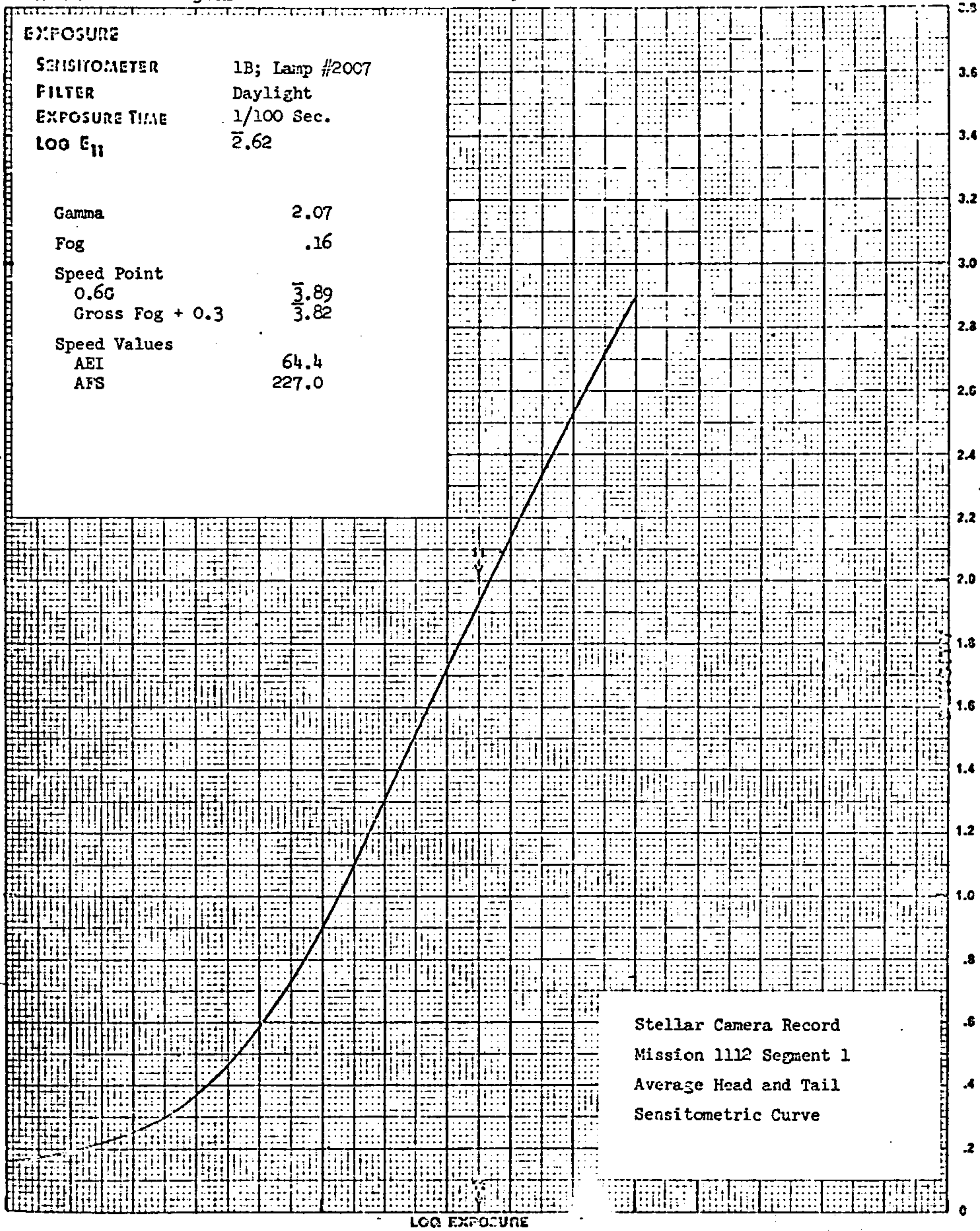
FILM TYPE 3404-453-8

FIGURE 5-10



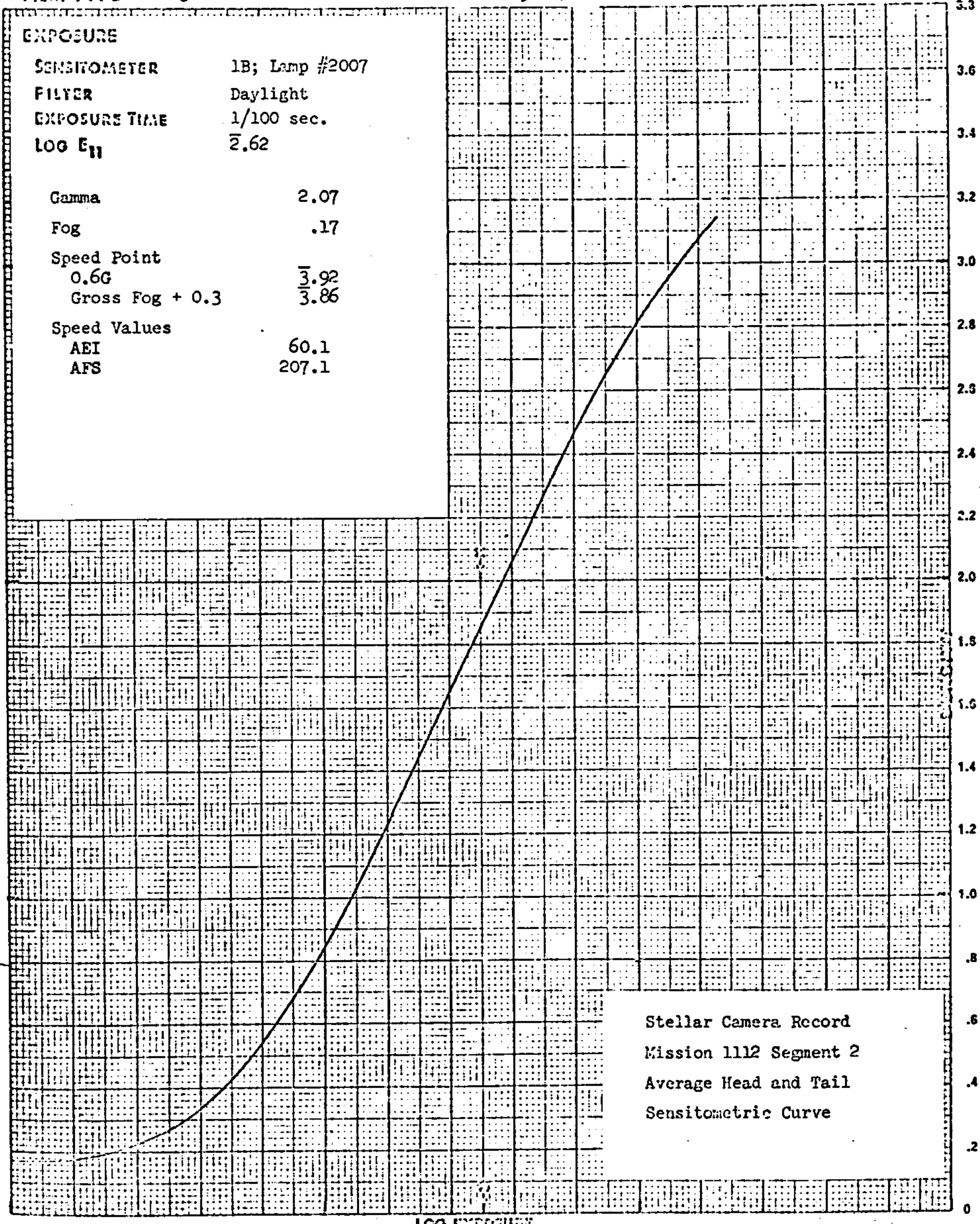
FILM TYPE 3401

FIGURE 5-11



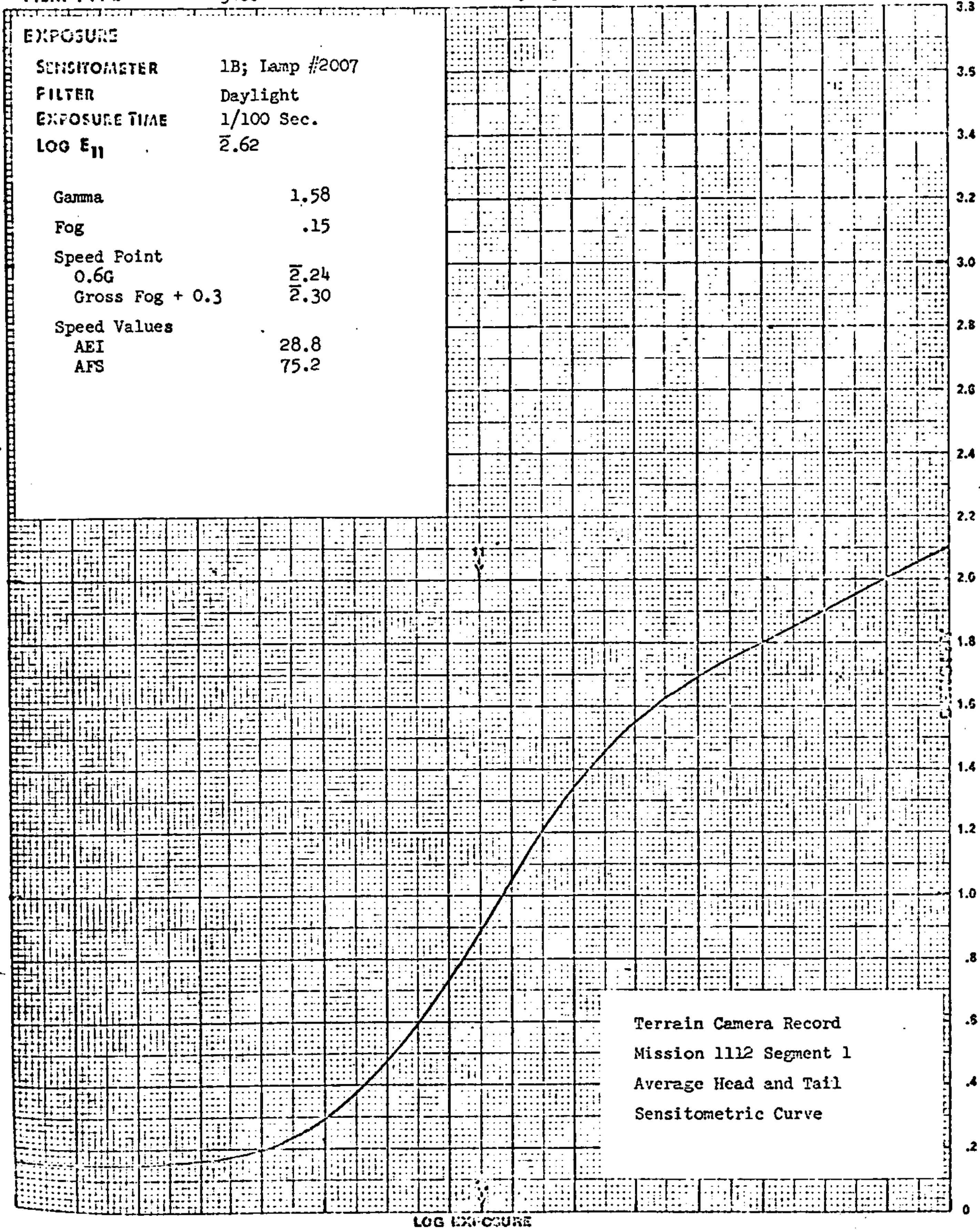
FILM TYPE 3401

FIGURE 5-12



FILM TYPE 3400

FIGURE 5-13



MISSION * 1112-1 * INSTR * FWD * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.53 * MEDIAN * 0.48 * STD DEV * 0.21 * RANGE * 0.25 TO 1.19 WITH 519 SAMPLES

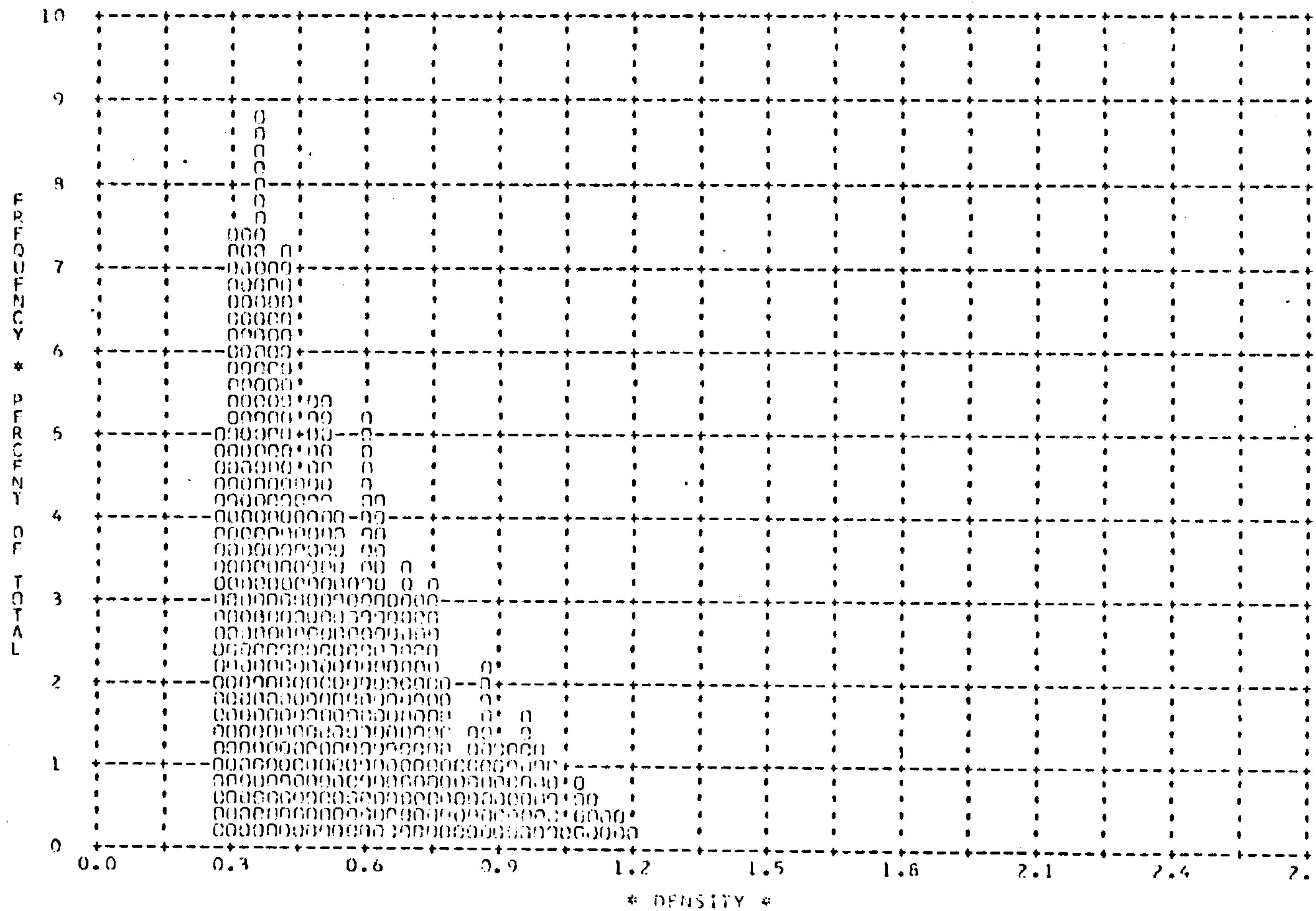


FIGURE 5-14

TOP SECRET/C

HANDLE VIA [redacted]

MISSION * 1112-1 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.38 /* MEDIAN * 1.41 * STD DEV * 0.22 * RANGE * 0.62 TO 1.80 WITH 519 SAMPLES

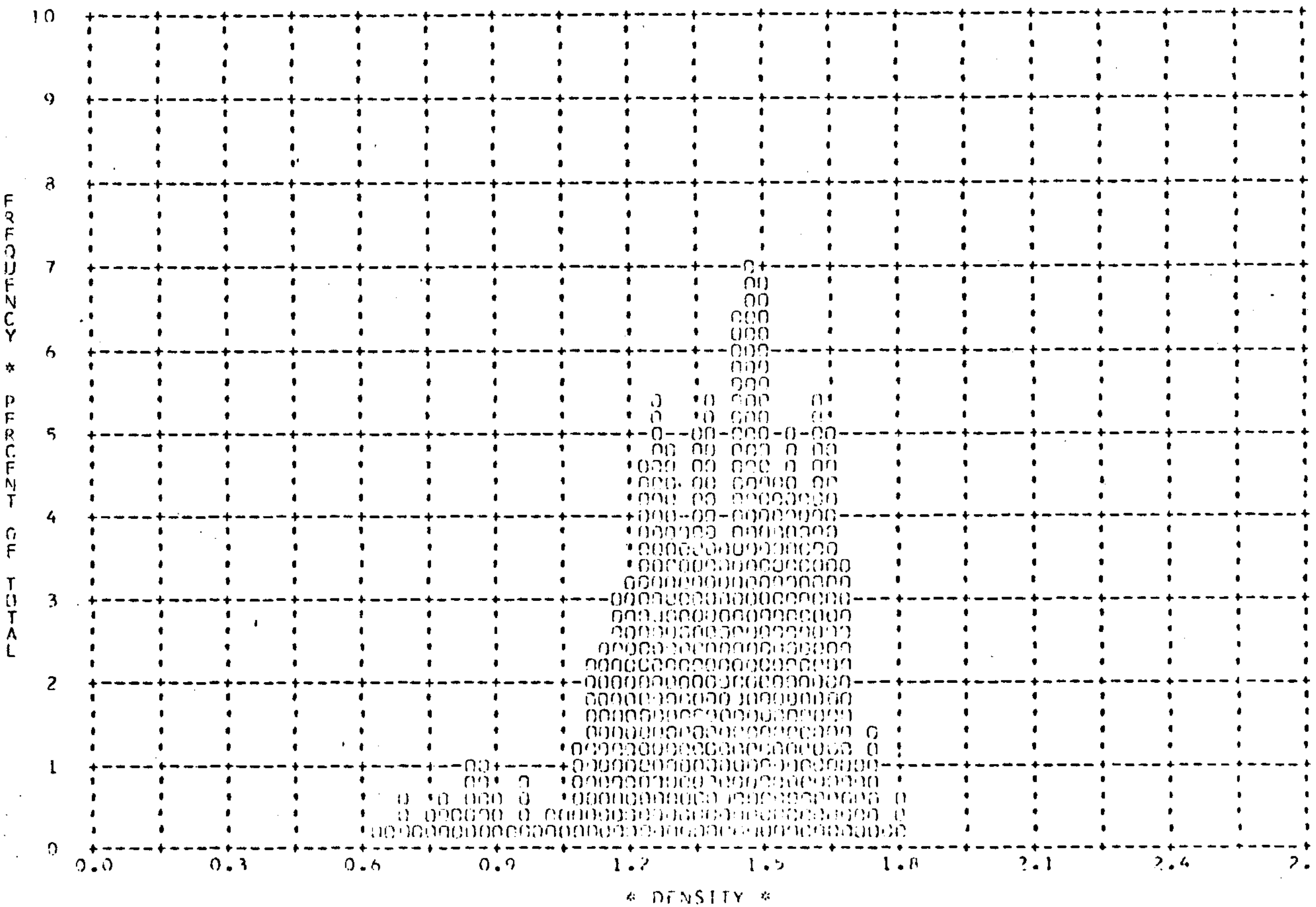


FIGURE 5-15

ARITH MEAN * 0.78 * MEDIAN * 0.82 * STD DEV * 0.30 * RANGE *0.11 TO 1.46 * WITH 519 SAMPLES

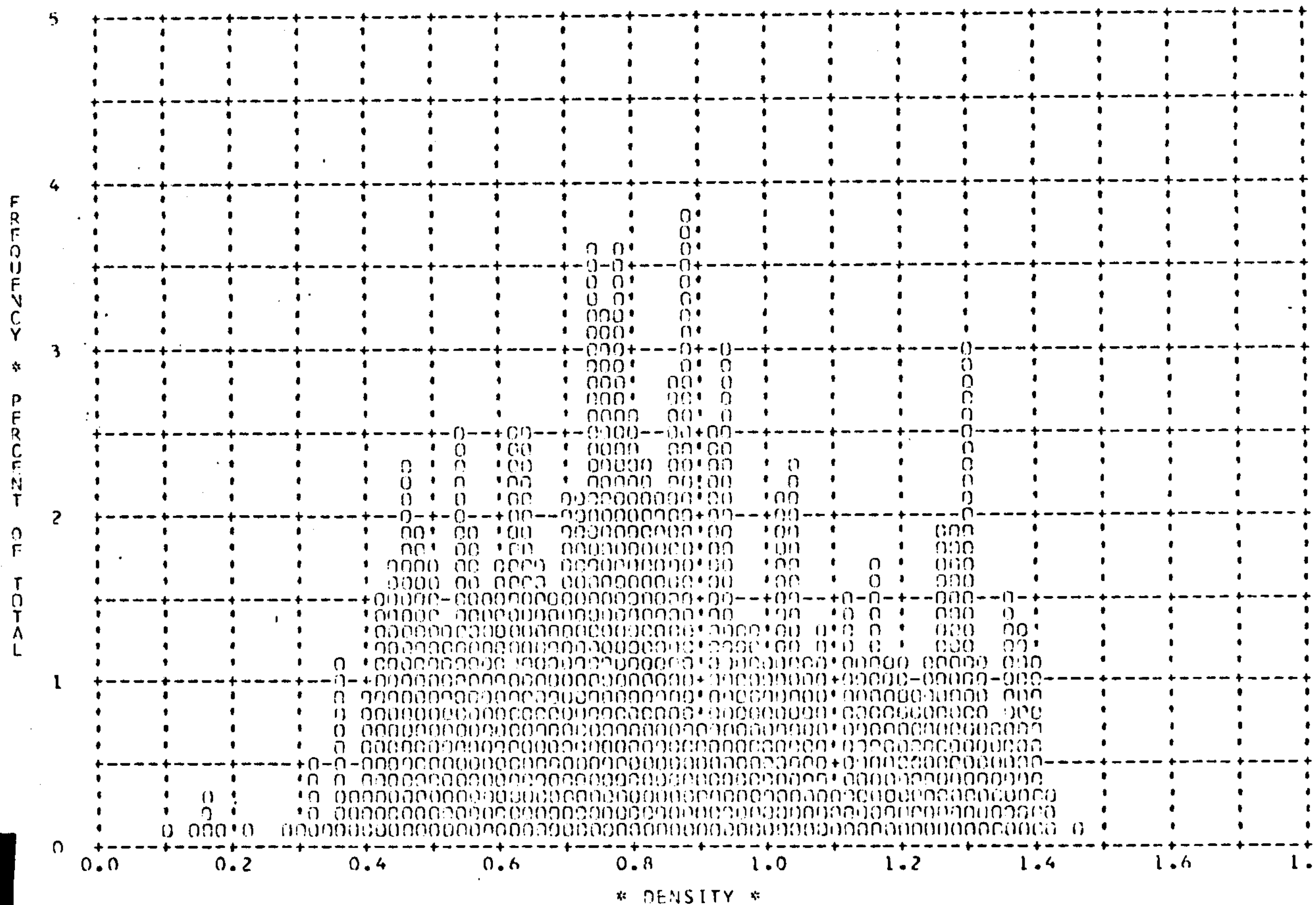


FIGURE 5-16

TOP SECRET/C

HANDLE VIA [redacted] CONTROL SYSTEM ONLY

MISSION * 1112-1 /* INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.58 * MEDIAN * 0.58 * STD DEV * 0.20 * RANGE * 0.26 TO 1.34 WITH 479 SAMPLES

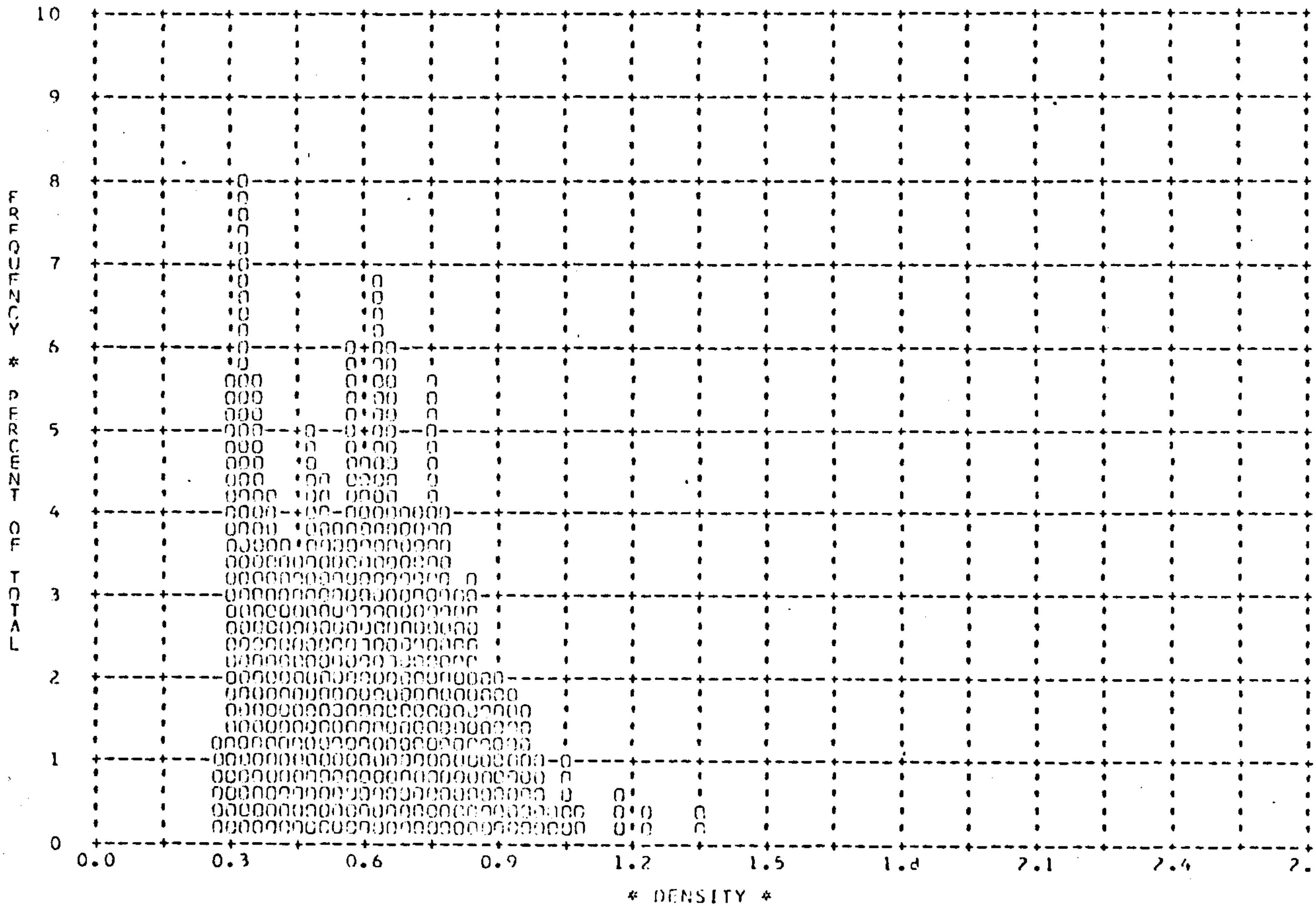


FIGURE 5-17

MISSION * 1112-1 /* INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.43 * MEDIAN * 1.43 * STD DEV * 0.17 * RANGE * 0.98 TO 1.79 WITH 479 SAMPLES

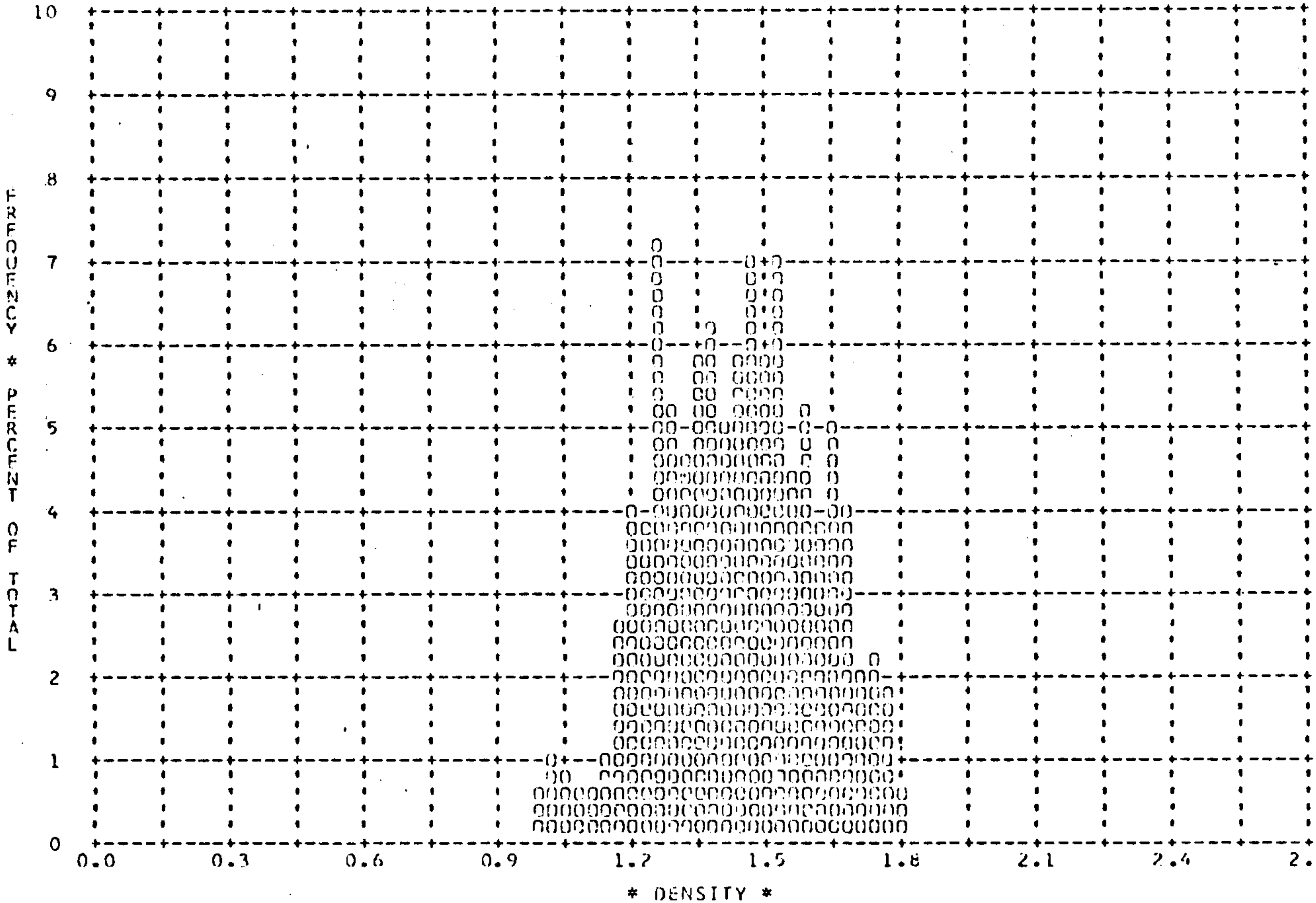


FIGURE 5-18

SION * 1112-4 * TEST * 300 * 01-04-71 PLOT OF DELTA DENSITIES * DUAL GAMMA *

ARITH MEAN * 0.81 * MEDIAN * 0.80 * STD DEV * 0.29 * RANGE *0.15 TO 1.47 * WITH 479 SAMPLES

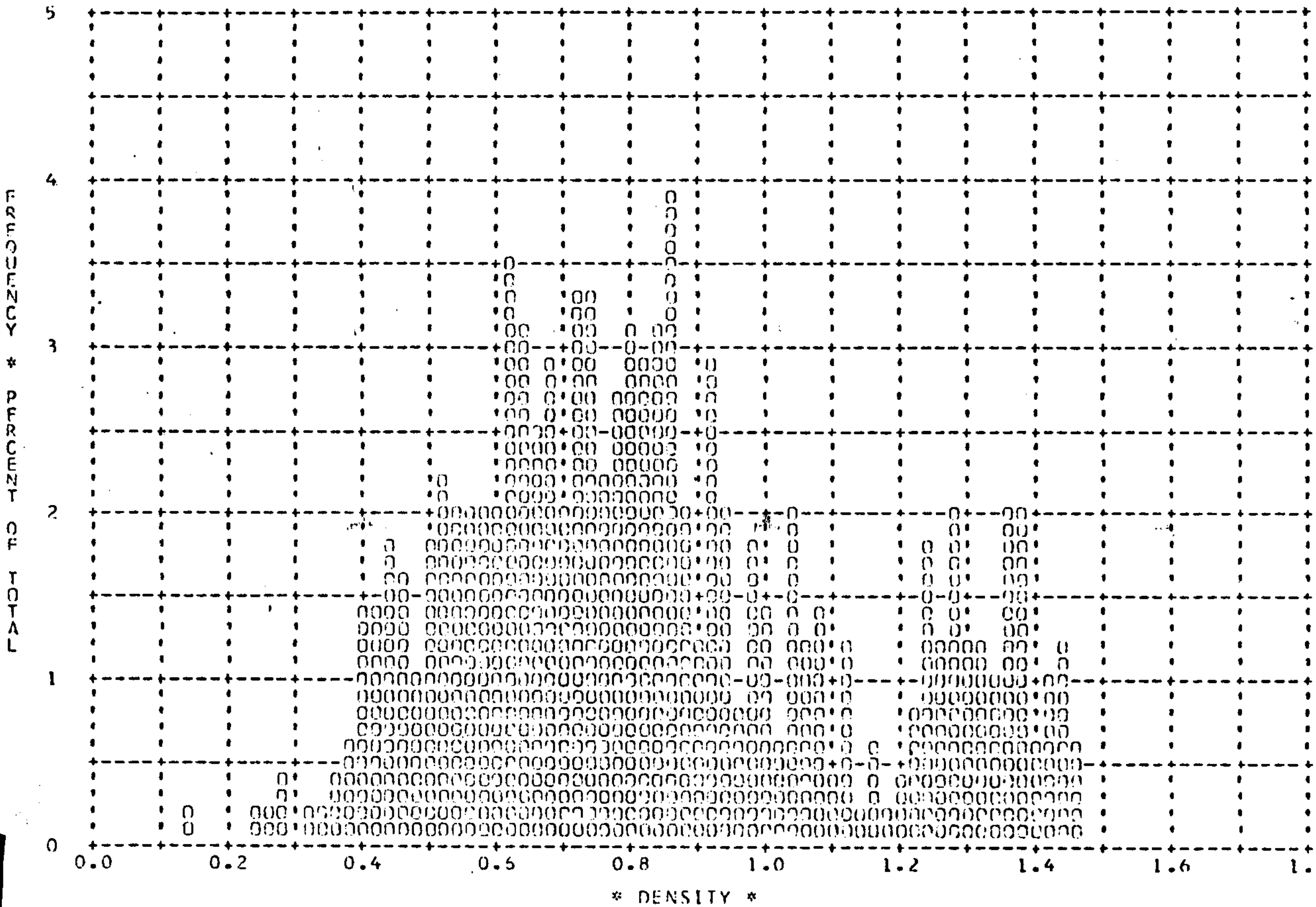


FIGURE 5-19

TOP SECRET/C

HANDLE VIA [redacted] CONTROL SYSTEM ONLY

MISSION * 1112-2 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.53 * MEDIAN * 0.45 * STD DEV * 0.22 * RANGE * 0.28 TO 1.31 WITH 300 SAMPLES

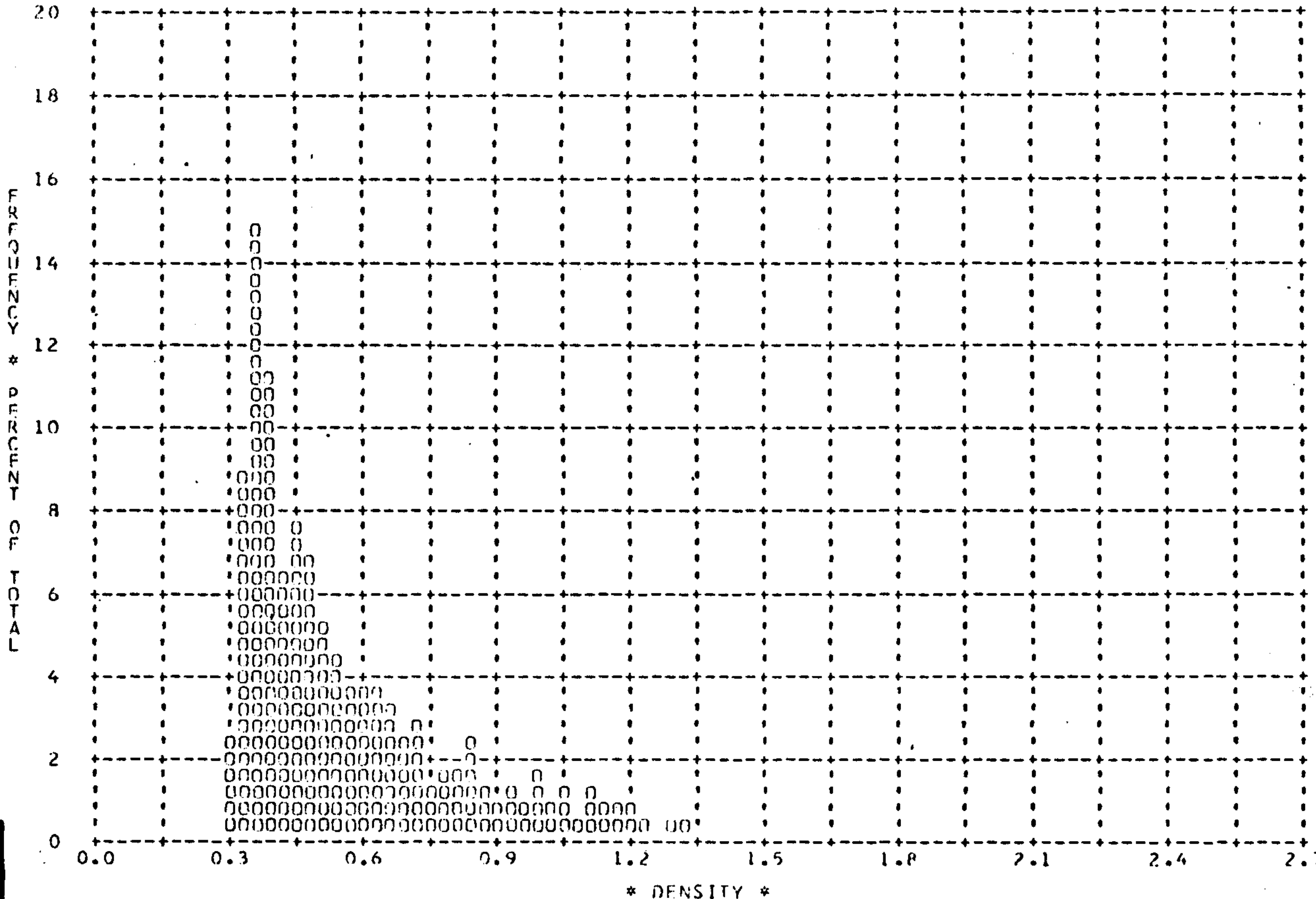


FIGURE 5-20

TOP SECRET/C

MISSION * 1112-2 * INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.34 */ MEDIAN * 1.36 * STD DEV * 0.26 * RANGE * 0.48 TO 1.81 WITH 300 SAMPLES

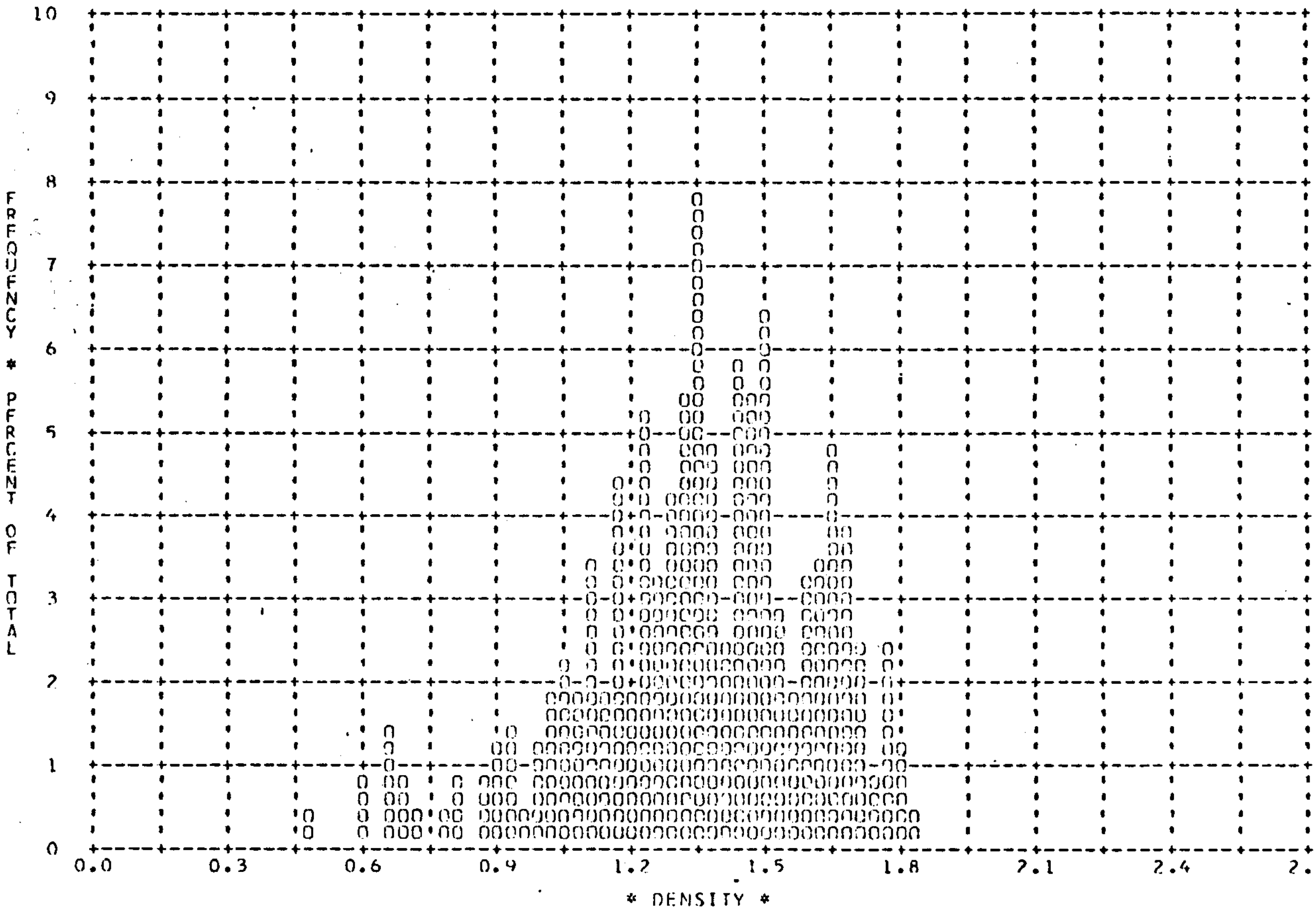


FIGURE 5-21

TOP SECRET/C

HANDLE VIA [redacted] CONTROL SYSTEM ONLY

ISSION * 1112-2 * INST */ 30P * 01-04-71 PLOT OF DELTA DENSITIES * DUAL GAMMA *

ARITH MEAN * 0.76 * MEDIAN * 0.80 * STD DEV * 0.32 * RANGE *0.0 TO 1.52 * WITH 303 SAMPLES

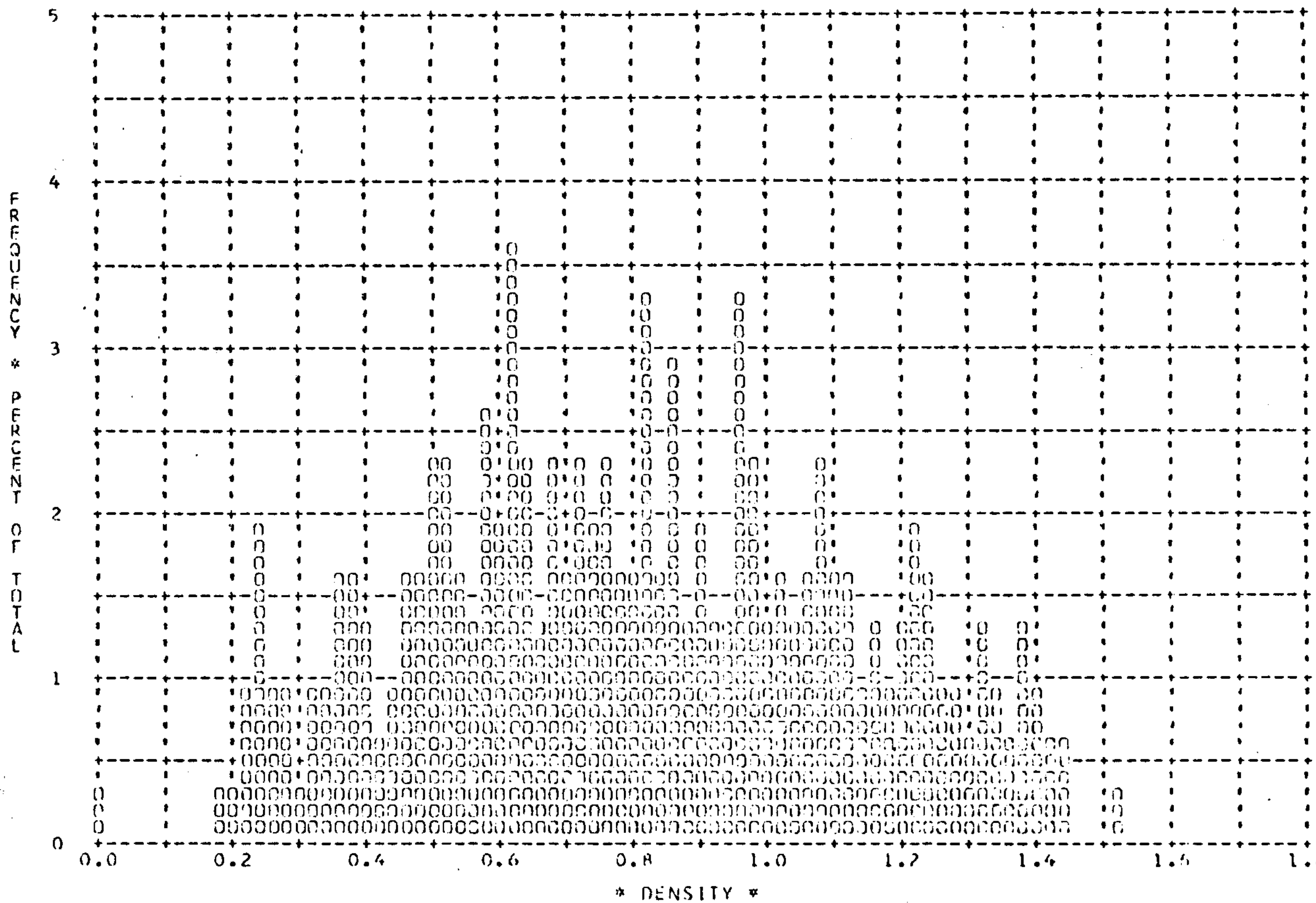


FIGURE 5-22

MISSION * 1112-1 * INSTR * 301 * 01-04-71 PLOT OF D-MIN * TERRAIN * PROCESSING * DUAL GAMMA
ARITH MEAN * 0.52 * MEDIAN * 0.47 * STD DEV * 0.20 * RANGE * 0.24 TO 1.48 WITH 468 SAMPLES

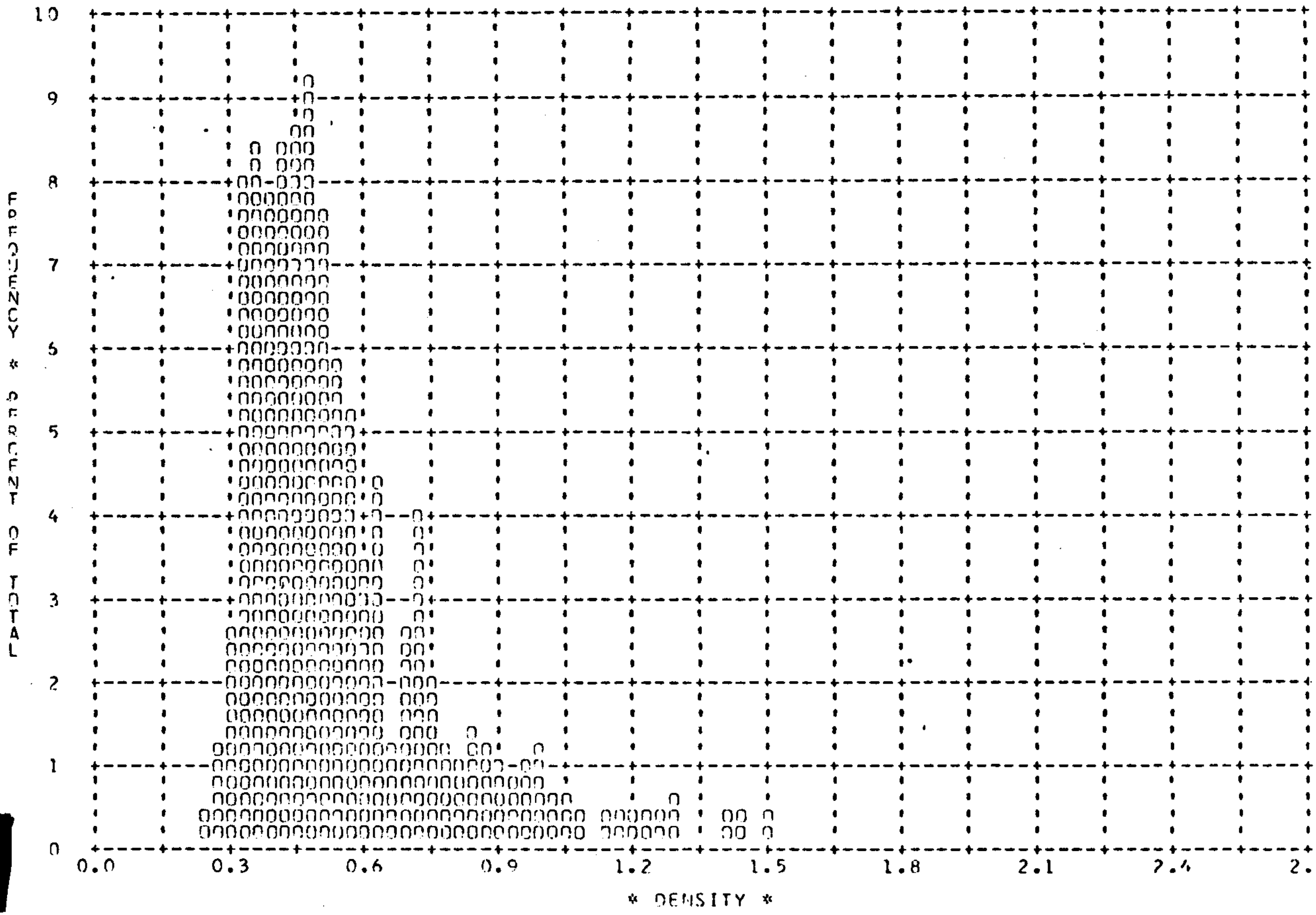
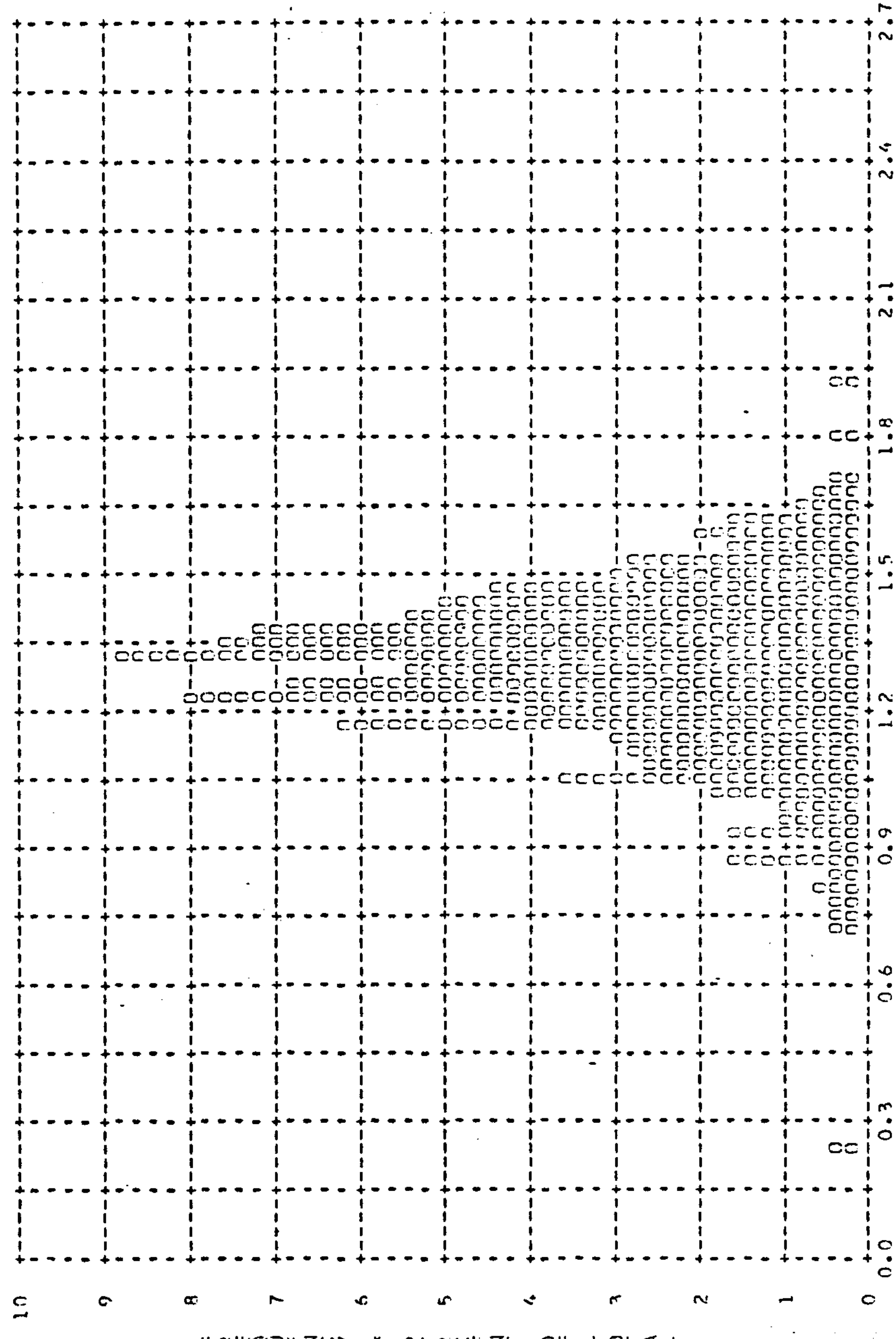


FIGURE 5-23

MISSION * 1112-1 * INSTR * 301 * 01-04-71 PLOT OF D-MAX * TERRAIN * PROCESSING * DUAL GAMMA
ARITH MEAN * 1.28 * MEDIAN * 1.30 * STD DEV * 0.19 * RANGE * 0.24 TO 1.91 WITH 468 SAMPLES



* DENSITY *
FIGURE 5-24

MISSION * 1112-1 * INST * 301 * 01-04-71 PLOT OF DELTA DENSITIES * DUAL GAMMA *
ARITH MEAN * 0.69 * MEDIAN * 0.77 * STD DEV * 0.24 * RANGE *0.0 TO 1.39 * WITH 468 SAMPLES

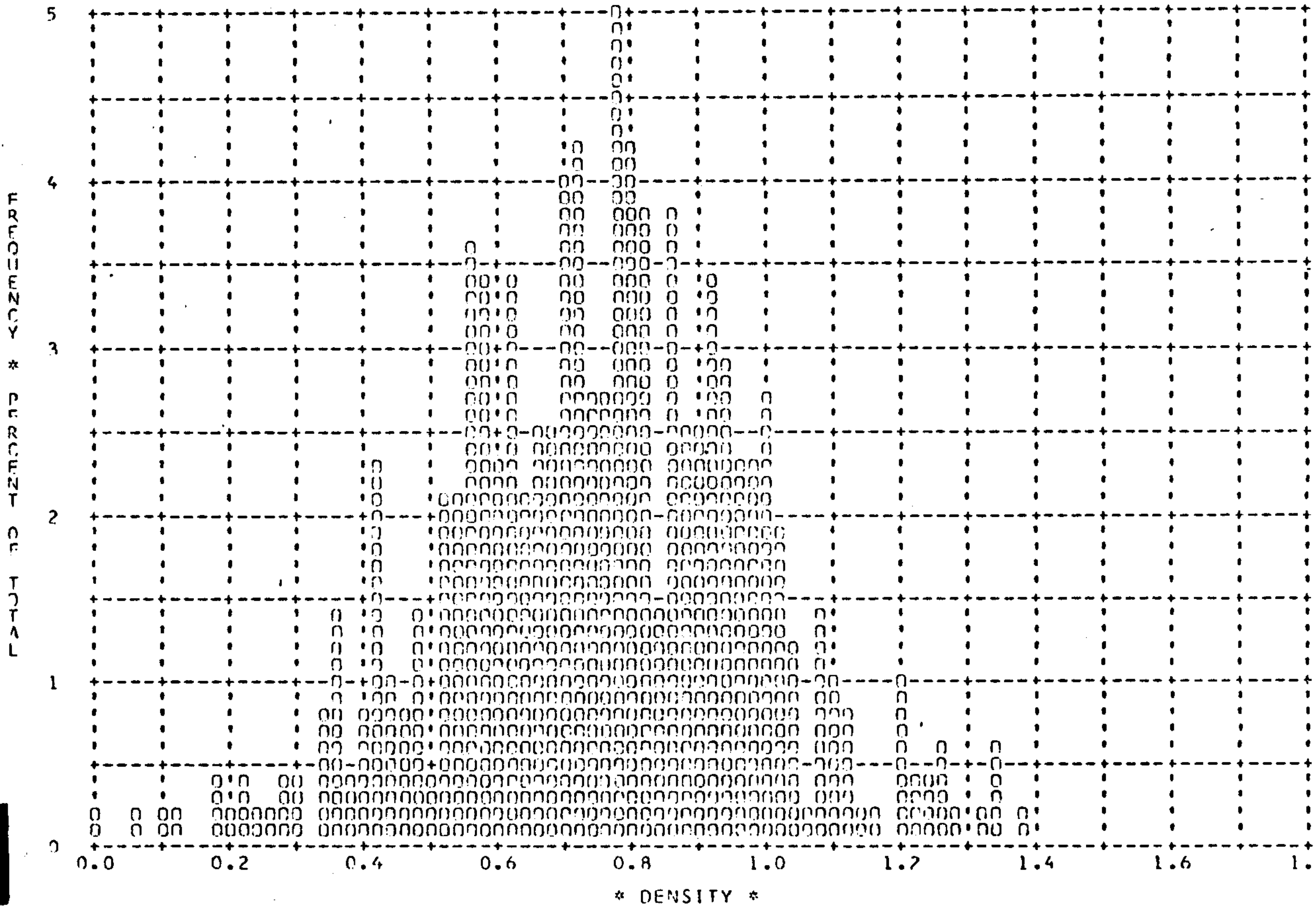


FIGURE 5-25

MISSION * 1112-1 * INSTR * 300 * 01-04-71 PLOT OF D-MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.58 * MEDIAN * 0.54 * STD DEV * 0.22 * RANGE * 0.28 TO 1.36 WITH 277 SAMPLES

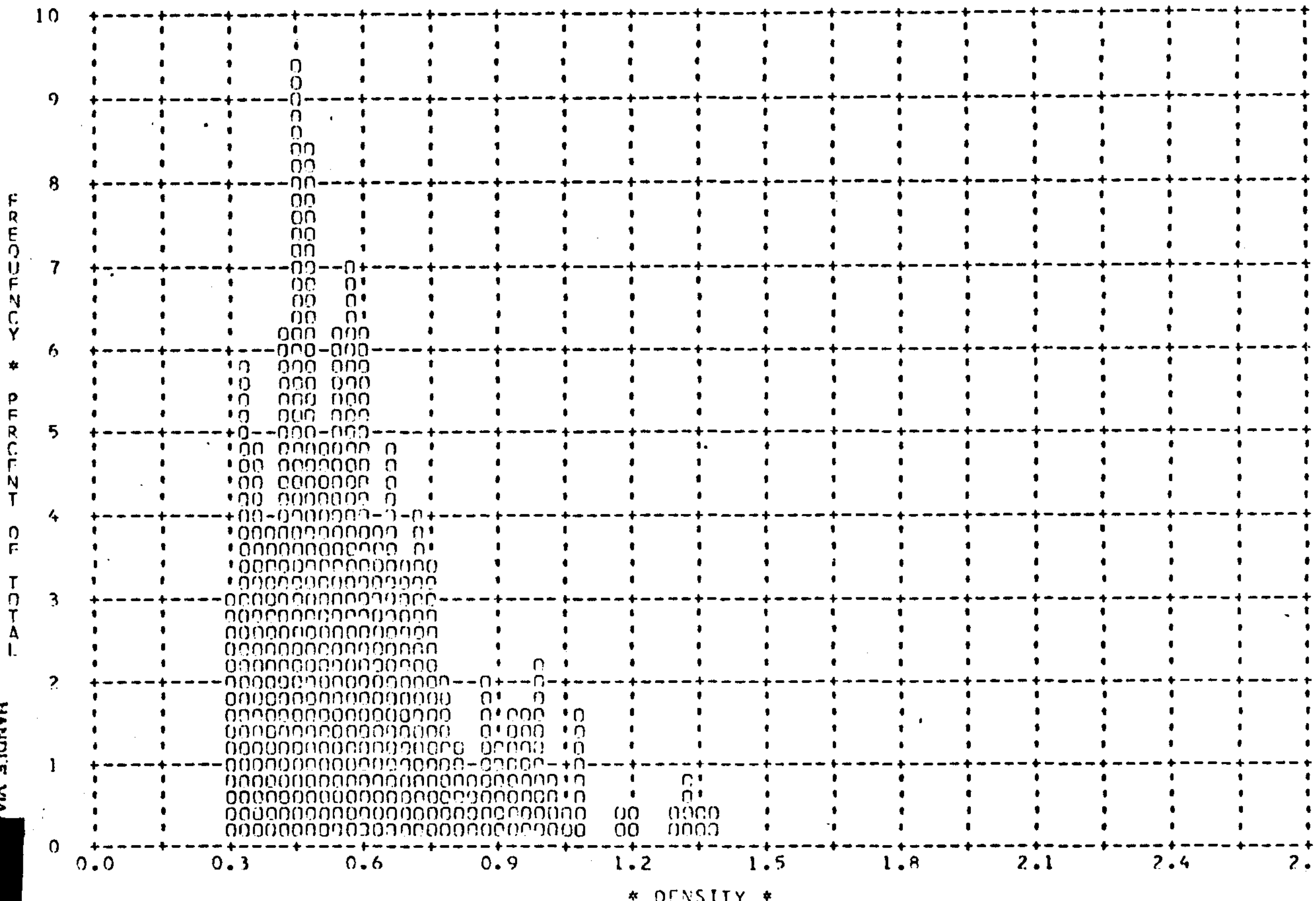


FIGURE 5-26

TOP SECRET/C

MISSION * 1112-1 * INSTR * 300 * 01-04-71 PLOT OF D-MAX * TERRAIN * PROCESSING * DUAL GAMMA
ARITH MEAN * 1.34 * MEDIAN * 1.35 * STD DEV * 0.19 * RANGE * 0.77 TO 1.95 WITH 277 SAMPLES

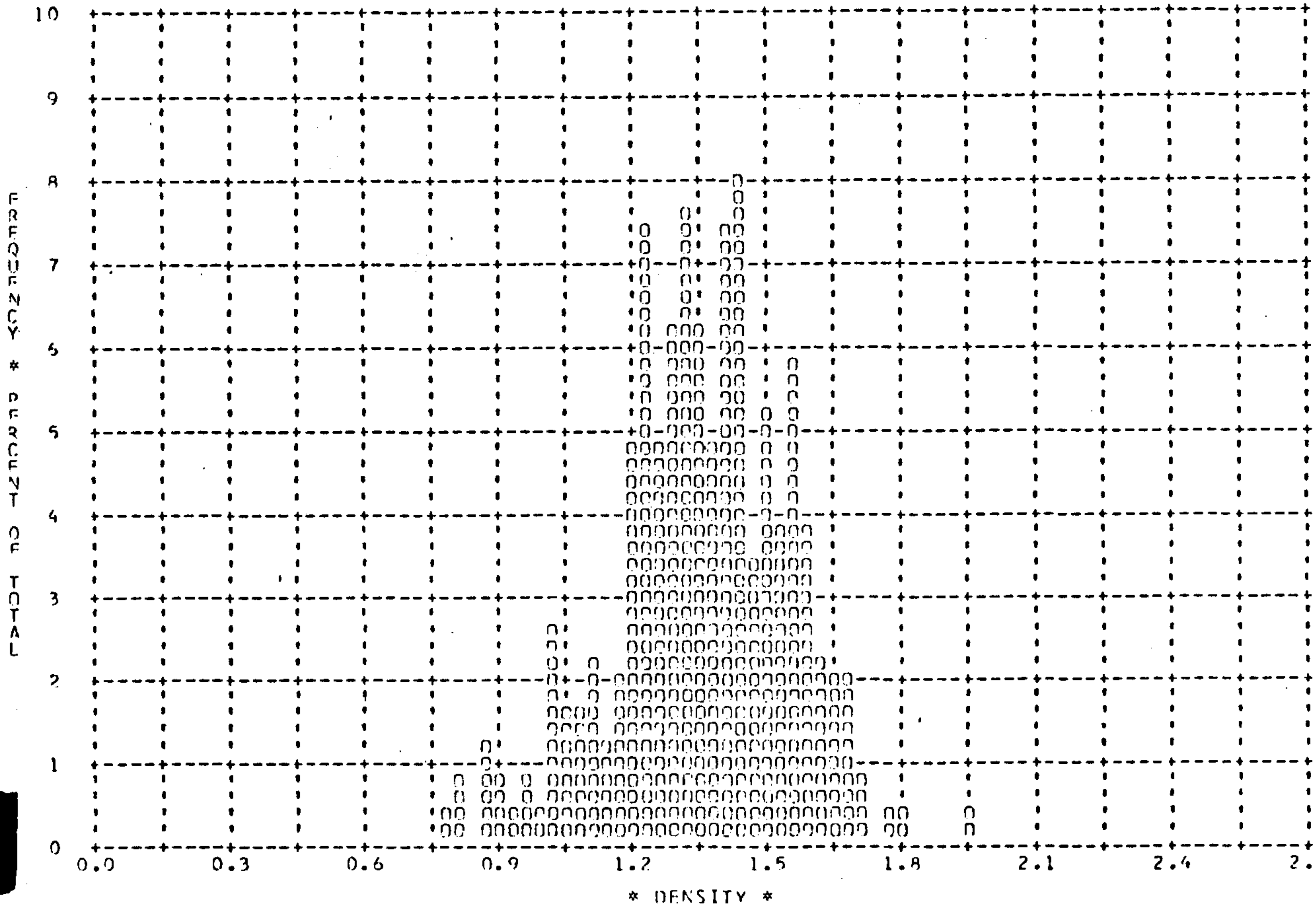


FIGURE 5-27

TOP SECRET/C

HANDLE VIA [redacted] CONTROL SYSTEM ONLY

TOP SECRET/C

MISSION * 1112-1 * INST * 300 * 01-04-71 PLOT OF DELTA DENSITIES * DUAL GAMMA *

ARITH MEAN * 0.77 * MEDIAN * 0.78 * STD DEV * 0.25 * RANGE *0.10 TO 1.45 * WITH 277 SAMPLES

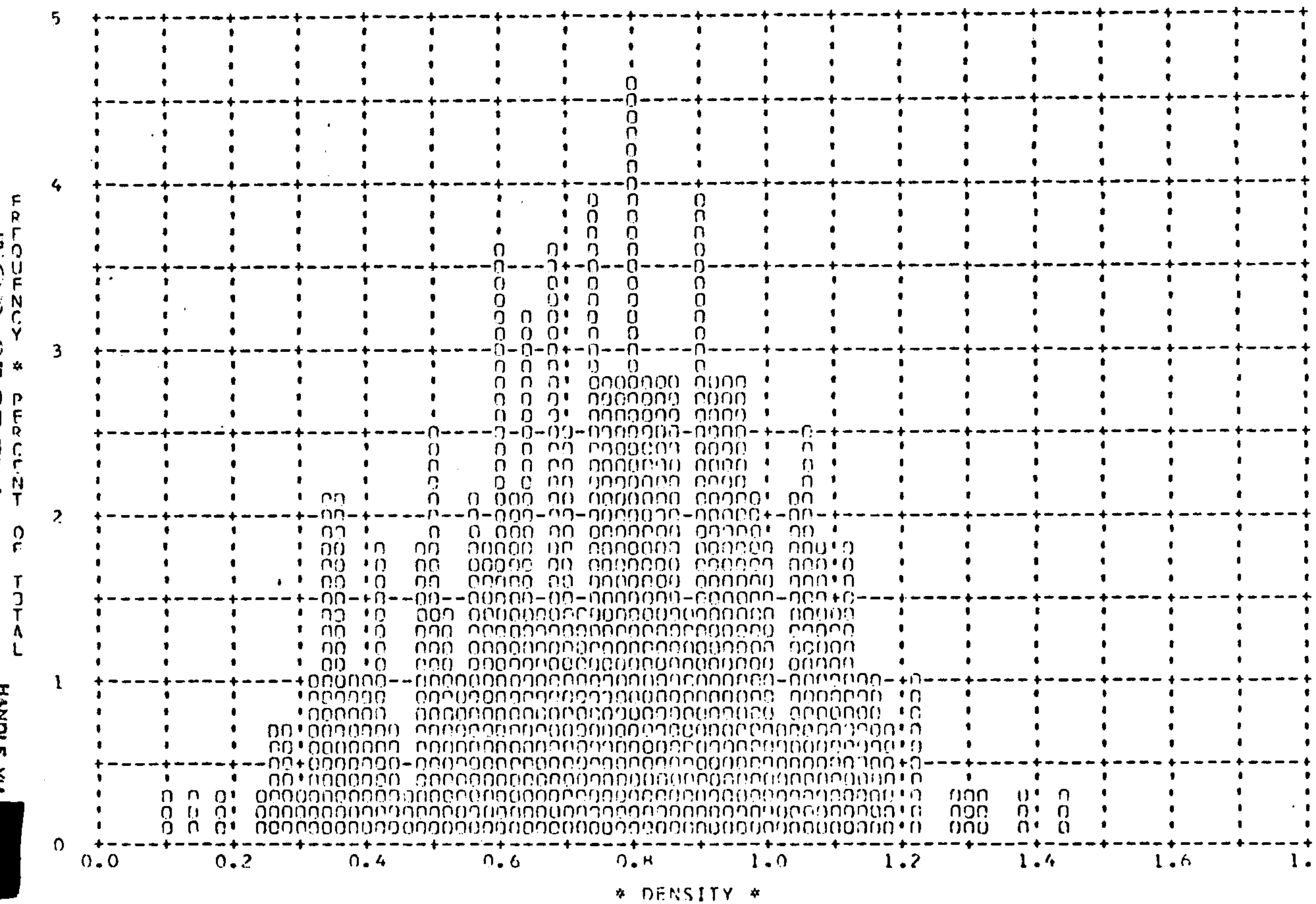


FIGURE 5-28

MISSION * 1112-2 * /INSTR * 300 * 01-04-71 PLOT OF D-MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.53 * MEDIAN * 0.46 * STD DEV * 0.21 * RANGE * 0.23 TO 1.49 WITH 578 SAMPLES

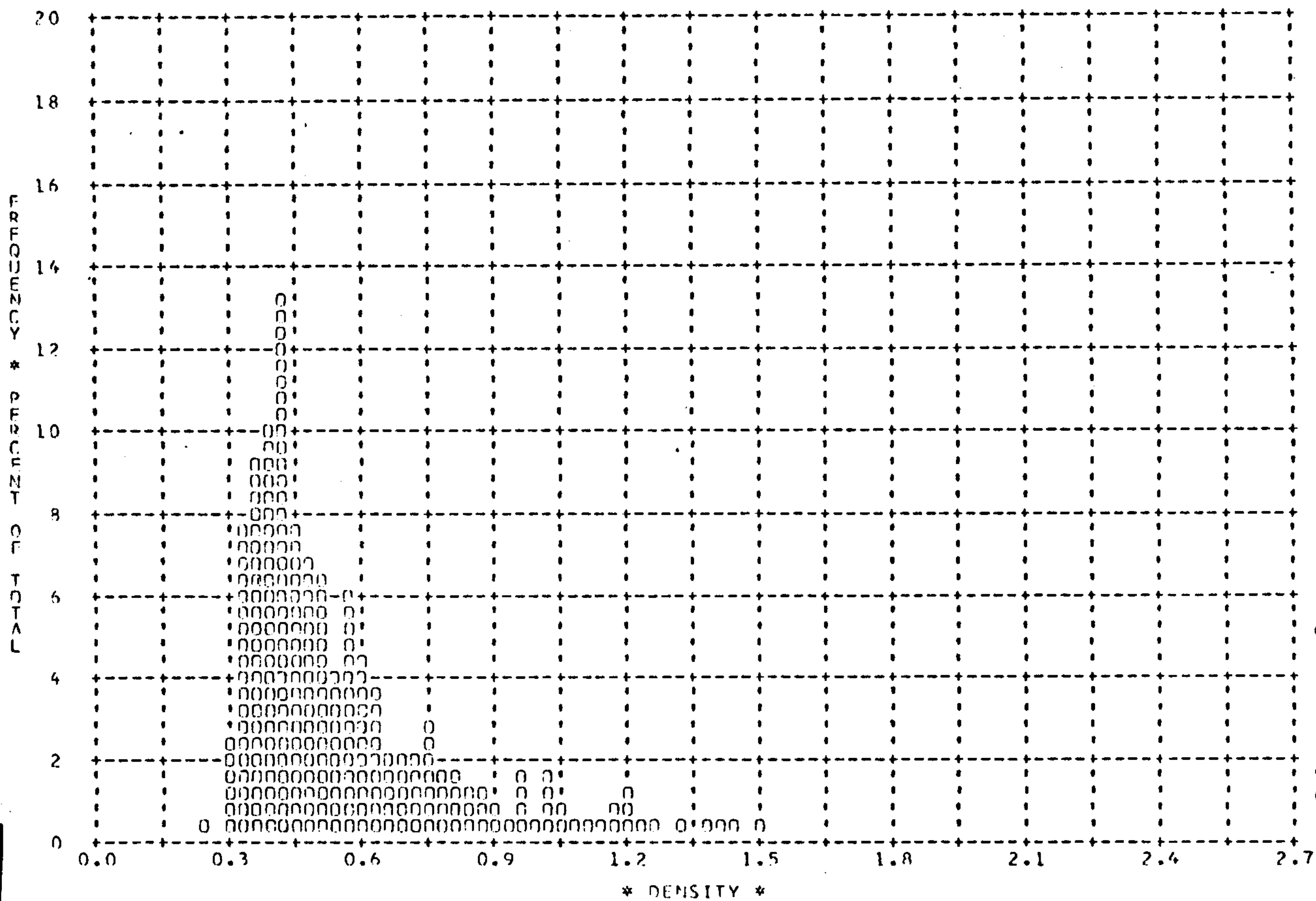


FIGURE 5-29

MISSION * 1112-2 * INSTR * 300 * 01-04-71 PLOT OF D-MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.31 * MEDIAN * 1.35 * STD DEV * 0.25 * RANGE * 0.23 TO 1.77 WITH 578 SAMPLES

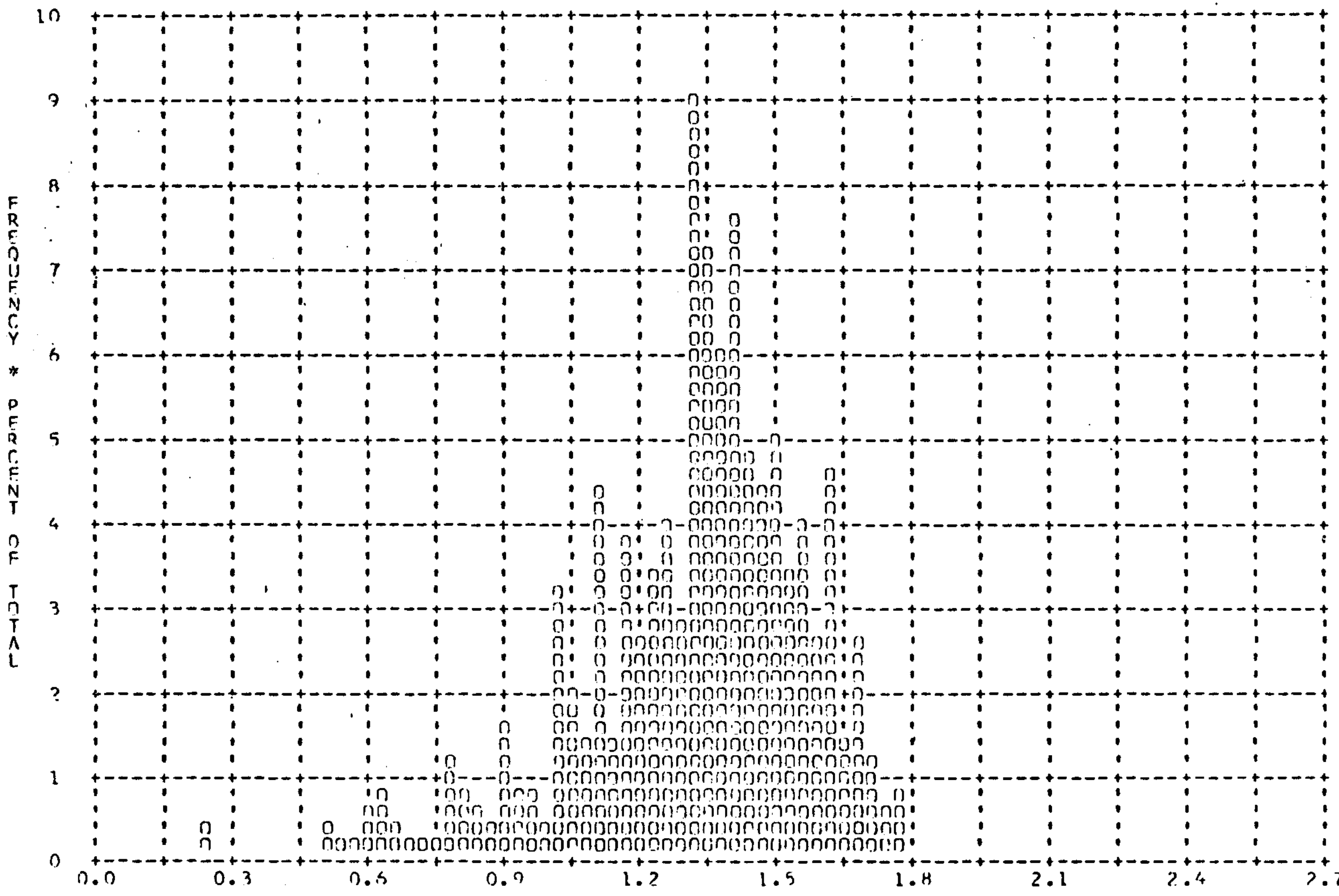


FIGURE 5-30

MISSION * 1112-2 * INST * 300 * 01-04-71 PLOT OF DELTA DENSITIES * DUAL GAMMA *
ARITH MEAN * 0.73 * MEDIAN * 0.80 * STD DEV * 0.28 * RANGE *0.0 TO 1.47 * WITH 578 SAMPLES

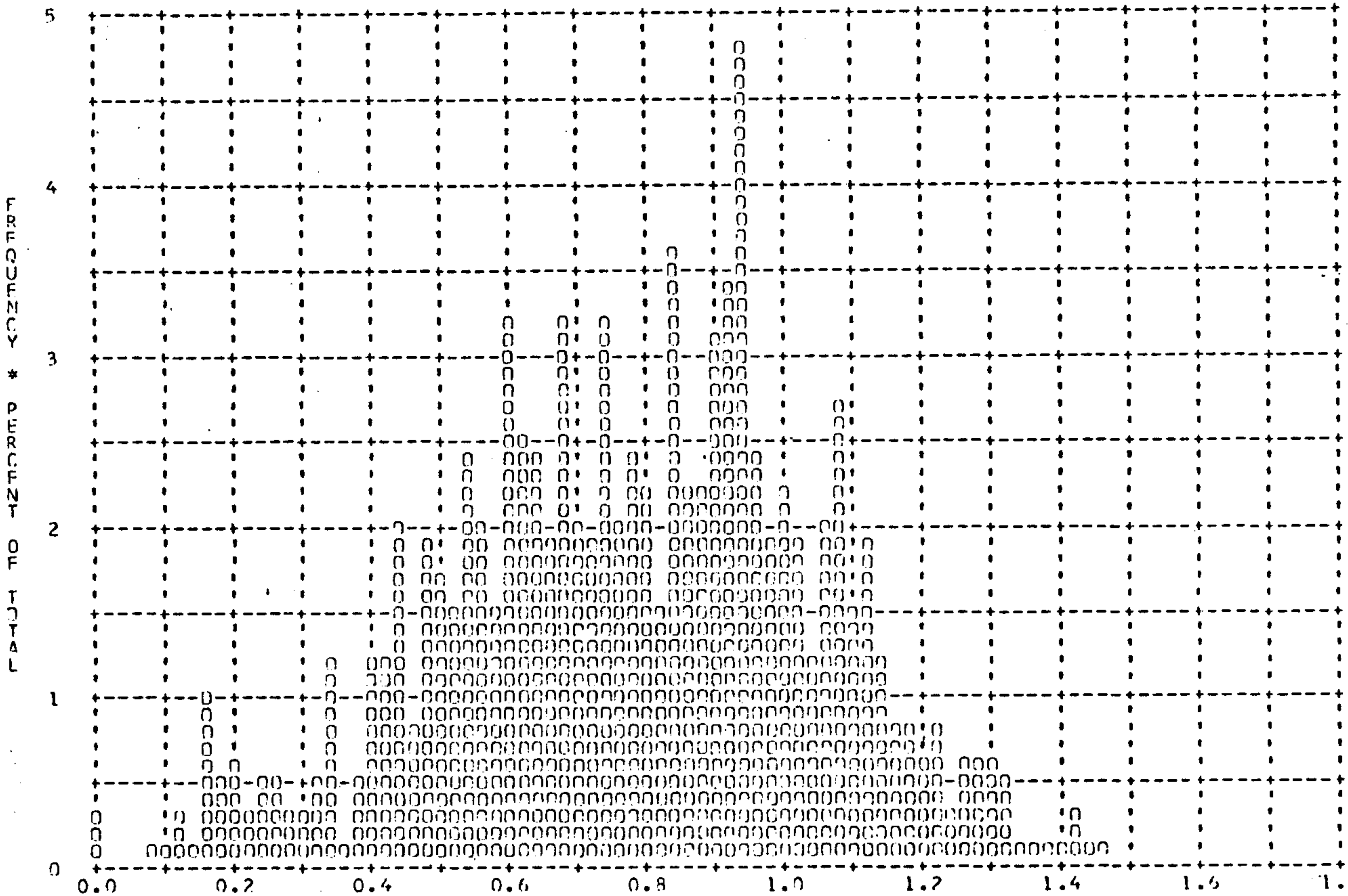


FIGURE 5-31

Comparison of the two density data sets is complicated by differences in sampling methods. The AFSPPF data for both cameras of Mission 1112-1 includes data for every frame except the first three, of selected revs. Thus the SPPF data for Mission 1112-1 forward camera includes only revs 3, 7, 22, 27, 40, 56, 71, 86, and 102. The aft camera data includes only the same revs, less rev 3. The sampling methods for the two data sets are similar for the -2 mission, with data generally collected for every tenth frame. In general, the same frames are not used. Although the differences in sampling of the -1 mission cause some statistical uncertainties, the conditions do permit some useful frame-by-frame comparisons. The principal statistical properties of the two density data sets are summarized in Table 5-3. The preceding limitations should be considered in use of this table.

While it is not the purpose of this report to provide a detailed analysis of the two data sets, there are observations and conclusions that are significant.

1. There are unexplained differences between the data sets.
2. Some of the unexplained differences appear to be systematic rather than random. However, the extent of such conditions appears to be limited to one rev or part of a rev.
3. The terrain minimum density data, most important for exposure analysis, shows good consistency (minor random variations) between the two sets.
4. The [redacted] data appear to be an adequate substitute for system exposure evaluation purposes.
5. Control limits and data management criteria for exposure evaluation have not been defined. Data from one additional mission will probably be sufficient to make such definitions.

TABLE 5-3

STATISTICAL COMPARISON* OF SPPF AND [redacted] DENSITY DATA

	1112-1 FWD		1112-1 AFT		1112-2 AFT	
	SPPF	[redacted]	SPPF	[redacted]	SPPF	[redacted]
Terrain minimum density						
Mean	0.53	0.52	0.58	0.58	0.53	0.53
Median	0.48	0.47	0.58	0.54	0.45	0.46
Standard deviation	0.21	0.20	0.20	0.22	0.22	0.21
Minimum value	0.25	0.24	0.26	0.28	0.28	0.23
Maximum value	1.19	1.48	1.34	1.36	1.31	1.49
Terrain maximum density						
Mean	1.38	1.28	1.43	1.34	1.34	1.31
Median	1.41	1.30	1.43	1.35	1.36	1.35
Standard deviation	0.22	0.19	0.17	0.19	0.26	0.25
Minimum value **	0.62	0.24	0.98	0.77	0.48	0.23
Maximum value	1.80	1.91	1.79	1.95	1.81	1.77
Terrain density range						
Mean	0.78	0.69	0.81	0.77	0.76	0.73
Median	0.82	0.77	0.80	0.78	0.80	0.80
Standard deviation	0.30	0.24	0.29	0.25	0.32	0.28
Minimum value	0.11	0.00	0.15	0.10	0.00	0.00
Maximum value	1.46	1.39	1.47	1.45	1.52	1.47
Sample size	519	468	479	277	300	578

* Significant statistical limitations of data are shown in text.

** Includes extremely low solar elevations and night engineering.

6. Mission 1112 does not appear to have had good exposure control. This is partly due to very low solar elevations beyond specified operating conditions. Data to evaluate the interaction of weather reports (snow cover) and corresponding exposure criteria has not been available.

F. TARGET DENSITY MEASUREMENTS

A technique of evaluating photographic exposure performance through microdensitometry of specified operational targets was developed under Project Sunny. The Sunny techniques were applied to Mission 1112 by AFSPPF. Because of other commitments by AFSPPF, this is the last Corona mission on which a Sunny analysis will be performed.

A total of 32 targets were analyzed. Of these, it was recommended that the exposure be increased on none and be reduced on three. Unfortunately, there are nine data errors resulting in maximum target luminances substantially in excess of 100,000 ft. Lamberts, more than ten times the normal noon maximum. The cases of recommended exposure reduction all had this defect. From other data, it appears that the three targets were overexposed but the amount, if any, can not be determined.

It appears more significant that 18 of the 32 Sunny targets had frame and/or target minimum densities less than 0.4, the lowest target density being 0.24. Examination of the data indicated several reasons why the computer analysis program did not flag these items as underexposed. All of the targets with low densities were exposed with solar elevations that should produce luminances within the capability of the flight system. The data available is not sufficient to clearly establish the existence of exposure errors and specific causes.

A general impression from examination of all of the density data available is that exposure control for this mission was not outstanding.

SECTION 6

IMAGE SMEAR

A. VEHICLE ATTITUDE AND RATES

A "Frame Time and Attitude Data" tape is supplied to Advanced Projects by NPIC. This tape contains the time word for each frame of panoramic photography. It also contains for each frame the pitch, roll, and yaw attitude elements that have been interpolated from the stellar photography of the DISIC. Using either this tape, or the time values from the system tape recorder, a computer program at A/P calculates the exposure time of each frame and compares the camera cycle rate with the APF ephemeris to calculate the V/h mismatch. Then, using the NPIC attitude data for each frame, rates are calculated and combined with the crab error required to compensate earth rotation at the latitude of each frame. The computer program rejects the first three frames of all operations as the large V/h error on the start-up cycles is not representative of the overall system operation.

Since the DISIC system failed early in the 1112-2 mission, the Frame Time and Attitude Data tape was not prepared for this mission segment. The failure of the system tape recorder at the start of the 1112-2 mission eliminated the normal source of frame time data. Although the binary times could be read directly from the individual pan camera formats, there appeared to be no operational requirement for this time-consuming procedure. Therefore, attitude and rate data are available only for the 1112-1 mission, and are summarized in Table 6-1.

TABLE 6-1

CAMERA ATTITUDE AND RATE ERRORS

			MISSION 1112-1	
Value	Units	Camera	90%	Range
Pitch error	(degrees)	Fwd	0.21	-0.40 to +0.19
		Aft	0.23	-0.52 to +0.18
Roll error	(degrees)	Fwd	0.19	-0.44 to +0.26
		Aft	0.19	-0.52 to +0.26
Yaw error	(degrees)	Fwd	0.77	0.00 to +2.10
		Aft	0.75	0.00 to +2.05
V/h error	(percent)	Fwd	1.53	-1.0 to +7.6
		Aft	1.35	-1.8 to +7.4
Pitch rate error	(^{o}/hr)	Fwd	25.21	-90 to +90
		Aft	26.94	-95 to +100
Roll rate error	(^{o}/hr)	Fwd	27.46	-34 to +66
		Aft	28.36	-36 to +96
Yaw rate error	(^{o}/hr)	Fwd	33.14	-90 to +100
		Aft	31.75	-90 to +100

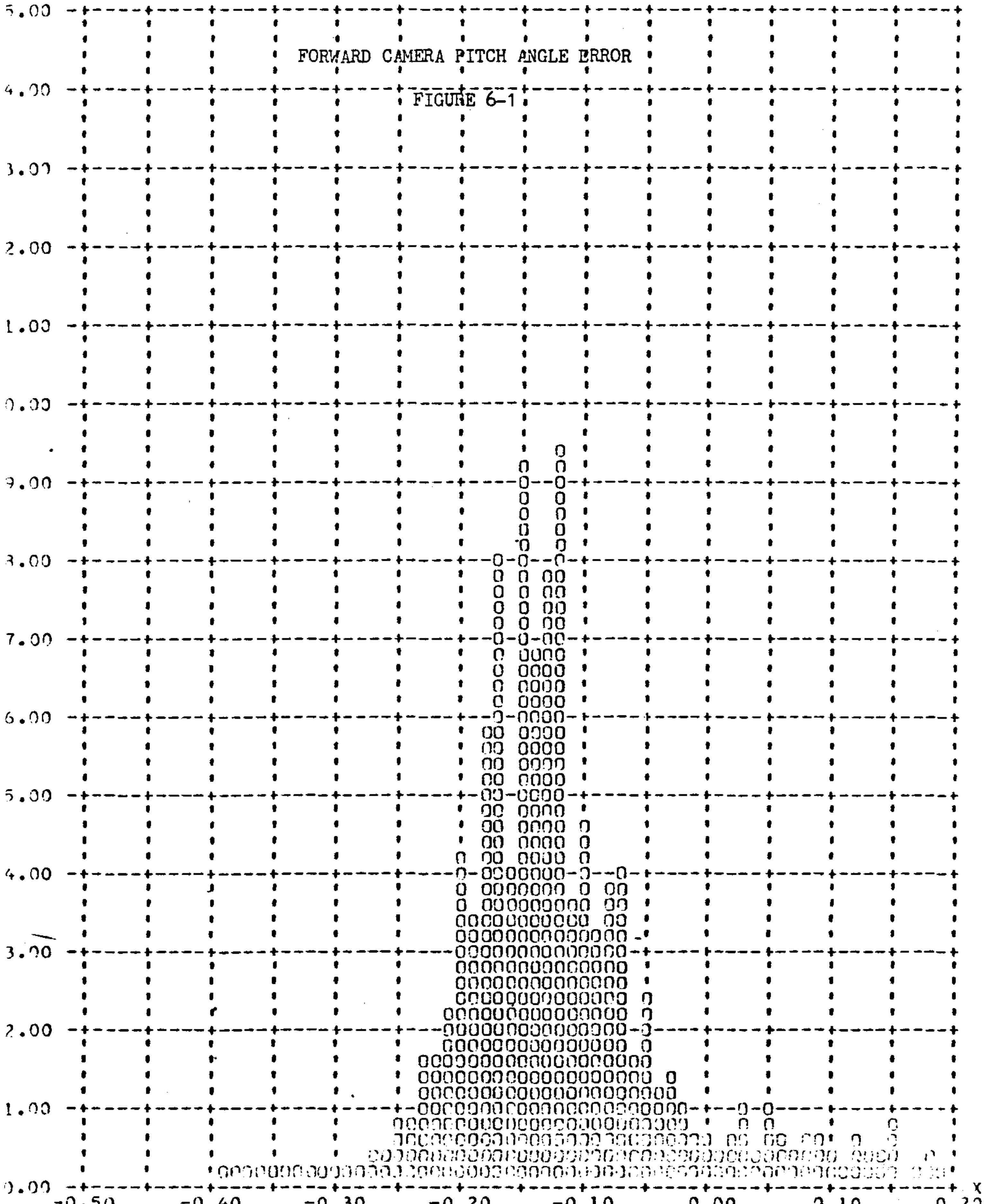
Examination of both pan camera photography and flight control gas consumption records indicates that while the entire 1112-2 mission involved mono-mode operation of the aft-looking pan camera, there was no substantial change in vehicle attitude and rate characteristics.

The Advanced Projects computer program also plots the frequency distribution of the rates and errors. These plots are included as Figures 6-1 through 6-14.

[redacted]

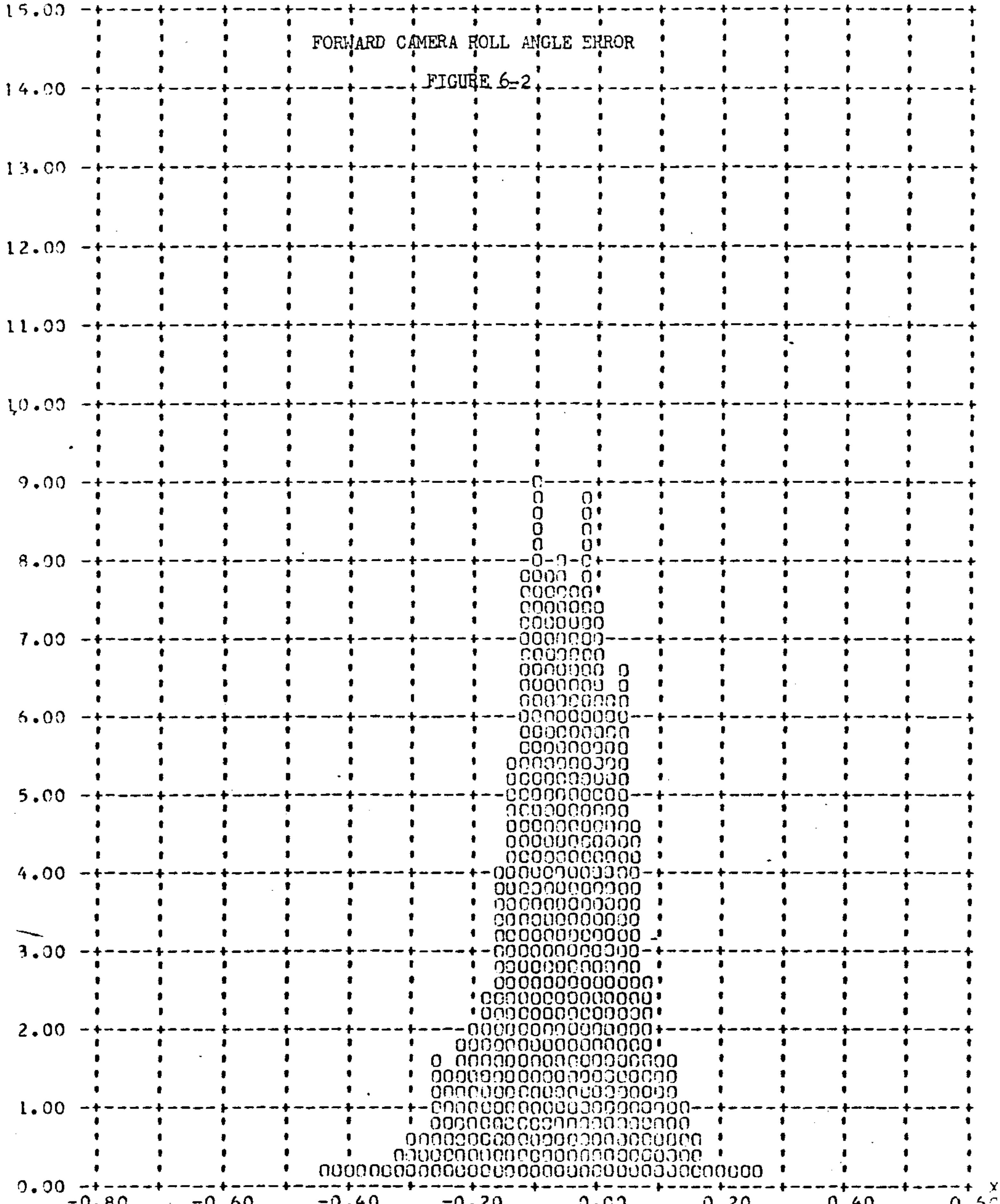
FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 0.21

Y   PITCH ANGLE ERROR - DEGREES (X) VERSUS FREQUENCY - PERCENT (Y)



FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 0.1?

Y   ROLL ANGLE ERROR - DEGREES (X) VERSUS FREQUENCY - PERCENT (Y)



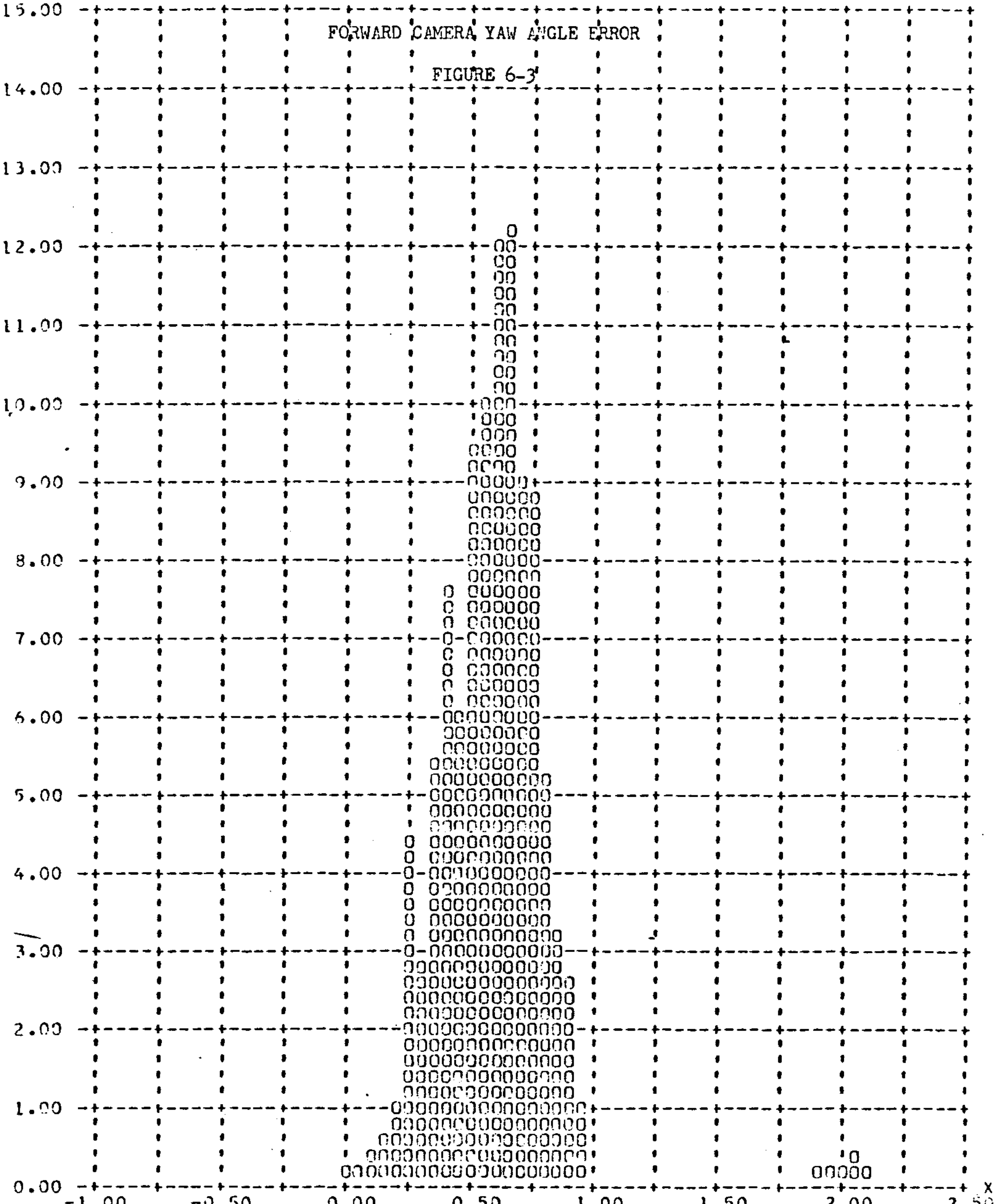
FORWARD CAMERA ROLL ANGLE ERROR

FIGURE 6-2

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 0.77

Y   YAW ANGLE ERROR - DEGREES (X) VERSUS FREQUENCY - PERCENT (Y)



FORWARD CAMERA YAW ANGLE ERROR

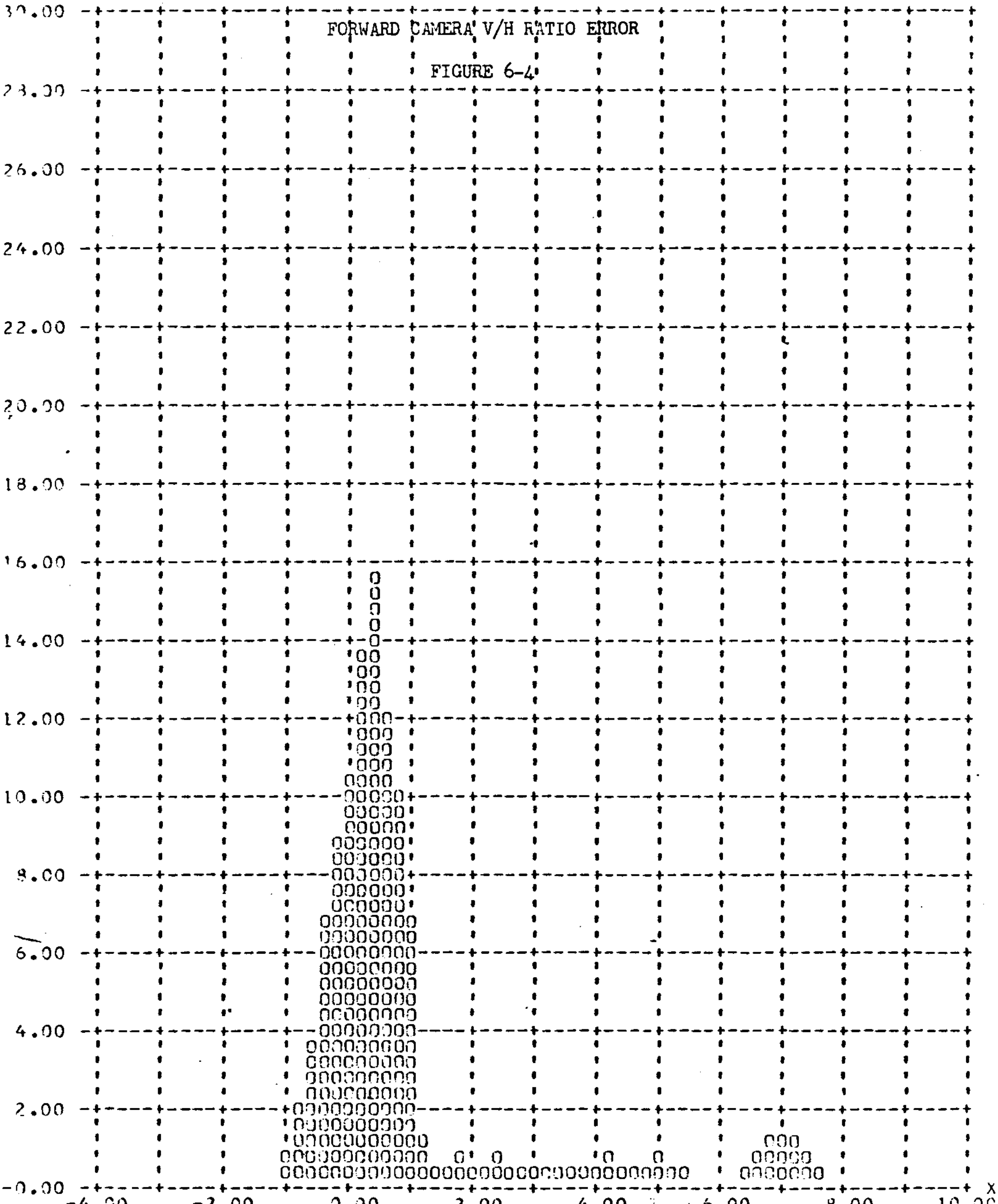
FIGURE 6-3

MISSION 1112A2   ~~TOP SECRET~~/C [redacted]

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 1.53

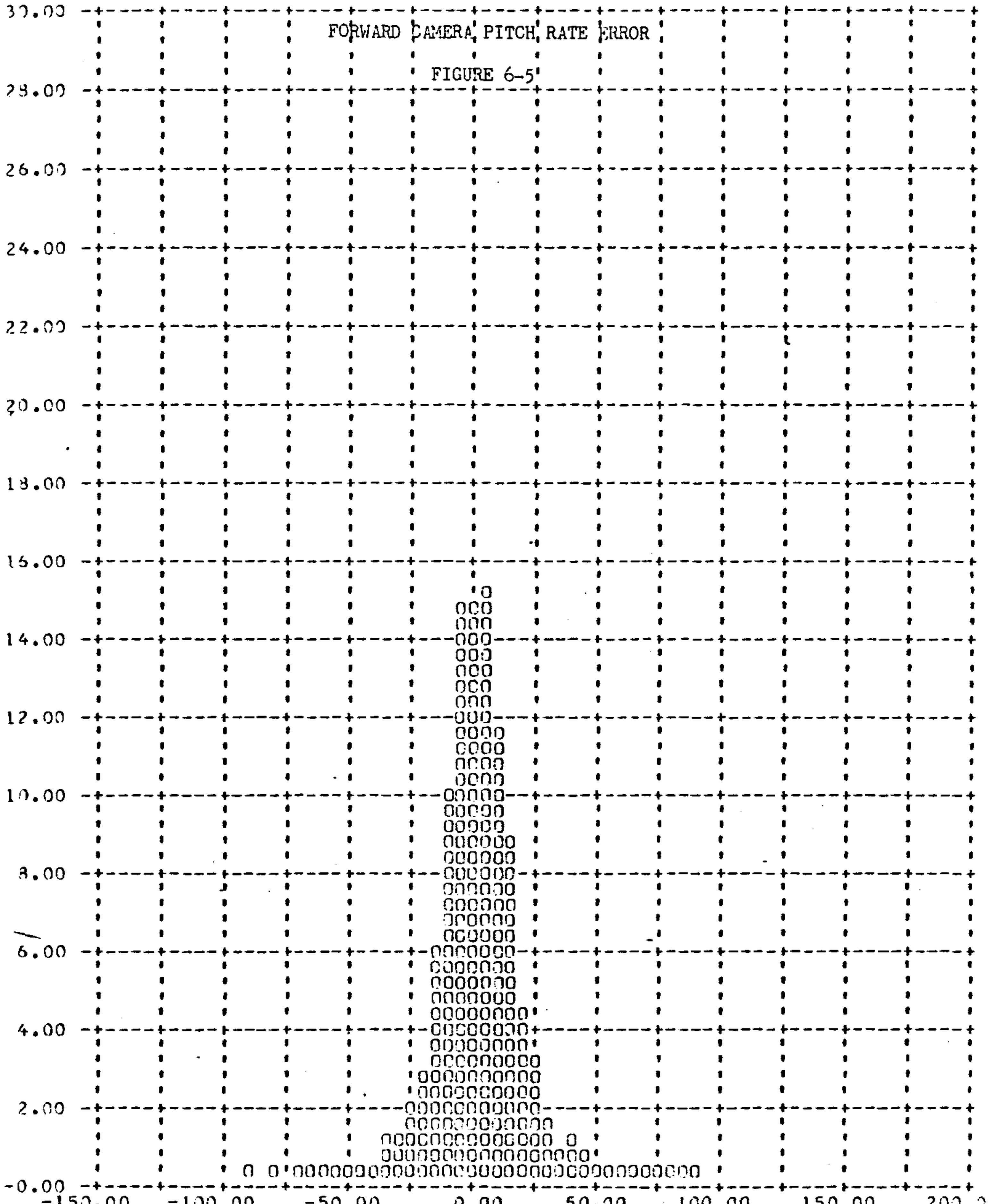
Y   V/H RATIO ERROR - PERCENT (X) VERSUS FREQUENCY - PERCENT (Y)



[redacted]

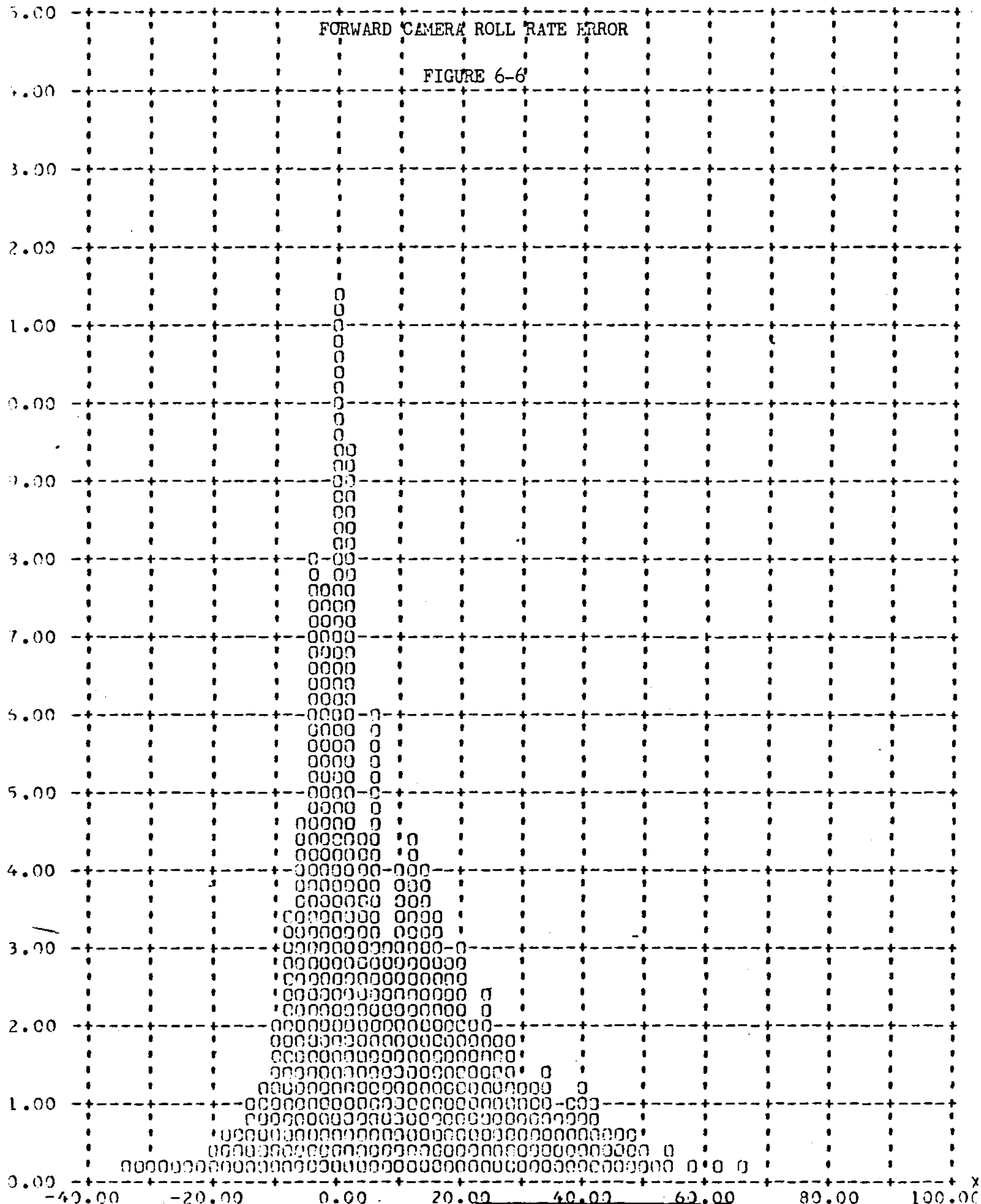
FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 25.21

Y   PITCH-RATE ERROR - DEG/HOUR (X) VERSUS FREQUENCY - PERCENT (Y)



FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 27.46

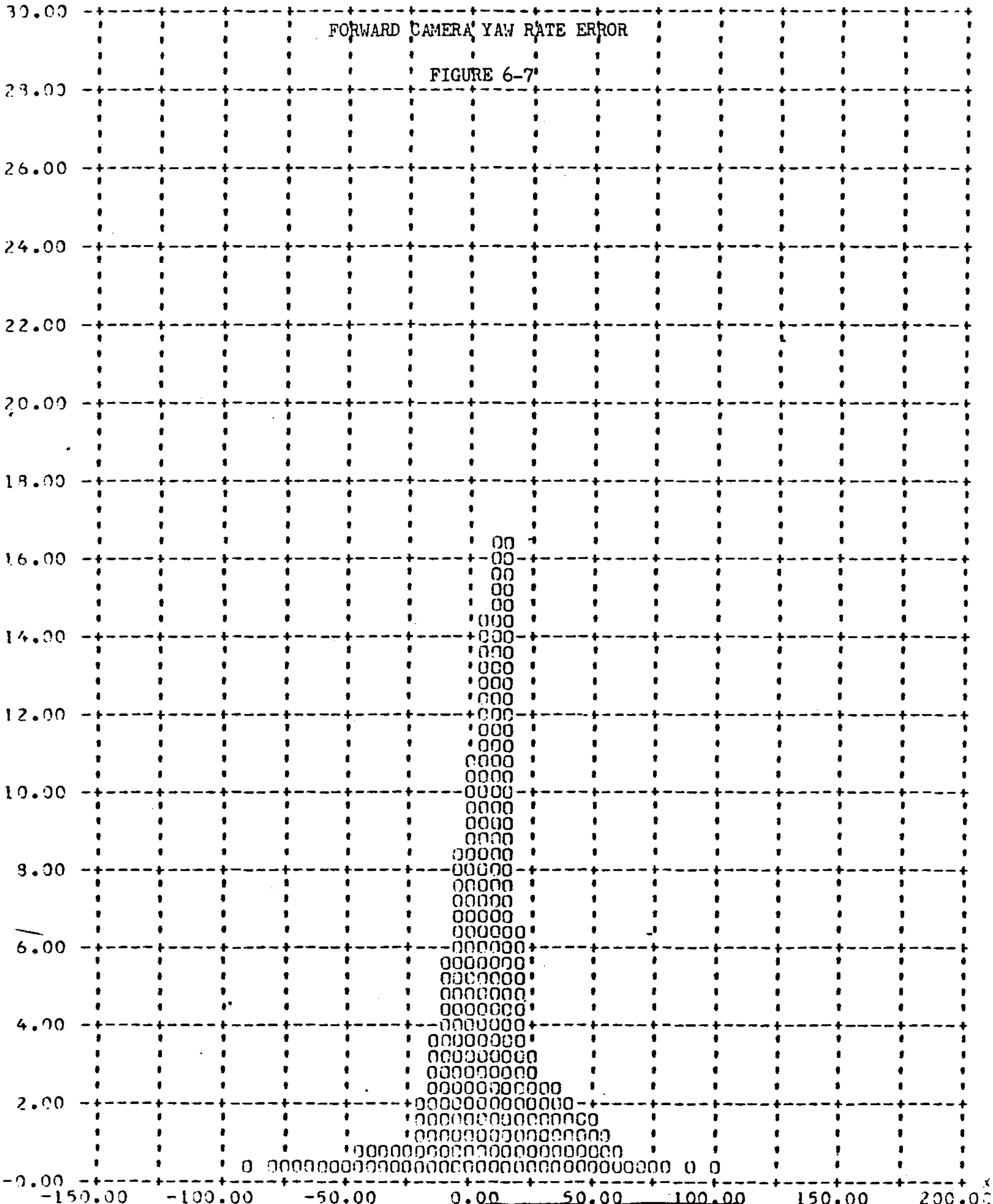
Y   ROLL RATE ERROR - DEG/HOUR (X) VERSUS FREQUENCY - PERCENT (Y)



[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 33.14

Y   YAW RATE ERROR - DEG/HOUR (X) VERSUS FREQUENCY - PERCENT (Y)

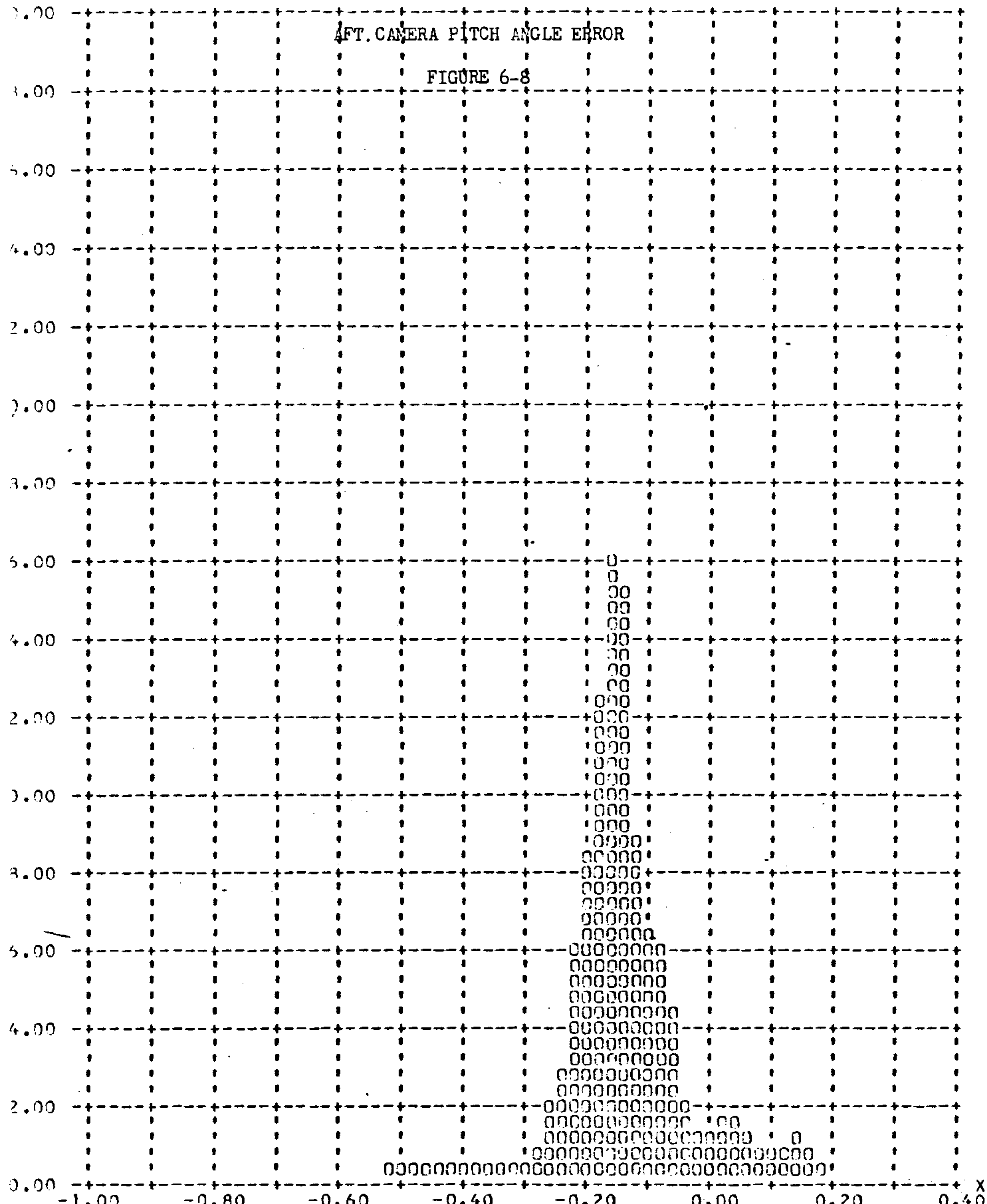


FORWARD CAMERA YAW RATE ERROR

FIGURE 6-7

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 0.23

Y   PITCH ANGLE ERROR - DEGREES (X) VERSUS FREQUENCY - PERCENT (Y)

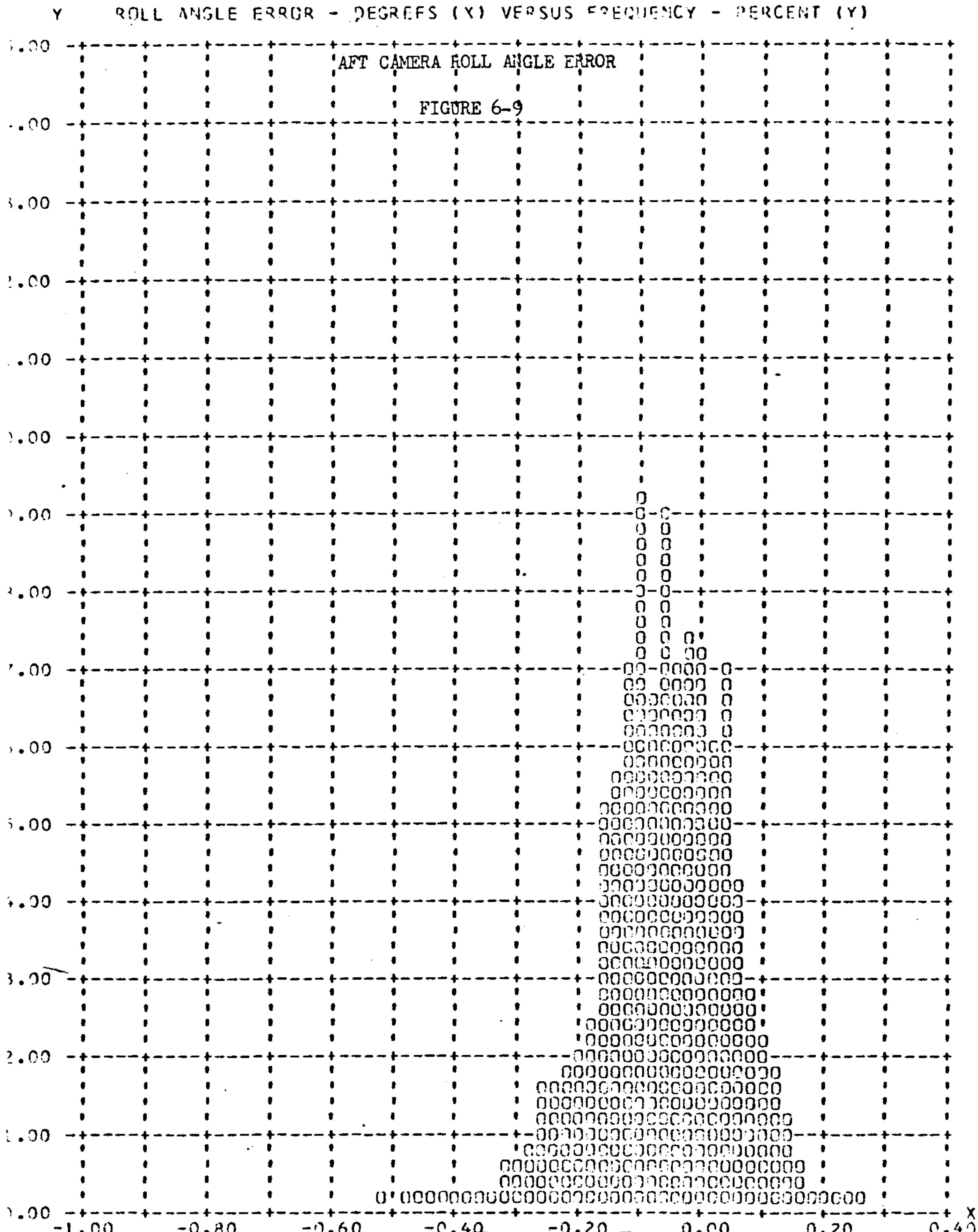


AFT.CAMERA PITCH ANGLE ERROR

FIGURE 6-8

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 0.19

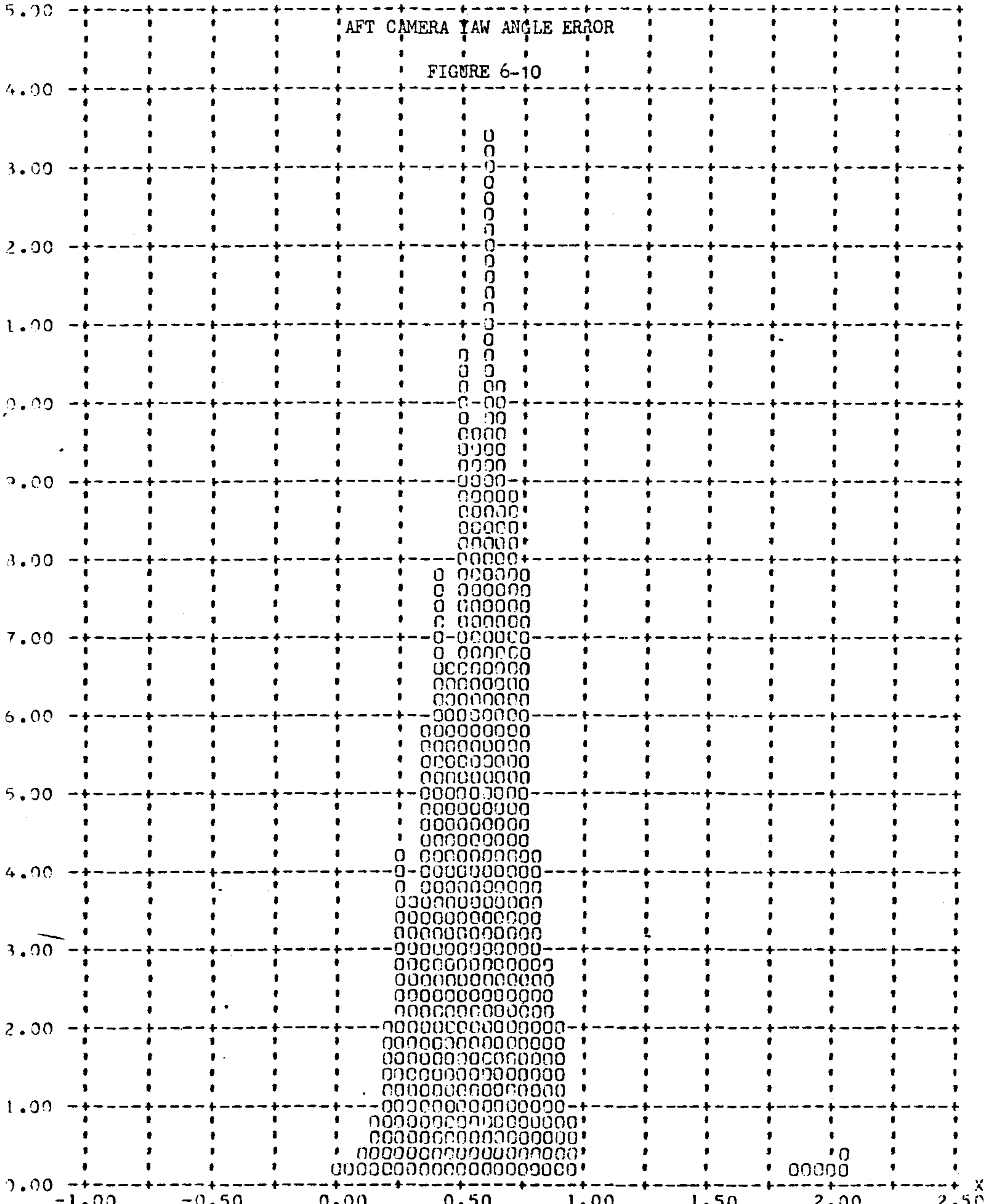


MISSION 1112A1   TOP SECRET/C [redacted]

[redacted]

FRAMES 1-3 OF EACH UP OMITTED 90 PERCENT = 0.75

Y YAW ANGLE ERROR - DEGREES (X) VERSUS FREQUENCY - PERCENT (Y)

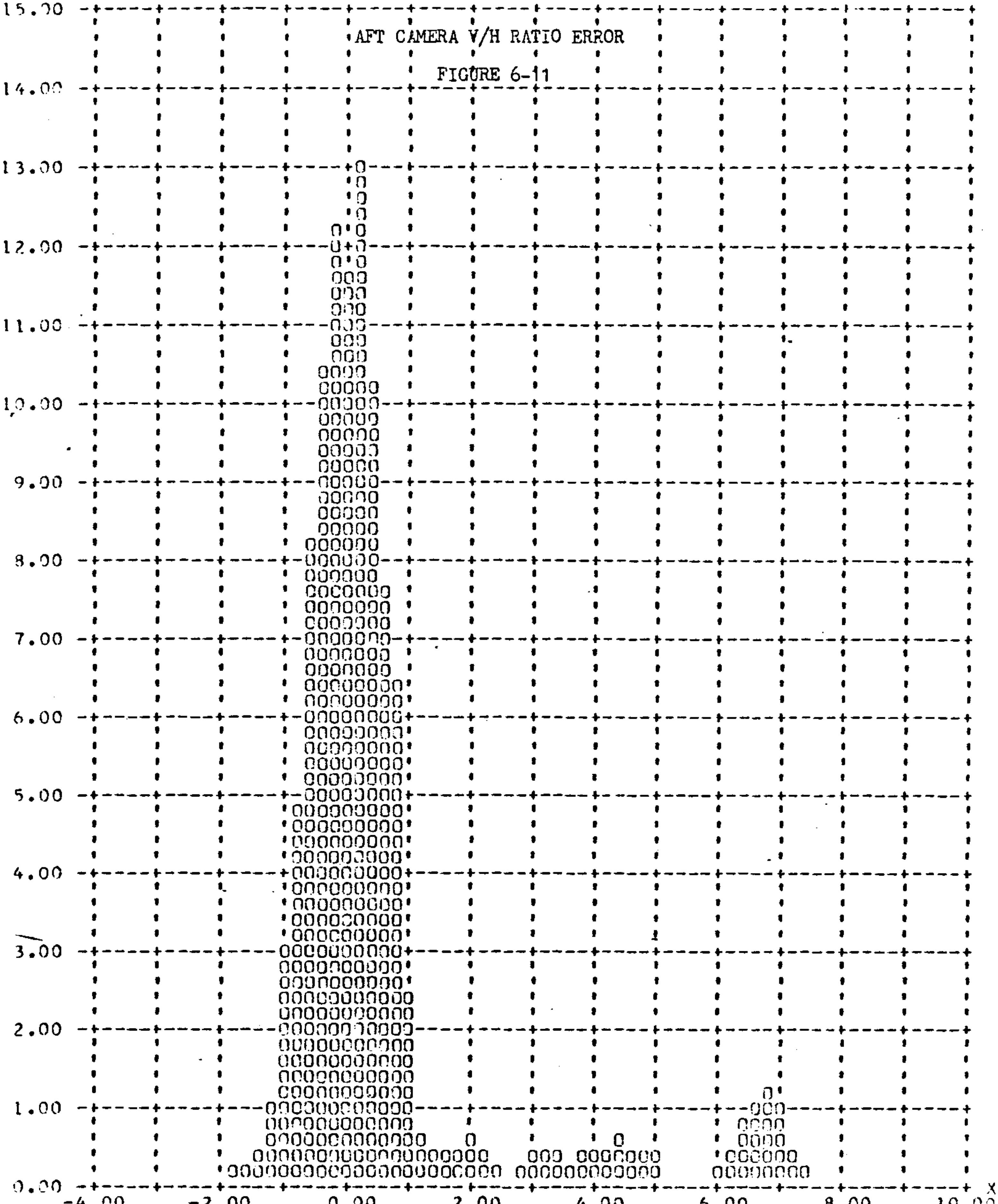


MISSION 1112A1 ~~TOP SECRET~~/C [redacted]

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 1.35

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

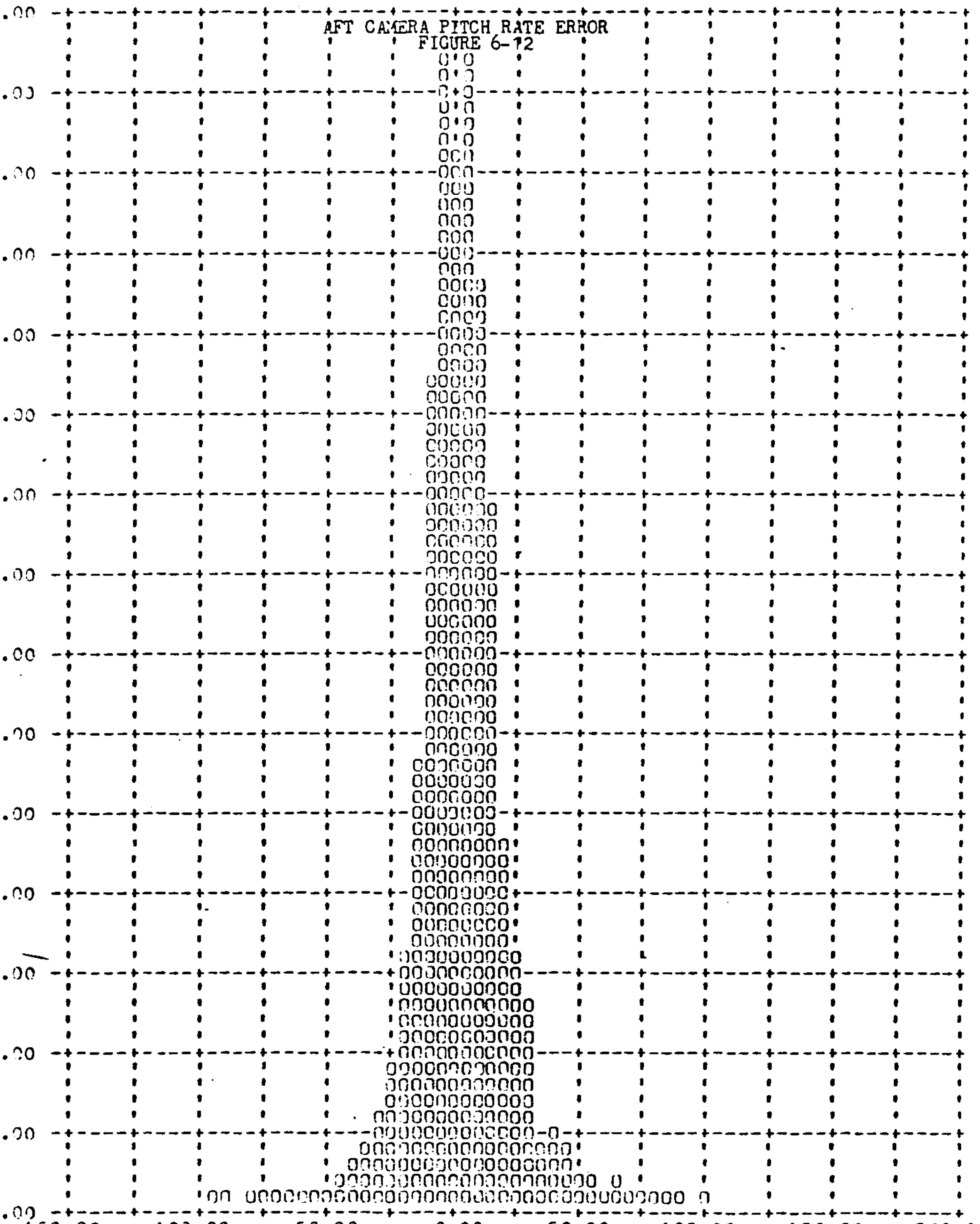


AFT CAMERA V/H RATIO ERROR

FIGURE 6-11

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 26.0%

Y   PITCH RATE ERROR - DEG/HOUR (X) VERSUS FREQUENCY - PERCENT (Y)

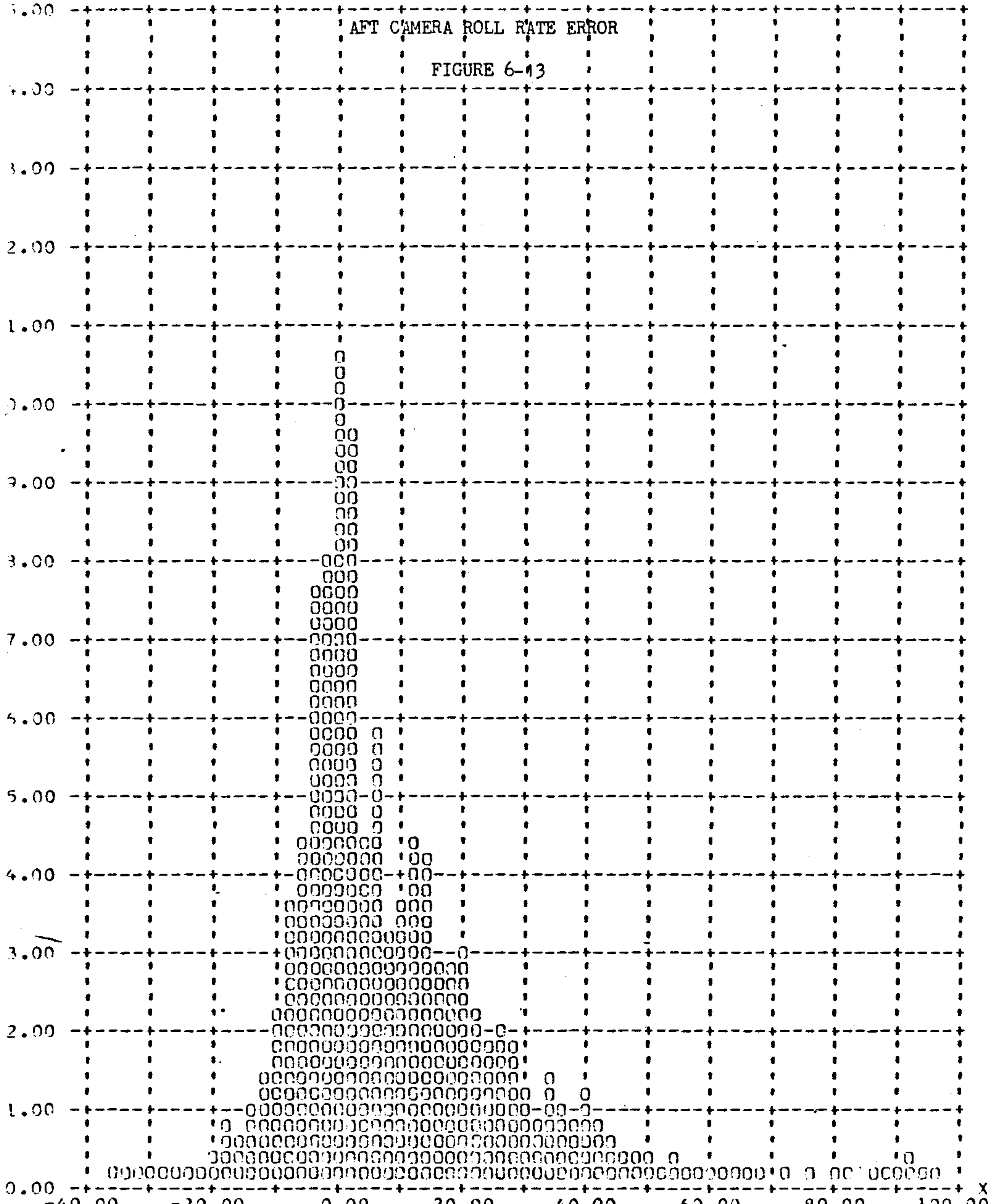


AFT CAMERA PITCH RATE ERROR
FIGURE 6-12

MISSION 1112A1   ~~TOP SECRET~~/C [redacted]

[redacted]

Y   ROLL RATE ERROR - DEG/HOUR (X) VERSUS FREQUENCY - PERCENT (Y)

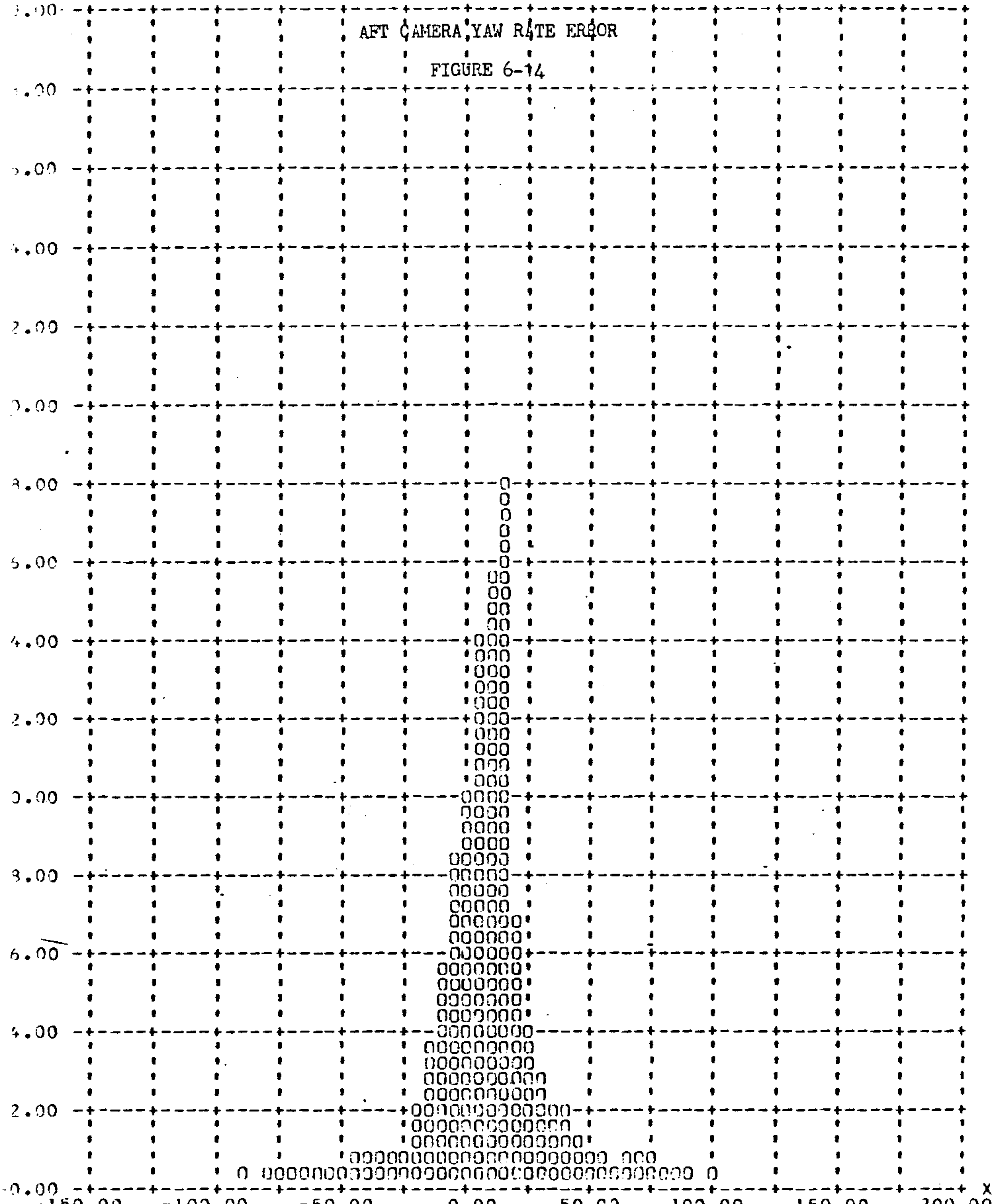


AFT CAMERA ROLL RATE ERROR

FIGURE 6-13

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 31.76

Y   YAW RATE ERROR - DEG/HOUR (X) VERSUS FREQUENCY - PERCENT (Y)



AFT CAMERA YAW RATE ERROR

FIGURE 6-14

B. SMEAR ANALYSIS

The computed attitude and rate data discussed in the preceding paragraphs are combined with panoramic camera geometry to provide measures of potential camera performance at the center of each format. One measure is the percentage error of image motion compensation. The other measure, termed "resolution limit", is equal to 70% of the motion in object space (on the ground) that occurred during the exposure interval. These values, measured intrack and cross-track, approximate the best ground resolution that could be achieved by a camera system of unlimited resolution capability. These data are summarized in Table 6-2. Corresponding frequency distribution plots comprise Figures 6-15 through 6-20.

TABLE 6-2

IMC ERROR AND RESOLUTION LIMITS

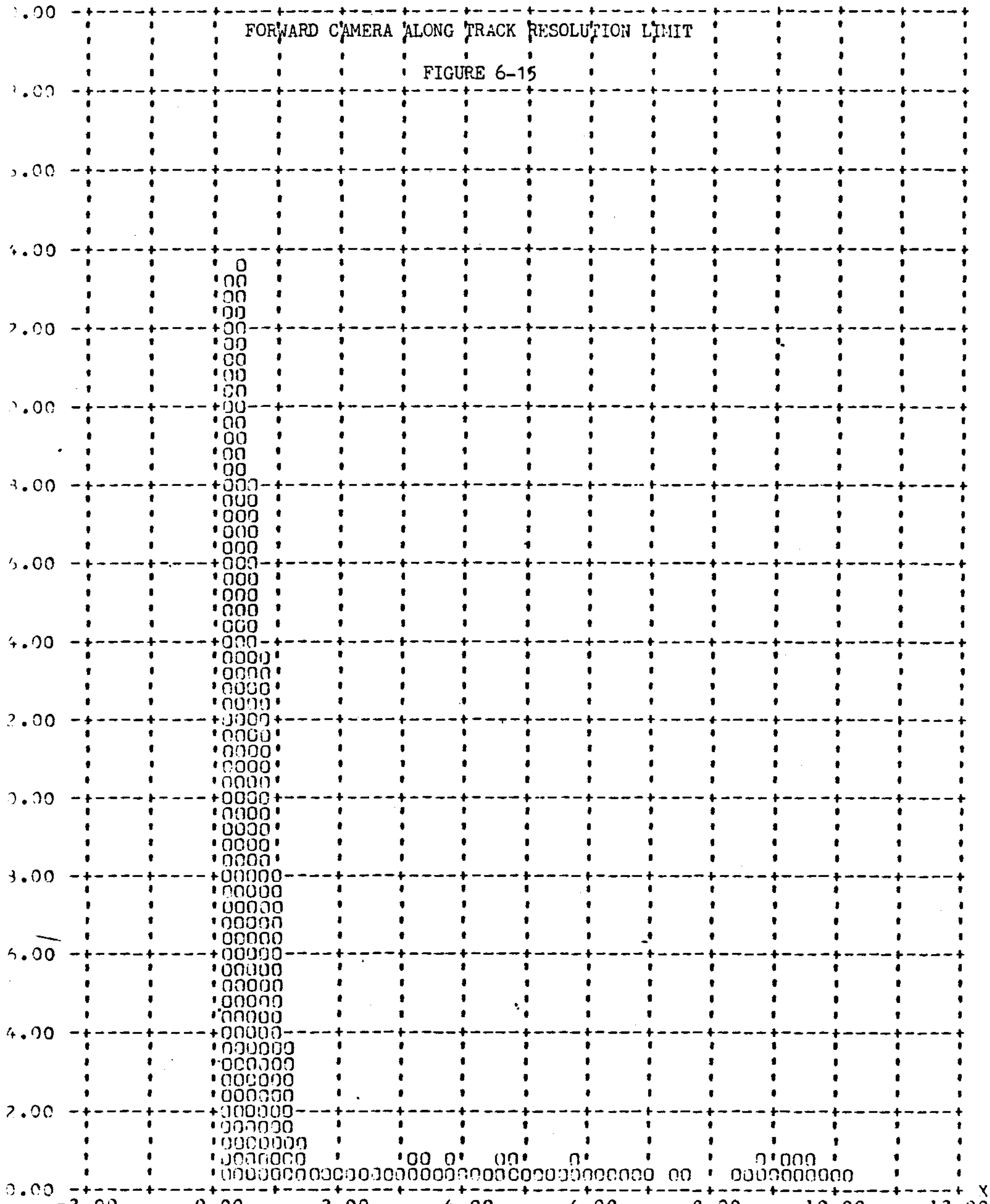
			MISSION 1112-1	
Value	Units	Camera	90%	Range
IMC Error	Percent	Fwd	1.56	-1.8 to +7.6
		Aft	1.57	-2.0 to +7.6
Intrack Resolution Limit	Feet	Fwd	1.91	0 to 10.2
		Aft	1.45	0 to 9.0
Crosstrack Resolution Limit	Feet	Fwd	6.65	1.0 to 8.4
		Aft	5.85	2.0 to 7.4

Because of the uncompensated motion, predominently crosstrack, that is inherent in the tipped panoramic camera, the crosstrack resolution limit varies greatly over the length of a format. A crosstrack smear at the center of the format will usually produce a smaller crosstrack smear to one side of the format, while the opposite side will have a much larger smear. It is this large crosstrack

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   99 PERCENT = 1.91

Y   ALONG TRACK RESOLUTION LIMIT - FEET (X) VERSUS FREQUENCY - PERCENT (Y)



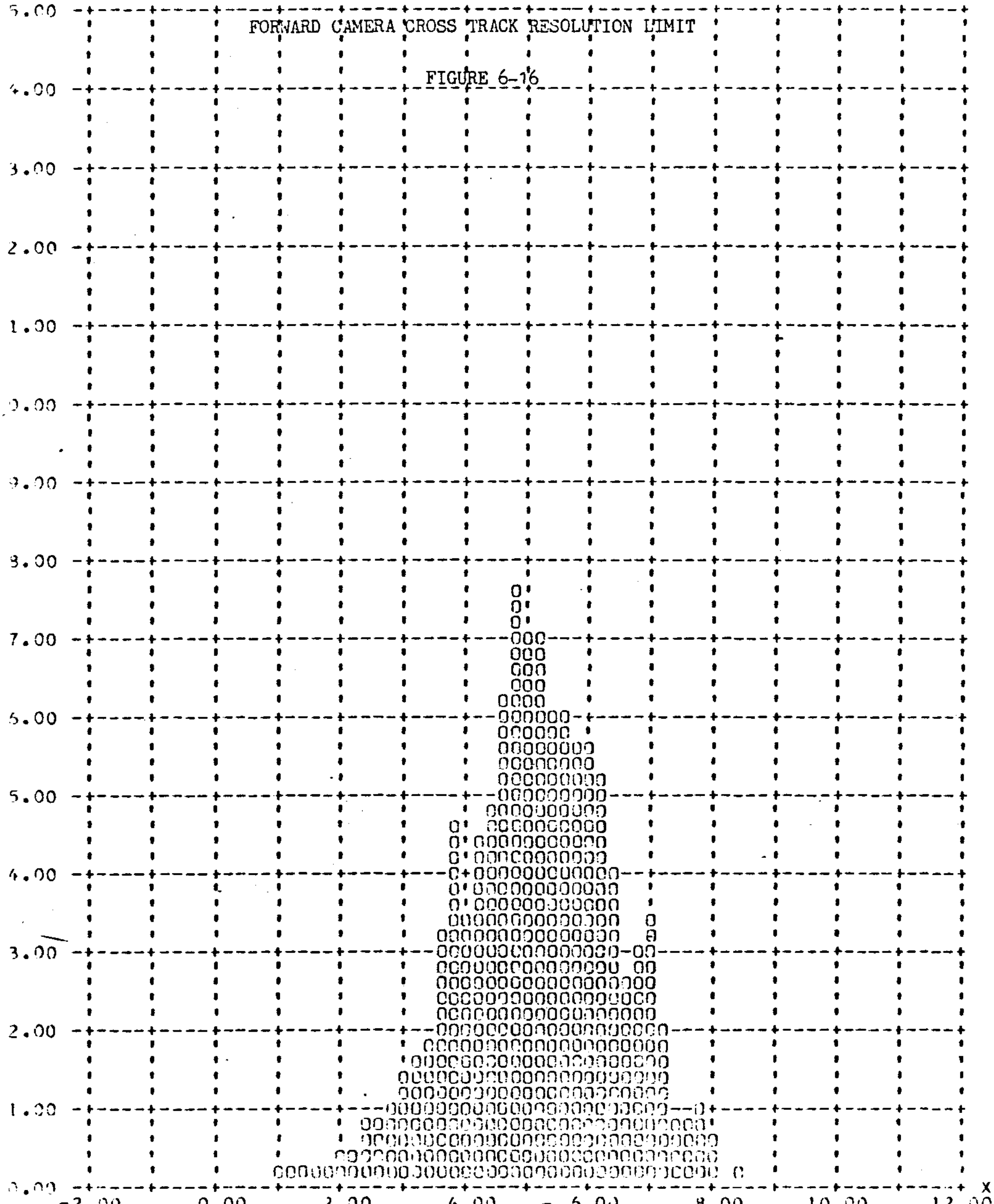
FORWARD CAMERA ALONG TRACK RESOLUTION LIMIT

FIGURE 6-15

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 6.65

Y   CROSS TRACK RESOLUTION LIMIT - FEET (X) VERSUS FREQUENCY - PERCENT (Y)



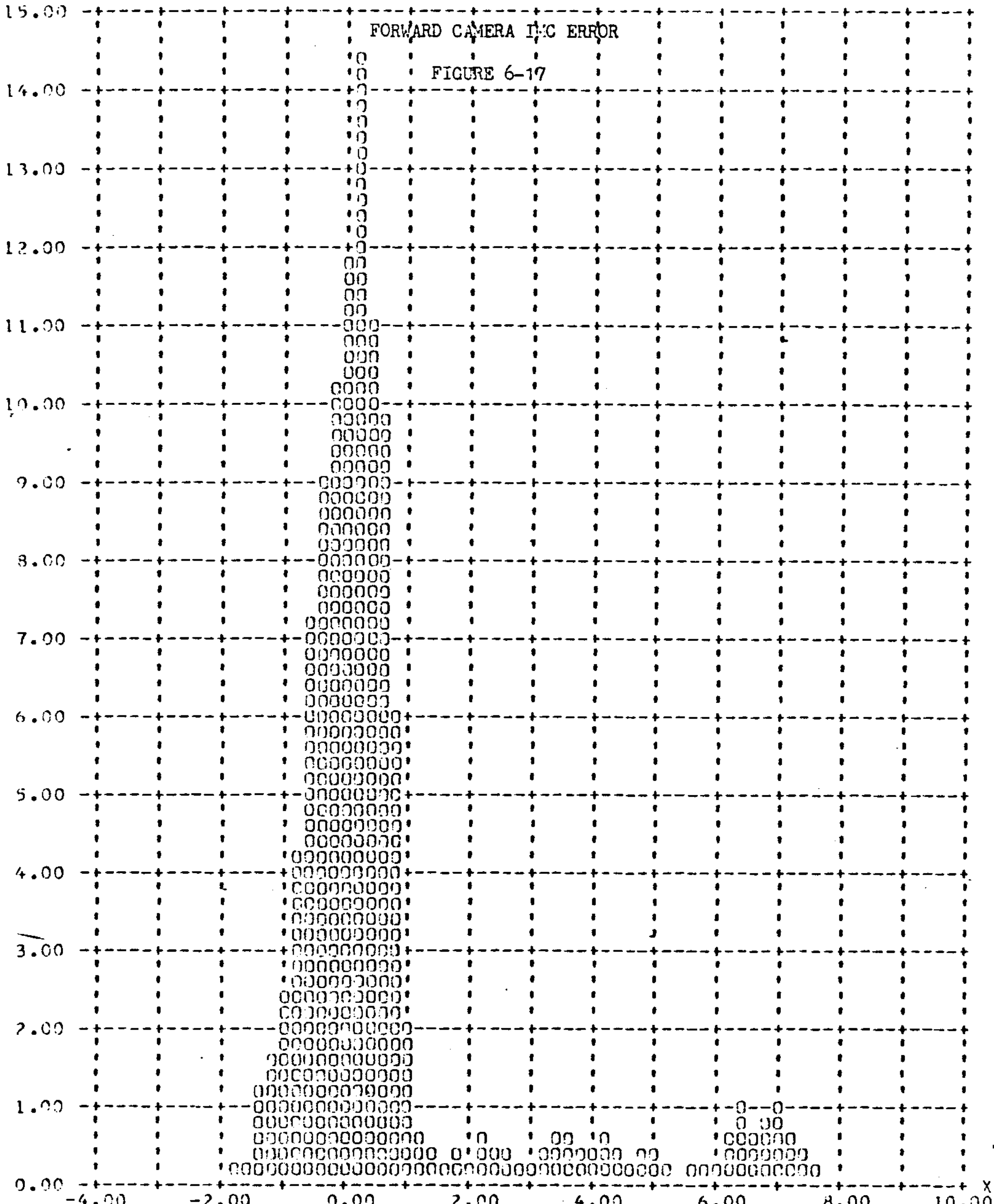
FORWARD CAMERA CROSS TRACK RESOLUTION LIMIT

FIGURE 6-16

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 1.56

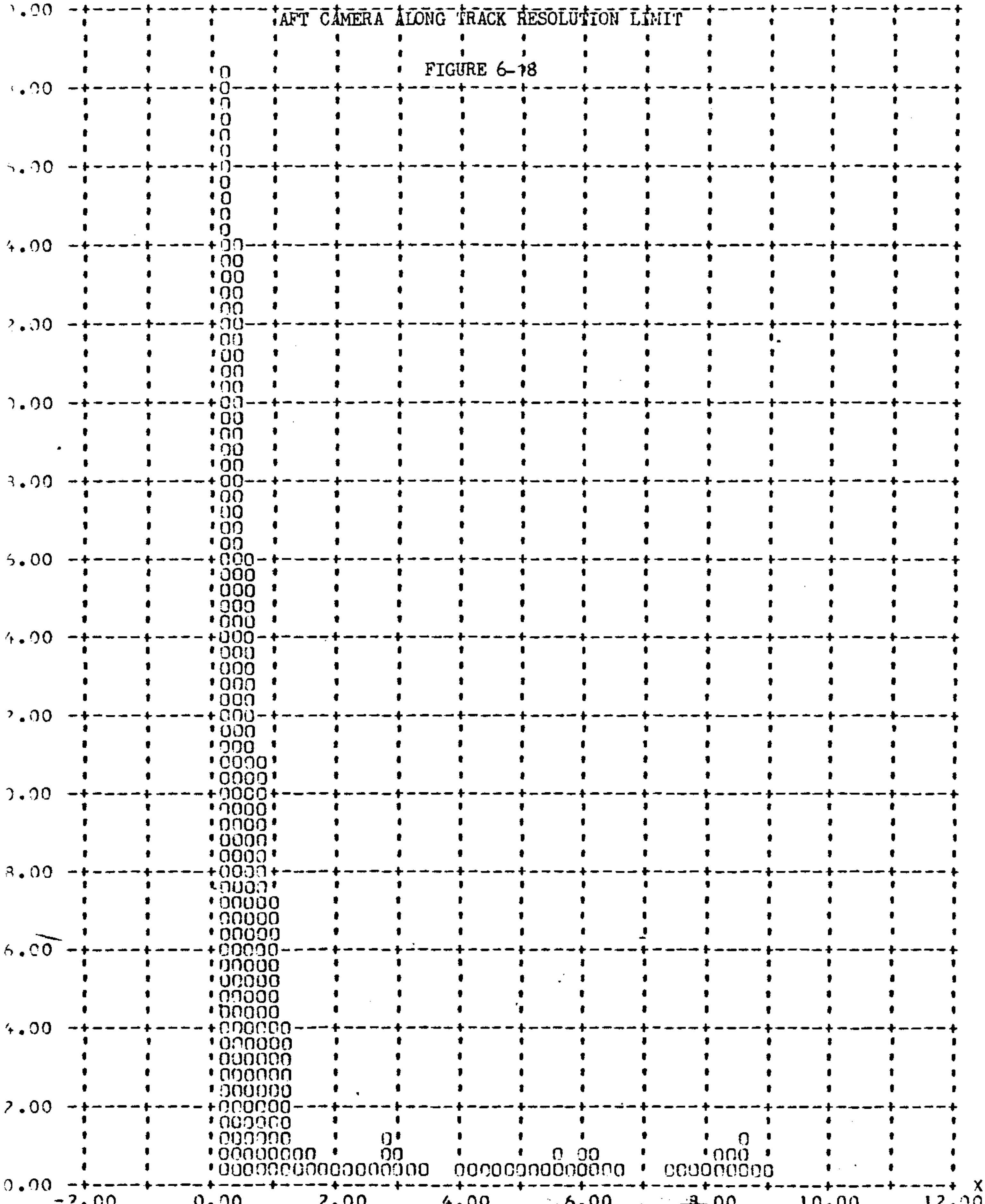
Y   IMC ERROR -- PERCENT (X) VERSUS FREQUENCY -- PERCENT (Y)



MISSION 1112A2   ~~TOP SECRET~~/C [redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT =   1.45

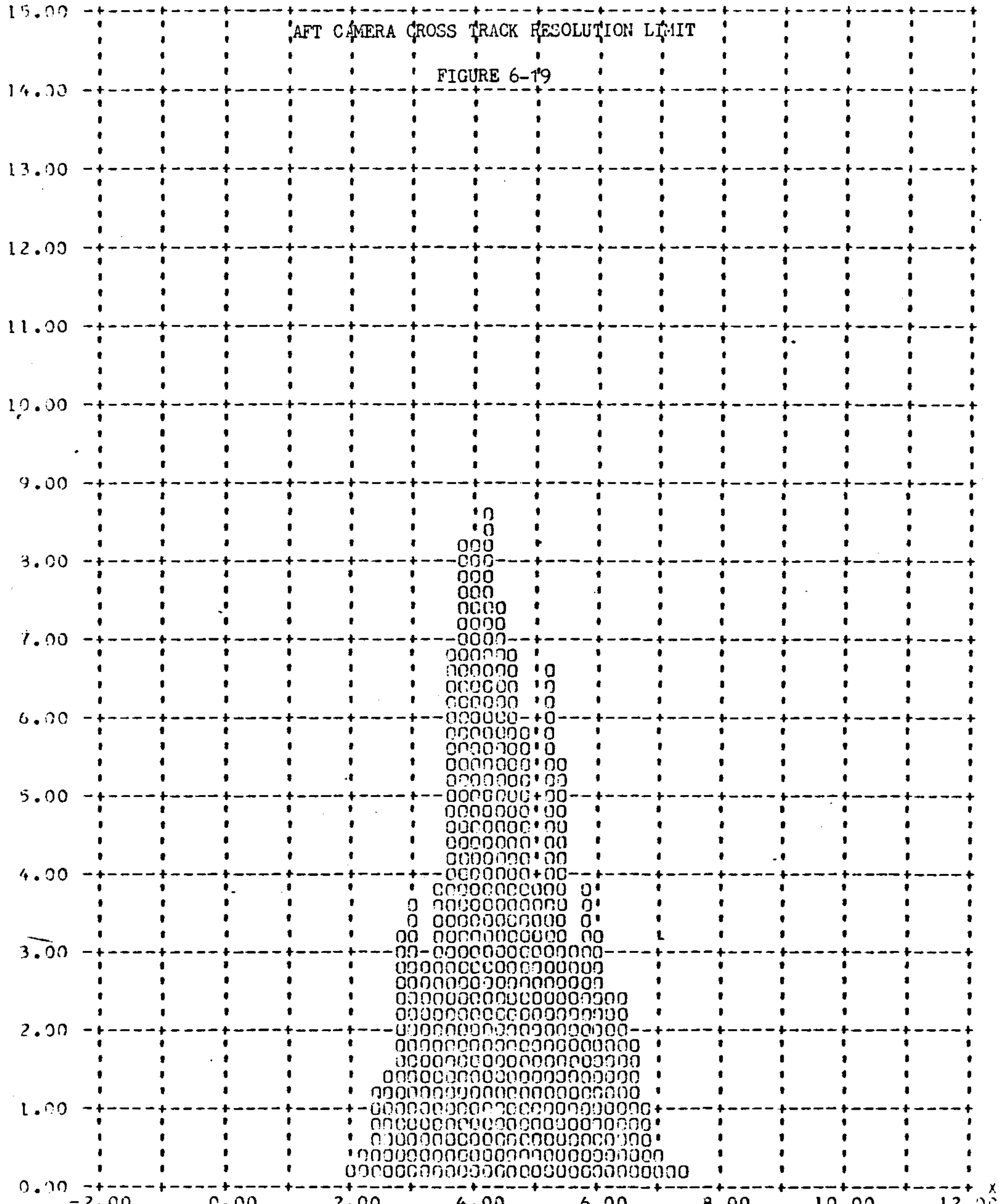
Y   ALONG TRACK RESOLUTION LIMIT - FEET (X) VERSUS FREQUENCY - PERCENT (Y)



[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 5.65

Y   CROSS TRACK RESOLUTION LIMIT - FEET (X) VERSUS FREQUENCY - PERCENT (Y)



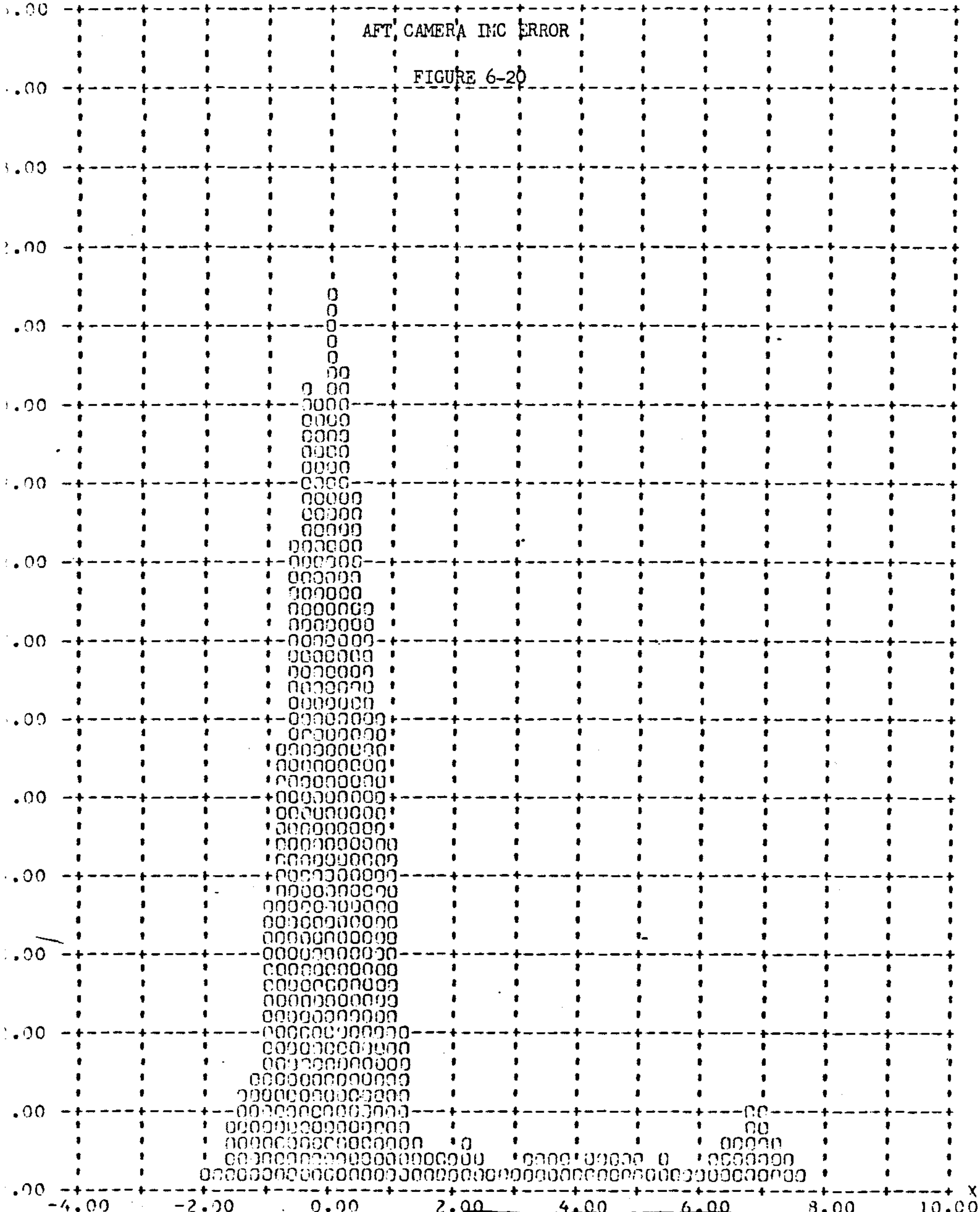
AFT CAMERA CROSS TRACK RESOLUTION LIMIT

FIGURE 6-19

[redacted]

FRAMES 1-3 OF EACH OP OMITTED   90 PERCENT = 1.57

Y   IMC ERROR -- PERCENT (X) VERSUS FREQUENCY -- PERCENT (Y)



MISSION 1112A1   TOP SECRET/C [redacted] smear at one side of the format that is often the best indication of crosstrack compensation error observed in the photography itself. It is notable that although the crosstrack error of the 1112-1 mission is above average, the associated characteristic smear was not detected.

The small number of very large intrack errors (V/h, IMC, intrack resolution) were caused almost entirely by operations at the beginning of the mission before accurate orbital elements were obtained and adjustments made for the large shift in perigee location.

SECTION 7

RELIABILITY

Reliability estimates in this section begin with samples taken from the Mural Program, M-7 system. As a result, most of the Mural Program and all of the Corona Program have been included in this analysis. The DISIC subsystem, used only on 1100 series missions, is treated separately.

Reliability estimates are shown for primary and secondary functions. In addition to the main panoramic cameras, the primary functions include three Advanced Projects provided functions: pan camera doors, command and control, and a digital clock. Together, these four categories comprise the on-orbit functions. The recovery system is regarded as a separate primary function. The secondary functions for which reliability is estimated are the horizon cameras and the DISIC subsystem.

Mission 1112 had two major failures which particularly affect the reliability estimates. The failure of the forward-looking camera occurred on transfer from "A" to "B" mission segments. The failure of the DISIC occurred shortly afterward.

In computing reliability for all repetitive or time related functions, some definition of a standard or normal mission magnitude is required. This includes all of the values listed in this section except for the pan camera doors and recovery systems. As the Corona Program has matured, the standard mission characteristics have changed, with duration and some quantities of photography increasing. The use of these increased values is necessary to relate reliability to what have become normal mission characteristics. Where a standard value is increased, the computed reliability of that function will decrease to some extent. The standard mission characteristics formerly used and now used are summarized in Table 7-1.

Table 7-1

STANDARD MISSION QUANTITIES

	Standard Quantities	
Function	Formerly Used	Mission 1112 & Up
Panoramic Cameras	3000 cycles/msn. segment	no change
Command & Control	168 hours/msn. segment	228 hours/msn. segment
Clock	168 hours/msn. segment	228 hours/msn. segment
Horizon Cameras	1500 cycles/msn. segment	no change
DISIC	4800 terrain cycles/msn.	5100 terrain cycles/msn.

In order to permit comparisons with reliability values from earlier missions, the reliability estimates summarized in Table 7-2 have been computed with both sets of standard quantities.

TABLE 7-2

ESTIMATED SYSTEM RELIABILITY

Function	Opportunities to Operate	Failures	Estimated Reliability Former Criteria	Estimated Reliability Msn. 1112 & Up
PRIMARY				
Panoramic Cameras	801,000 cycles	5	0.9790	0.9790
A/P Functions	—	-	0.9651	0.9545
Pan Camera Doors	156 msns	0	0.9955	0.9955
Command & Control	18,240 hours	2	0.9757	0.9671
Clock	18,240 hours	0	0.9936	0.9914
Combined On-Orbit Functions	—	-	0.9448	0.9344
Recovery System	127 missions	1	0.9867	0.9867
SECONDARY				
Horizon Cameras	172,000 cycles	0	0.9939	0.9939
DISIC	57,766 cycles	5	0.6784	0.6622

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