CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1110-1 and 1110-2

FTV 1656, CR-11

Approved [redacted]
Manager
Advanced Projects

Approved [redacted]
Manager
Program

[redacted]

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1656.

Lockheed Missiles and Space Company has the contractual responsibility for evaluating payload performance. This document is the final payload test and performance evaluation report for Mission 1110-1 and 1110-2 which was launched on 20 May 1970.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1110-1 and 1110-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the CR-11 payload system and to identify the source of in-flight anomalies.

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

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

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

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

SECTION 1

MISSION SUMMARY

A. MISSION OBJECTIVES

The payload section of Mission 1110, placed into orbit by Flight Test Vehicle 1656 and THORAD Booster (SLV-2H) S/N 69-045, 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 CR-11 payload system. The Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. An eight day -1 mission and a seven day -2 mission was planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2135:10Z (1435:10 PDT) on 20 May 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, Calif. Mission 1110-1 consisted of an 11-day operation and was completed by air recovery on 31 May 1970. Mission 1110-2 was completed with an air recovery on 8 June 1970 following a 7-day photographic operation.

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

ORBITAL PARAMETERS

Parameter	Planned	Orbit 2 Actuals
Period (Min.)	88.73	88.69
Perigee (N.M.)	88.5	91.0
Apogee (N.M.)	146.7	143.1
Inclination (Deg.)	83.00	83.01
Perigee Latitude (Deg. N)	38.56	41.65
Eccentricity	0.0084	0.0071

Four drag make-up rockets were fired during Mission 1110-1, and three during 1110-2.

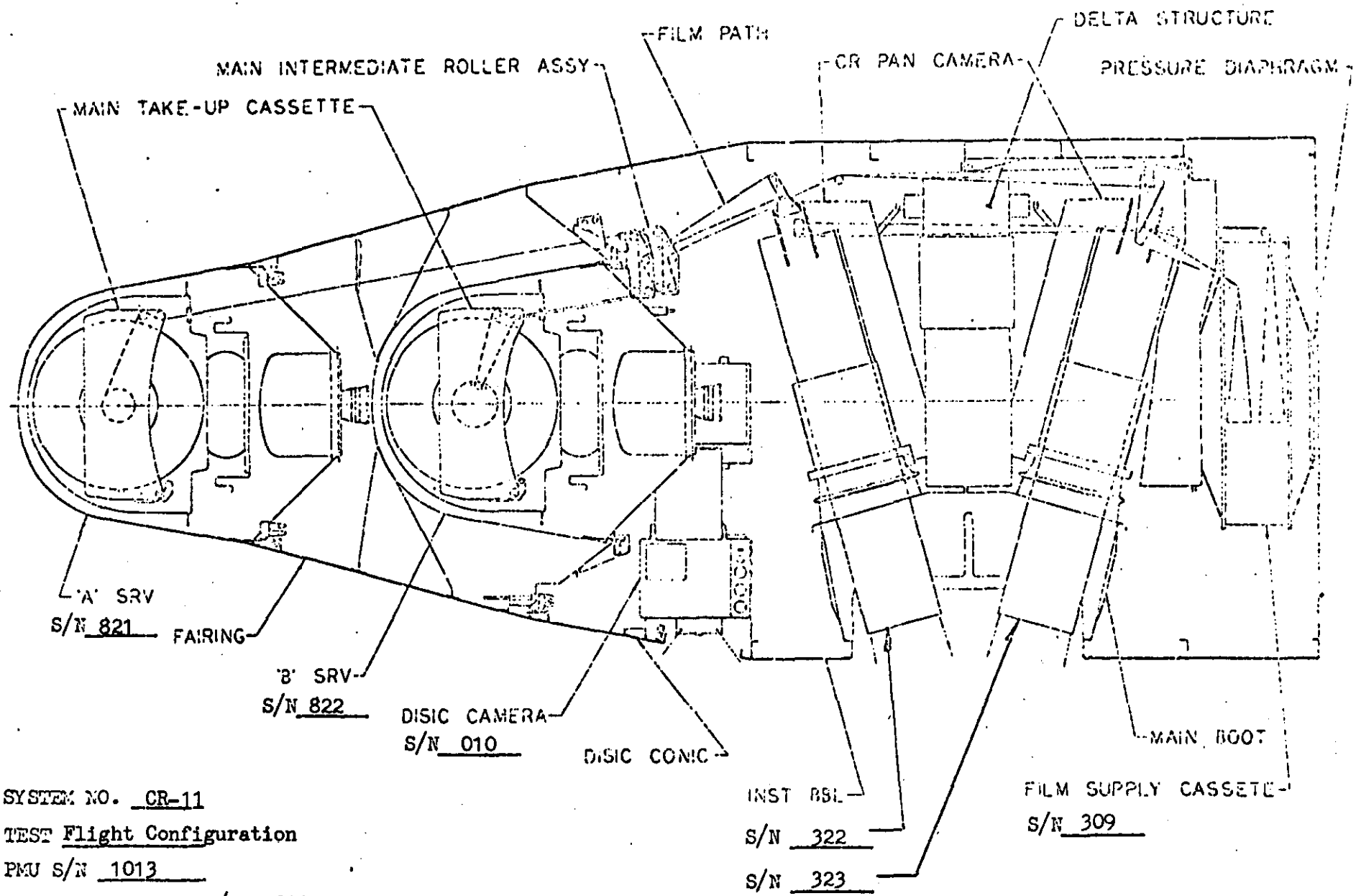
C. PANORAMIC CAMERAS

Both instruments operated satisfactorily throughout both missions. The image quality of the recovered photography was rated as good to poor by the photointerpreters. The basic assessment of the mission photography by the Performance Evaluation Team was that only mediocre performance was achieved on this mission. Both small scale imagery caused by the high altitude orbit and the poor resolution performance of the camera system during ground test were the most significant factors contributing to poor performance.

D. DISIC CAMERA

The DISIC camera operated satisfactorily throughout both missions. Although several characteristic markings are present on the record, no significant photographic degradation occurred. Approximately 12 to 20 point type stellar images are present in most stellar frames and the image quality of the index record was good where not degraded by static fog.

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-11

TEST Flight Configuration

PMU S/N 1013

SLOPE PROGRAMMER S/N 211

CLOCK S/N 624

SWITCH PROGRAMMER S/N 213

FIGURE 1-1

E. OTHER SUBSYSTEMS

With the exception of the exposure control programmer which exhibited one erroneous time out and the -1 recovery system which experienced a deceleration chute malfunction, all subsystems performed satisfactorily during the entire mission.

F. COMPONENT IDENTIFICATIONS AND SETTINGS

1. Forward Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	323
Main Camera Lens	I210
Supply Horizon Camera Lens	E23810
Take-up Horizon Camera Lens	E23768

b. Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Widths	
S_1	0.141"
S_2	0.167"
S_3	0.203"
S_4	0.108"
F/S	0.153"
Filter Types	
Primary	Wratten 23A
Secondary	Wratten 25

Film Types

Primary	Eastman Type 3404 (14300 ft)
Secondary	Eastman Type SO-349 (2000 ft)

Supply (Port) Horizon Camera:

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

Take-up (Starboard) Horizon Camera:

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

2. Aft Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	322
Main Camera Lens	I193
Supply Horizon Camera Lens	E40783
Take-up Horizon Camera Lens	E40772

b. Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Widths	
S_1	0.104"
S_2	0.132"
S_3	0.160"
S_4	0.080"
F/S	0.118"

Filter Types

Primary	Wratten 21
Secondary	Wratten 23

Film Types

Primary	Eastman Type 3404 (14,300 Ft.)
Secondary	Eastman Type SO-349 (2,000 Ft.)

Supply (Starboard) Horizon Camera:

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

Take-up (Port) Horizon Camera:

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

3. DISIC Camera

a. Component Assignment

Component	Serial Number
Camera	010
Index Reseau	114
Stellar Reseaus	
Port	9P
Starboard	12

b. Camera Data and Flight Settings

Stellar Cameras:

Lens	3 in. f/2.8
Exposure Time	1.5 seconds
Filter Type	None
Film Type	Eastman Type 3401 (2000 Ft.)
Aperture Setting	f/2.8

Index Camera:

Lens	3 in. f/4.5
Exposure Time	1/500 second
Filter Type	Wratten 12
Film Type	Eastman Type 3400 (2200 Ft.)
Aperture Setting	f/6.3

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 CR-11 during pre-flight testing are as follows:

A. ENVIRONMENTAL TESTING

Payload system CR-11 was tested in the environmental HIVOS chamber; in Aschenbrenner Grid Test (AGT) configuration from November 17 through November 24 1969.

1. HIVOS Test

Pan Instruments

The test was performed using SO-380, UTB material. Instrument system operation was generally satisfactory with the exception of a number of anomalies as follows: the forward looking instrument's supply horizon shutter failed open several times during the test. The forward looking instrument failed to shut down twice after a long run and failsafe occurred once at the end of the power off time delay period. The aft looking instrument exhibited weak or absent inboard rail holes.

Evaluation of the material revealed no corona or density marking was generated by the pan instruments.

Analysis of the AGT test records indicates that UTB lift increases with decreasing temperature. As a result, modified thermal conditioning was provided to obtain optimized temperature range during flight in order to minimize temperature effects on payload lift.

DISIC Camera

The material from the DISIC instrument NO. 10 exhibited a number of anomalies as follows: During the "A" mission the stellar material contained the usual skew bead marking. Stellar material obtained from the "B" mission had a corona stripe through the format area with a maximum density of 0.60 above base fog on approximately 20% of the frames. Approximately 18% of the terrain material from the "B" mission exhibited corona stripes along the edges of the frames within the format area. The terrain SLP was misadjusted resulting in out of focus dots which bloomed beyond the specified maximum diameter.

The terrain take-up rotational TM and the terrain shutter pulse TM was erratic throughout the test.

Command Subsystem

Exposure control (Uncle 101) could not be commanded manually or from the orbital programmer after rev. 2 and remained in position 11 throughout the remainder of the HIVOS test.

Pressure Make-Up Subsystem

The pressure make-up surge valve and pulser valve functioned erratically through rev 8 of the "A" mission. Both the surge valve and pulser valve malfunctioned during one operate interval in the "B" mission.

Subsystem Performance

All other subsystems including clock, exposure control subsystem, FMC programmer, tape recorders, and instrumentation subsystem functioned normally.

B. RESOLUTION TEST

Initial resolution tests were performed using SO-380 UTB material. The conversion of CR-11 from UTB to 3404 film invalidated the initial resolution tests. The preliminary resolution test using 3404 film was performed on 4 March 1970. The results indicated that the peak through focus position (for each camera) was marginal and that .0005 inch shim would have to be removed from the scan heads of each pan camera. The final resolution test conducted on 6 March 1970 using 3404 film verified that the marginal peak position had been corrected and demonstrated acceptable performance by both cameras.

Results of the through-focus resolution test on pan cameras 322 and 323 show the following characteristics:

Aft-looking Camera No. 322

Maximum low contrast resolution 125 lines/mm at -0.0010 inches peak focal position.

Fwd-looking Camera No. 323

Maximum low contrast resolution 178 lines/mm at -0.0007 inches peak focal position.

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

C. LIGHT LEAK TEST

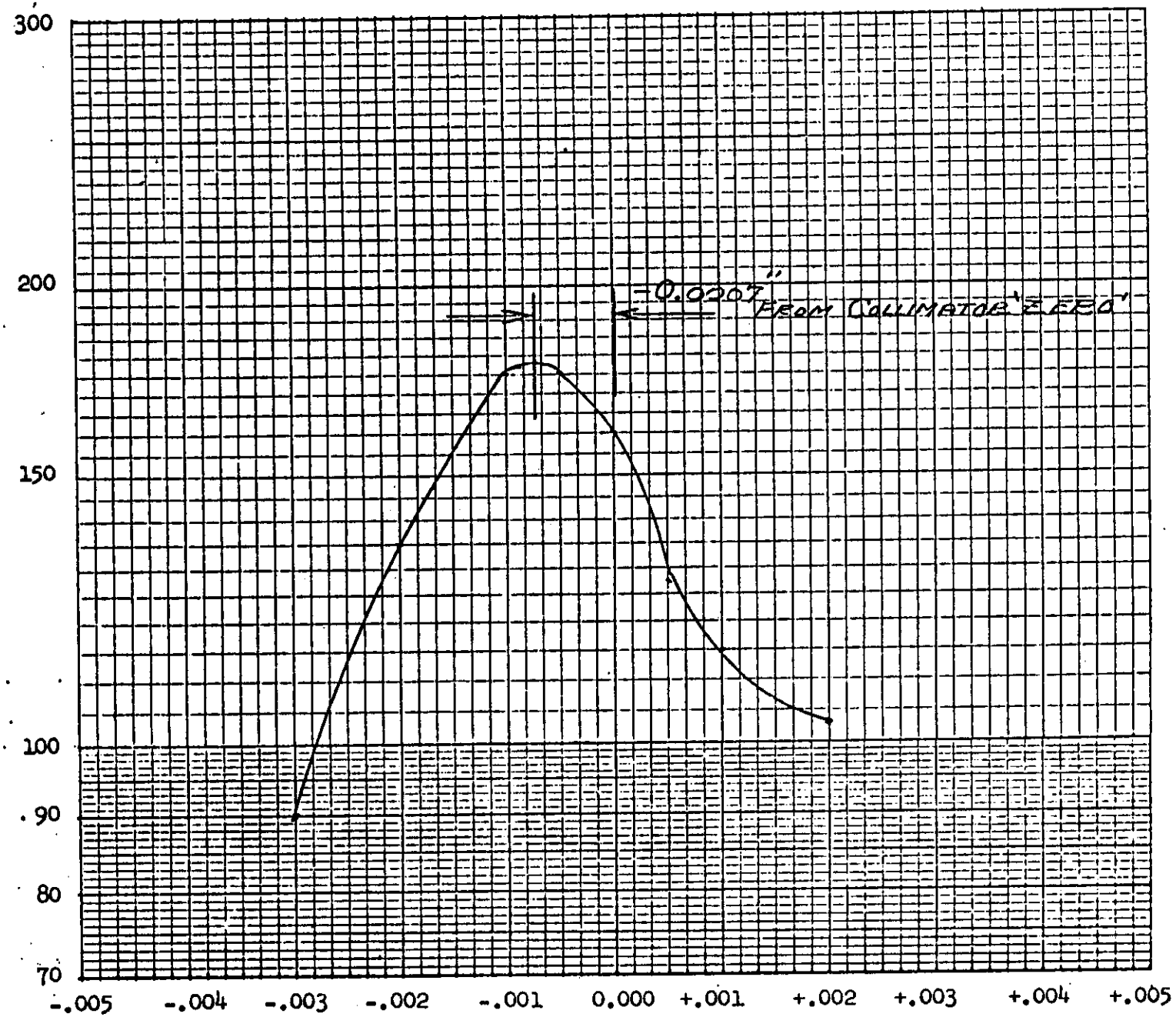
The photomultiplier light search test conducted after flight loading indicated that the system was free of light leaks with the exception of a very small leak in the forward camera drum. No corrective action was deemed necessary or practical.

D. FLIGHT LOADING AND CERTIFICATION

DISIC No. 10 was loaded and installed in the CR-11 payload system on the 7th and 8th of May 1970. Film samples taken from both DISIC and pan systems were processed and evaluated. The photographic qualities were found to be satisfactory. The film from the forward looking camera No. 323 was inspected and a pressure induced plus density stripe was observed extending through the H.O. format varying in length from five to seven inches. It was decided that no significant loss of photographic utilization would be caused as a result of the plus density stripe.

A waiver of performance specification was granted for the corona marking generated by DISIC No. 10 during HIVOS testing. The extent of the marking was not considered to have a significantly degrading effect on overall mission interpretability.

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No. 323

Payload No. CR-11

Resolution (l/mm)

High Contrast: N/A

Low Contrast: 178

Film Type: 3404

Test Date: 3/6/70

Prepared By: _____

Date: _____

FIGURE 2-1

TOP SECRET/C

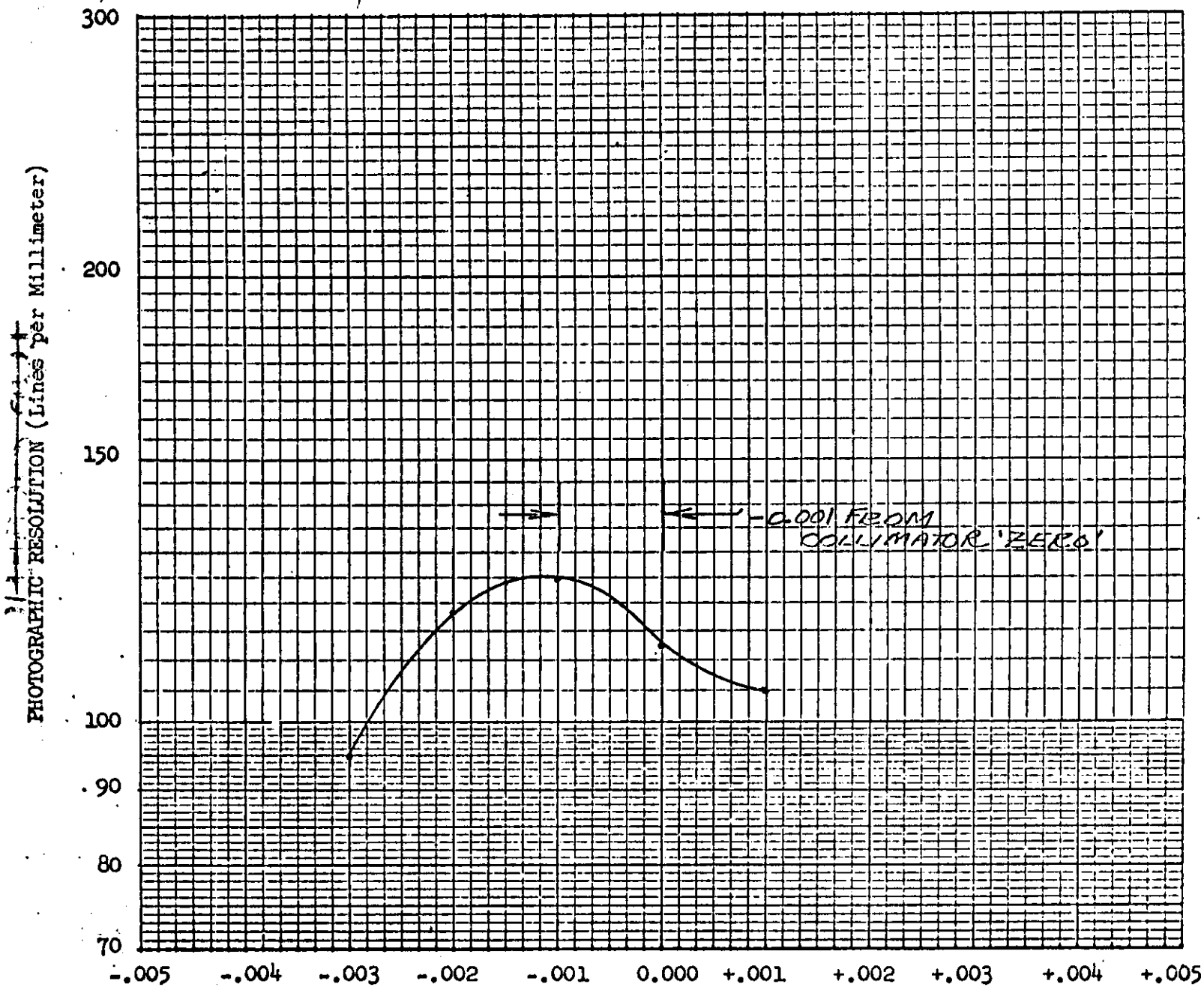


FIGURE 2-2

Camera No. 322

Payload No. CR-11

Resolution (1/mm)

High Contrast: N/A

Low Contrast: 125

Film Type: 3404

Test Date: 3/6/70

Prepared By: ———

Date: _____

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Lift off occurred at 21:35:10 GMT (System Time 77710.7) on 20 May 1970 from SLC-3 west pad. All launch, ascent and injection events occurred as programmed. The orbit achieved was within the 3 sigma predicted dispersions.

Both panoramic cameras operated normally throughout the flight. The transfer sequence occurred normally when commanded.

The DISIC system operated satisfactory during the flight. The cut and splice sequence was completed normally.

The Digital Storage Register Command System operated satisfactorily throughout the flight.

The clock system operated normally and satisfactory clock system time correlation was obtained.

The exposure control programmer appeared to operate satisfactorily except for one observed incorrect time out during the flight.

The Forward Motion Compensation (FMC) generator operated normally and a satisfactory match was maintained to the required FMC throughout the mission.

The pressure make-up system operated normally during the mission.

The instrumentation system functioned normally throughout the flight.

The thermal environment was generally lower than predicted but within acceptable limits.

Both SRV tape recorders performed satisfactorily during the mission.

Both recovery systems were successfully recovered by air catch and except for an anomaly of the -1 chute deployment, all events were normal.

B. DMU OPERATION

Seven DMU rockets were fired during the mission to maintain ground track and period control. The Ground Track Error at the ascending node ranged from 25.8 nautical miles west to 23.3 nautical miles east. The DMU firings programmed, were satisfactory for attaining mission objectives. The following is a summary of DMU firings:

Rocket No.	Pass Fired	System Time (Sec.)	Period Change (Sec.)	Velocity Change (Ft/Sec.)	Period at Firing (Min.)
1	40	32291	15.04	24.2	88.49
2	82	81640	10.20	16.3	88.53
3	127	63373	14.92	24.0	88.43
4	156	43412	10.09	16.1	88.53
5	196	82784	17.36	27.7	88.46
6	239	53535	17.49	28.1	88.44
7	288	54847	17.70	28.3	88.47

Figures 3-1 and 3-2 are plots of orbit history and operation distribution data.

C. ORBITAL PARAMETERS

The following tabulation describes the orbital parameters both predicted and Pass 2 actual.

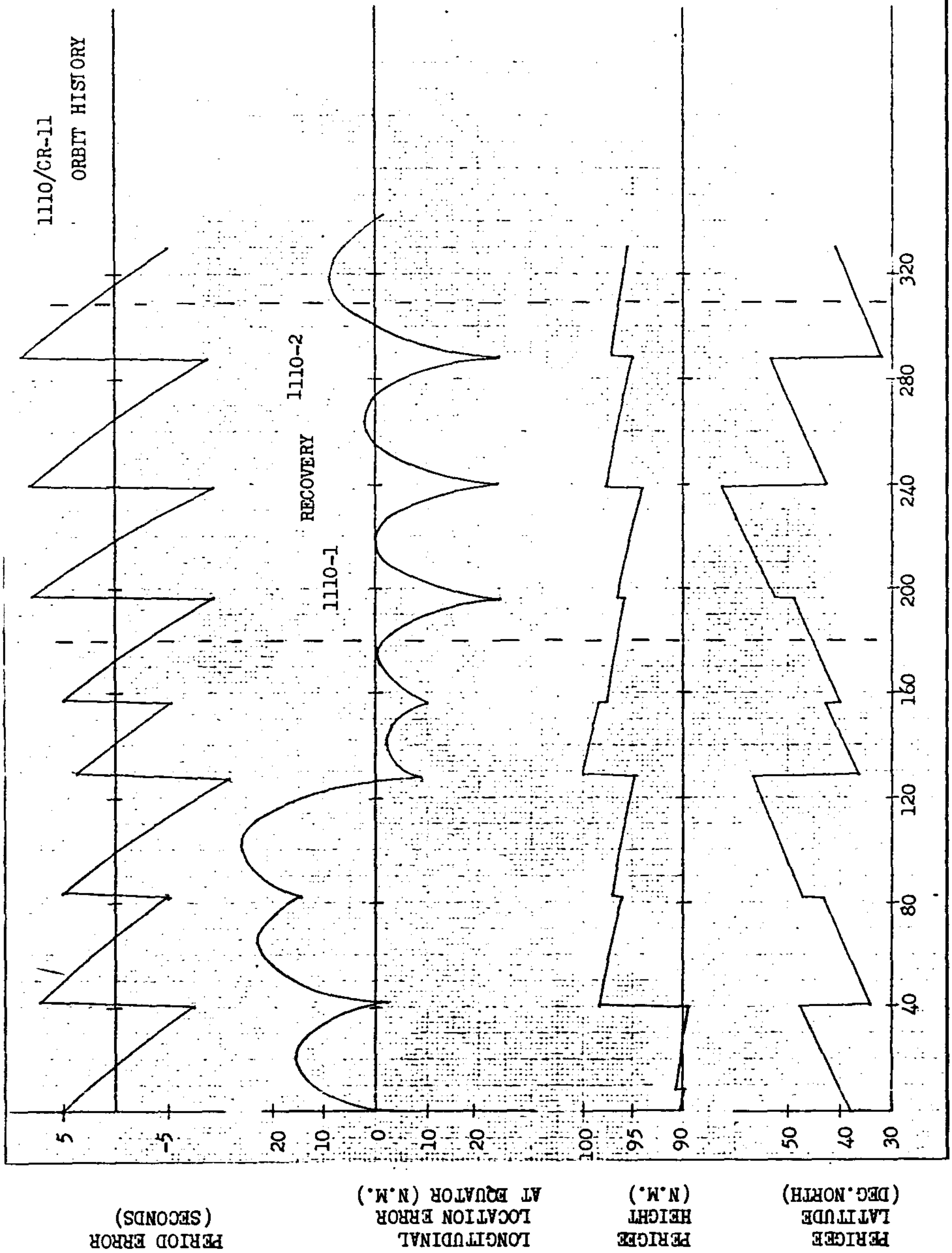
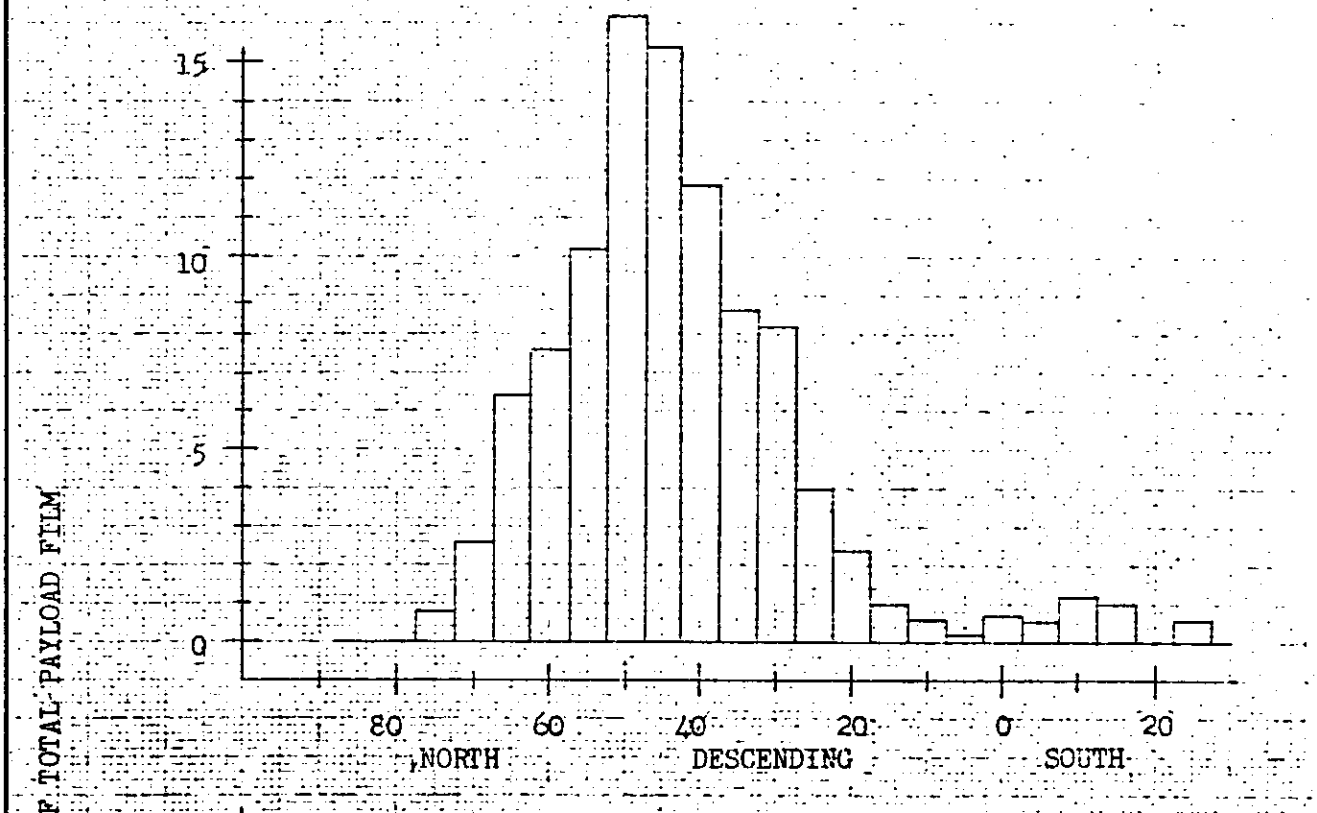

1110/CR-11
ORBIT HISTORY
PERIOD ERROR (SECONDS)
5
-5
LONGITUDINAL LOCATION ERROR AT EQUATOR (N.M.)
20
10
0
10
20
PERIGEE HEIGHT (N.M.)
100
95
90
PERIGEE LATITUDE (DEG. NORTH)
50
40
30
RECOVERY
1110-1
1110-2
40
80
120
160
200
240
280
320
ORBIT REVOLUTION

FIGURE 3-1

1110/CR-11 OPERATION



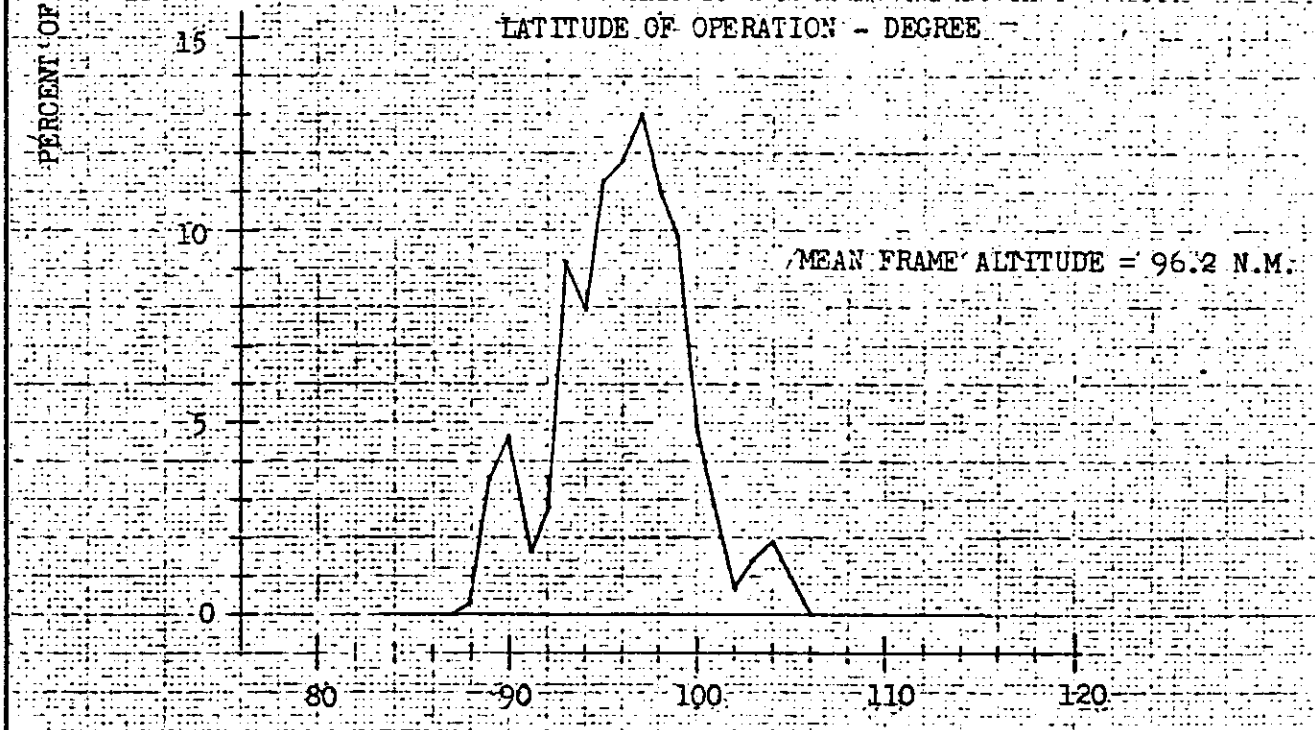


FIGURE 3-2

Orbit Parameter	Predicted	Pass 2 Actual
Period (Min.)	88.73 (+0.33,-0.38)	88.69
Perigee (N.M.)	88.5 (+7,-7)	91.0
Apogee (N.M.)	146.7 (+12,-14)	143.1
Eccentricity	0.0084(+0.0020,-0.0024)	0.0071
Inclination (Deg.)	83.00 (+0.20,-0.15)	83.01
Arg. of Perigee (Deg.)	141 (+66,-63)	138
Regression Rate (Deg/Rev)	22.31	22.29
Geodetic Latitude of Perigee (Deg.)	38.56	41.65

D. PANORAMIC CAMERA PERFORMANCE

Both panoramic cameras exhibited normal film transport characteristics and operated satisfactorily throughout the flight.

Both cameras were loaded with 3404 and SO-349 (3414) film types. The aft looking camera was loaded with 12,150 ft of 3404 spliced to 2000 ft. of SO-349 spliced to 2150 ft. of 3404. The forward looking camera was loaded with 13150 ft. of 3404 spliced to 2000 ft. of SO-349 spliced to 1150 ft. of 3404. Aft looking camera film depletion occurred on frame 42 during Pass 300. Film depletion of the forward looking camera occurred on frame 30 during Pass 300.

Film consumption is listed in the following tabulation:

FRAMES

	Pan 322 (Aft Looking)	Pan 323 (Fwd Looking)
Sample	15	15
Pre-Launch	130	130
-1 Mission	2995	2994
-2 Mission	3027	3014
Total	6167	6153

E. DISIC PERFORMANCE

The DISIC camera performed satisfactorily throughout the flight. Cut, splice and transfer to the second recovery stystem occurred satisfactorily when commanded by KZ-39. Film depletion on the terrain camera occurred on frame 55 during Pass 301. The stellar payload was not exhausted at -2 mission recovery. The stellar camera was loaded with 2000 ft. of 3401 film and the terrain camera was loaded with 2000 ft. of 3400 film.

Film consumption is listed in the following tabulation:

	FRAMES	
	Stellar	Terrain
Sample	44	26
Pre-Launch	125	109
-1 Mission	2510	2422
-2 Mission	2910	2749
Total	5589	5306

F. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

The instrumentation system operated normally throughout the flight. The command system, both Real Time Commands (RTC's) utilizing Uncle and SILO command systems, and Orbital Programmer Stored Programmer Commands (SPC's) operated satisfactorily throughout the flight.

G. FORWARD MOTION COMPENSATION PERFORMANCE

The FMC programmer operated satisfactorily during the entire mission. A satisfactory match to the required FMC was maintained throughout the -1 and -2 missions. Mismatch error was less than plus or minus one percent for 82.5 percent

of the -1 mission operations and 89.3 percent of the -2 mission operations. The mean error was 0.22 percent for the -1 mission and 0.01 percent for the -2 mission. The V/H match performance is shown in Figures 3-3 through 3.6.

H. EXPOSURE CONTROL SYSTEM PERFORMANCE

The exposure control programmer was observed to time out incorrectly once during the flight. The early timeout occurred on Pass 38 at [redacted] After SPC 51, the timer should have stepped to slit width 3 in 240 seconds, however the timer stepped in 20 seconds.

I. CLOCK SYSTEM PERFORMANCE

The clock system operation was normal throughout the flight and good correlation between clock and system time was obtained. Correlation equations and constants are as follows:

First Order Fit

System Time = $A_0 + A_1$ (clock time) where:

A_0 = 0.78004999460D 04

A_1 = 0.999999707955D 00

Sigma = 0.00996

Number of points = 37

Second Order Fit

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

A_0 = 0.78004706980D 04

A_1 = 0.999999798020D 00

A_2 = 0.50776241450760D -13

Sigma = 0.00325

Number of points = 37

FRAMES 1-3 OF EACH 10 OMITTED 30 PERCENT = 0.74

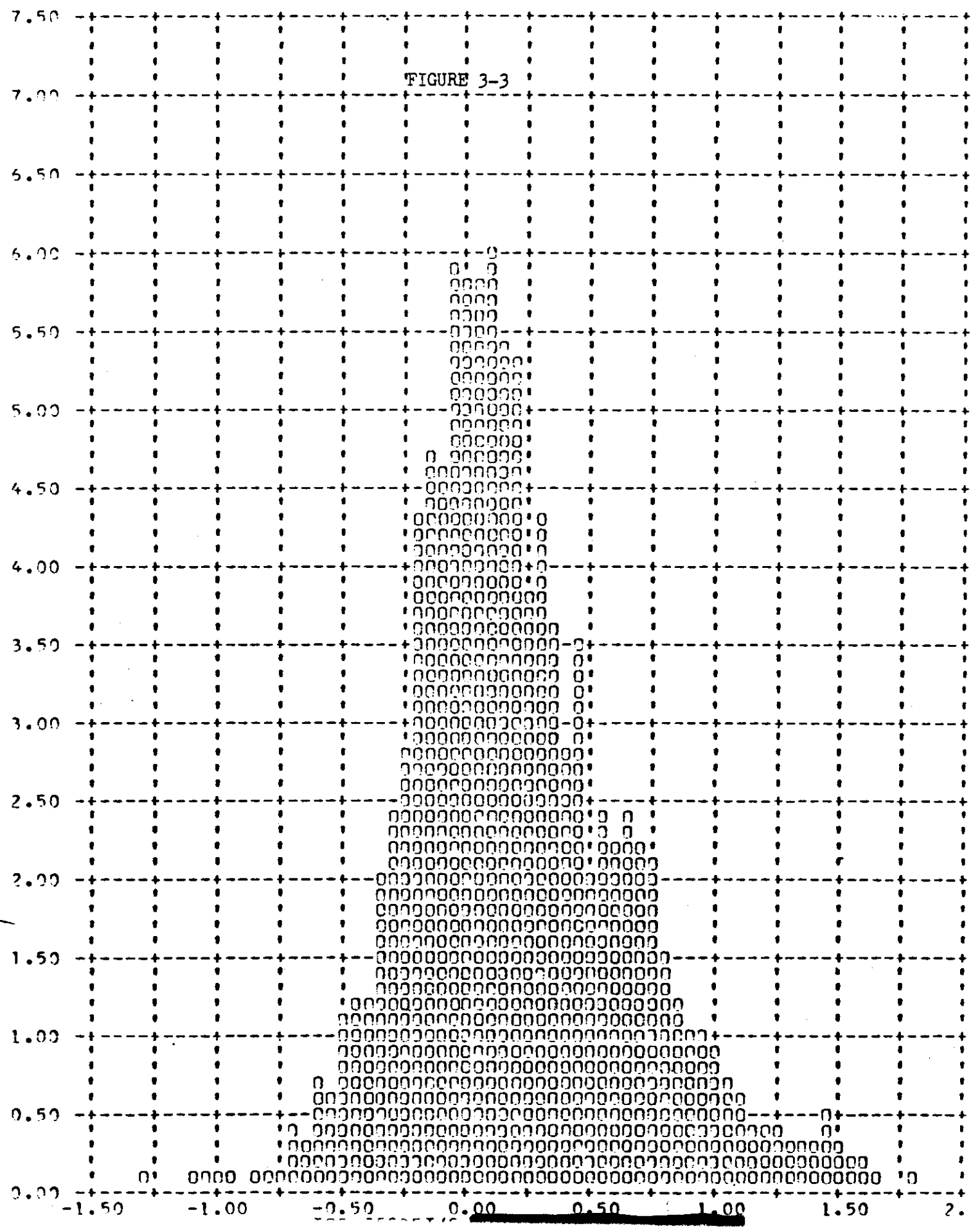


FIGURE 3-3

FRAMES 1-3 OF EACH 30 OMITTED 30 PERCENT = 0.70

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

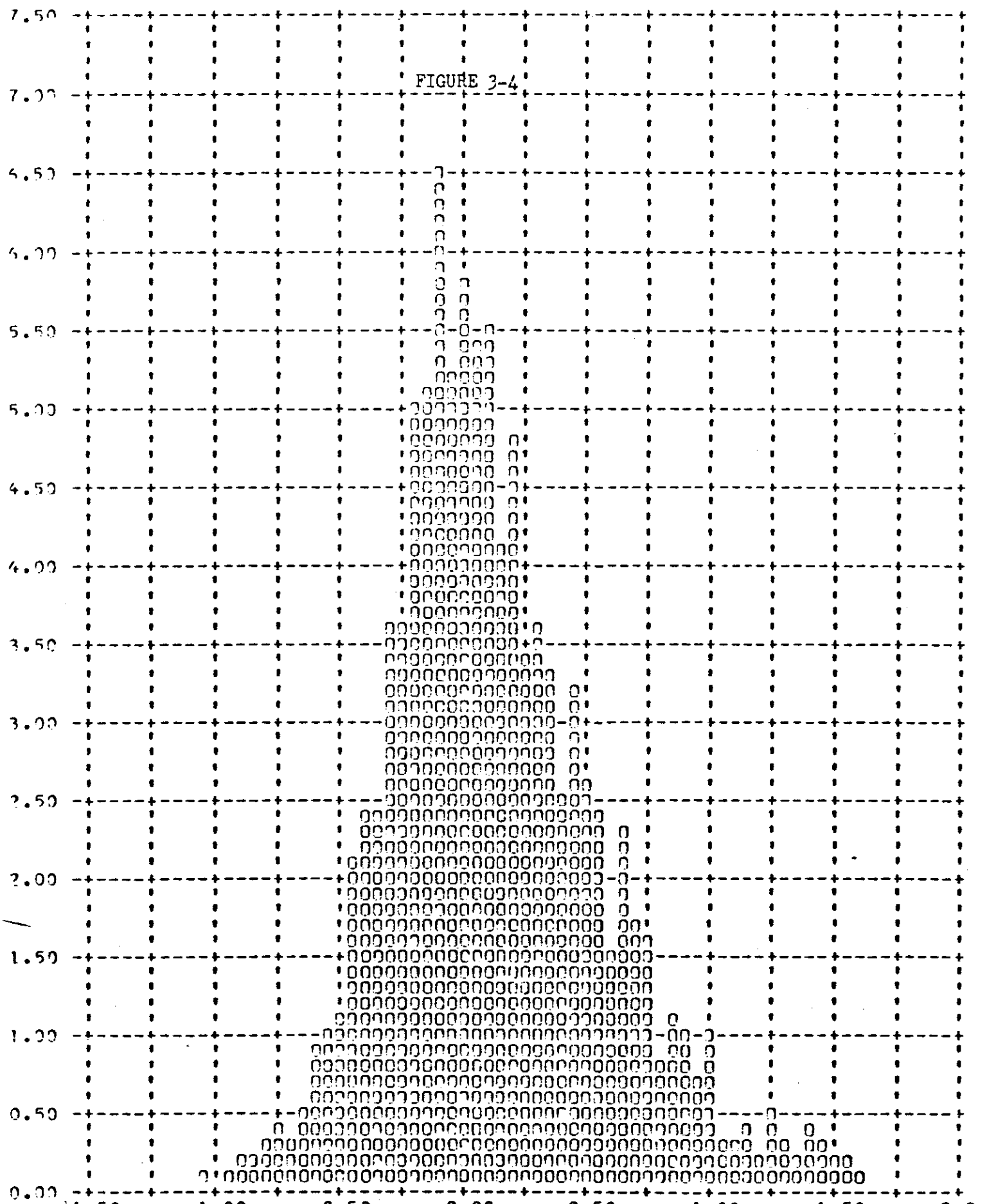


FIGURE 3-4

FRAMES 1-3 OF EACH OP OMITTED 20 PERCENT = 0.75

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

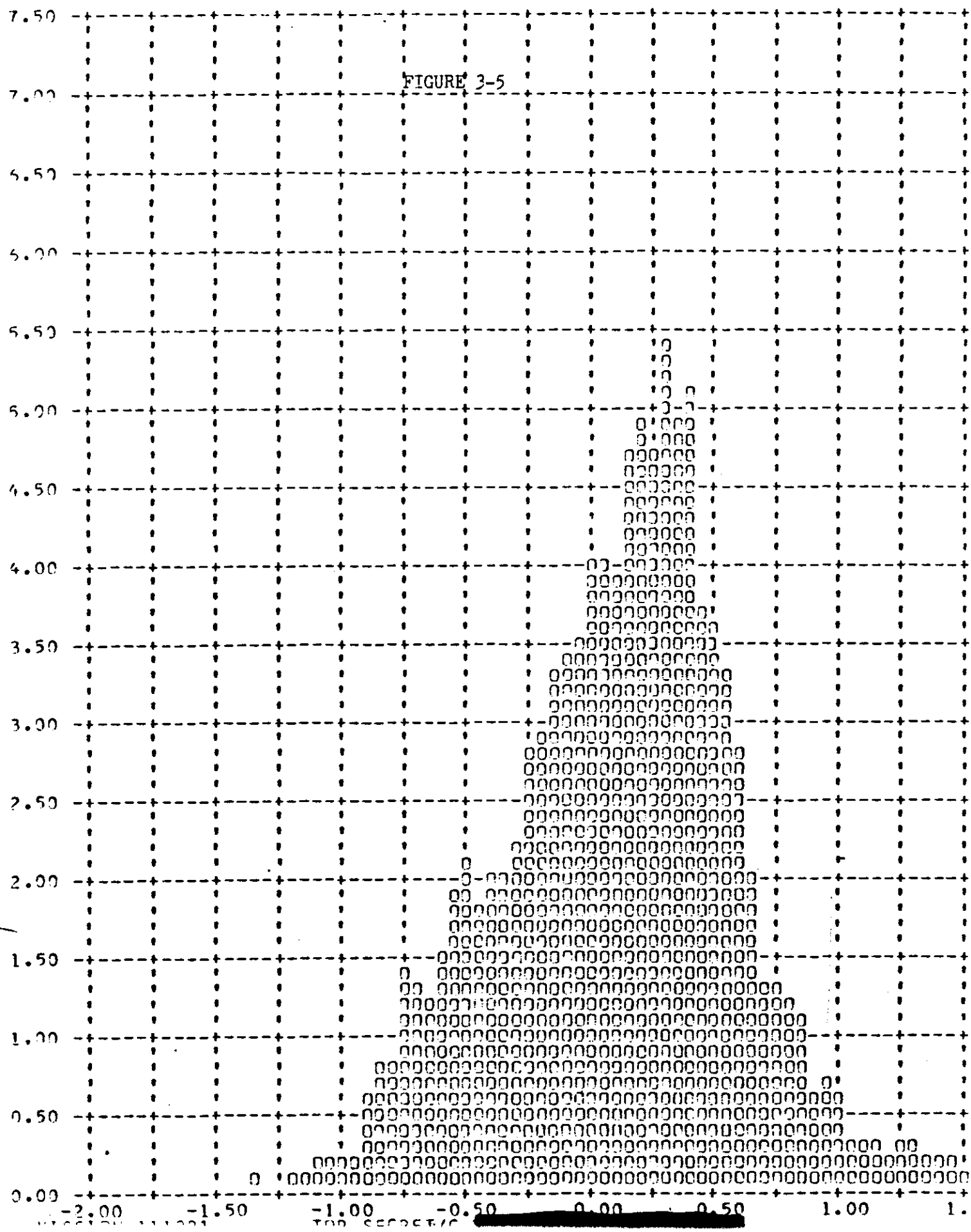


FIGURE 3-5

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 0.74

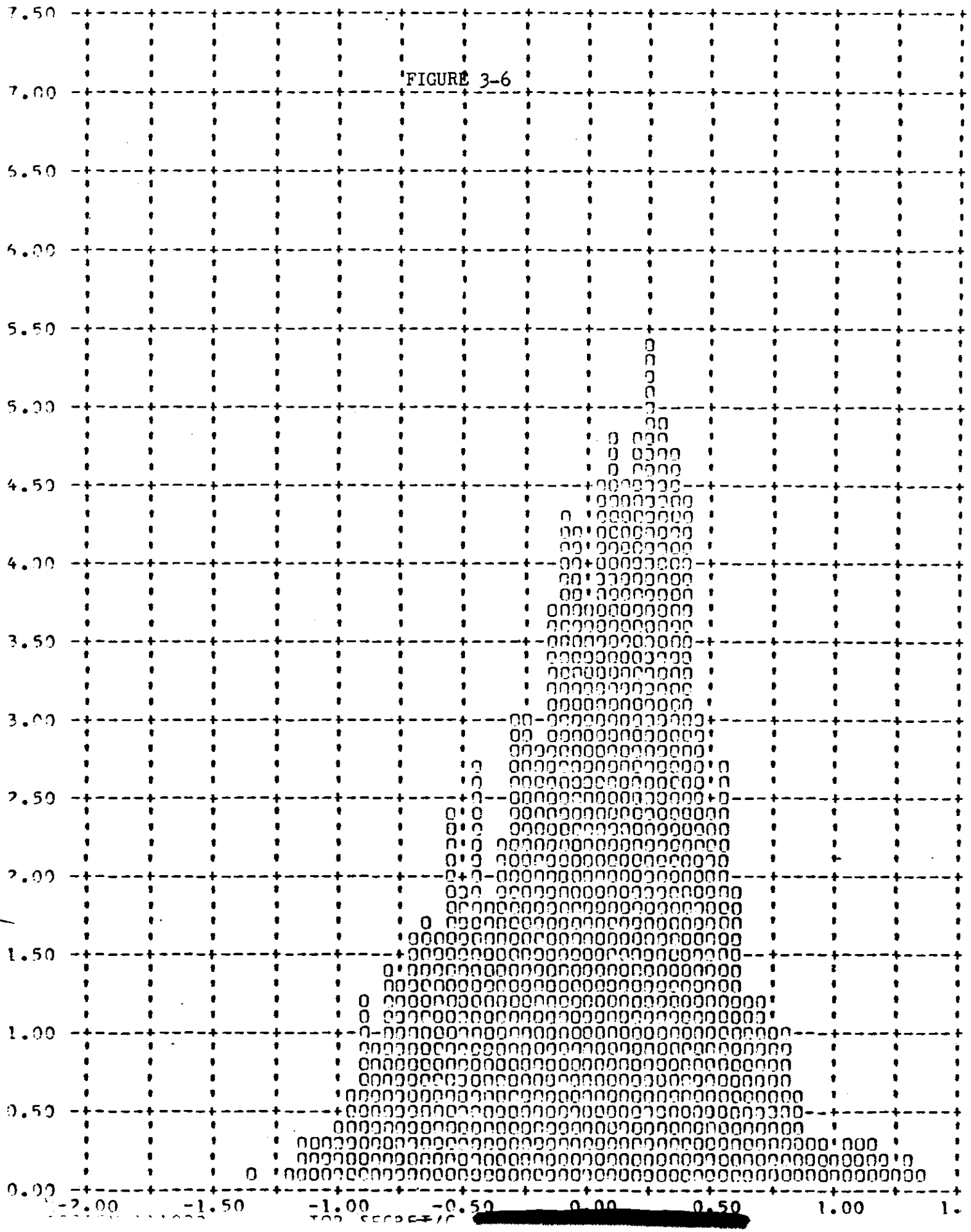


FIGURE 3-6

J. PMU SYSTEM OPERATION

The PMU operation was normal with a gas consumption of 6.64 psi/min with 1800 psi remaining at the end of the -2 mission.

K. THERMAL ENVIRONMENT

Temperature data obtained during the flight indicated the temperature environment was below the pre-flight predictions. The average temperatures during the -1 mission were 61°F for both panoramic cameras. The average temperatures during the -2 mission were 60°F for both panoramic cameras. Figure 3-7 shows a graphical plot of the actual average camera temperature versus the predicted temperature as a function of the beta angle. Figures 3-8 and 3-9 show each camera's rail temperature for selected revs.

L. RECOVERY SYSTEM PERFORMANCE

a. -1 Recovery System

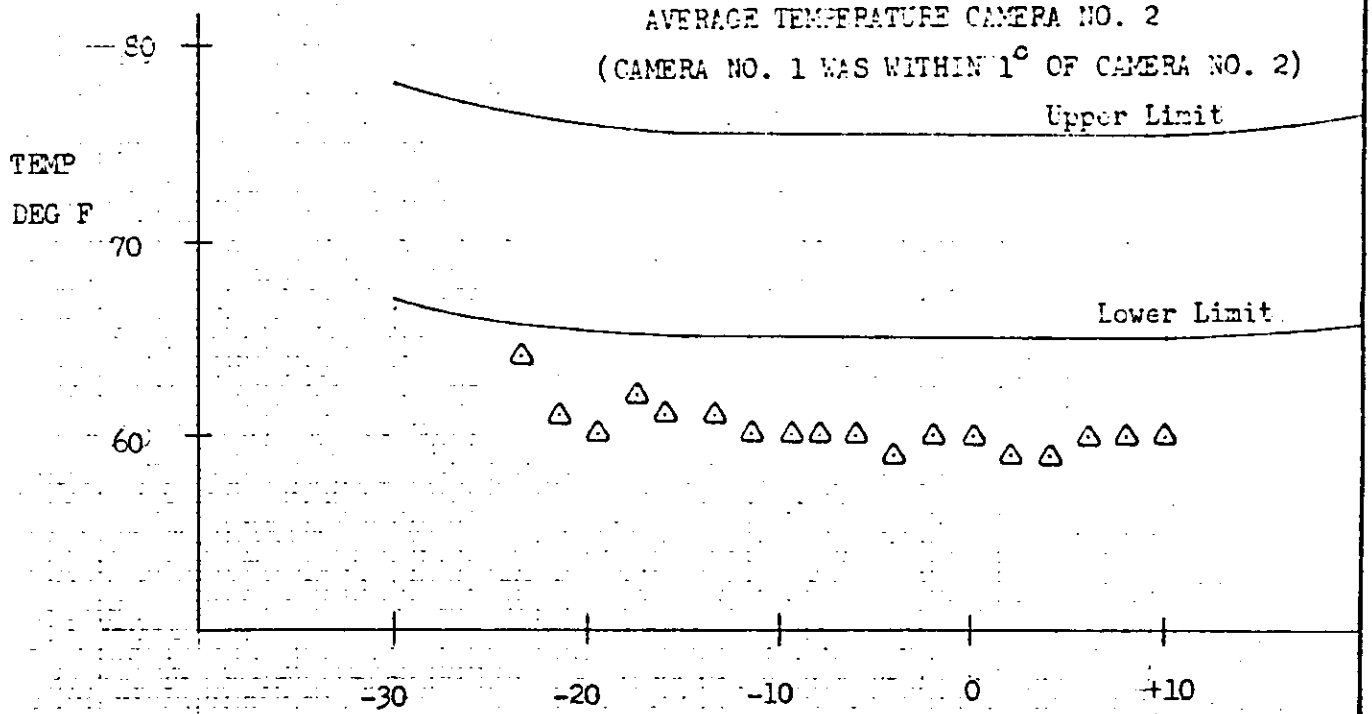
The -1 recovery capsule was successfully recovered by air catch on Rev 179. All re-entry events were within tolerance. A malfunction of the deceleration chute caused air recovery at lower than predicted altitude. Telemetry data indicated that the deceleration chute malfunctioned during deployment inhibiting its function, and causing the main chute to take the extra load. The impact was near predicted.

b. -2 Recovery System

The -2 recovery capsule was successfully recovered by air catch on Rev. 309. All re-entry events were within tolerance. The impact was near predicted.

M. SRV TAPE RECORDER SYSTEM

The SRV tape recorders for the -1 and -2 missions performed satisfactorily. There were a number of spurious center of format pulses recorded which were generated at the start-up of camera 322. A total of 211 minutes of data was recorded and retrieved from both recorders.


AVERAGE TEMPERATURE CAMERA NO. 2
(CAMERA NO. 1 WAS WITHIN 1° OF CAMERA NO. 2)
Upper Limit
Lower Limit
TEMP
DEG F
80
70
60
-30
-20
-10
0
+10
BETA ANGLE - DEGREES

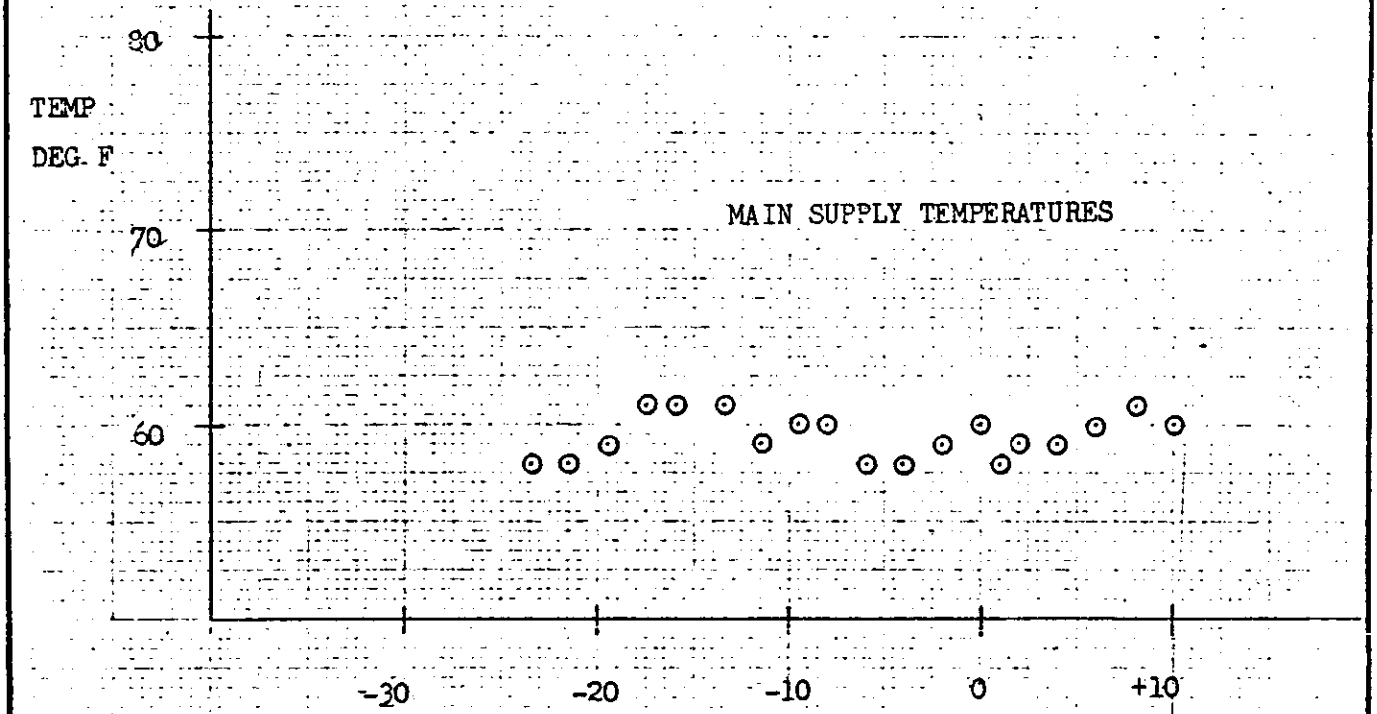

MAIN SUPPLY TEMPERATURES
TEMP
DEG. F
80
70
60
-30
-20
-10
0
+10
BETA ANGLE - DEGREES

FIGURE 3-7

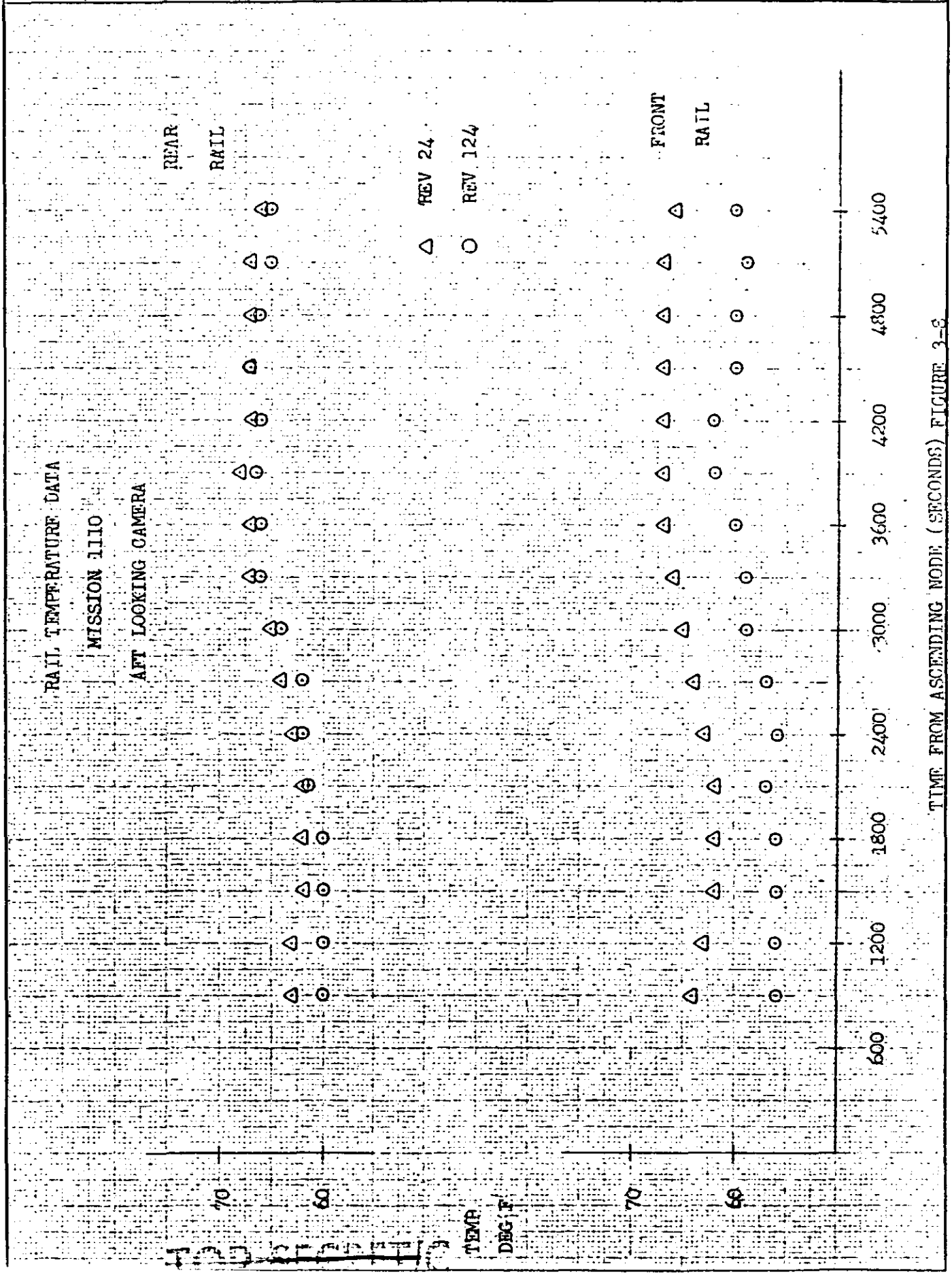

RAIL TEMPERATURE DATA
MISSION 1110
AFT LOOKING CAMERA
REAR RAIL
REV 24
REV 124
FRONT RAIL
TEMP DEG F
70
60
70
60
600
1200
1800
2400
3000
3600
4200
4800
5400
TIME FROM ASCENDING NODE (SECONDS)

FIGURE 3-8

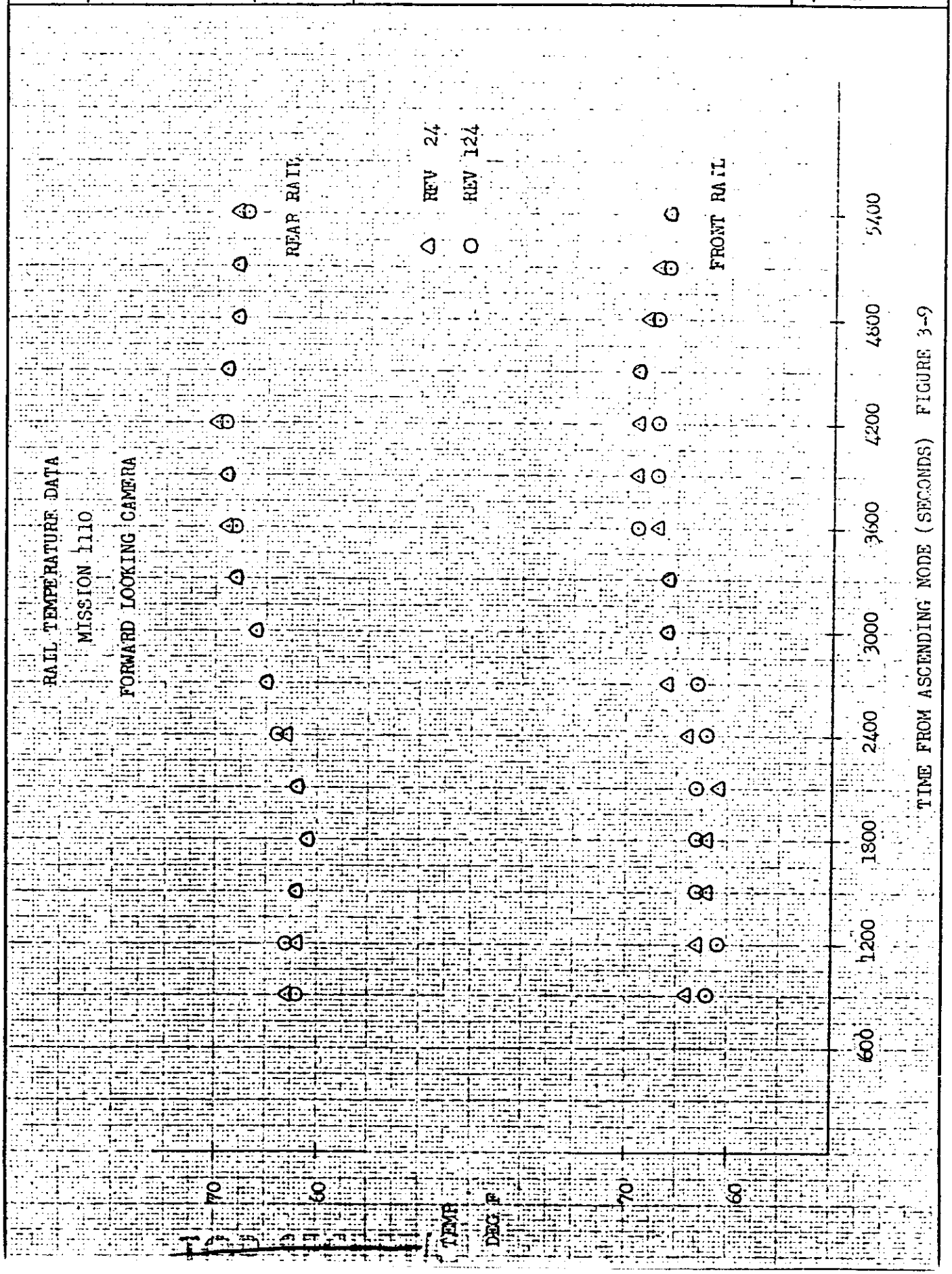

RAIL TEMPERATURE DATA
MISSION 1110
FORWARD LOOKING CAMERA
REAR RAIL
FRONT RAIL
REV 24
REV 124
TEMP DEG F
70
60
70
60
600
1200
1800
2400
3000
3600
4200
4800
5400
TIME FROM ASCENDING NODE (SECONDS)

FIGURE 3-9

N. POST EVENT 2 TESTING

The system was enabled on Rev. 309 [redacted] and operated for a number of cycles before the tag end of the film caused camera 323 to malfunction. After slipping the belt, camera 323 released the tag end and operated normally.

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

Photography from the panoramic cameras was of mediocre quality compared to previous 1100 series missions. A Mission Information Potential (MIP) of 90 was assigned to Mission 1110-1 and an MIP of 95 was assigned to Mission 1110-2. Both were selected from the forward looking camera photography. The best image quality of the forward looking camera photography was slightly better than the photography from the aft looking camera. However the overall image quality of the aft looking camera photography is comparable to that provided by the forward looking camera.

Photointerpreters rated the utility of the photography from good to poor and mostly in the fair to poor category.

Photography from the DISIC terrain camera exhibited good image quality although some of it was degraded by static fog.

The photography from the stellar cameras revealed approximately 12 to 20 point type star images on most port and starboard formats.

B. PANORAMIC CAMERAS

1. Image Quality

The overall image quality of the forward looking camera photography is somewhat less than achieved by previous 1100 Corona series missions. The photography appeared sharp and clearly defined at magnifications of 25 power whereas an out-of-focus appearance resulted at magnifications of 50 power. It was observed that system characteristic out-of-focus areas were present on the third and fourth frames of some operations.

The overall image quality of the aft looking camera photography is comparable to that provided by the forward. However the best imagery from the aft looking camera is slightly less than the corresponding forward imagery. System characteristic out-of-focus areas were detectable on the fourth and fifth frames of some operations. The image quality of Mission 1110-1 is more variable than Mission 1110-1.

Several factors contributed to the mediocre photography experienced on this mission. The system was launched into a nominal 100 nautical mile orbit thereby reducing the scale of the imagery. The higher orbit favors increased coverage over image scale; directly affecting image quality.

The camera system resolution performance of Mission 1110 during ground test was the poorest of any 1100 series payload systems previously flown; which also contributed to its mediocre performance. Peak low contrast resolution for the forward camera was 166 lines/mm and 120 lines/mm for the aft camera. Each of these resolution values was approximately 20 lines/mm lower than previous 1100 series missions. The effect of the lower than normal resolution values on mission performance is partially borne out by the ground resolution values read from the three CORN targets covered on this mission. The CORN target resolution values tabulated below are generally poorer than those from previous missions. (These values are not a completely reliable indication of the effect of the camera system resolution values achieved during test, since vehicle attitude perturbations also affected these values.)

GROUND RESOLUTION IN FEET

Pass	FWD Looking		AFT Looking	
	In Track	Across Track	In Track	Across Track
D129	9	9	7	Cloud Covered
D210	8	8	7.5	7.5
D226	9	9	8	7.5

The above values are an average of seven readers from NPIC, LMSC, AFSSD, and ITEK.

The readings from the forward looking camera are somewhat higher than could be expected from its ground test resolution data. The losses appear to be caused by an out-of-focus condition. The imagery on the forward looking camera was more degraded on the film's outboard edge which indicated a film plane tilt had occurred.

The actual focus was forward of the film plane; a condition aggravated by the lower temperatures achieved during the mission. The temperatures achieved during the mission were, however, within the thermal design envelope. Lower temperatures are known to increase film lift variability and this variability permitted out-of-focus conditions to occur.

It was also observed that a ground resolution improvement of 1 foot was achieved by the forward looking camera on the pass during which the Wratten #25 filter was used. The third generation Petzval lens flown in this camera was designed for use with the W-25 filter and the recommendation was made that it be used as the primary filter for future missions with the 1100 series cameras that use this lens.

This was the first flight employing Type SO-349 film. Approximately 2000 feet of this film, now called type 3414 film, was placed in the supply of each camera for consumption near the end of the mission.

There was no distinguishable difference between the image quality of the 3404 type film and the SO-349 (type 3414) type film.

SO-349 film was used because it is approximately 0.5 photographic stop faster than type 3404 film. Use of this faster film permitted shorter exposure times which significantly reduces smear effects in the imagery.

2. Quality Measurements

Microdensitometer edge trace measurements produced by AFSPPF were used to establish an objective basis for quality evaluation. The Aerial Image Modulation (AIM) curve for the appropriate film type at 2:1 contrast and the resultant Modulation Transfer function for each edge traced were plotted to determine the point of intersection. The resultant MTF/AIM value is obtained from this intersection:

	1110-1 cy/mm	1110-2 cy/mm	Mission Average cy/mm	ground resolution
Fwd looking	66.3	75.6	73.5	14.48
Aft looking	80.7	85.4	83.1	12.5 Ft.

The above data are averaged values of all scenes edge-traced throughout both missions. These quality measurements are in agreement with the preceding subjective analysis of the photographic quality of this mission.

3. Data Recording

Auxiliary data recording was generally satisfactory throughout both missions. The clock word readout was operational and imaged properly on both pan cameras.

The collimator traces, rail holes and frequency marks were imaged properly on both pan camera records.

4. Anomalies

Some characteristic anomalies having a minor affect on performance were present on the film from both cameras. A minor splash-type fog pattern was present on the first frame of most operates on the film from the aft looking camera and occasionally on the forward looking camera film. This static fog is a characteristic of the CR camera system. There were out-of-focus areas present on the film from both cameras during some passes. This occurred on frames four and five of the aft looking camera and frames three and four of the forward looking camera. The cause of this is attributed to set in the film during longer 'sit' times between operates. An equipment image associated fog pattern is present on the fourth frame from the end of some operates on the forward looking camera. Cause of this was attributed to a minor light leak at a corner of the forward light shield assembly. The density was minor and no image degradation was noted.

In addition to the above the following anomalies were observed on the panoramic camera records.

4.1 - A band of diagonal marks approx. 0.1 inch wide and 0.3 inch in from the Binary edge ran continuously from frame 23 to frame 38 on pass D263 of the forward looking camera. This band of marks, having a rope-like appearance recurred in frames 43 through 92 of the same pass. No physical damage or image degradation is associated with this marking. No cause for it was determined.

4.2 - An intermittent longitudinal emulsion scratch approx. 8 inches long was present on the forward looking camera formats, originating approx.

3 inches from the supply end of the effected frames and extending through the A.O. format and into the adjacent frame. This scratch was located approx. one inch in the format from the binary edge of the film. The severity of the scratch decreased as the mission progressed. The mark was present during system test and considerable effort was expended to locate the source of the problem. It was determined that the scratch was caused on the supply side immediately prior to entering the A.O. platen. During flight readiness testing with the actual flight take-ups installed, this pressure mark was observed to be less severe and further inspection was considered unwarranted.

4.3 - Underexposure and overexposure was observed on parts of some forward looking frames during that portion of the mission where SO-349 film and type 3404 film were being exposed simultaneously. This occurred because the film (SO-340) was staggered in position on the film supply. This necessitated a restriction in slit selection during pre-flight exposure analysis since SO-349 film is approx. one-half stop faster than type 3404 film. Since one slit on each camera was assigned specifically for SO-349 only three slits were available for use on type 3404 film. Coupled with operational constraints in the exposure programmer, this slit limitation prevented the attainment of optimum exposures when both film types were being exposed simultaneously. The resultant under and over exposure was to be expected.

4.4 - Several minus density defects are present intermittently throughout the SO-349 aft looking camera record and at least once in the SO-349 forward looking camera record. The original analysis of this anomaly indicated that a liquid substance formed a drop on the film during flight and it was squeegeed by the rollers during transport. This squeegeed pattern was repeated four to five times at a pitch of six and three eighths inches and either desensitized the emulsion or prevented penetration of the developer. This effect has been confirmed but later investigation has shown that the source of the contaminant occurred at the [redacted] location during processing.

4.5 - Three nicks and a crease were observed on frames 25 and 26 of the aft looking camera film on pass D187. They were caused during pre-splice at the processor's plant when the film tracked over the flange on a guide roller. The cause was attributed to slack in the film resulting from out of round condition of the film roll. However this sudden slack condition occurred when a manufacturer's splice peeled off the supply in frame 26 and may have been caused by adhesion between this splice and the adjacent wrap.

4.6 - The thermometers installed in the film handling cases indicated that the film had been subjected to excessive temperature during transit to the processors facility. It was later determined that the dial thermometers were at fault and that the film showed no indication of having experienced other than normal temperatures. The thermometers employed were found to be shock sensitive and they have been replaced by recording thermographs.

4.7 - The camera number was imaged several times on the last frame of most operations and an extra time word occurred on the next to last freme of some operates. These conditions result when the inhibit pulse is not long enough to prevent double firing during creep mode. This anomaly can occur frequently during shut down with no resulting damage.

4.8 - Random intermittent plus density spots were present on 1110-2 mission only. They appeared on both film types on both cameras. The size of the spots varied with the largest being approx. five thousandths of an inch in diameter. The degradation attirubtable to these spots was minimal. During initial investigation to determine the cause of this anomaly, the source of sensitization which resulted in these spots could not be established. It was, however, felt to have occurred during flight. Subsequent investigation and analysis by representatives from LMSC and ITEK, led to the conclusion that the spots are the result of miniscule electrostatic discharges between the film and scan head and/or drum rollers. It was felt that they are caused by friction resulting from differing velocities between the film and rollers. Investigation is continuing to determine the source of sensitization of the spots.

5. Horizon Cameras

All four horizon cameras operated properly throughout both missions. The horizon arcs were well defined and the PET reported no anomalies.

6. DISIC Camera

Both stellar cameras and the Index camera were operational throughout both missions. Approximately 12 to 20 stars were present in each stellar format.

The clock word readout was operational and imaged properly on both DISIC units except on four frames during the second mission where the readout was missing. No light leaks were observed on the DISIC film. Multiple Corona and dendritic discharge traces were present intermittently throughout the mission on both stellar and terrain films. In addition the stellar film was marked by static marks induced by the pressure plate on both port and starboard formats. The Index film quality, where not degraded by static fog, was good.

SECTION 5

PANORAMIC EXPOSURE AND DENSITY ANALYSIS

Exposure Control on the panoramic camera system is primarily a function of the slit widths and scan rate required to accommodate selected orbit parameters. The computer analysis, employed to determine the optimum settings of these variables, utilizes the actual orbital criteria, filter attenuation and earth illumination profile. In addition, analysis of the computer program output provides detailed information for selecting the best launch window to optimize photographic coverage of northern latitudes.

The filters and slits selected for the panoramic cameras are as follows:

Filter Type	Aft-Looking Camera #322	Fwd-Looking Camera #323
Primary	W-21	W-23A
Alternate	W-23A	W-25
Slit Width (inches)		
Position 1	0.104	0.141
Position 2	0.132	0.167
Position 3	0.160	0.203
Position 4	0.080	0.108
Failsafe	0.118	0.153

The supply cassette for this mission contained approximately 2000 feet of the new type SO-349 film loaded in a staggered position for each camera. Since this film is approximately one half stop faster than the type 3404 film used for the balance of the supply film, slit No. 4 on each camera was selected to accommodate this faster exposure time. Consequently the remaining three slits were adjusted to cover the required exposure time range for the type 3404 film.

The failsafe slit was selected to accommodate the optimum exposure time of the type 3404 film for the desired target latitude range.

The nominal exposure times of the panoramic cameras are shown as a function of latitude for Passes D53, D152 and D250 in Figures 5-1 through 5-6 which are representative of the mission. Superimposed on these plots are relative distributions of camera operations for the portion of the mission represented by each mission.

The exposures achieved on mission 1110 as shown by analysis of AFSPPF macrodensity data indicate that somewhat lesser quality photography was obtained than on previous missions. The criterion used to determine proper exposure is that minimum scene density should range between 0.4 and 0.9. The measurements extracted from AFSPPF data are tabulated below:

Terrain Density Analysis of Exposure in % of total frames

	Fwd.		Aft	
	3404	SO-349	3404	SO-349
Correct Exposure (0.4 to 0.9 Dmin)	42.4%	42.60%	46.14%	52.61%
Overexposed (> 0.9 Dmin)	9.39%	0 %	15.72%	5.79%
Underexposed (< 0.4 Dmin)	48.23%	57.41%	38.16%	41.62%

The percentages of correct exposures is somewhat less than normal. Normal correct exposures for other systems has ranged as high as 70 to 85 percent of the total samples. Assignment of one slit for use with the SO-349 material as described earlier precluded the possibility of obtaining optimum photography on either type film.

The scene area measured is selected subjectively, and does not necessarily represent the absolute minimum image density; the measurements are randomly made of relatively gross natural and cultural areas. But as the photograph is utilized by the photointerpreter, the information content is largely based upon density variations at or near the resolution threshold of cultural targets only. Therefore, the 0.4 to 0.9 criterion is not considered a completely adequate indicator of optimum target exposure.

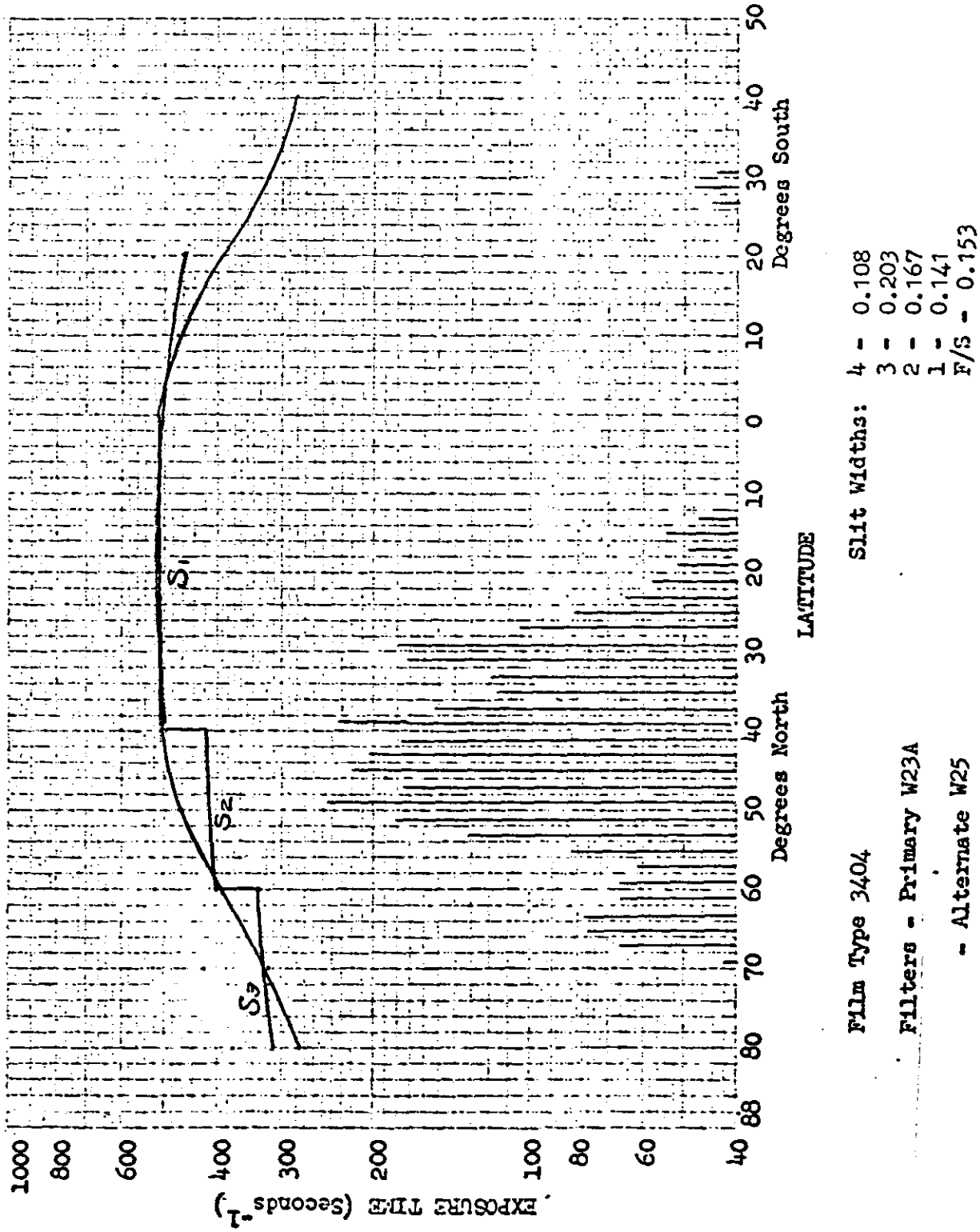
Maximum intelligence is generally derived from specific cultural minimum densities ranging between 0.4 and 0.9. This will usually result in minimum gross scene densities below 0.4, as the reflectance value range for natural areas tends to be lower than that for cultural areas. It becomes apparent that missions with the more desirable information will probably be reported as tending towards underexposure, using these evaluation techniques.

The macrodensity measurements supplied by AFSPPF are processed by computer at Lockheed and result in the density plots shown in Figures 5-7 through 5-18. These plots show representative terrain and cloud cover densities experienced by each camera for both missions.

FIGURE 5-1 , EXPOSURE PROFILE, Mission 1110, Payload CR-11

Fwd - Looking Camera # 322 , Pass # 53

Launched 5-20-70



TOP SECRET/C

FIGURE 5-2 , EXPOSURE PROFILE, Mission 1110, Payload CR-11

Fwd - Looking Camera # 323 , Pass # 152

Launched 5-20-70

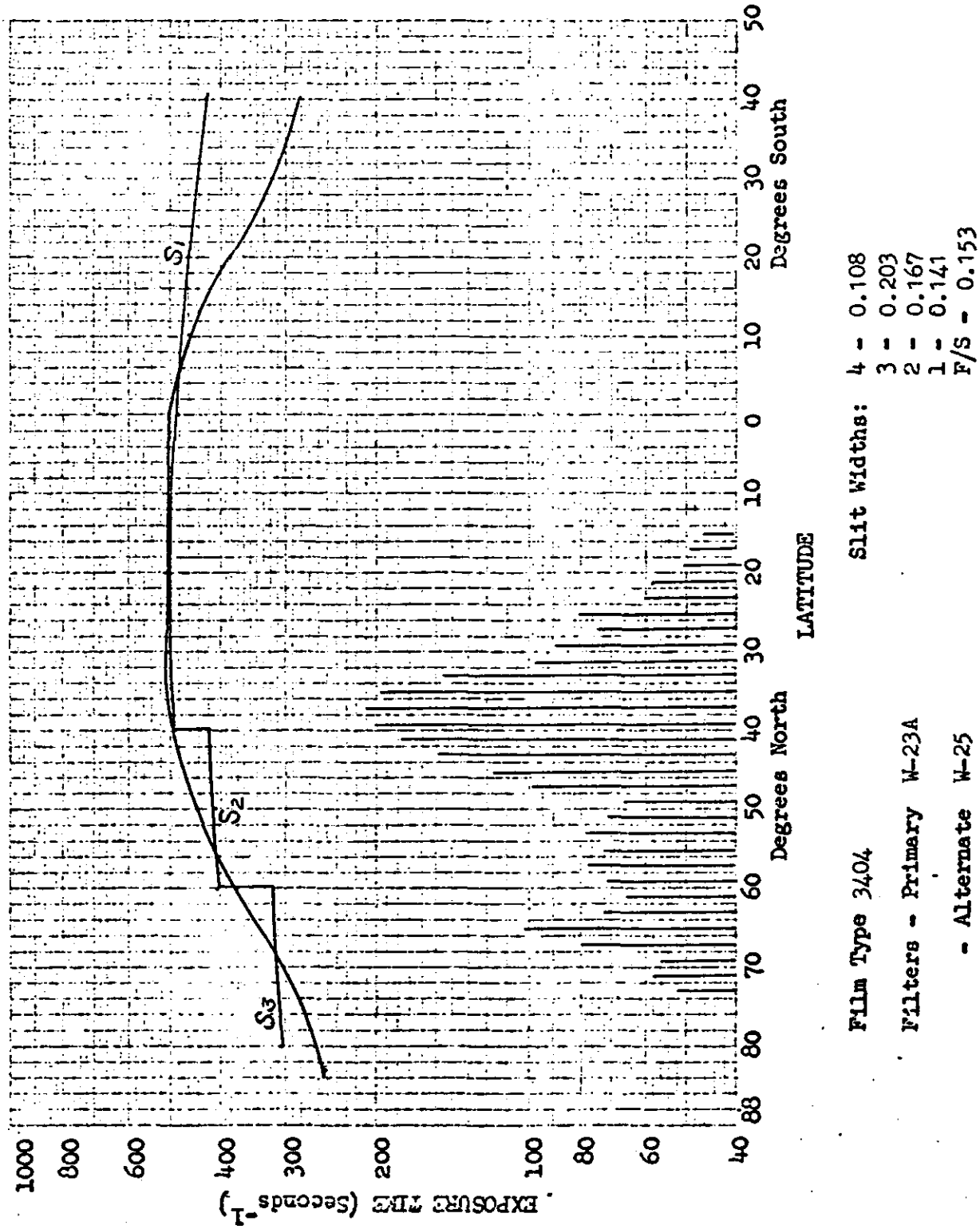


FIGURE 5-3 , EXPOSURE PROFILE, Mission 1110, Payload CR- 11

Fwd - Looking Camera # 323 , Pass # 250

Launched 5-20-70

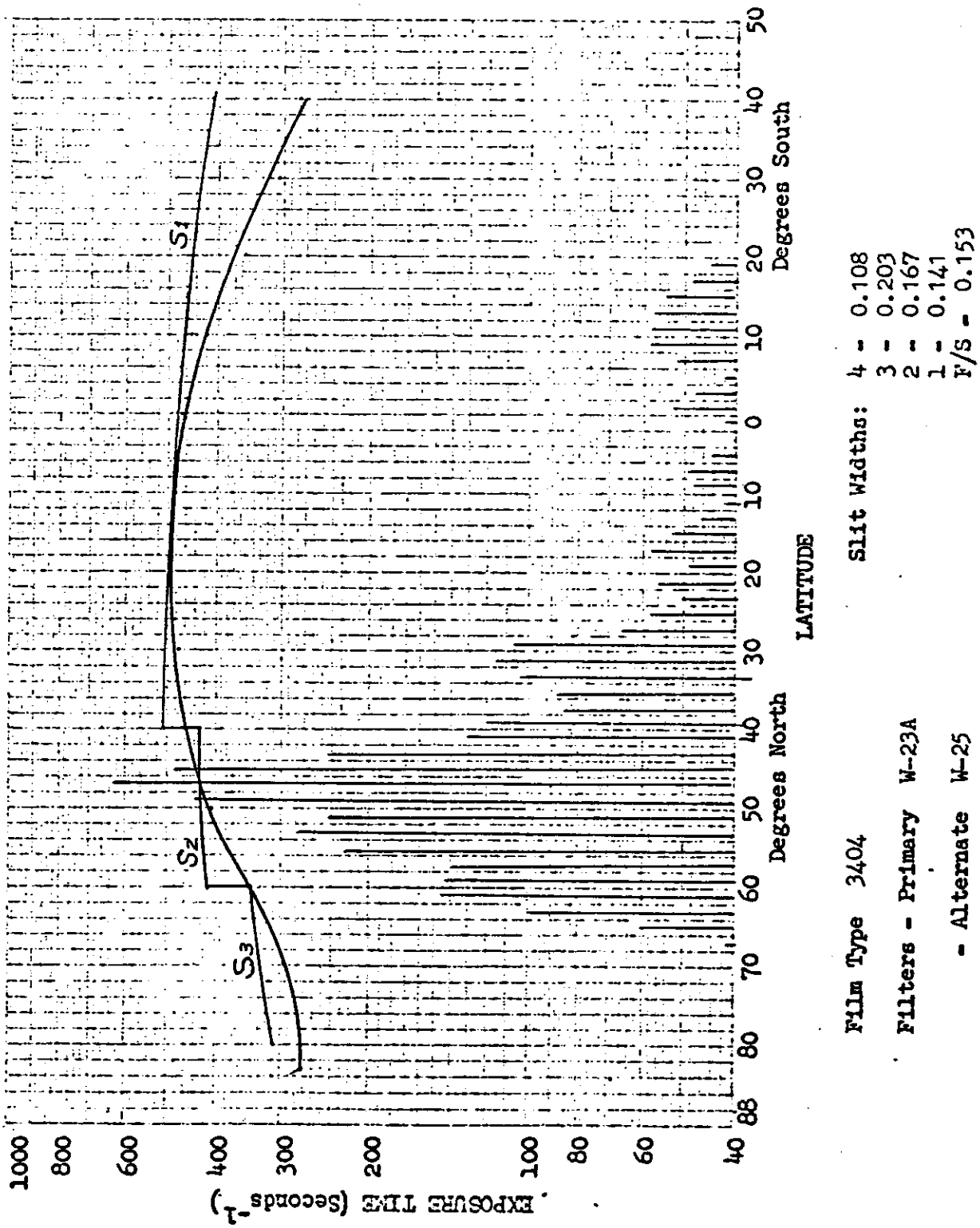


FIGURE 5-4 , EXPOSURE PROFILE, Mission 1110, Payload CR- 11

Fwd - Looking Camera # 322 , Pass # 53

Launched 5-20-70

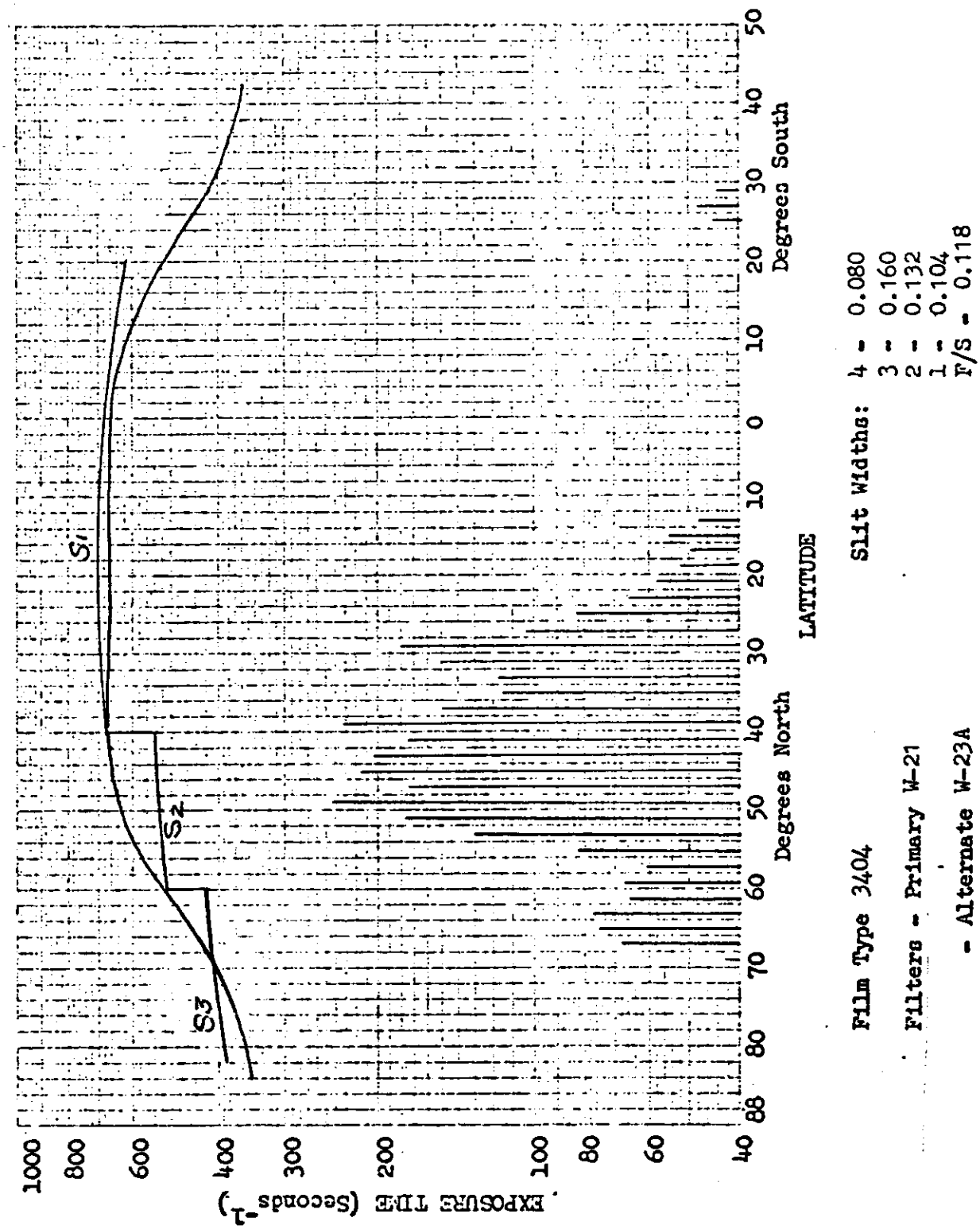


FIGURE 5-5 , EXPOSURE PROFILE, Mission 1110, Payload CR- 11

Fwd - Looking Camera #322 , Pass #152

Launched 5-20-70

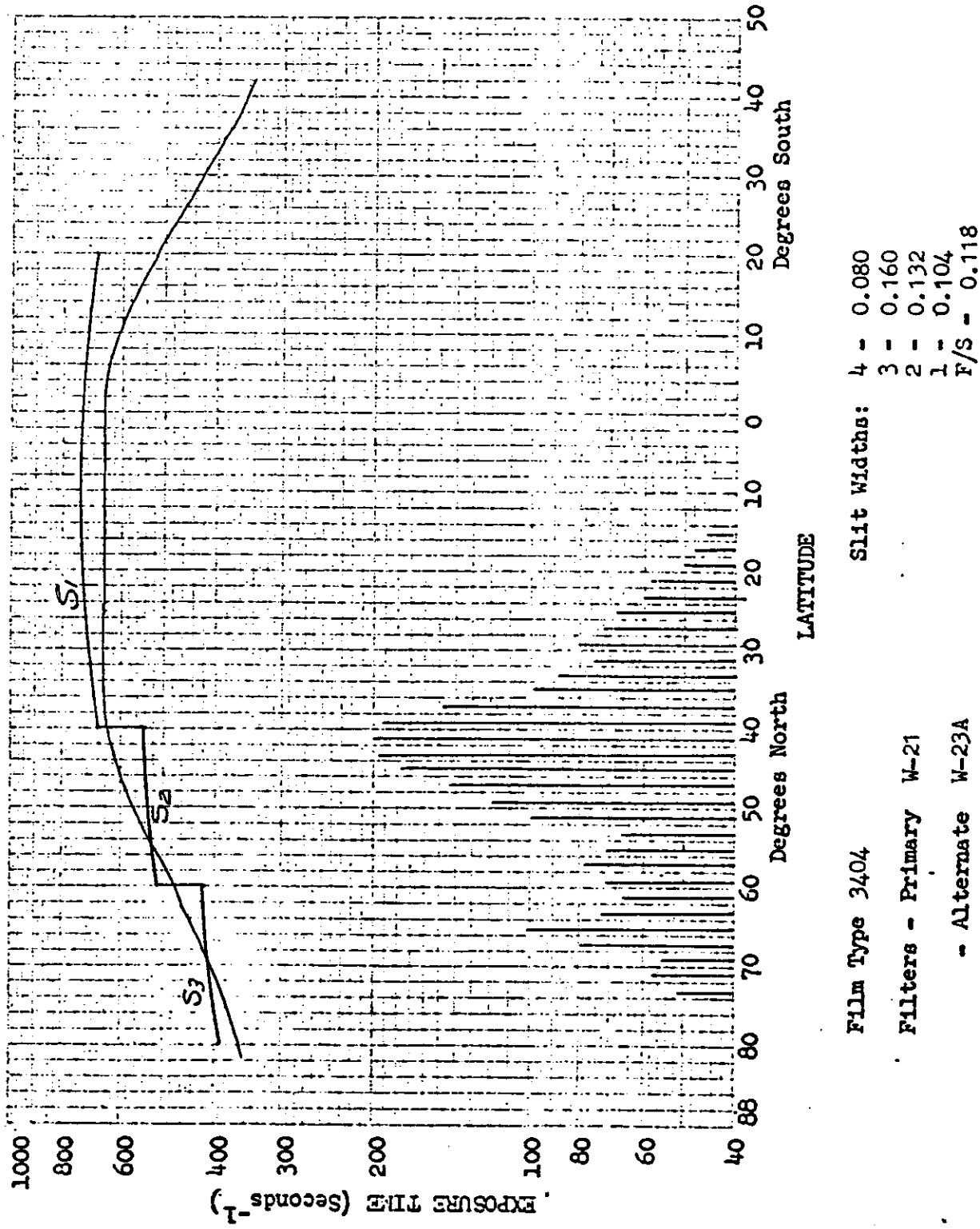
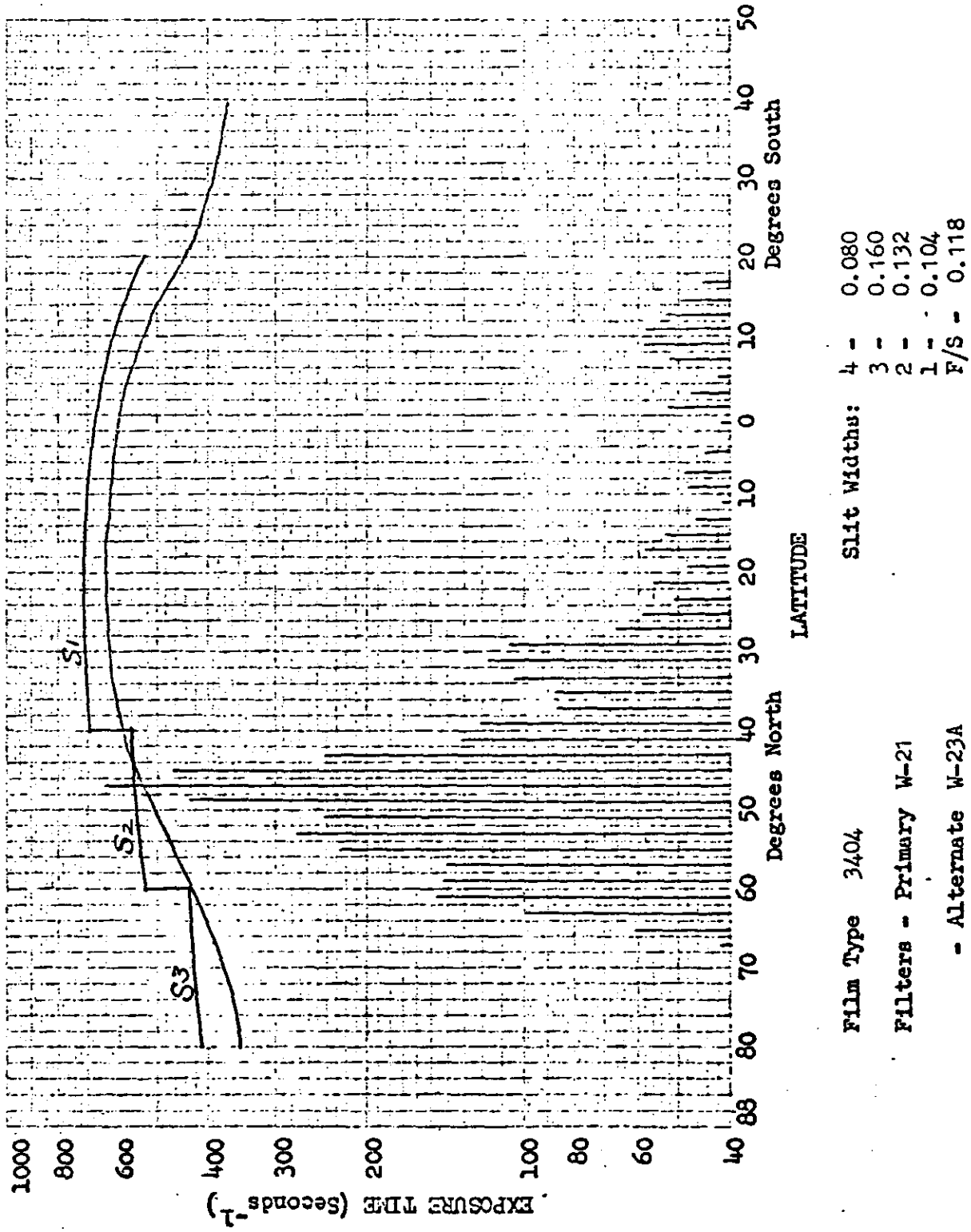


FIGURE 5-6 , EXPOSURE PROFILE, Mission 1110, Payload CR- 11

Aft - Looking Camera # 322 , Pass # 250

Launched 5-20-70



ISSION * 1110-2 * INSTR * FWD * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

RITH MEAN * 0.46 * MEDIAN * 0.38 * STD DEV * 0.17 * RANGE * 0.27 TO 1.36 WITH 454 SAMPLES

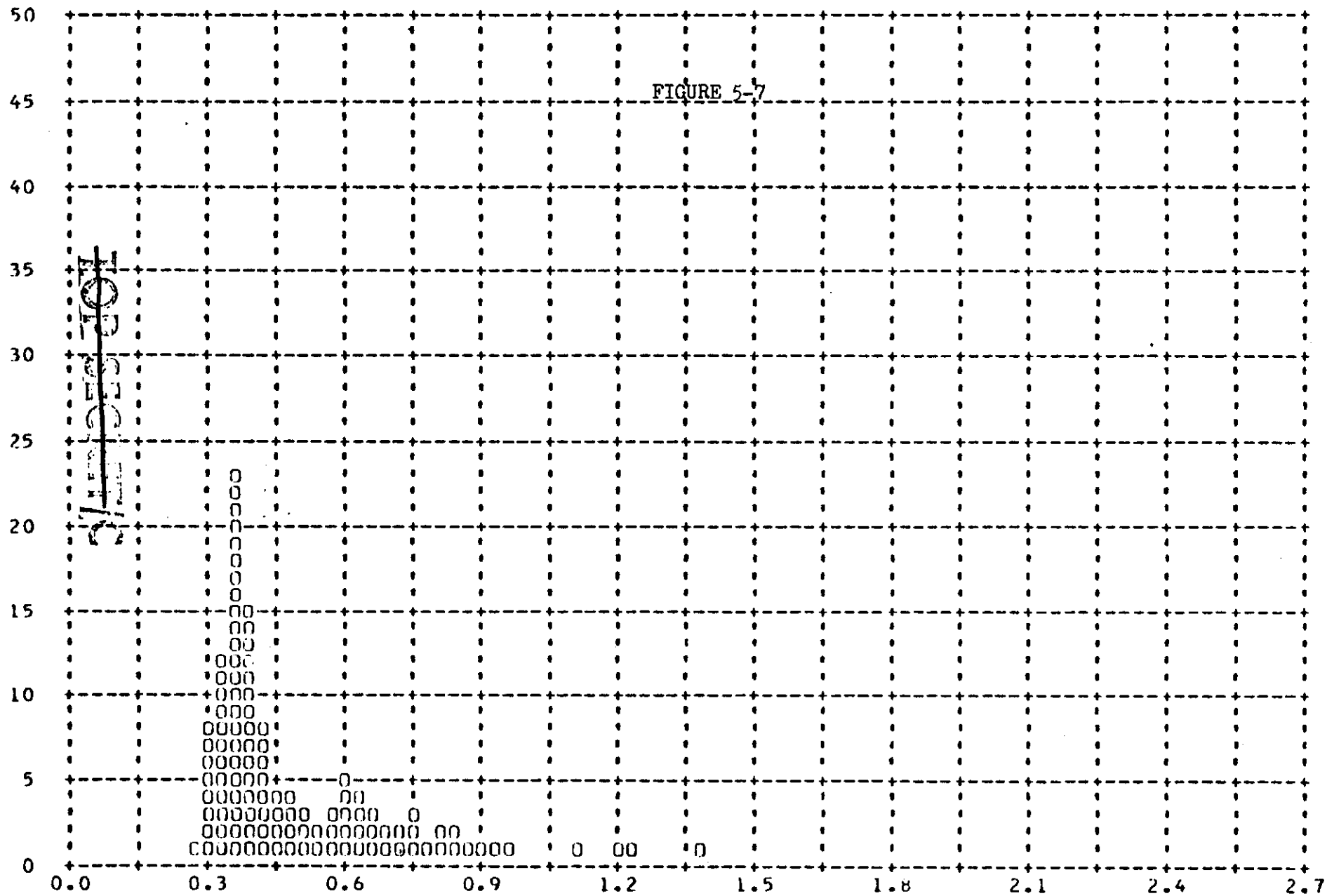
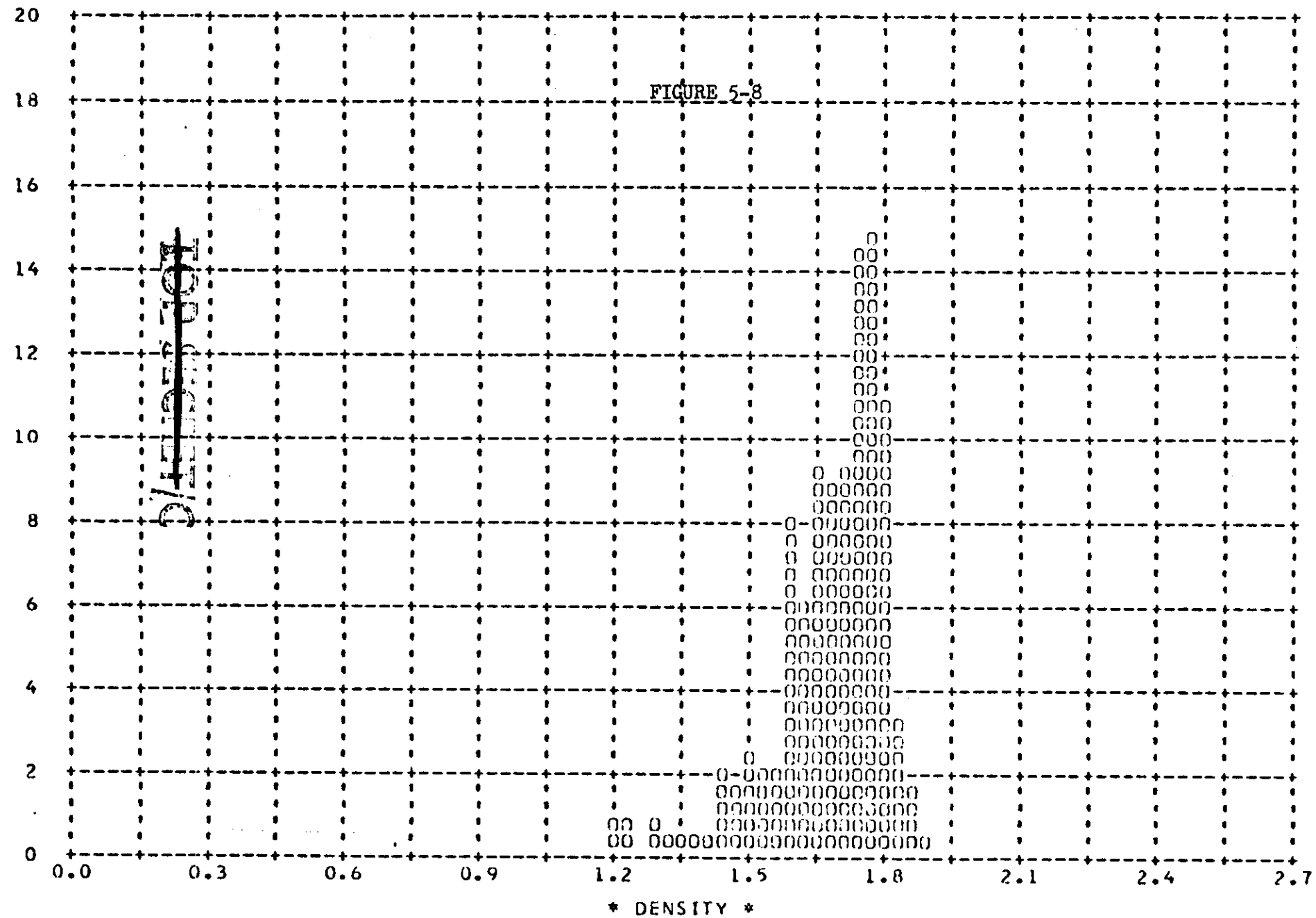


FIGURE 5-7

MISSION * 1110-1 * INSTR * AFT * PLOT OF D MAX * CLOUD * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.67 * MEDIAN * 1.70 * STD DEV * 0.12 * RANGE * 1.19 TO 1.88 WITH 251 SAMPLES

FIGURE 5-8



ISSION * 1110-1 * INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

RITH MEAN * 1.35 * MEDIAN * 1.30 * STD DEV * 0.26 * RANGE * 0.69 TO 1.84 WITH 463 SAMPLES

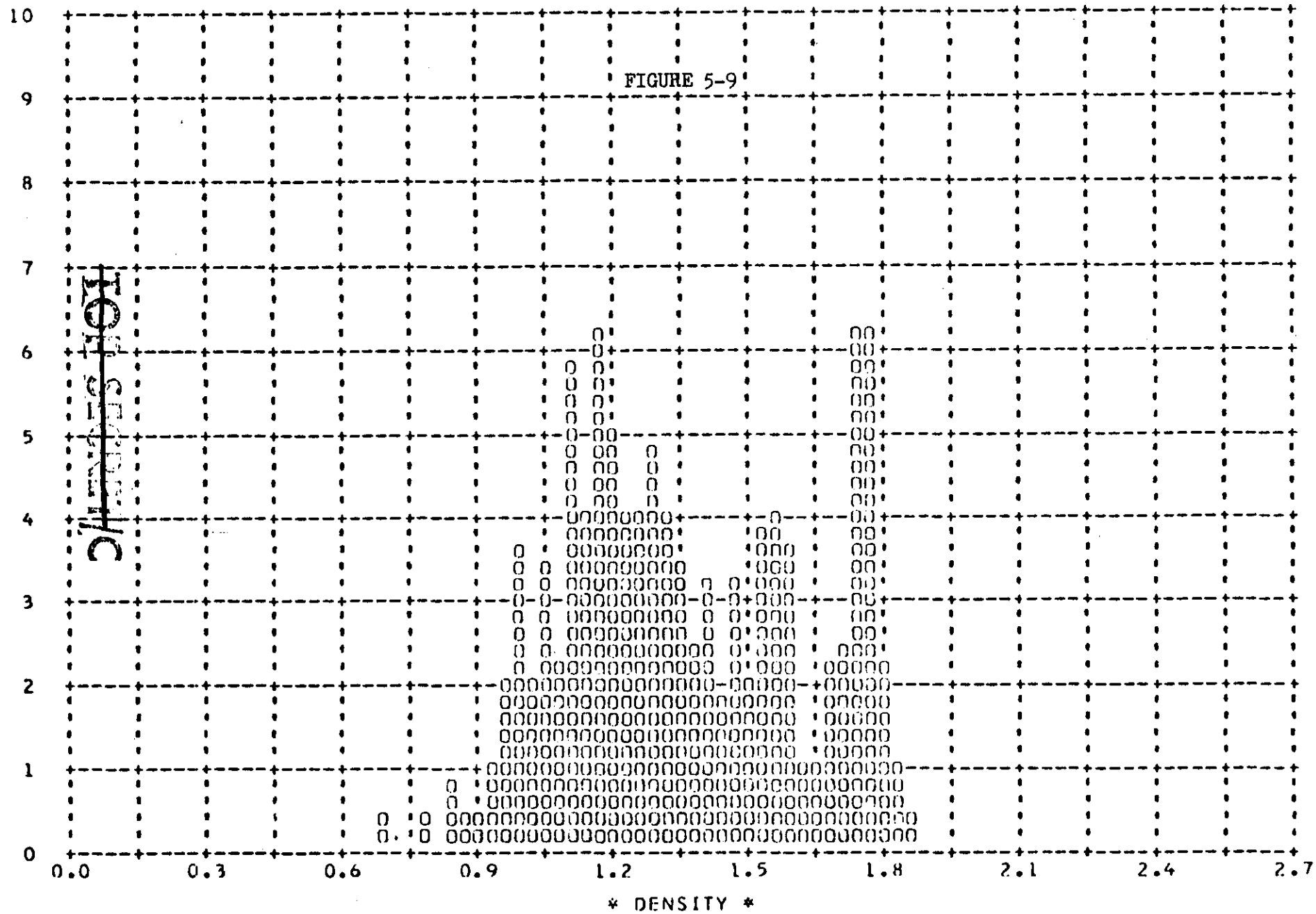


FIGURE 5-9

ISSION * 1110-1 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

WITH MEAN * 0.55 * MEDIAN * 0.51 * STD DEV * 0.16 * RANGE * 0.29 TO 1.36 WITH 463 SAMPLES

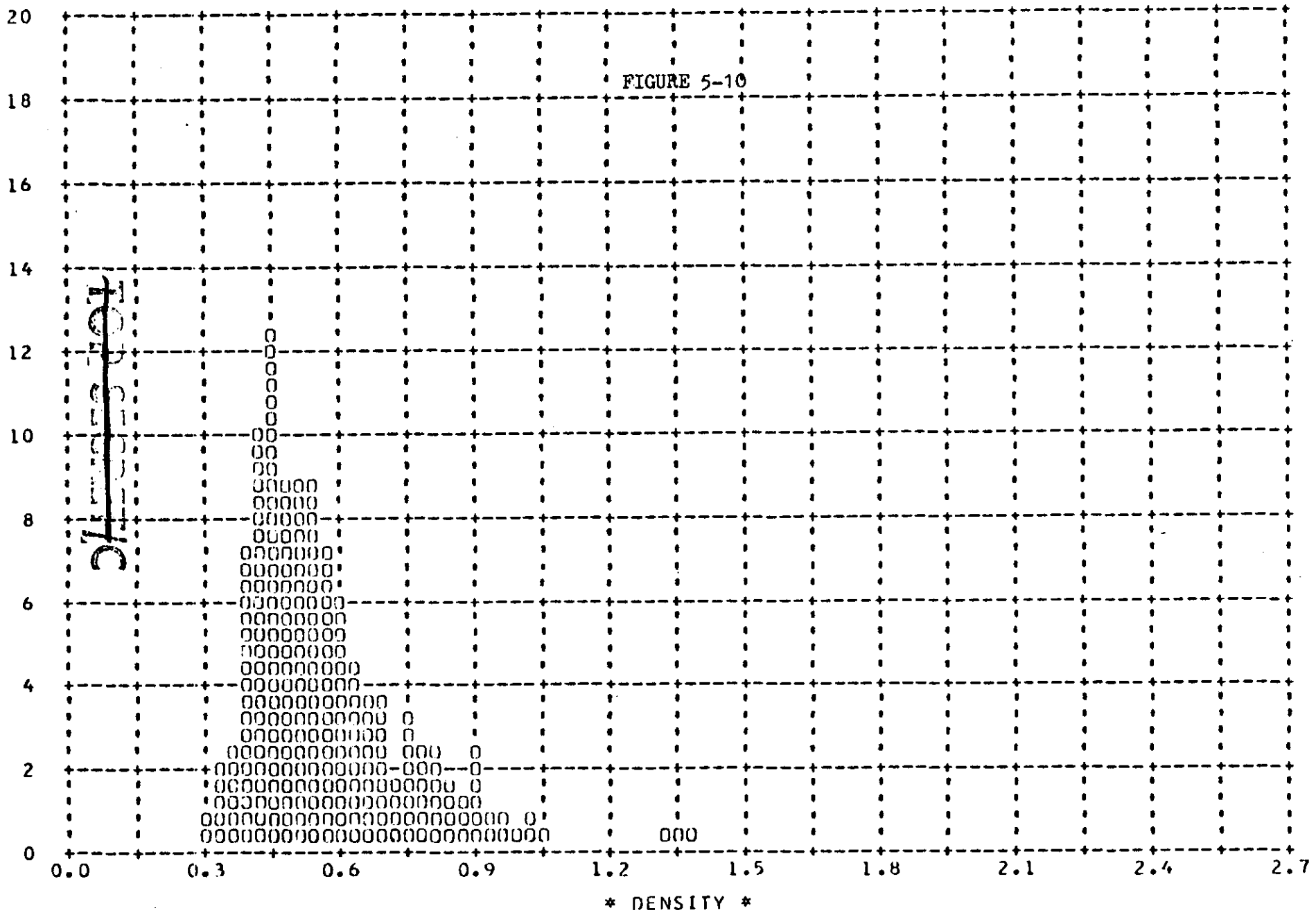


FIGURE 5-10

ISSION * 1110-1 * INSTR * FWD * PLOT OF D MAX * CLOUD * PROCESSING * DUAL GAMMA

RITH MEAN * 1.63 * MEDIAN * 1.63 * STD DEV * 0.13 * RANGE * 1.22 TO 1.97 WITH 244 SAMPLES

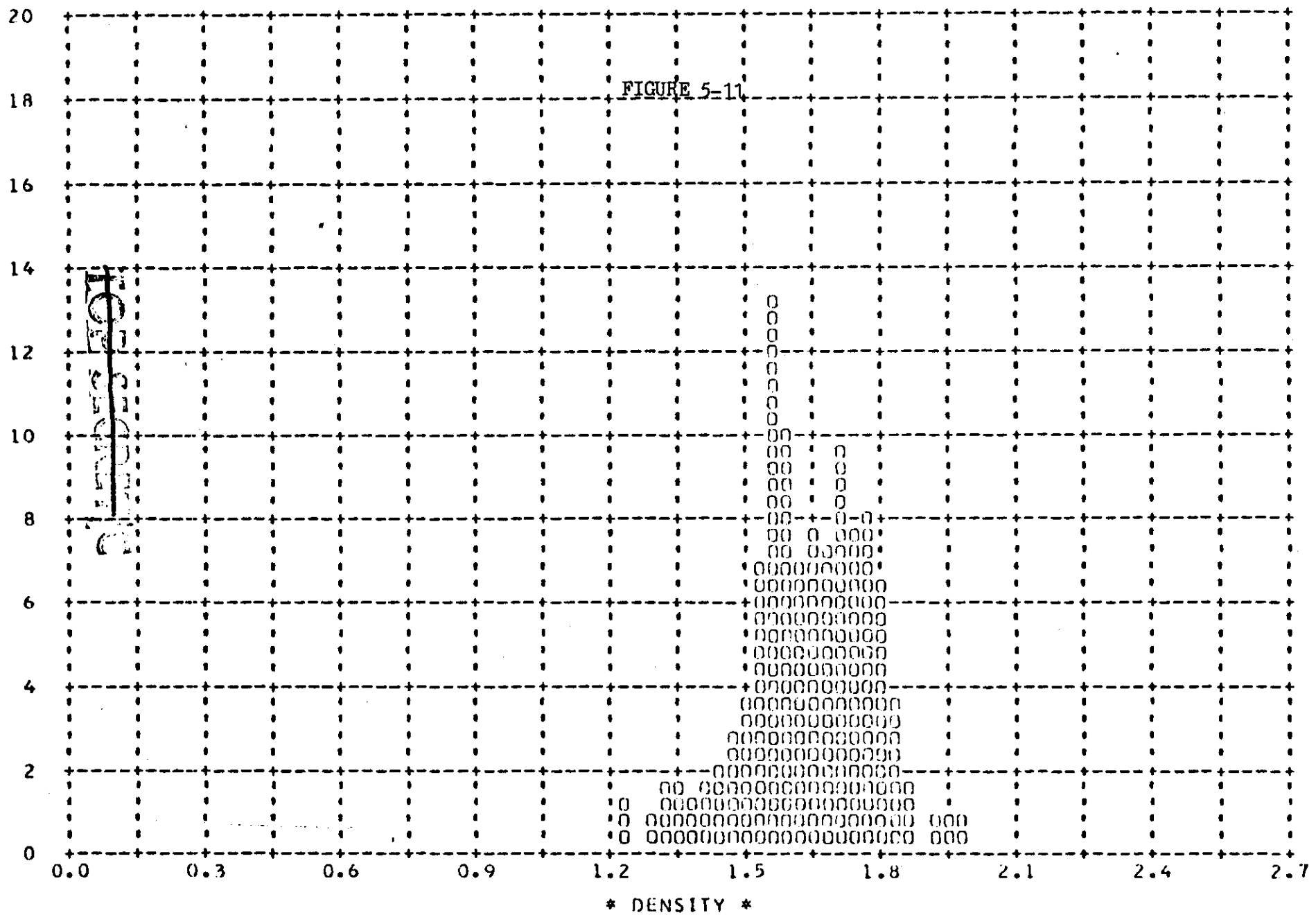
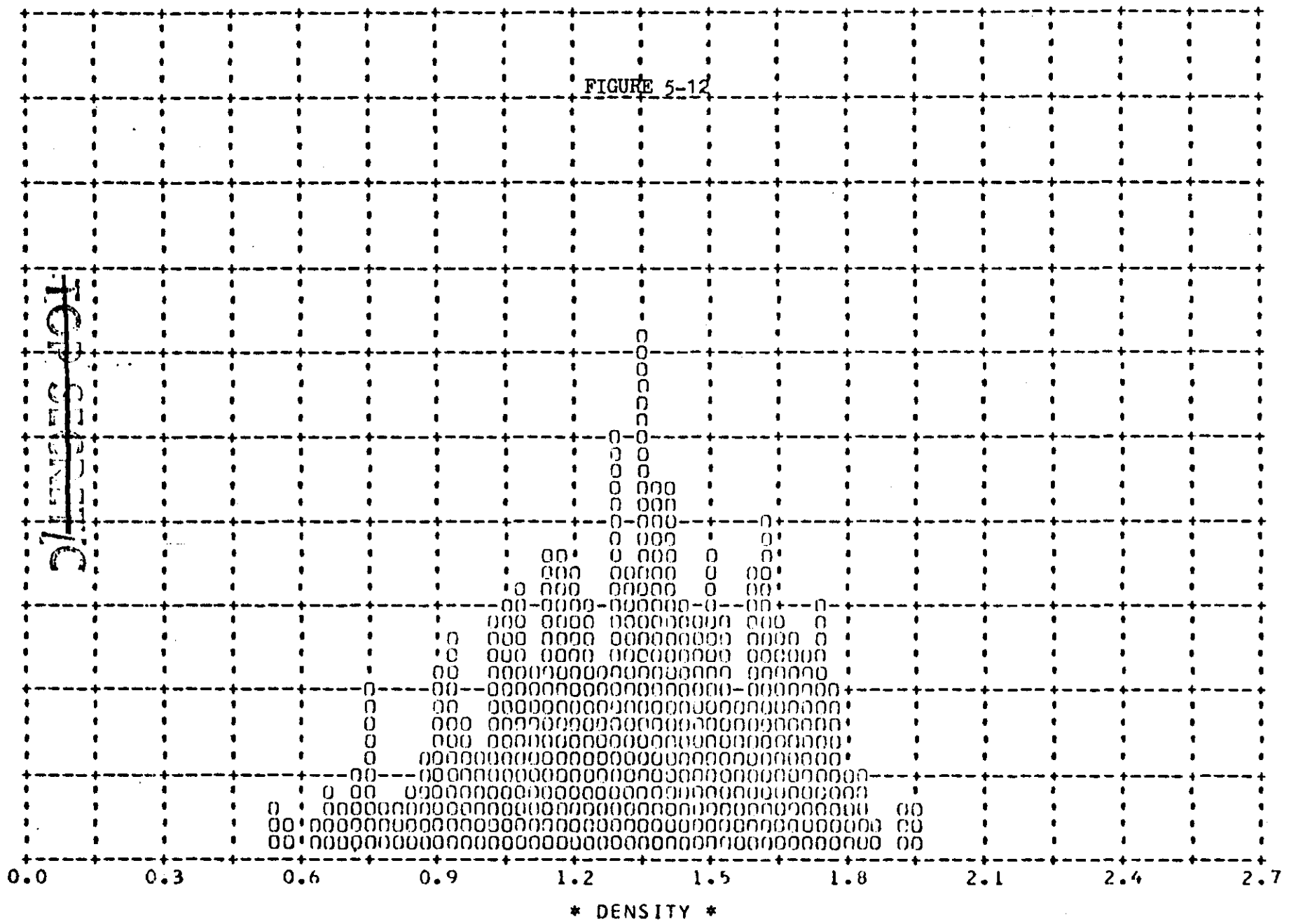


FIGURE 5-11

MISSION * 1110-1 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.31 * MEDIAN * 1.33 * STD DEV * 0.29 * RANGE * 0.53 TO 1.95 WITH 473 SAMPLES

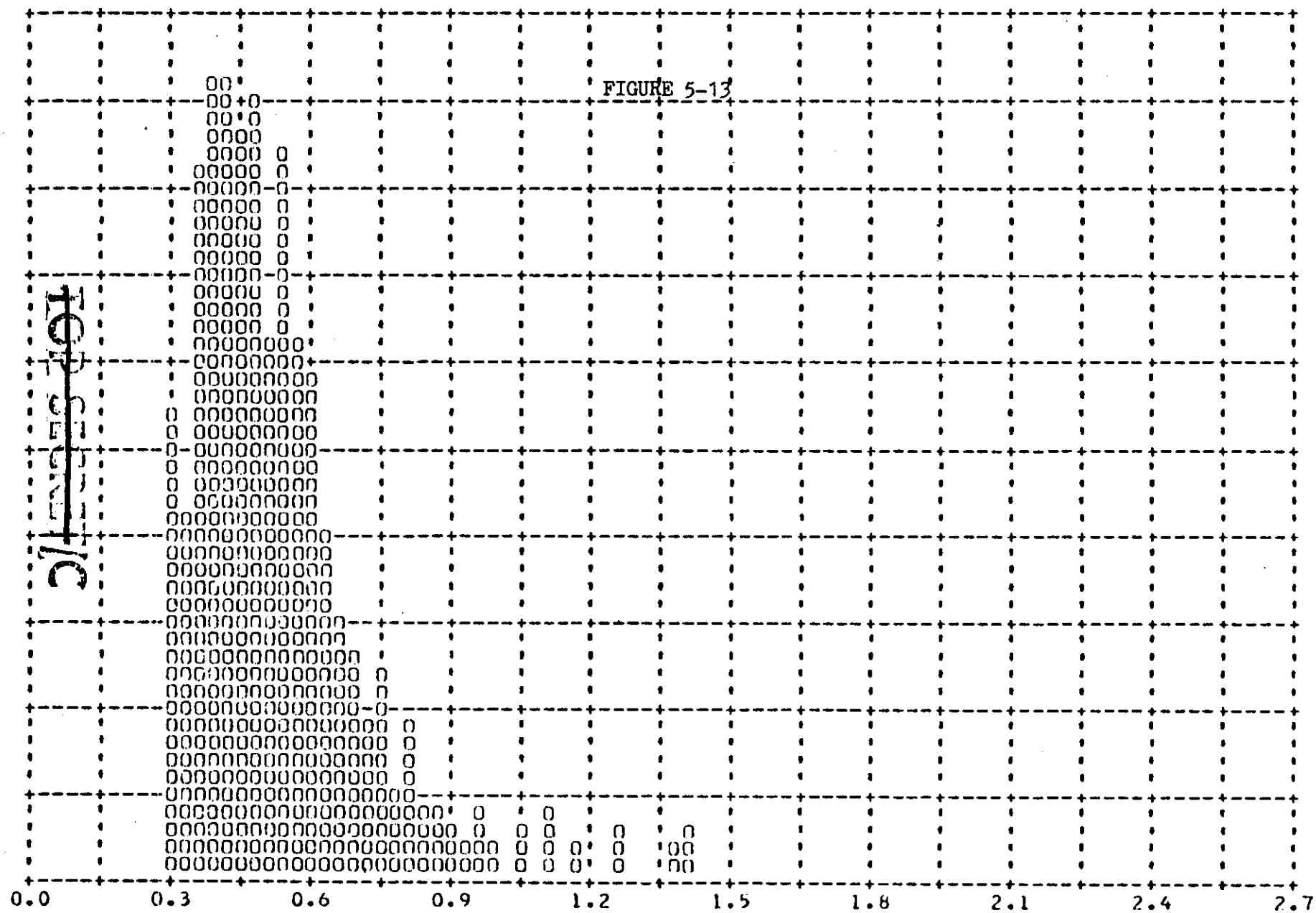
FIGURE 5-12



ISSION * 1110-1 * INSTR * FWD * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

RITH MEAN * 0.51 * MEDIAN * 0.48 * STD DEV * 0.18 * RANGE * 0.28 TO 1.41 WITH 473 SAMPLES

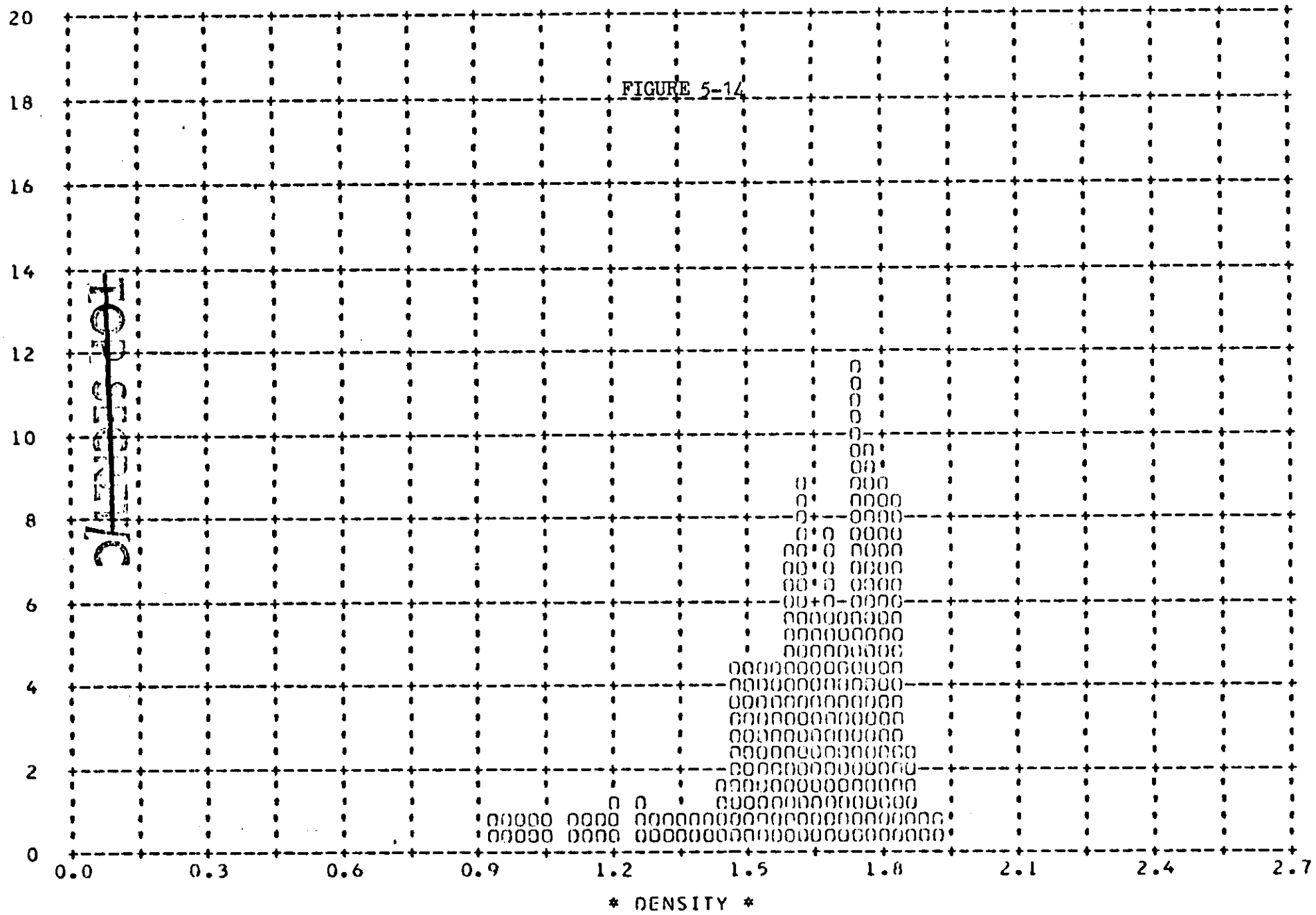
FIGURE 5-13



ISSION * 1110-2 * INSTR * AFT * PLOT OF D MAX * CLOUD * PROCESSING * DUAL GAMMA

RITH MEAN * 1.63 * MEDIAN * 1.67 * STD DEV * 0.17 * RANGE * 0.92 TO 1.91 WITH 234 SAMPLES

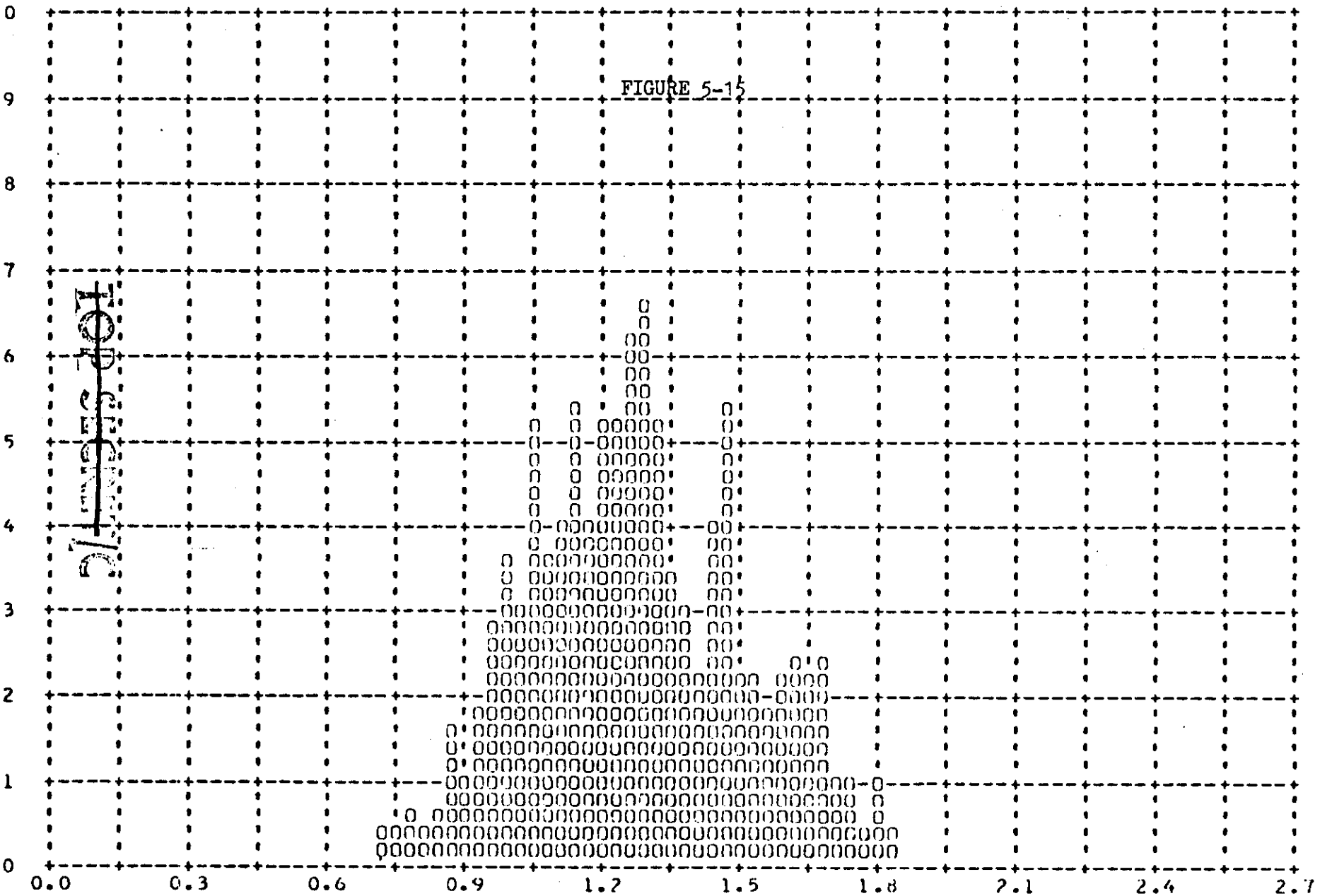
FIGURE 5-14



MISSION * 1110-2 * INSTR * AFT * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 1.26 * MEDIAN * 1.25 * STD DEV * 0.23 * RANGE * 0.70 TO 1.81 WITH 339 SAMPLES

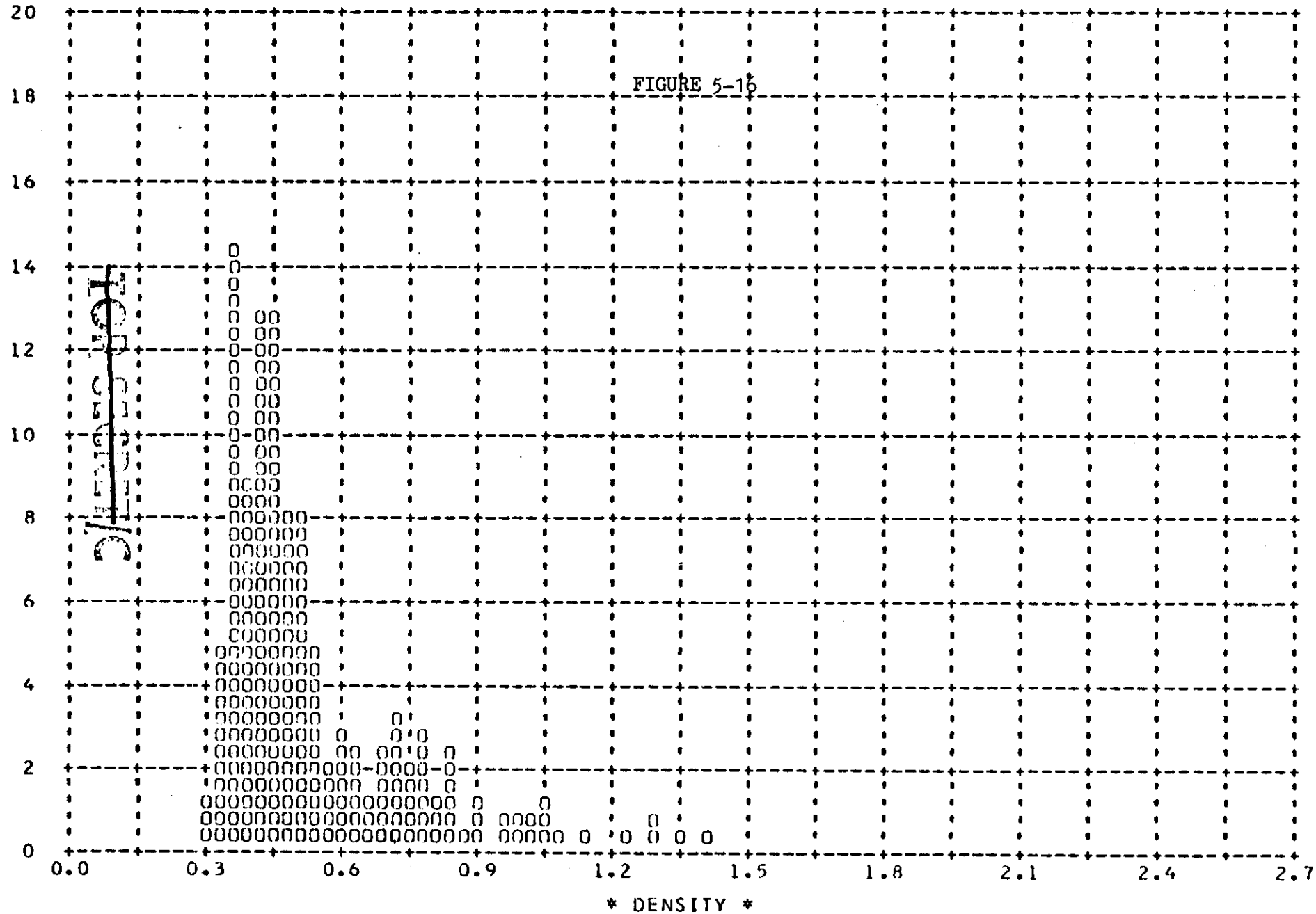
FIGURE 5-15



ISSION * 1110-2 * INSTR * AFT * PLOT OF D MIN * TERRAIN * PROCESSING * DUAL GAMMA

ARITH MEAN * 0.51 * MEDIAN * 0.44 * STD DEV * 0.19 * RANGE * 0.30 TO 1.39 WITH 339 SAMPLES

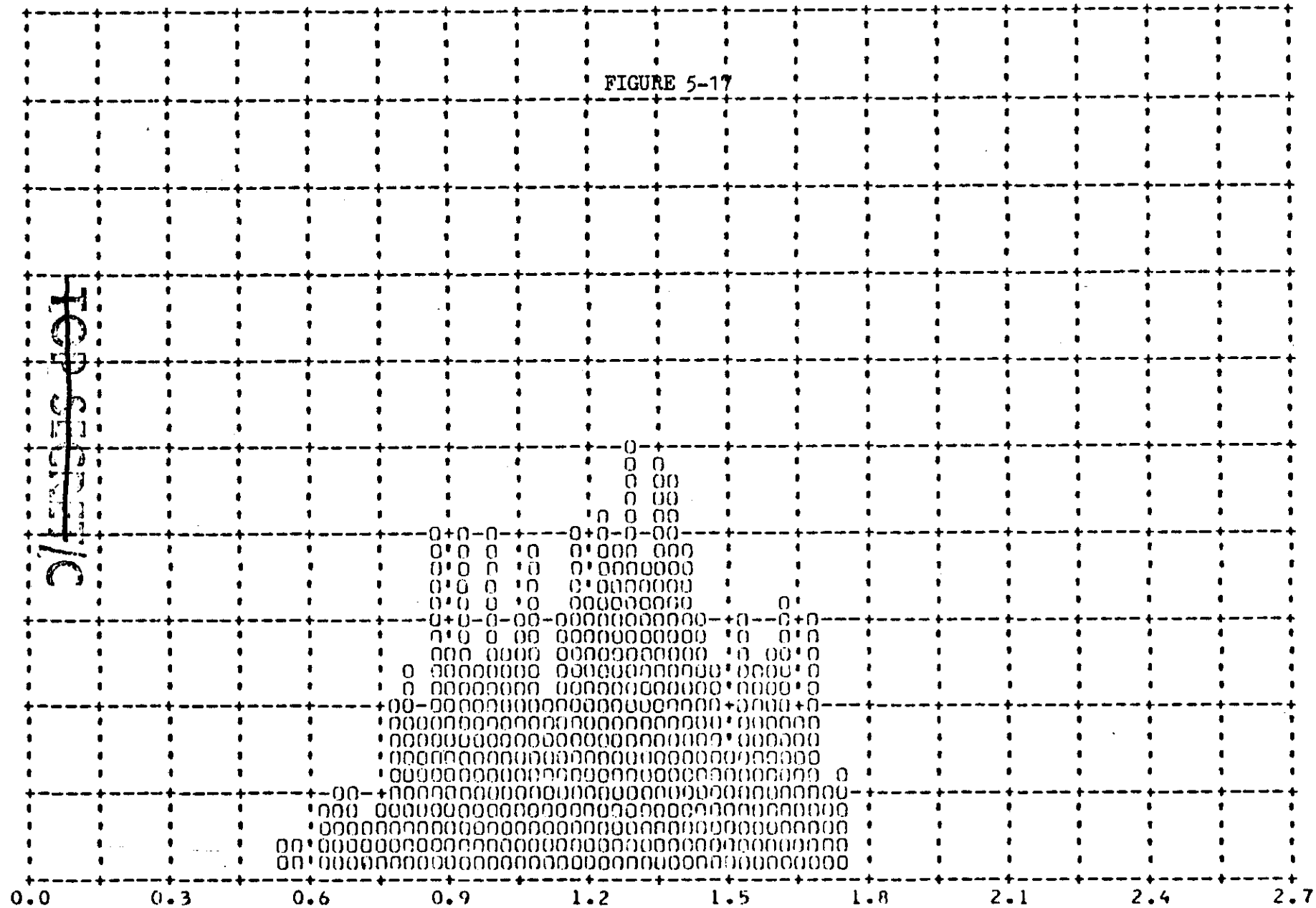
FIGURE 5-16



ISSION * 1110-2 * INSTR * FWD * PLOT OF D MAX * TERRAIN * PROCESSING * DUAL GAMMA

ITH MEAN * 1.21 * MEDIAN * 1.23 * STD DEV * 0.27 * RANGE * 0.54 TO 1.74 WITH 454 SAMPLES

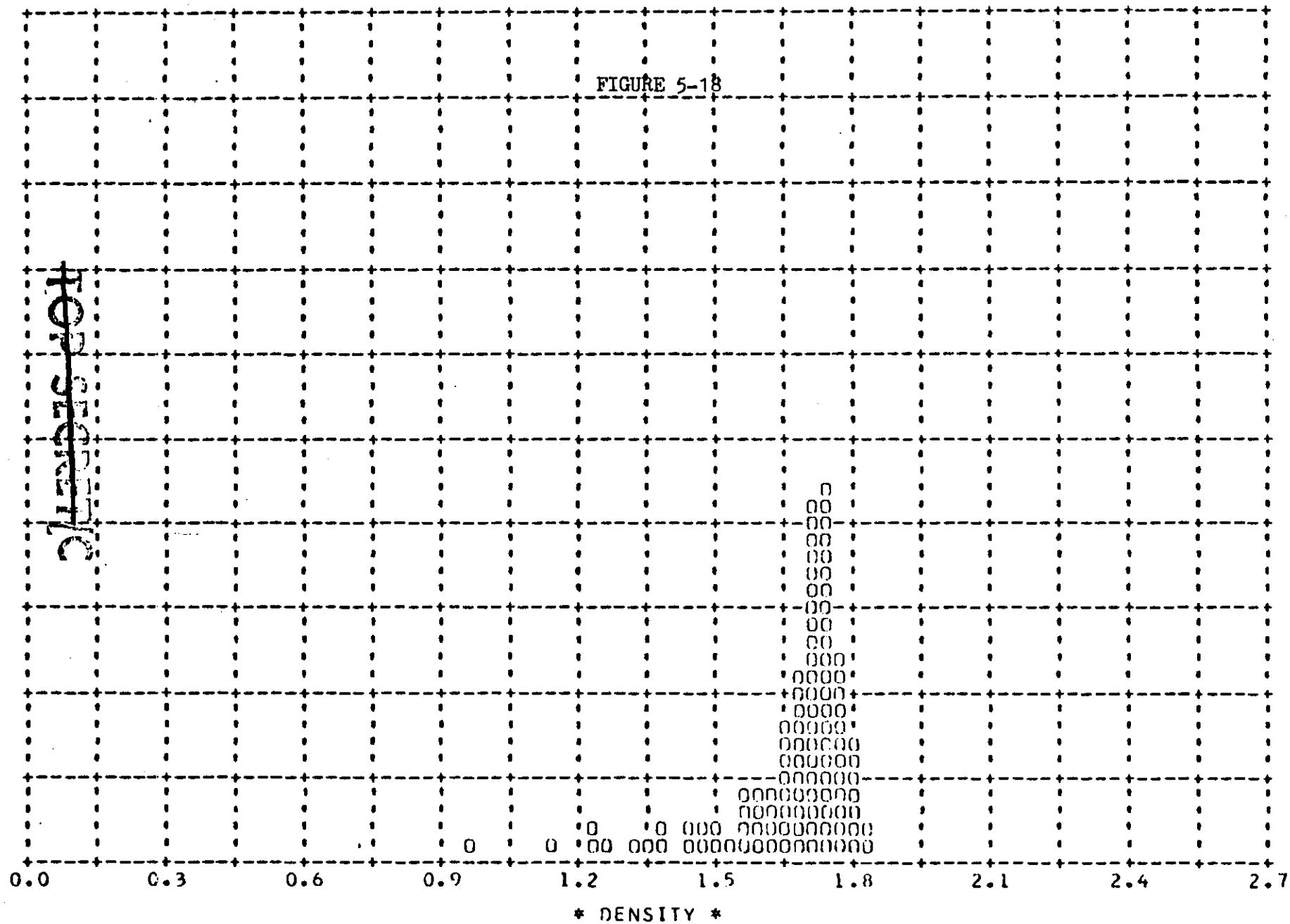
FIGURE 5-17



ISSION * 1110-2 * INSTR * FWD * PLOT OF D MAX * CLOUD * PROCESSING * DUAL GAMMA

WITH MEAN * 1.67 * MEDIAN * 1.70 * STD DEV * 0.12 * RANGE * 0.96 TO 1.83 WITH 260 SAMPLES

FIGURE 5-18



SECTION 6

IMAGE SMEAR AND VEHICLE ATTITUDE

A. SMEAR ANALYSIS

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

The computer rejects the first three frames of all operations as the large V/H error induced by camera start-up is not representative of the overall system operations.

The summary table 6-1 presents the maximum IMC errors and resolution limits that existed during 90% of the photographic operations and the total range of values during all operations that were computed. The IMC ratio error and the along track resolution limits are nominal and within the normal performance limits. However, the yaw angle and rate deviations shown in this section, part B, exceeded the normal performance limits and contributed to poor cross track resolution limits. While smear, per se, did not contribute significantly to the degraded photography experienced on this mission, degradation was present because of higher-than-normal cross track resolution limits.

IMC and Resolution limits are shown in Figures 6-1 through 6-12.

IMC RATIO AND RESOLUTION LIMITS

VALUE	UNITS	CAMERA	MISSION 1110-1 90%	MISSION 1110-1 RANGE	MISSION 1110-2 90%	MISSION 1110-2 RANGE
IMC Ratio Error	%	FWD	0.84	-1.5 to +1.75	0.96	-1.6 to +2.2
		AFT	0.85	-1.6 to +2.2	1.11	-2.0 to +1.4
Along Track Resolution Limit	Feet	FWD	0.72	0.0 to 1.54	0.75	0.2 to 1.75
		AFT	0.53	0.0 to 1.26	0.53	0.2 to 1.36
Cross Track Resolution Limit	Feet	FWD	4.26	0.6 to 7.6	4.24	0.2 to 6.4
		AFT	3.32	1.2 to 6.4	3.40	1.0 to 6.6

TABLE 6-1

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 0.85

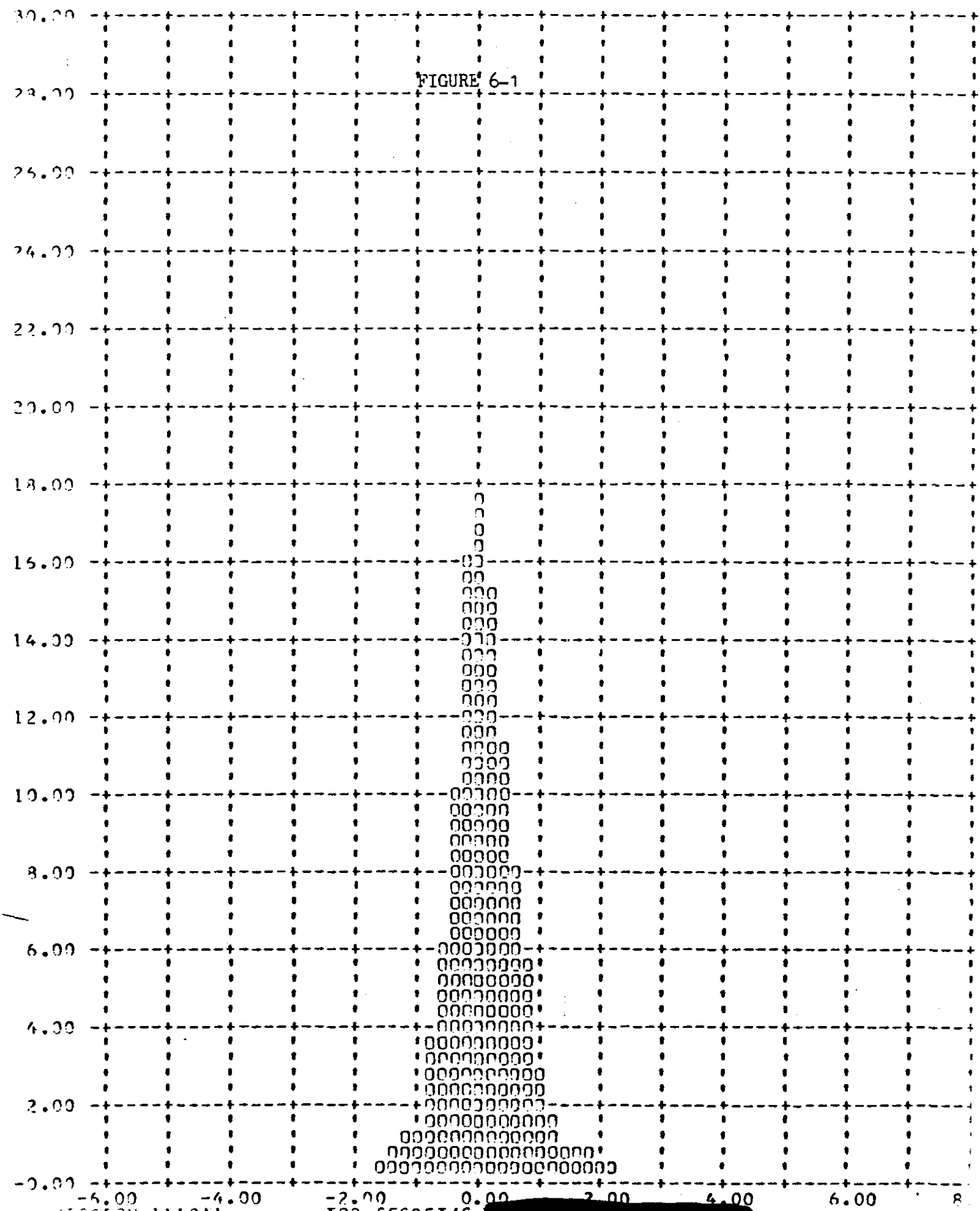


FIGURE 6-1

FRAMES 1-3 OF EACH OP OMITTED 99 PERCENT = 1.11

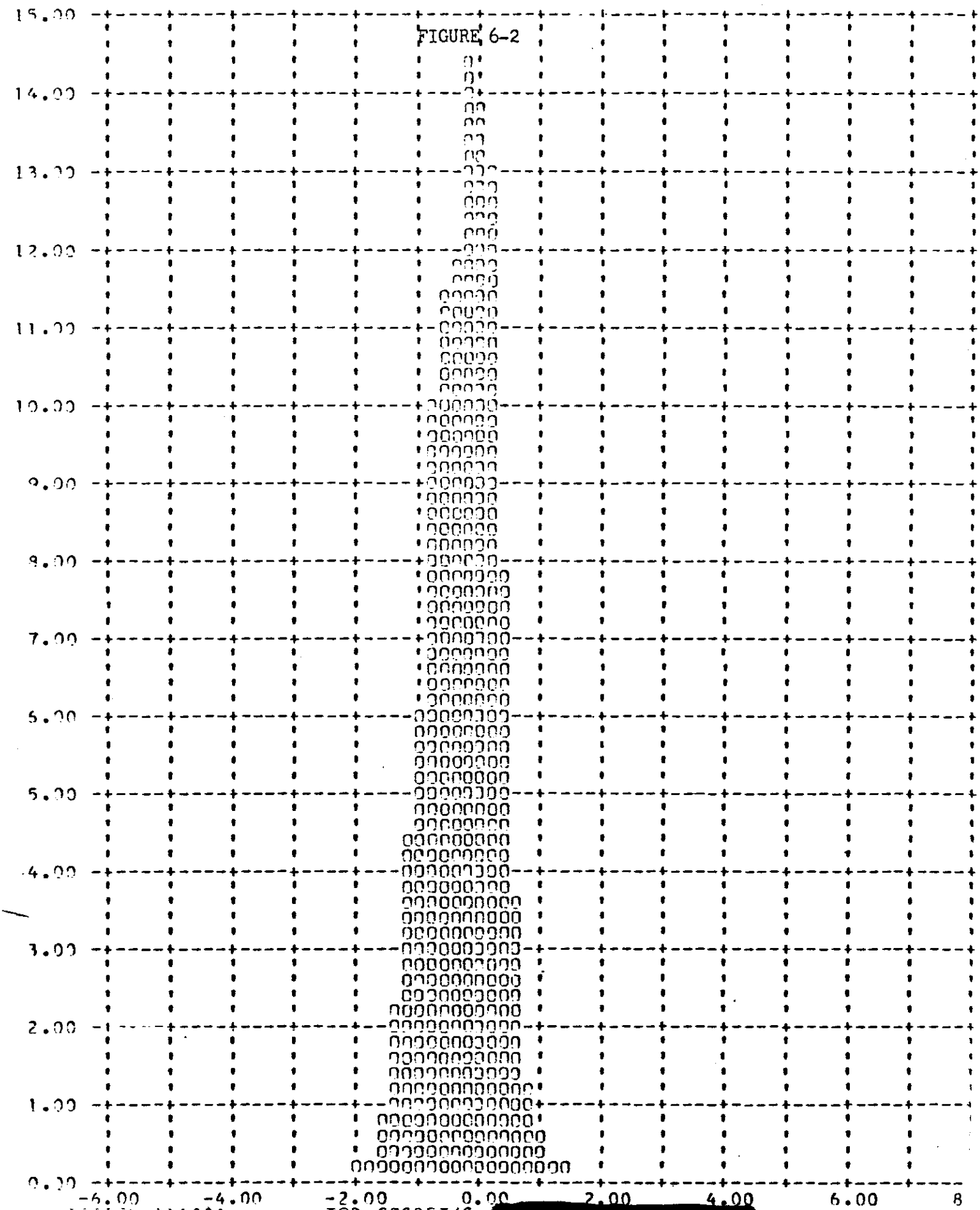


FIGURE 6-2

FRAMES 1-3 OF EACH OP OMITTED 20 PERCENT = 0.34

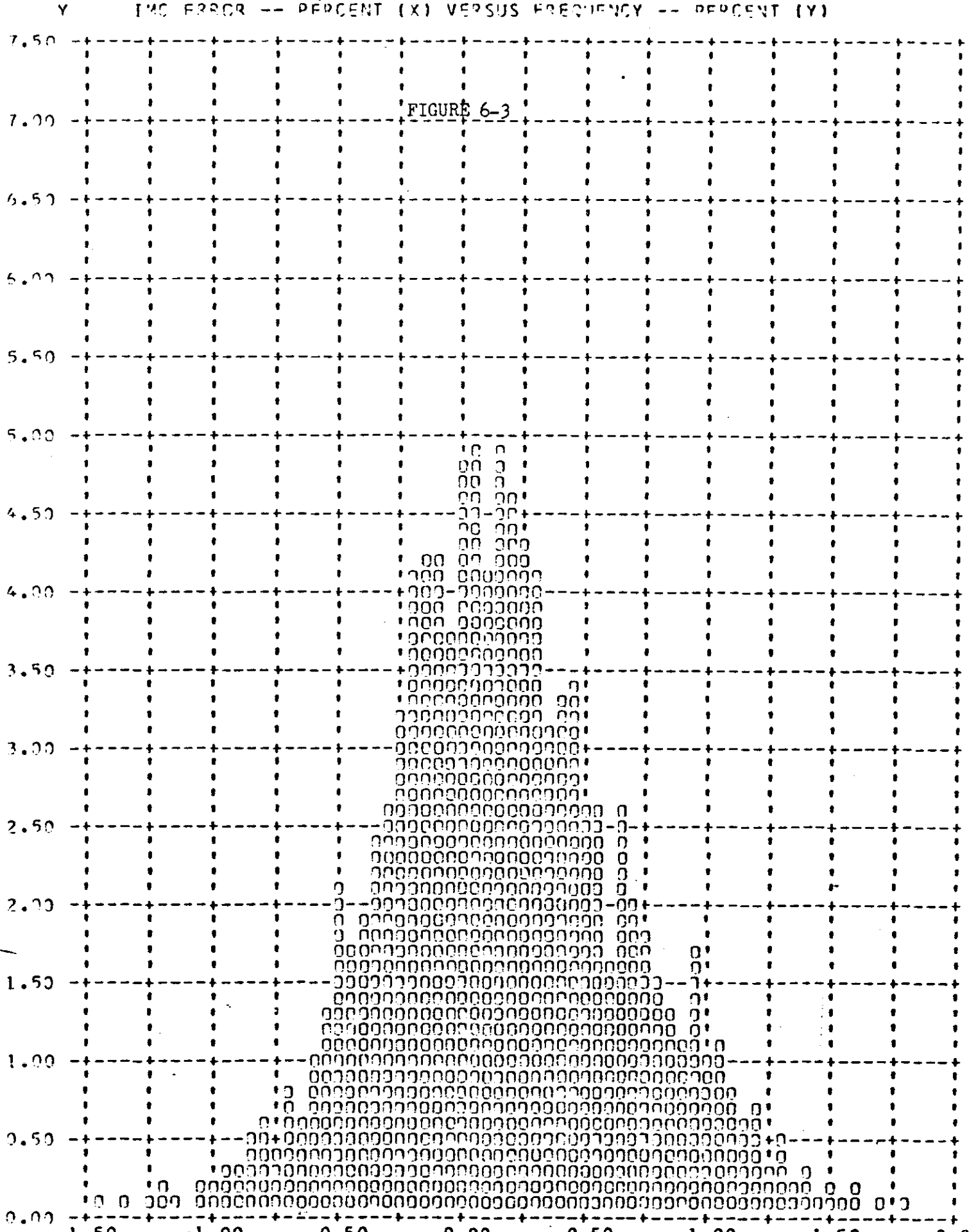


FIGURE 6-3

FRAMES 1-3 OF EACH OP OMITTED 30 PERCENT = 0.96

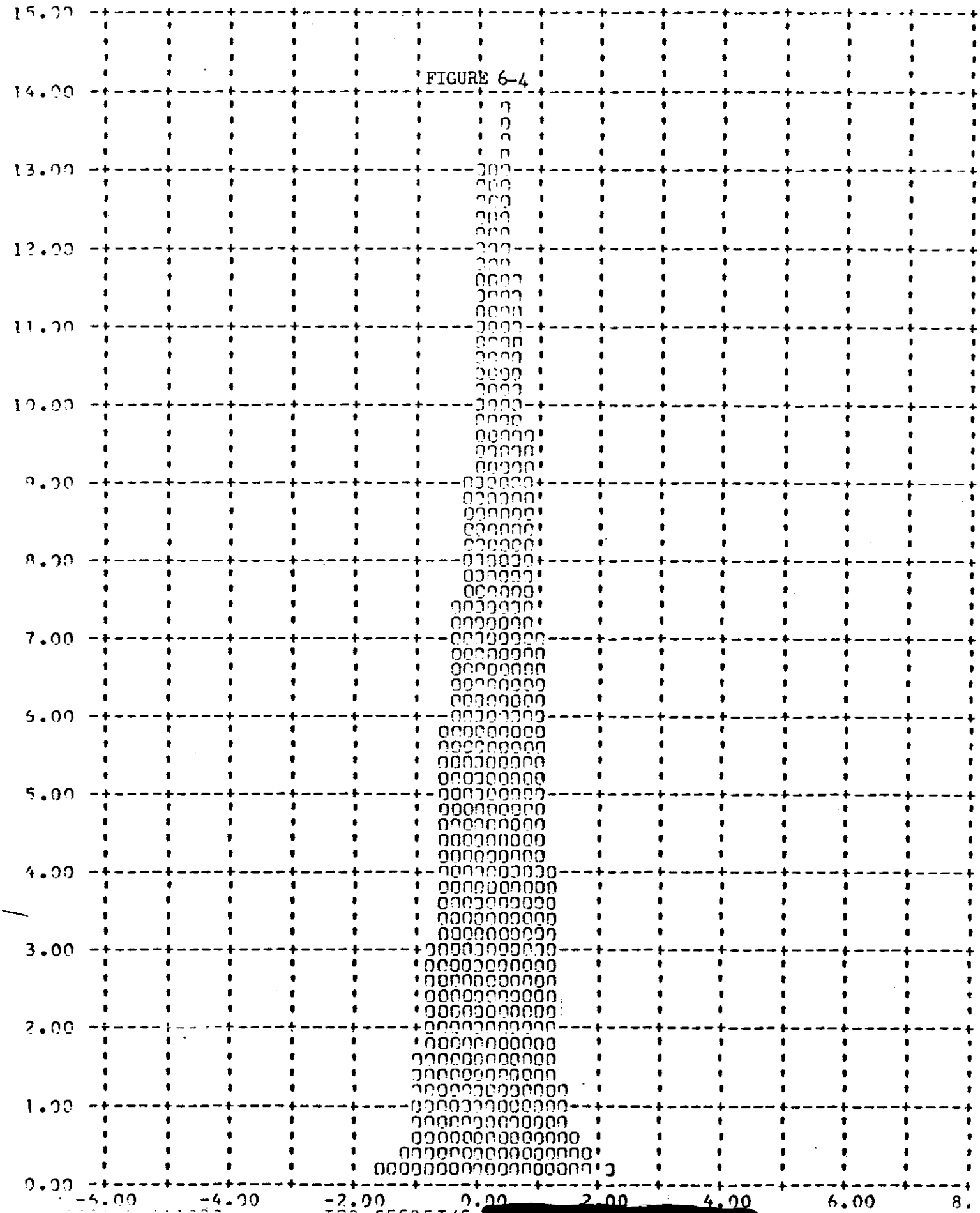


FIGURE 6-4

FRAMES 1-3 OF EACH 30 OMITTED 90 PERCENT = 4.24

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

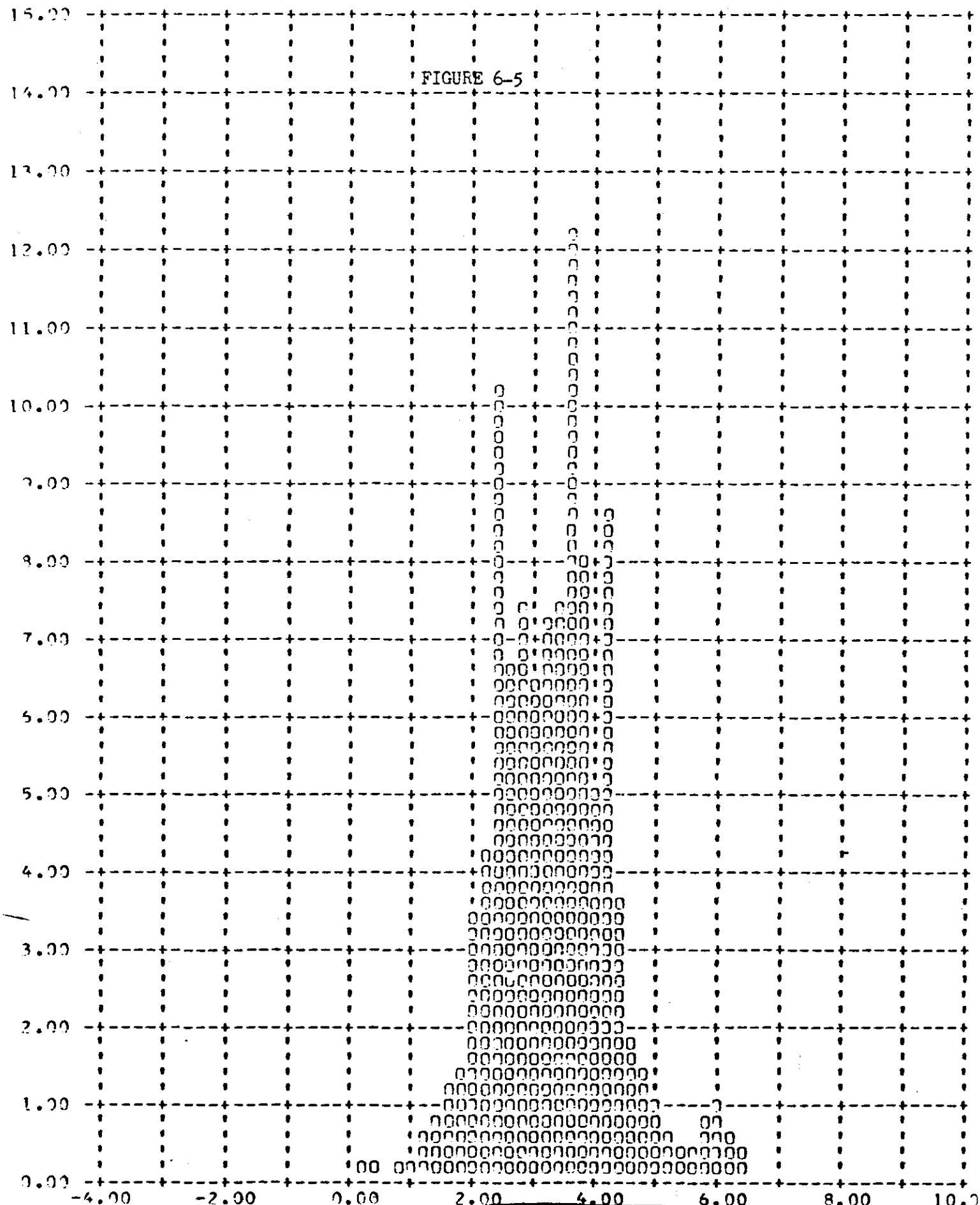


FIGURE 6-5

FRAMES 1-3 OF EACH OP OMITTED 20 PERCENT = 0.75

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

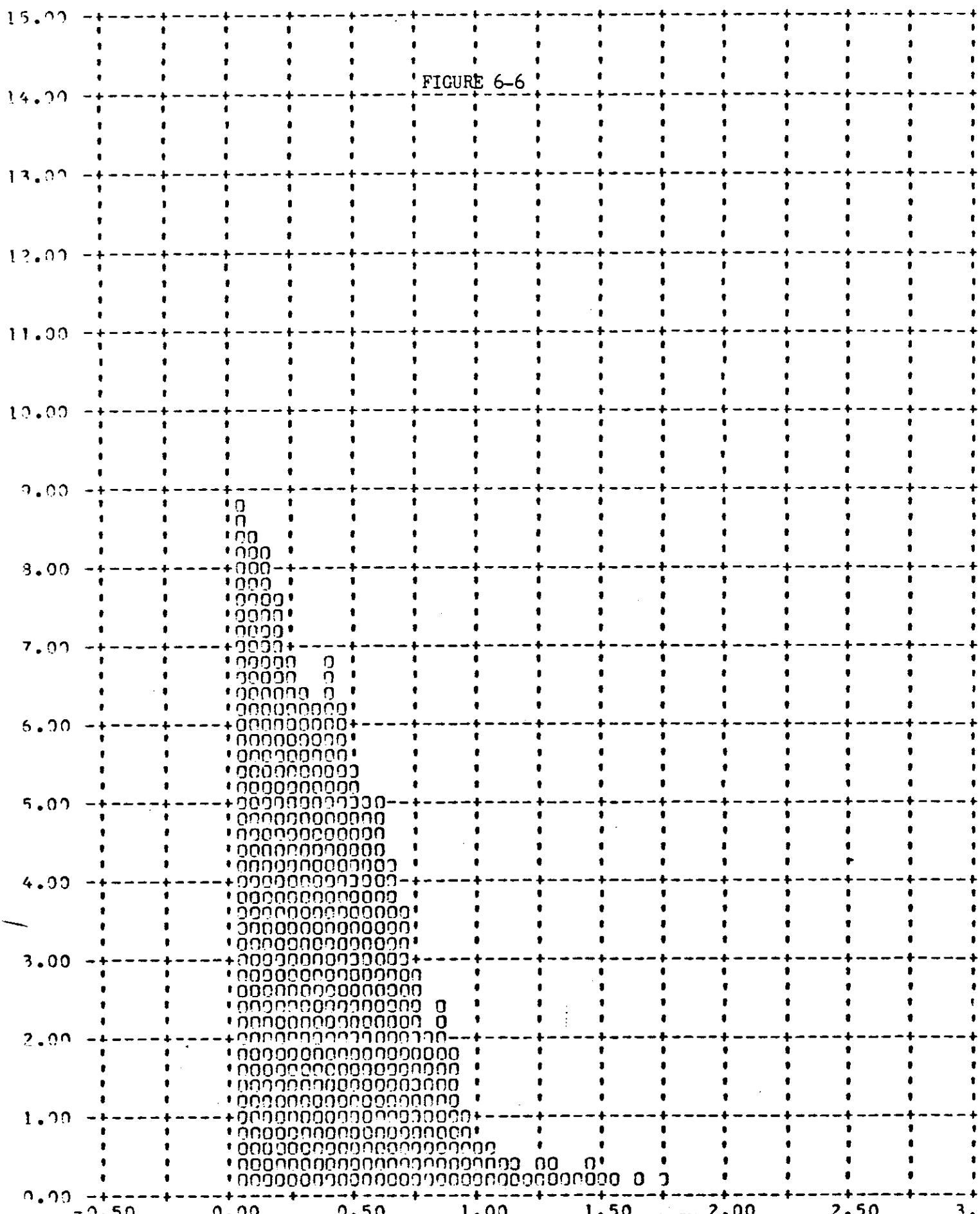


FIGURE 6-6

FRAMES 1-3 OF EACH OP OMITTED 99 PERCENT = 3.40

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

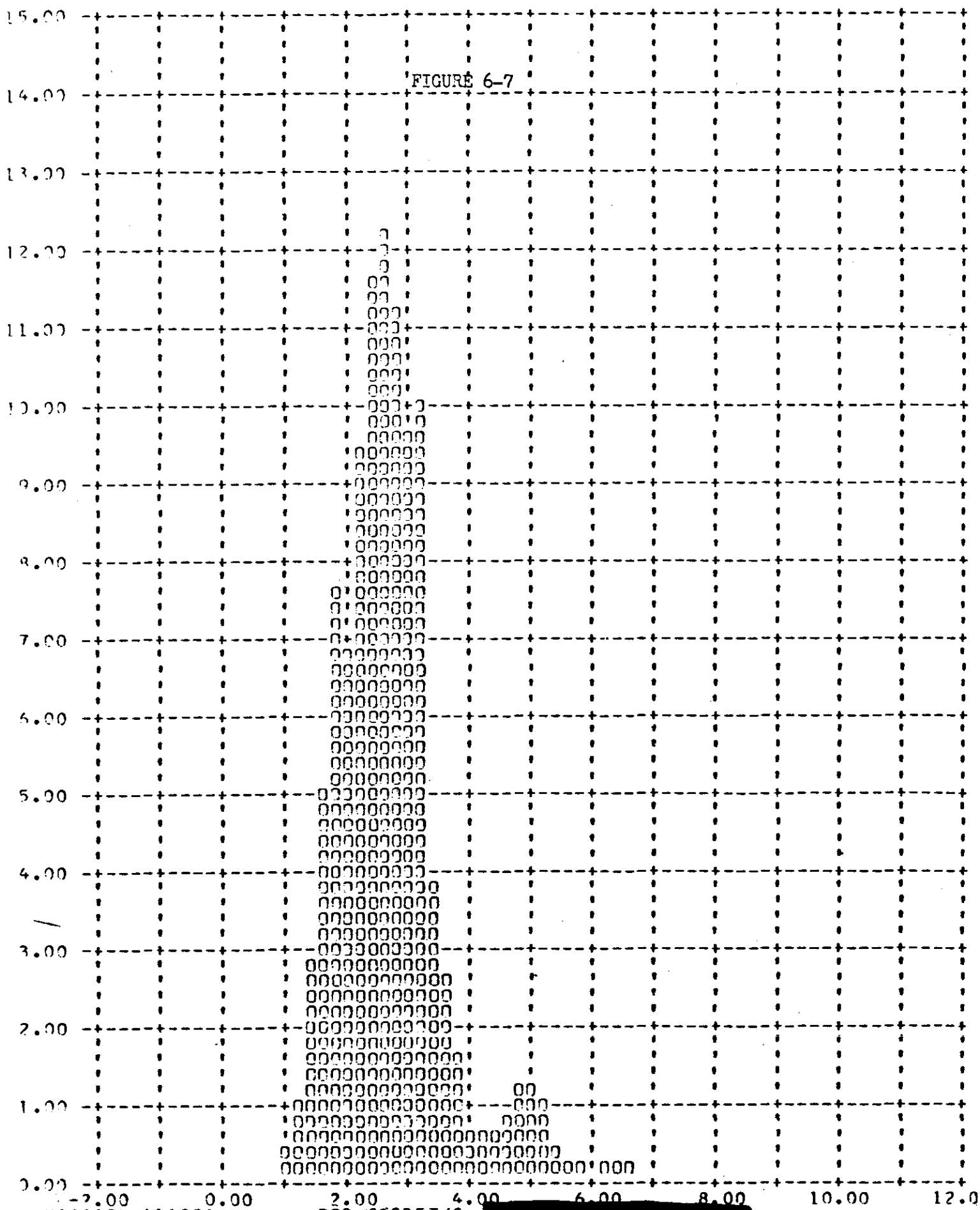


FIGURE 6-7

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 0.5

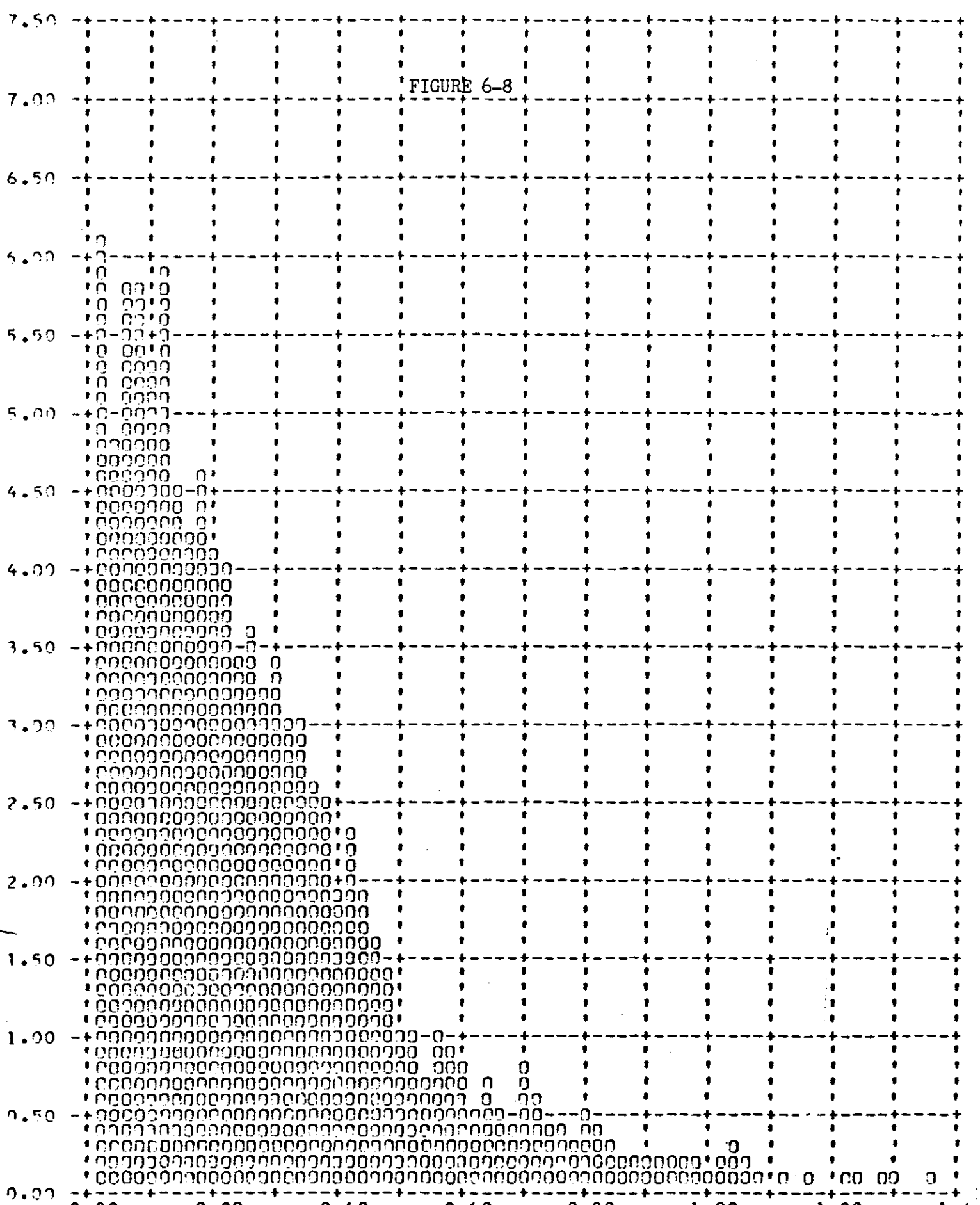


FIGURE 6-8

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 4.25

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

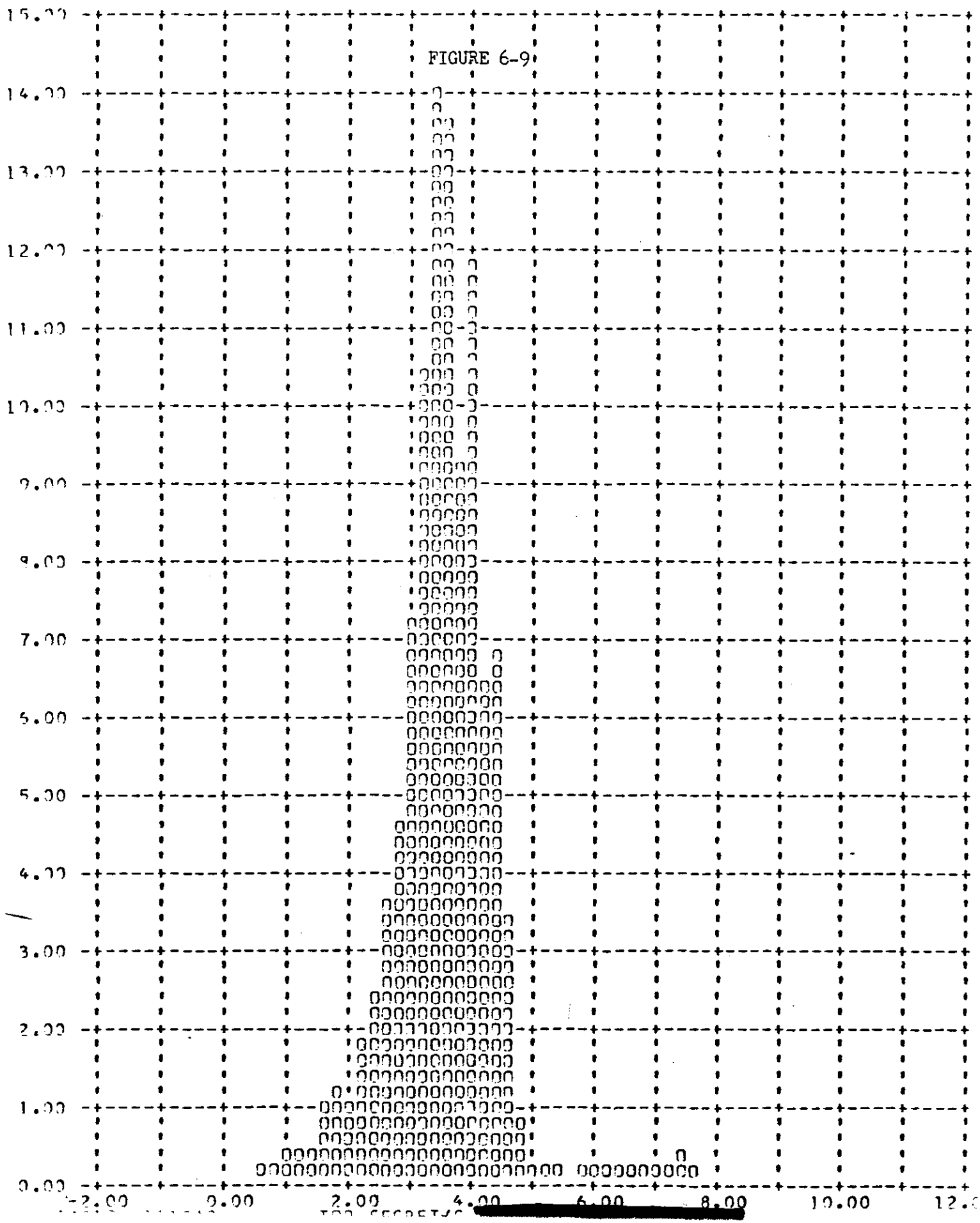


FIGURE 6-9

FRAMES 1-3 OF EACH 30 OMITTED 90 PERCENT = 0.72

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

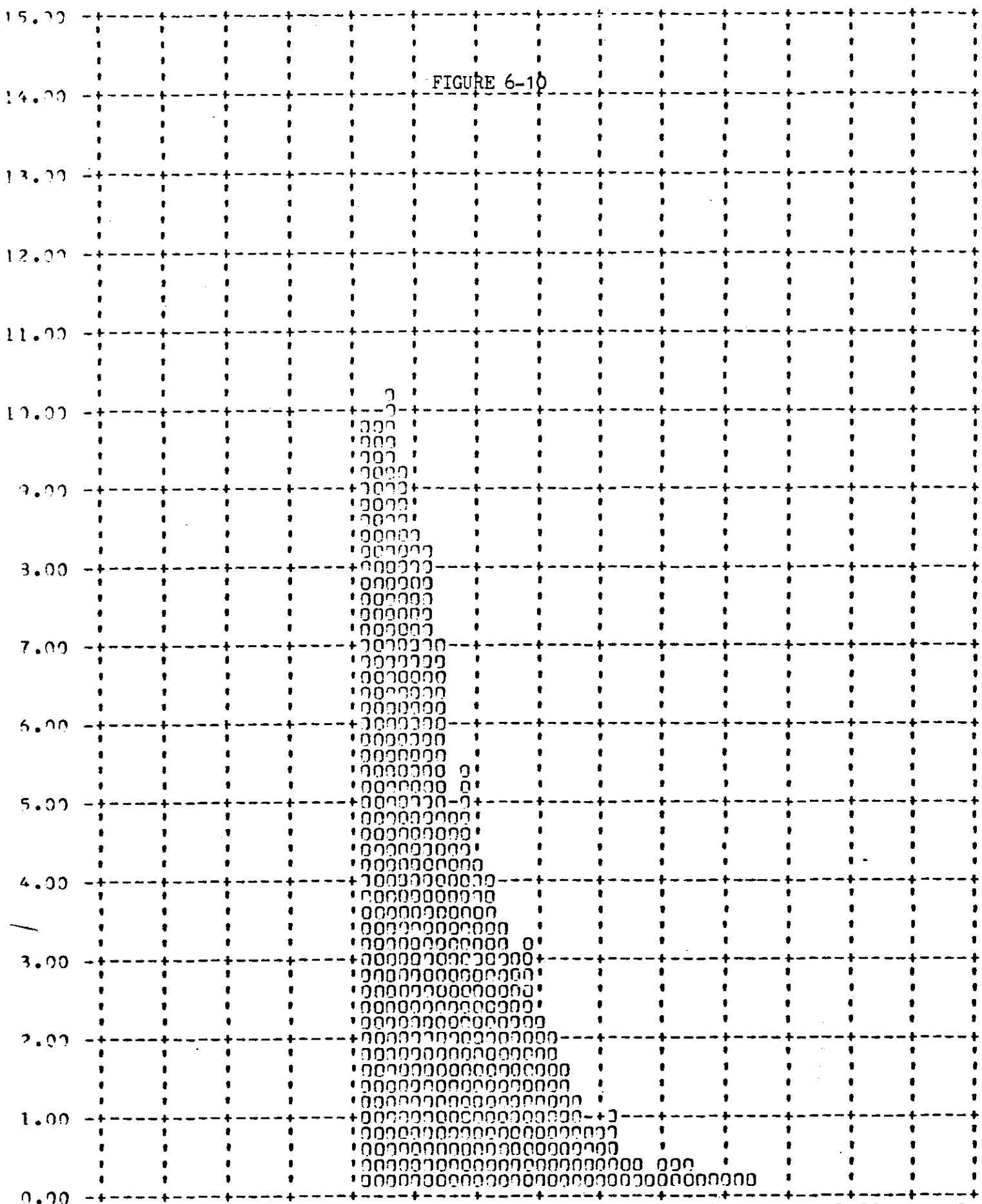


FIGURE 6-10

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 3.32

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

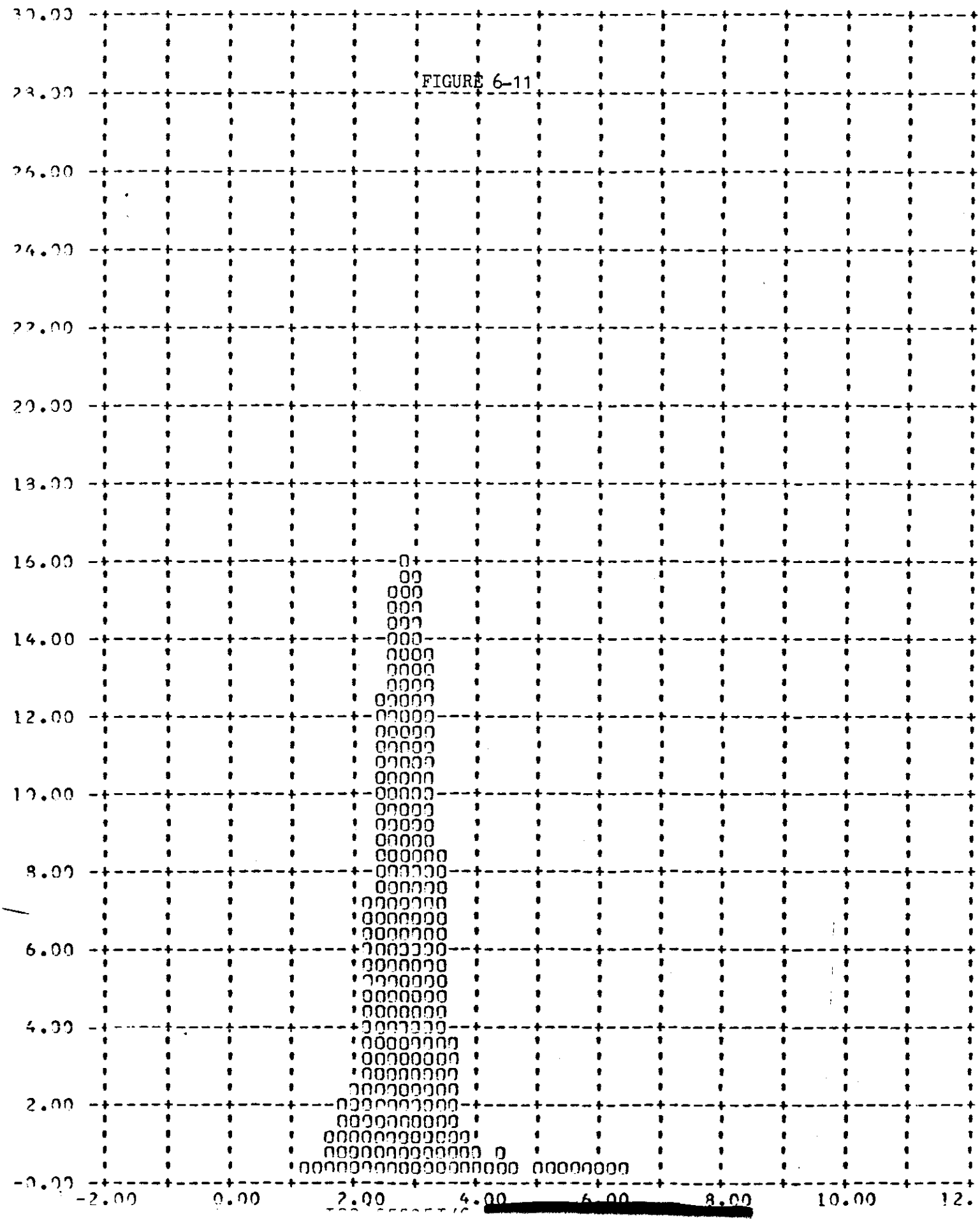


FIGURE 6-11

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 0.5

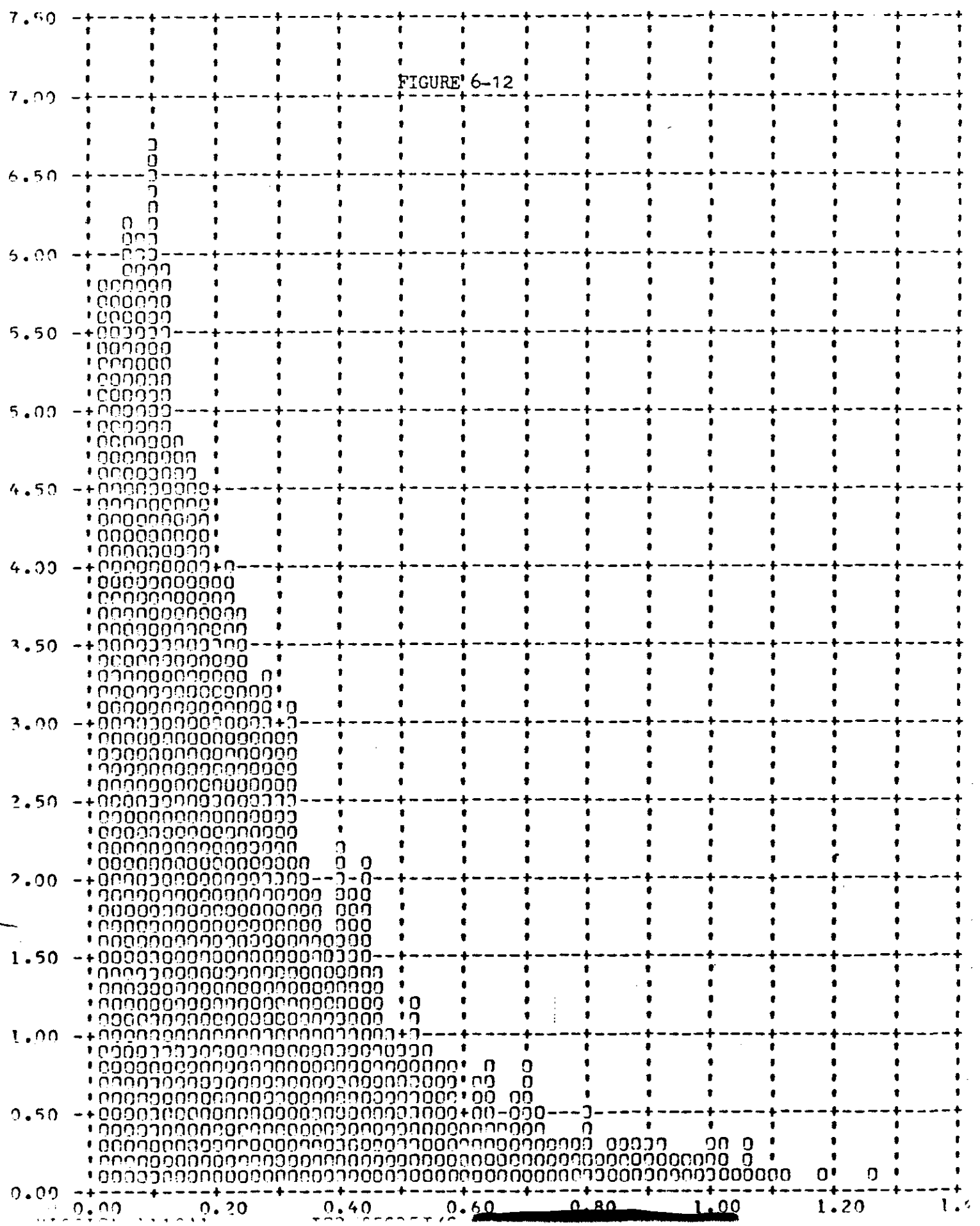


FIGURE 6-12

B. VEHICLE ATTITUDE

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

Performance of the attitude control system was normal, although the yaw angle and rates were above nominal. While any angular deviation will cause geometric variation in the photography and any rate deviation will tend to cause relative image motion, only the yaw rate deviation can be considered degrading to the panoramic photography of this mission. The table below summarizes both the total range of attitude variation and that experienced during ninety percent of photographic operations.

	1110-1		1110-2	
	90%	Total Range	90%	Total Range
Angle Deviation (deg.):				
Pitch	0.21	- .46 to +0.38	0.51	-0.04 to +0.6
Roll	0.17	-0.2 to +0.36	0.19	+0.4 to +0.37
Yaw	0.49	-0.25 to +1.5	0.52	-0.1 to +0.84
Rate Deviation (deg/hr):				
Pitch	28.38	-98 to +100	39.76	-80 to +100
Roll	22.03	-42 to +74	21.79	-52 to +60
Yaw	66.03	-98 to +100	57.41	-96 to +100

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

Figures 6-13 through 6-36 are the computer outputted vehicle attitude and rate deviations experienced throughout Mission 1110.

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 0.20

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

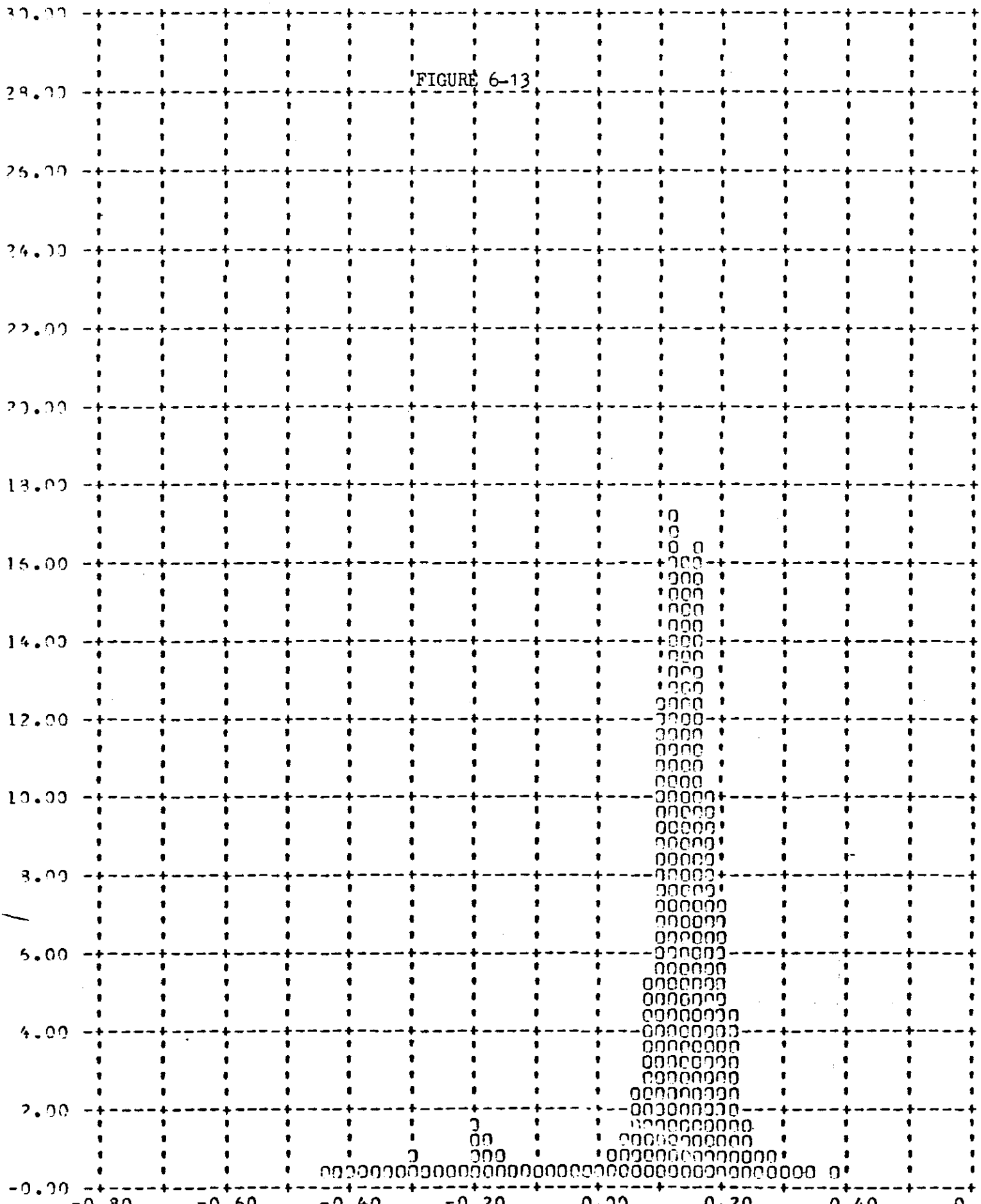


FIGURE 6-13

FRAMES 1-3 OF EACH OP OMITTED 99 PERCENT = 0.17

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

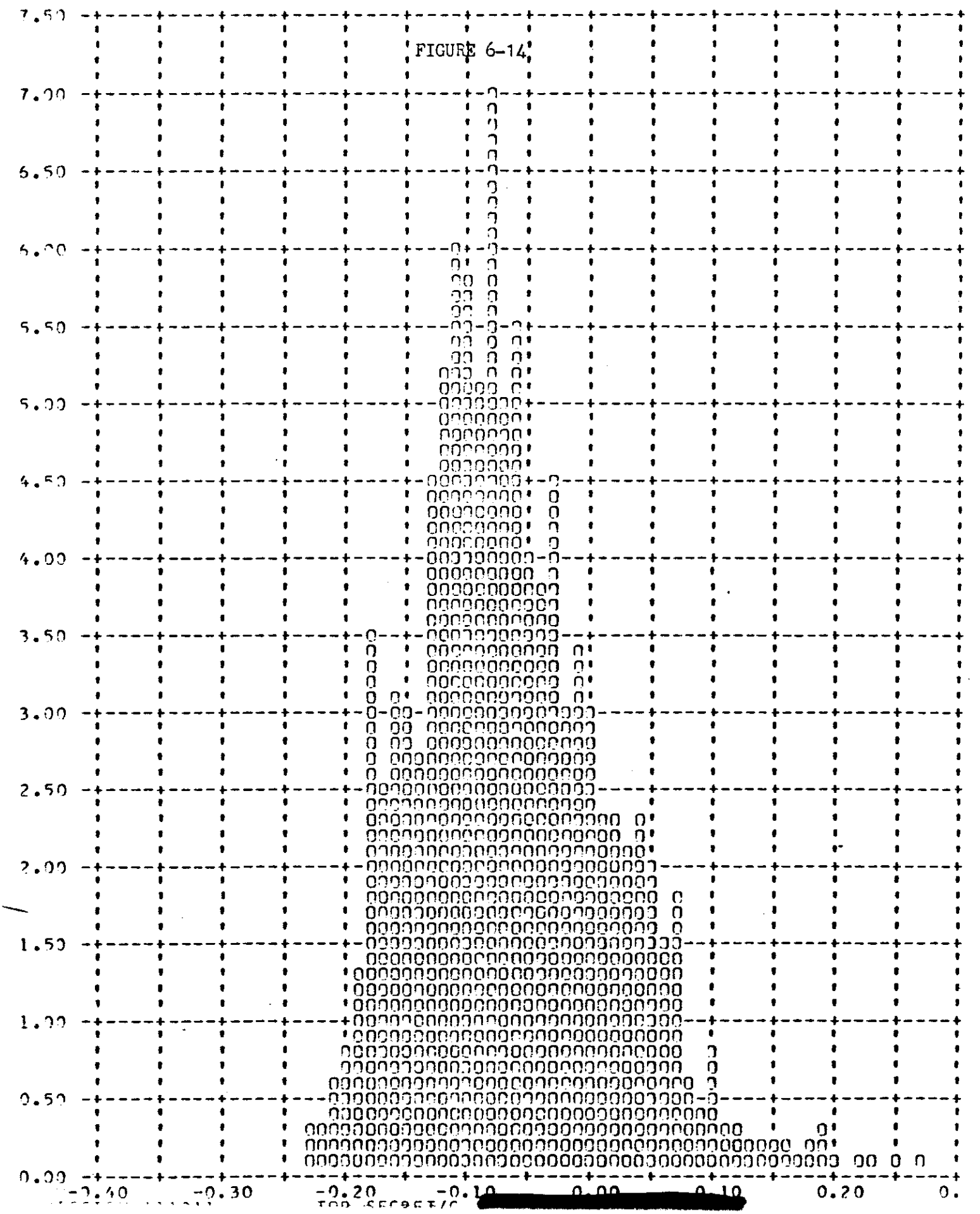


FIGURE 6-14

FRAMES 1-3 OF EACH OF OMITTED 33 PERCENT = 0.48

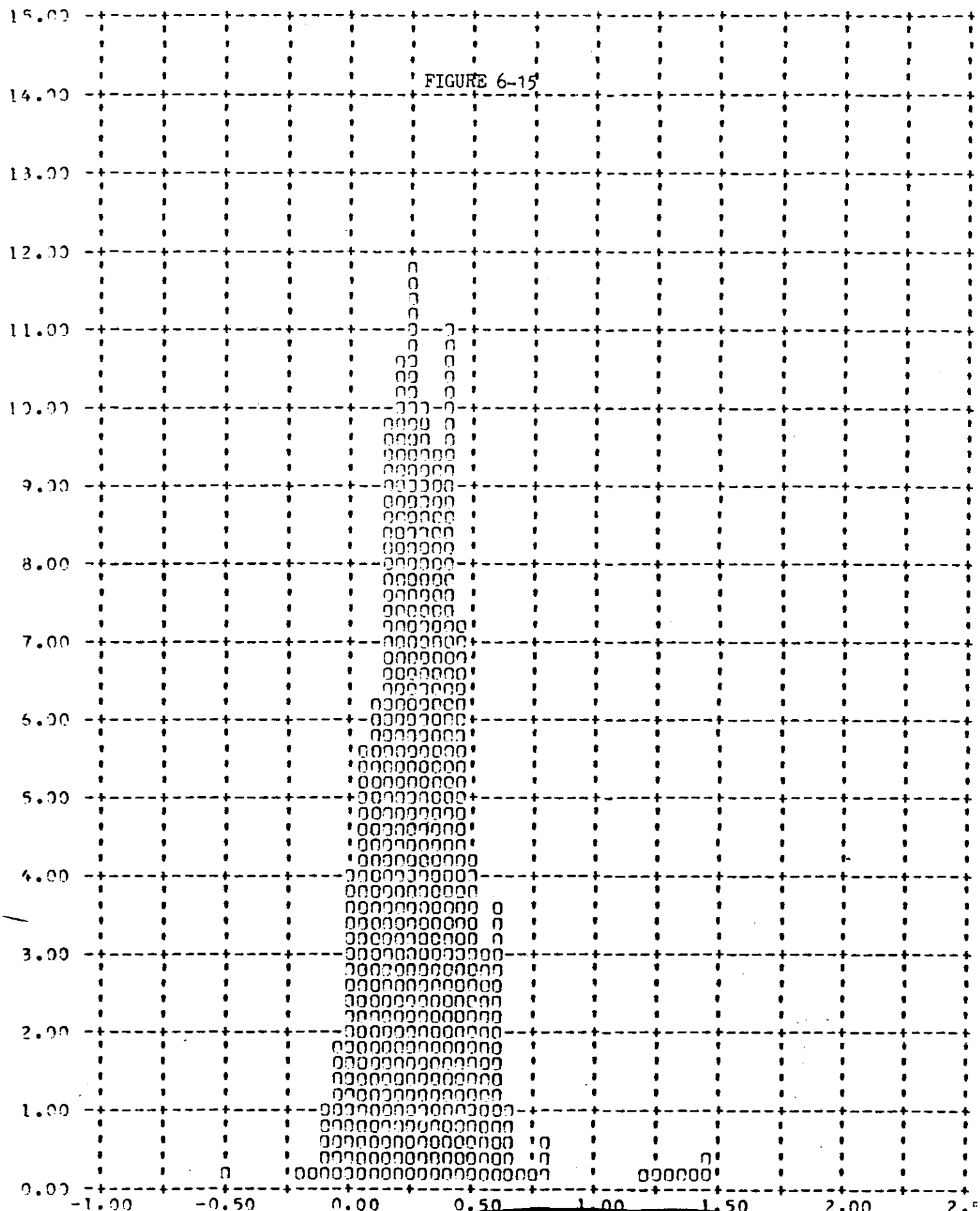


FIGURE 6-15

FRAMES 1-3 OF EACH DP OMITTED 90 PERCENT = 0.2

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

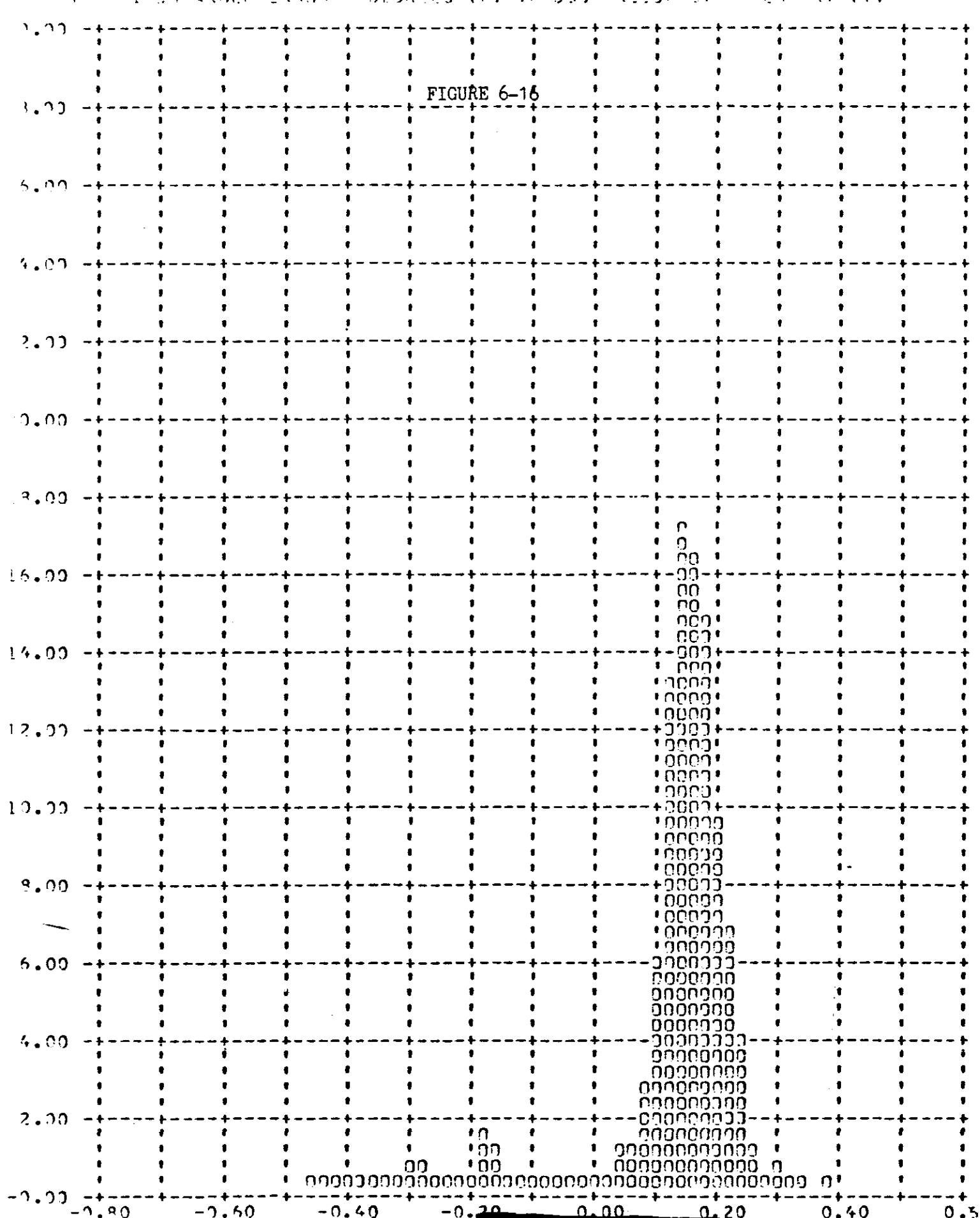
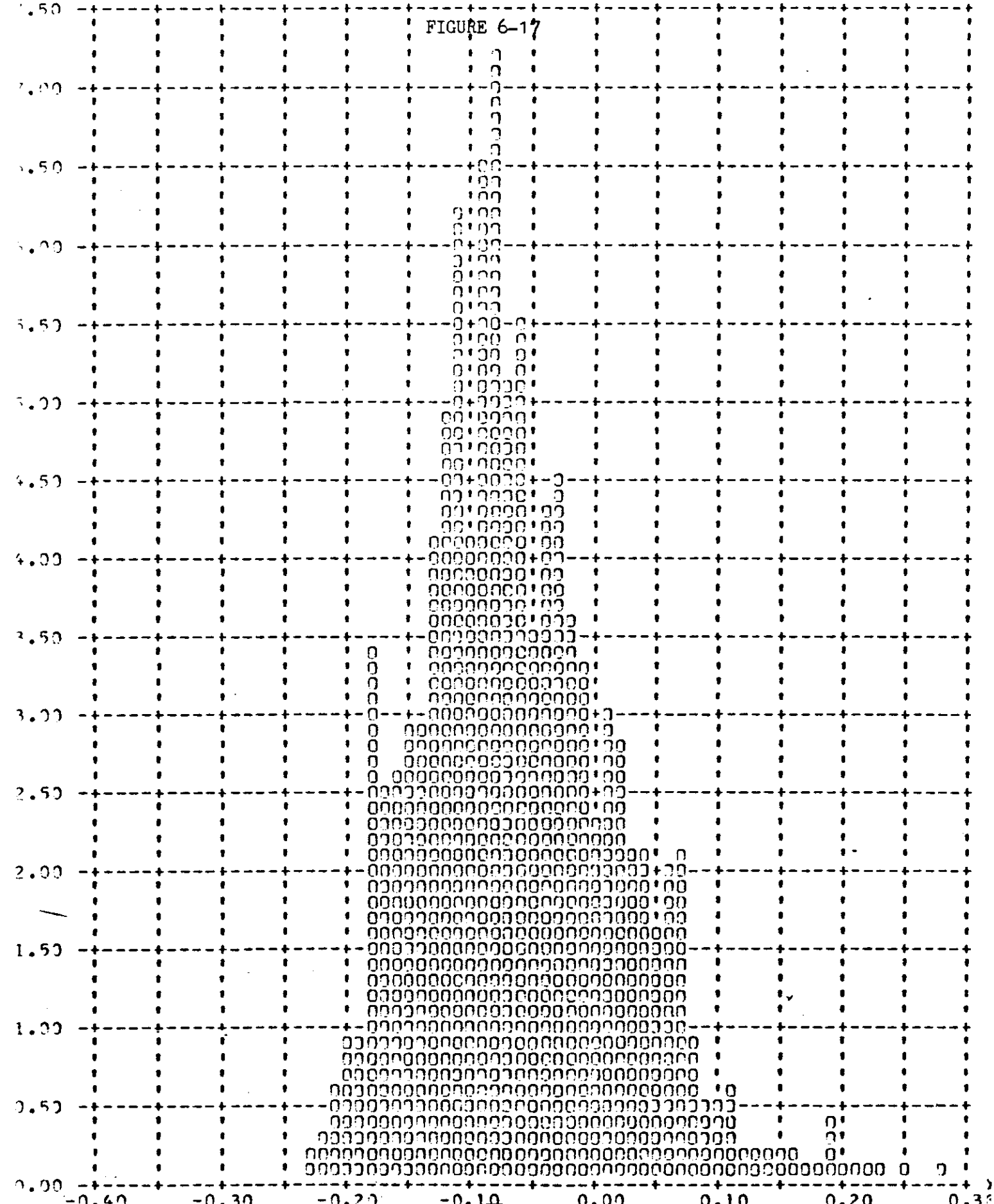


FIGURE 6-16

FRAMES 1-3 OF EACH 32 OMITTED 80 PERCENT = 0.17

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



FRAMES 1-3 OF EACH 30 OMITTED 20 PERCENT = 0.49

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

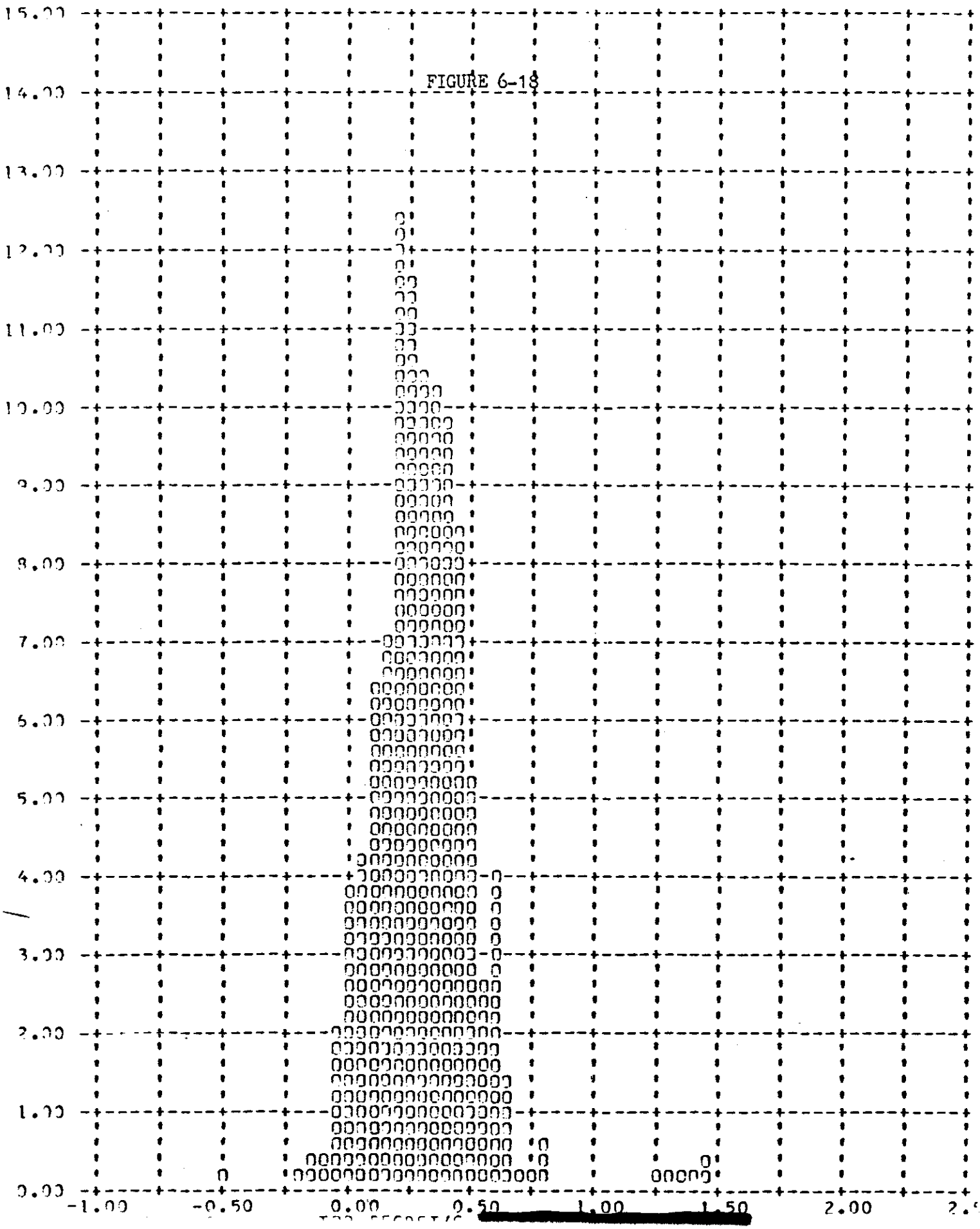


FIGURE 6-18

[redacted]

FRAMES 1-3 OF EACH OR OMITTED 30 PERCENT = 0.51

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

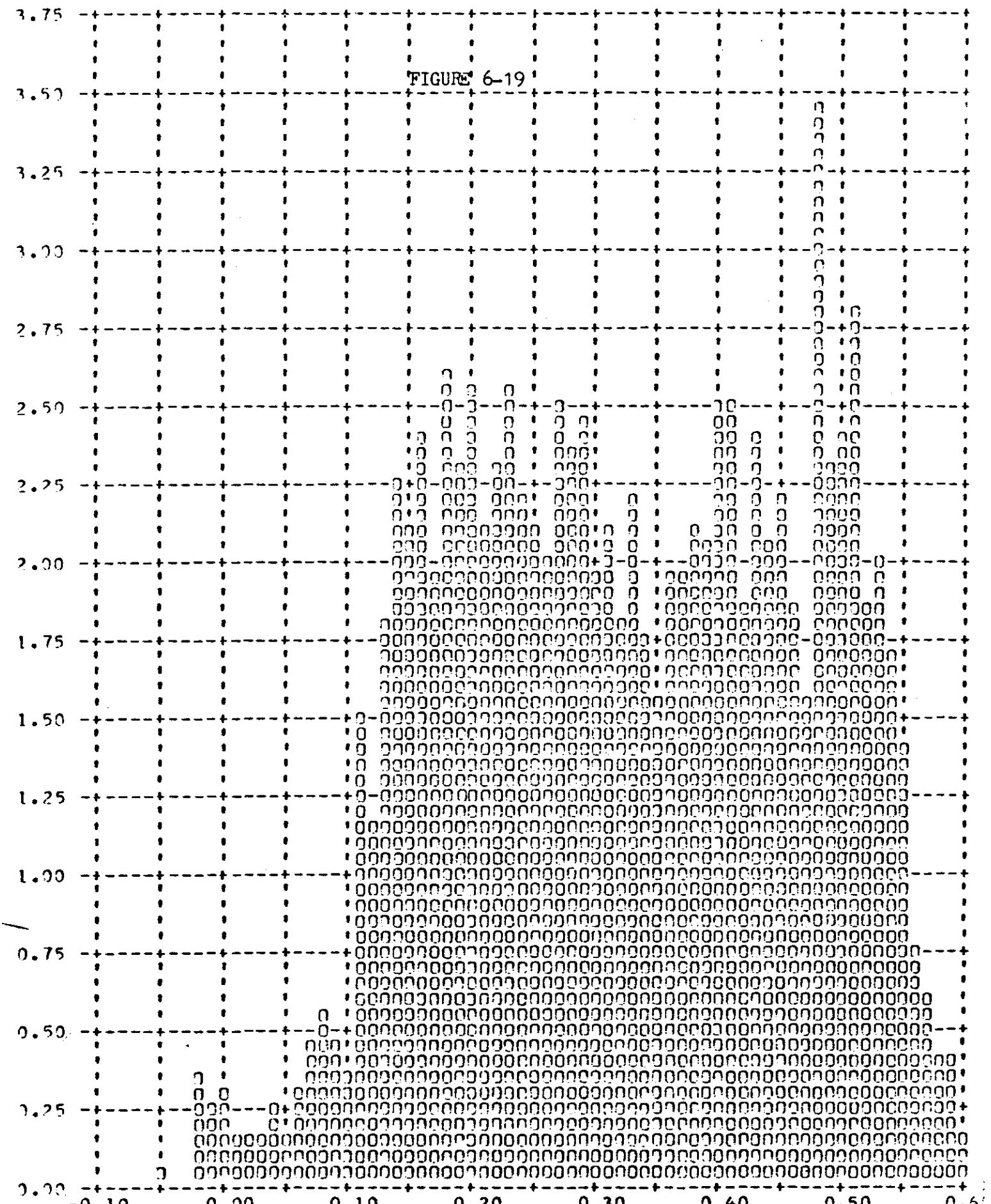


FIGURE 6-19

FRAMES 1-3 OF EACH OR OMITTED 30 PERCENT = 0.10

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

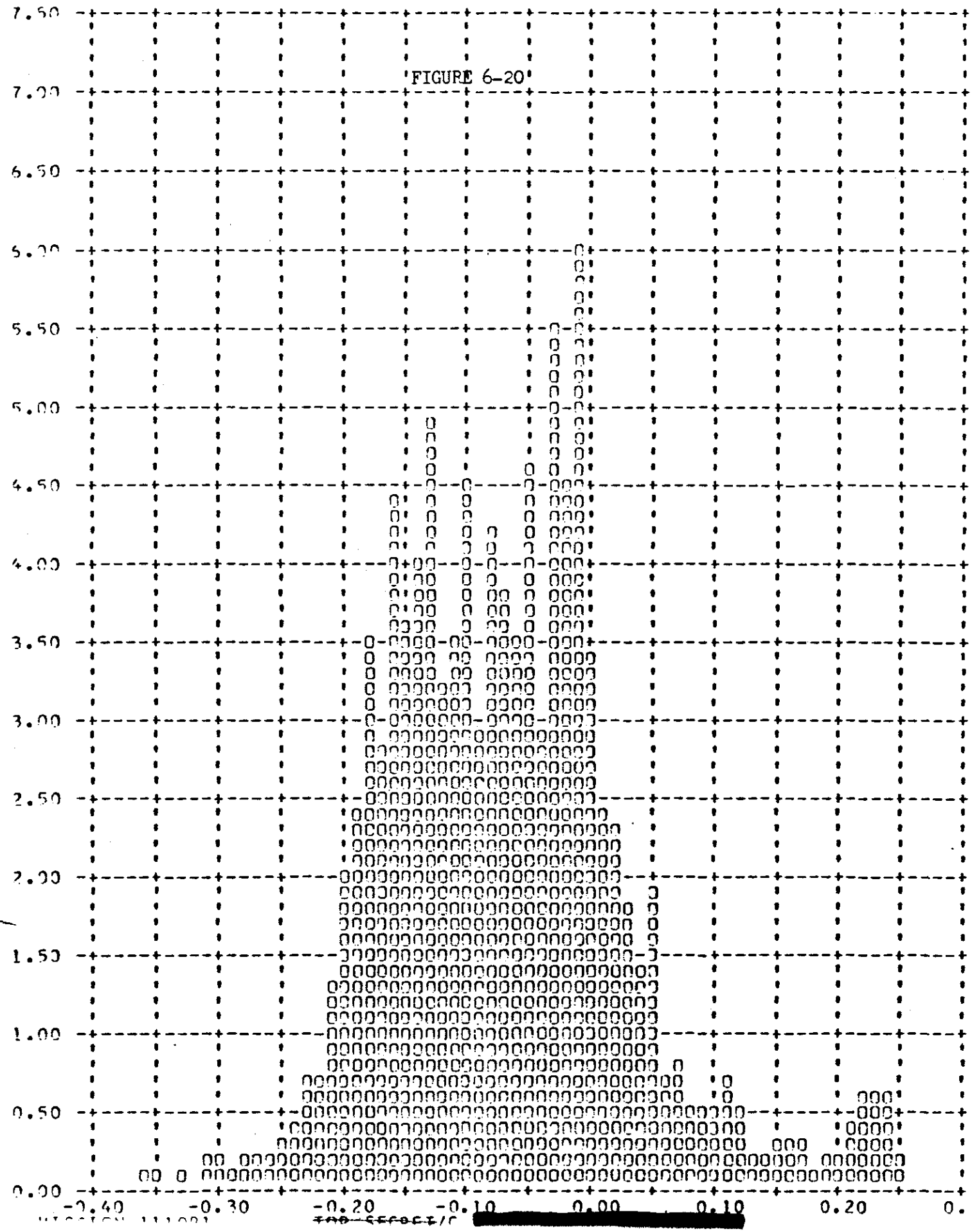


FIGURE 6-20

FRAMES 1-3 OF EACH TP OMITTED 00 PERCENT = 0.

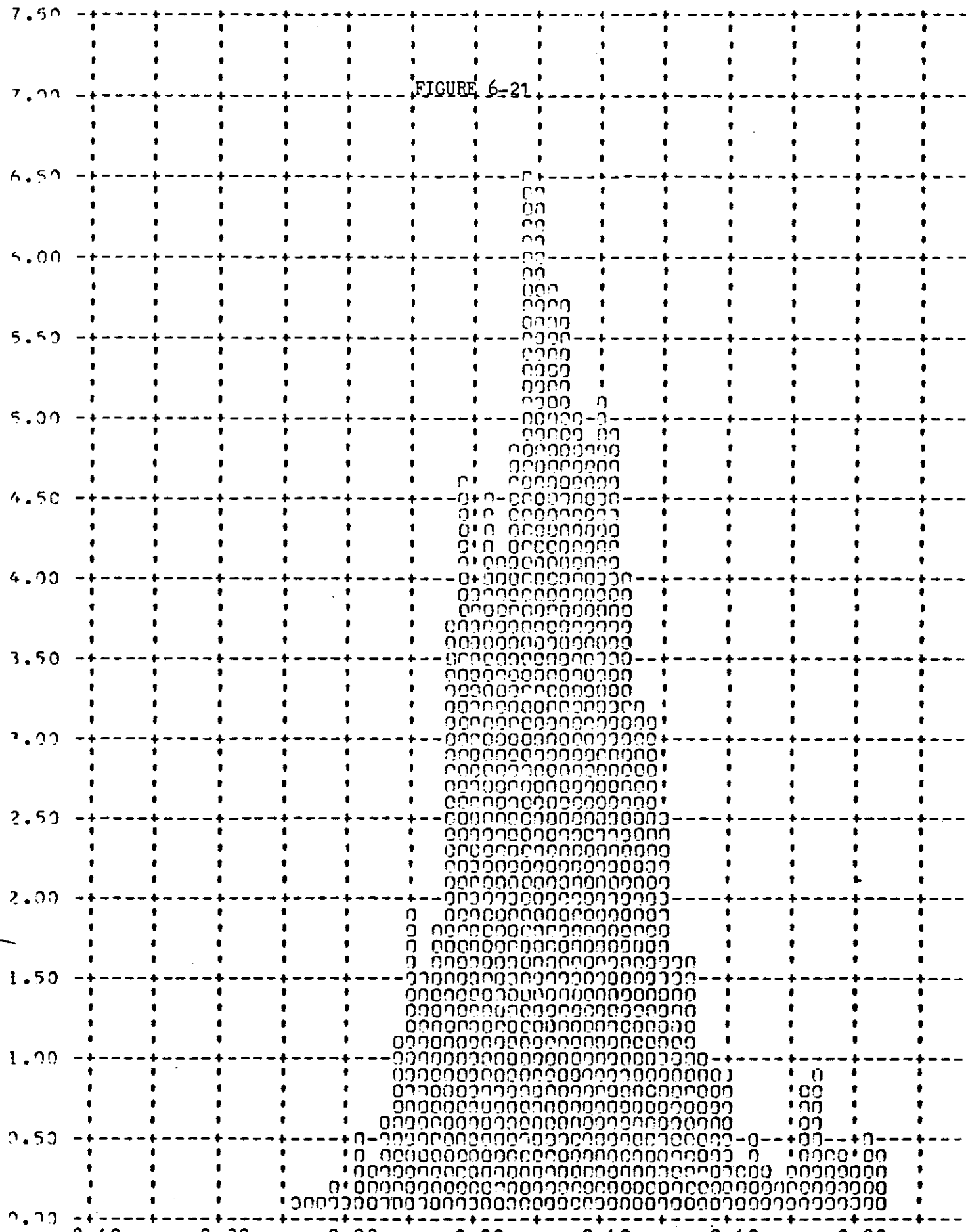


FIGURE 6-21

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 0.51

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

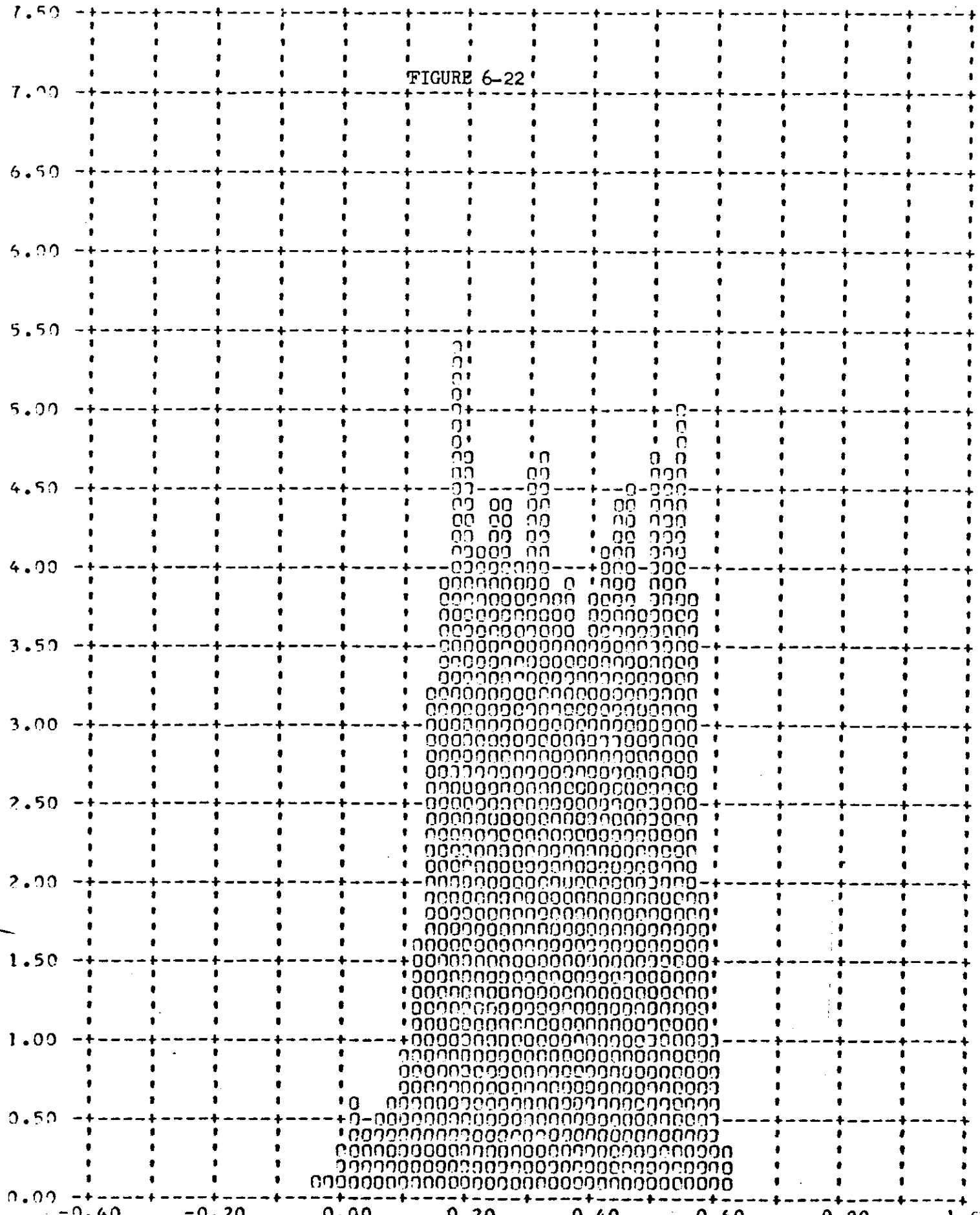


FIGURE 6-22

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

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

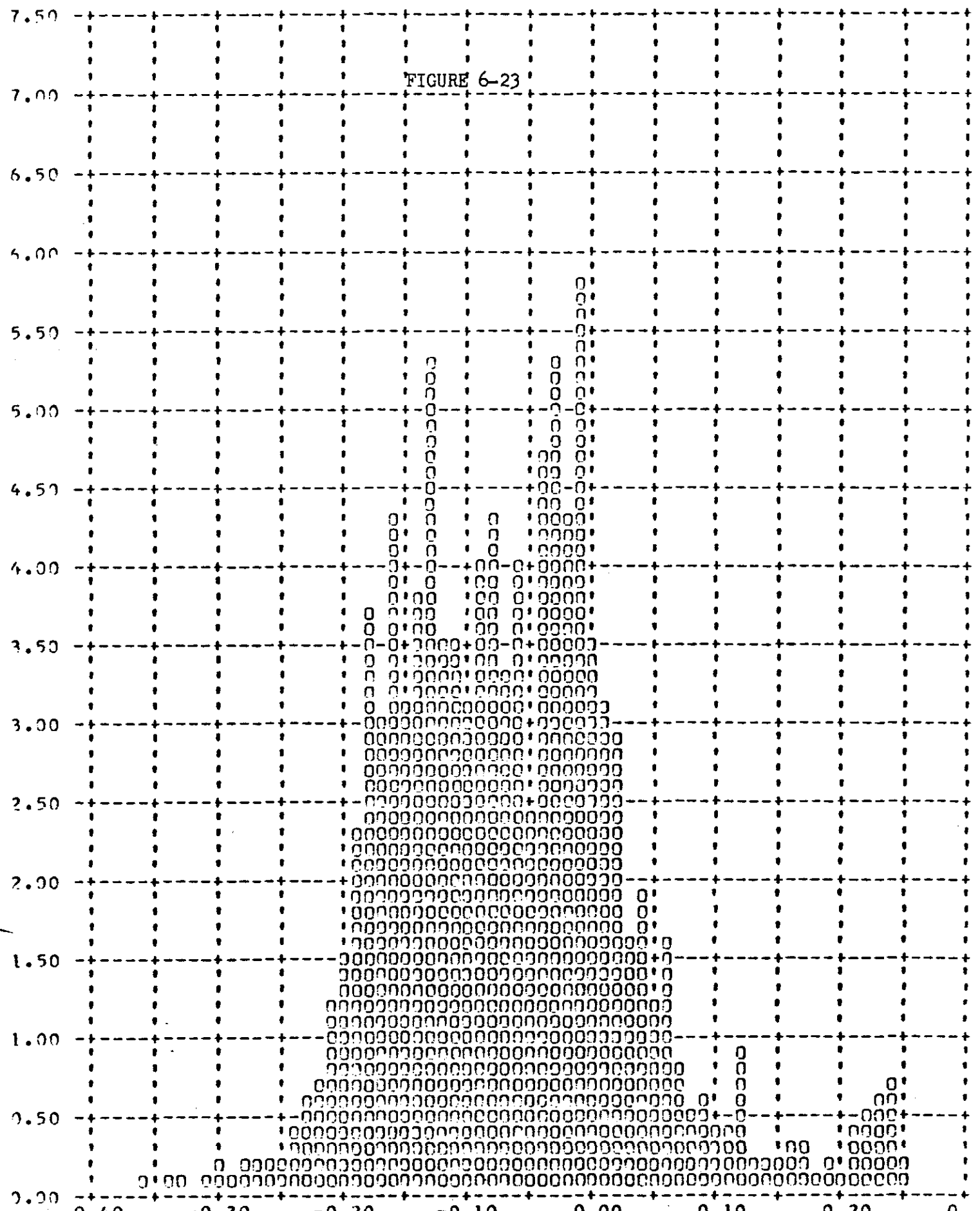


FIGURE 6-23

FRAMES 1-3 OF EACH OP OMITTED 30 PERCENT = 0.5

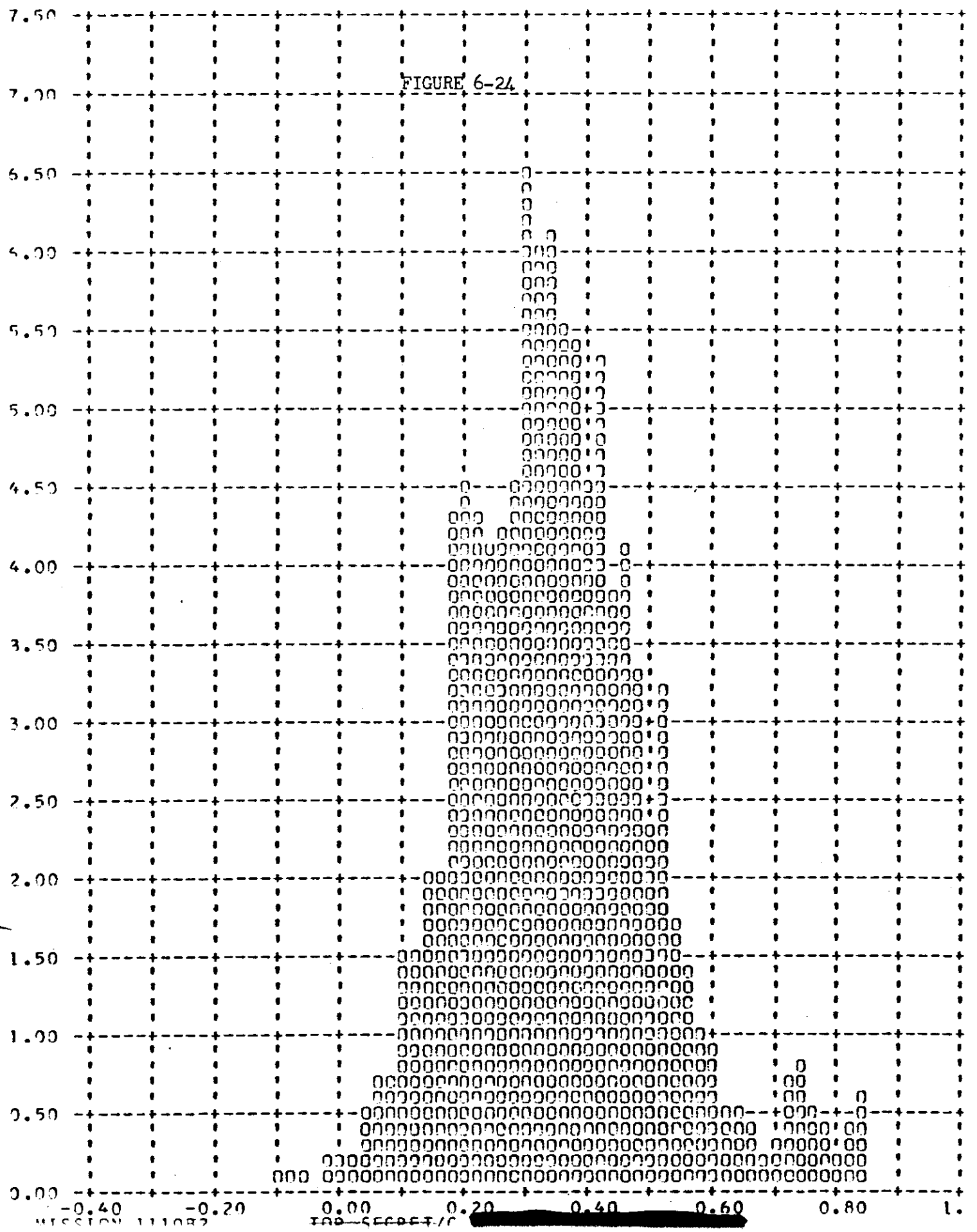


FIGURE 6-24

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 28.24

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

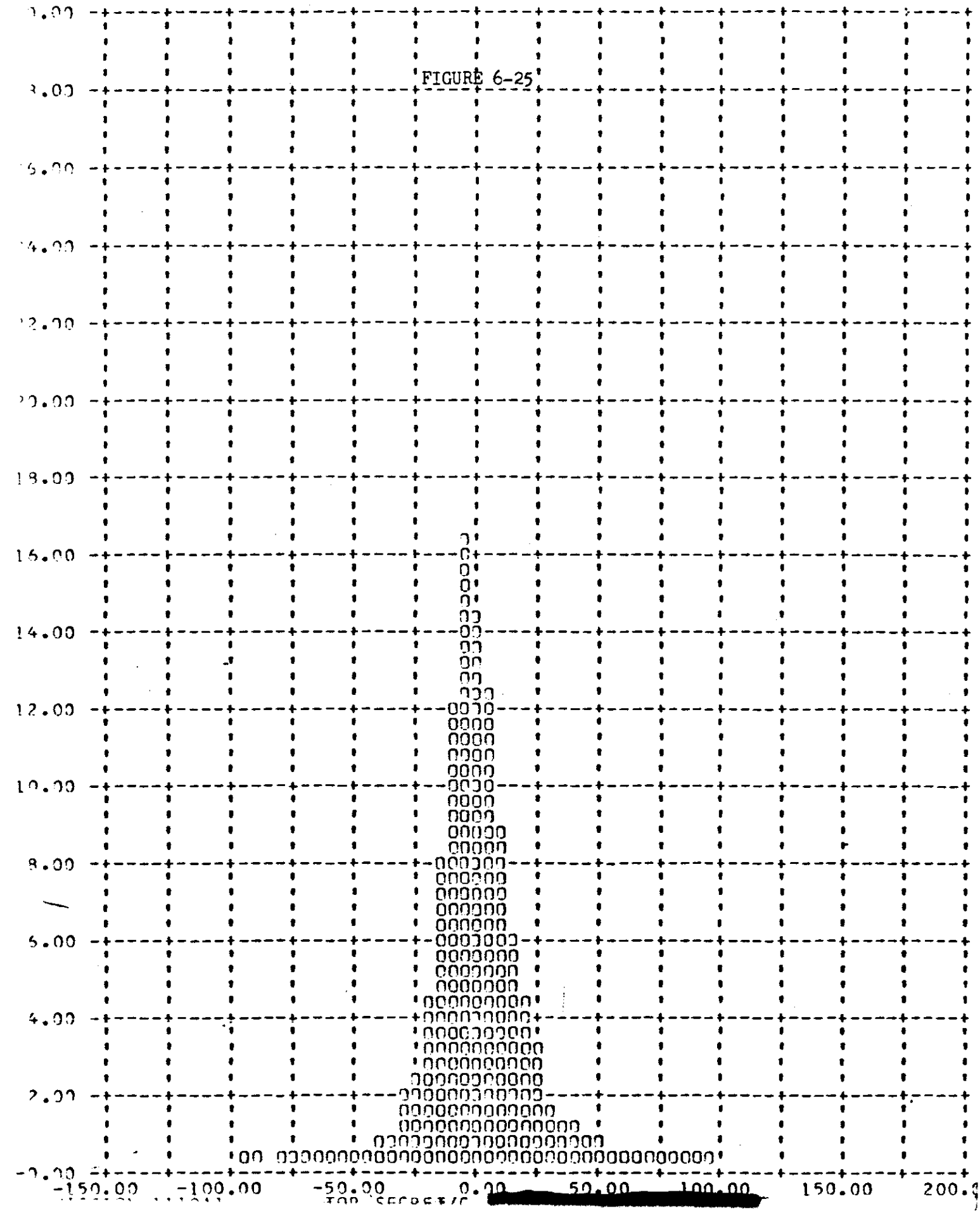


FIGURE 6-25

FRAMES 1-3 OF EACH 09 OMITTED 20 PERCENT = 22.0

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

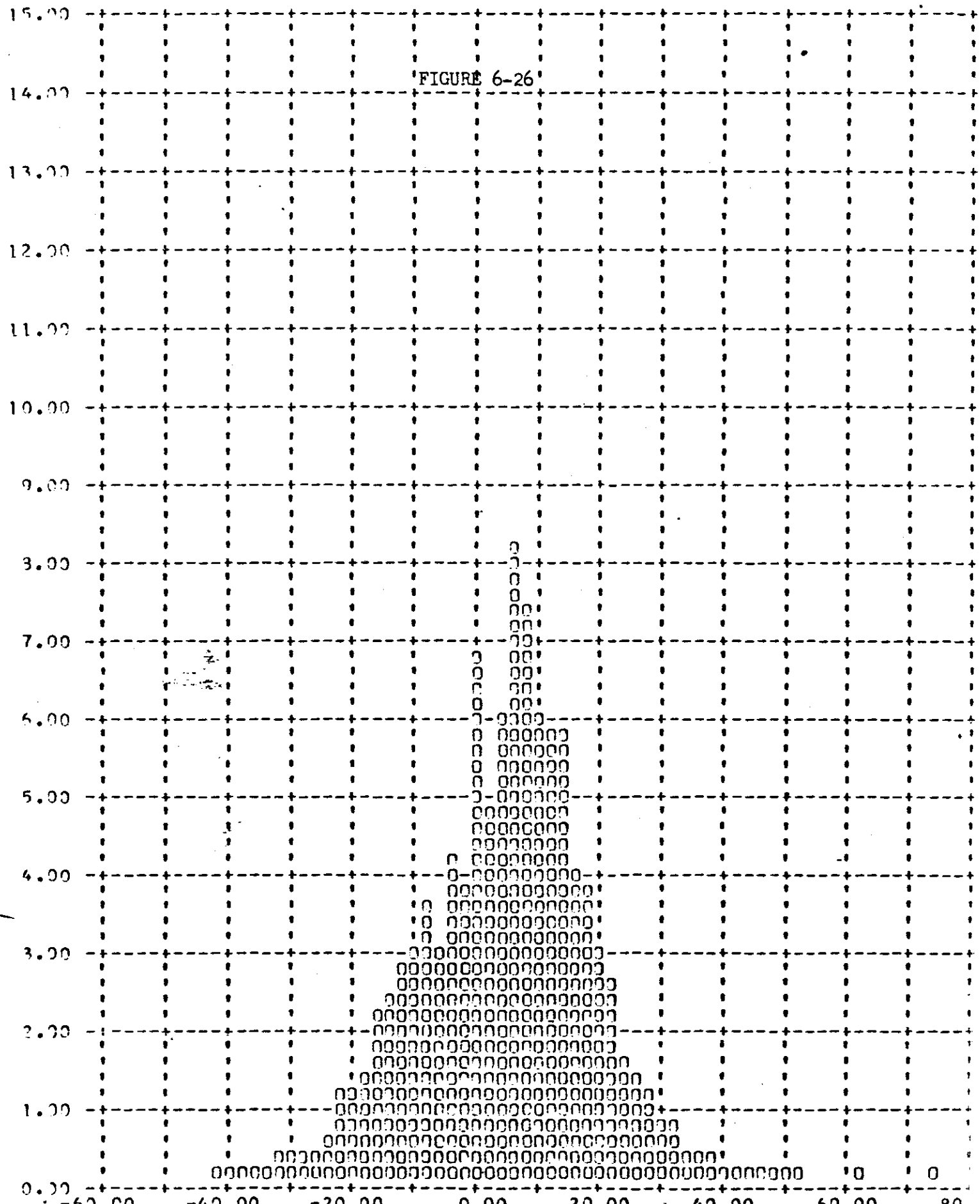


FIGURE 6-26

FRAMES 1-3 OF EACH OF OMITTED 99 PERCENT = 64.2

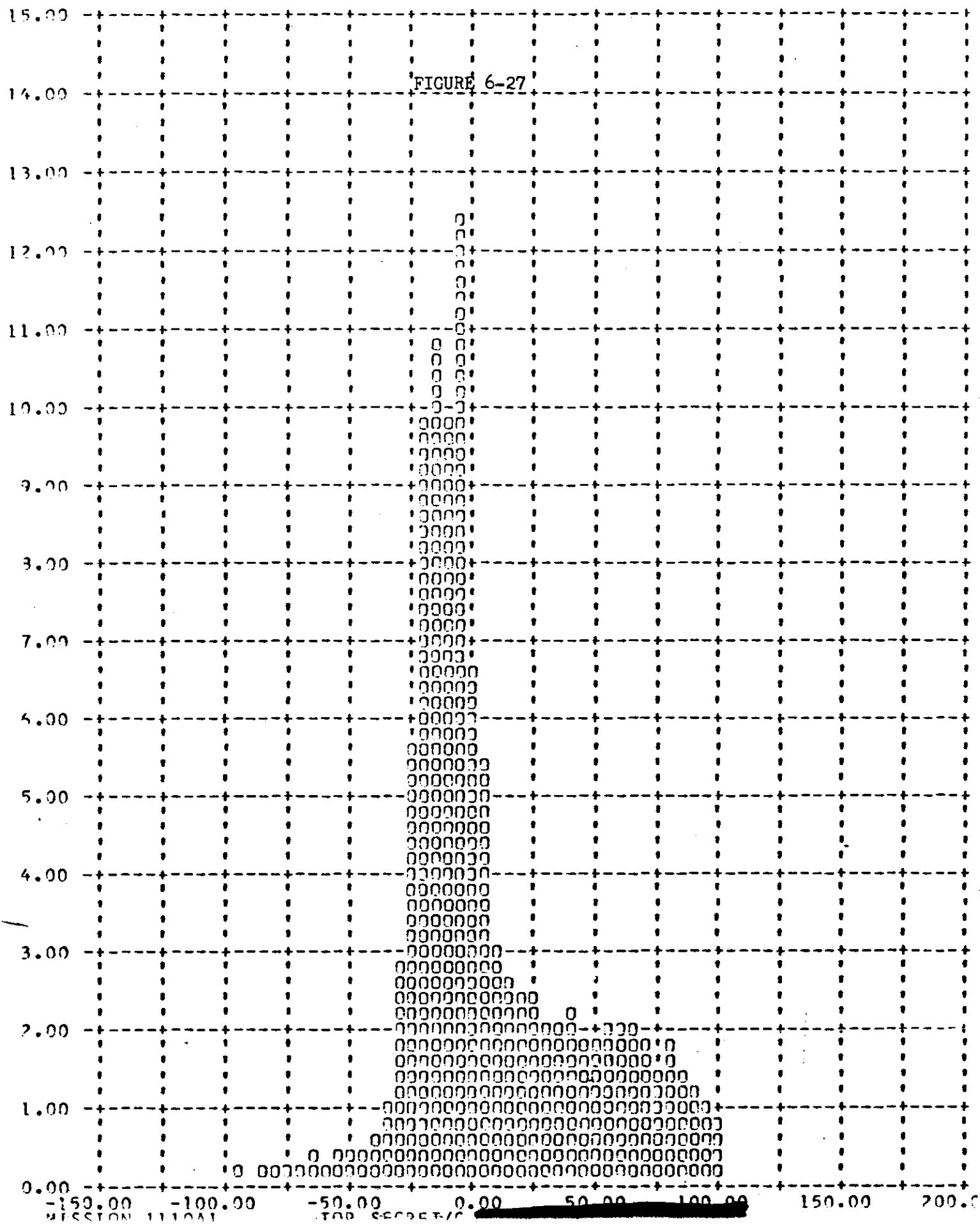


FIGURE 6-27

FRAMES 1-3 OF EACH OP OMITTED 99 PERCENT = 28.33

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

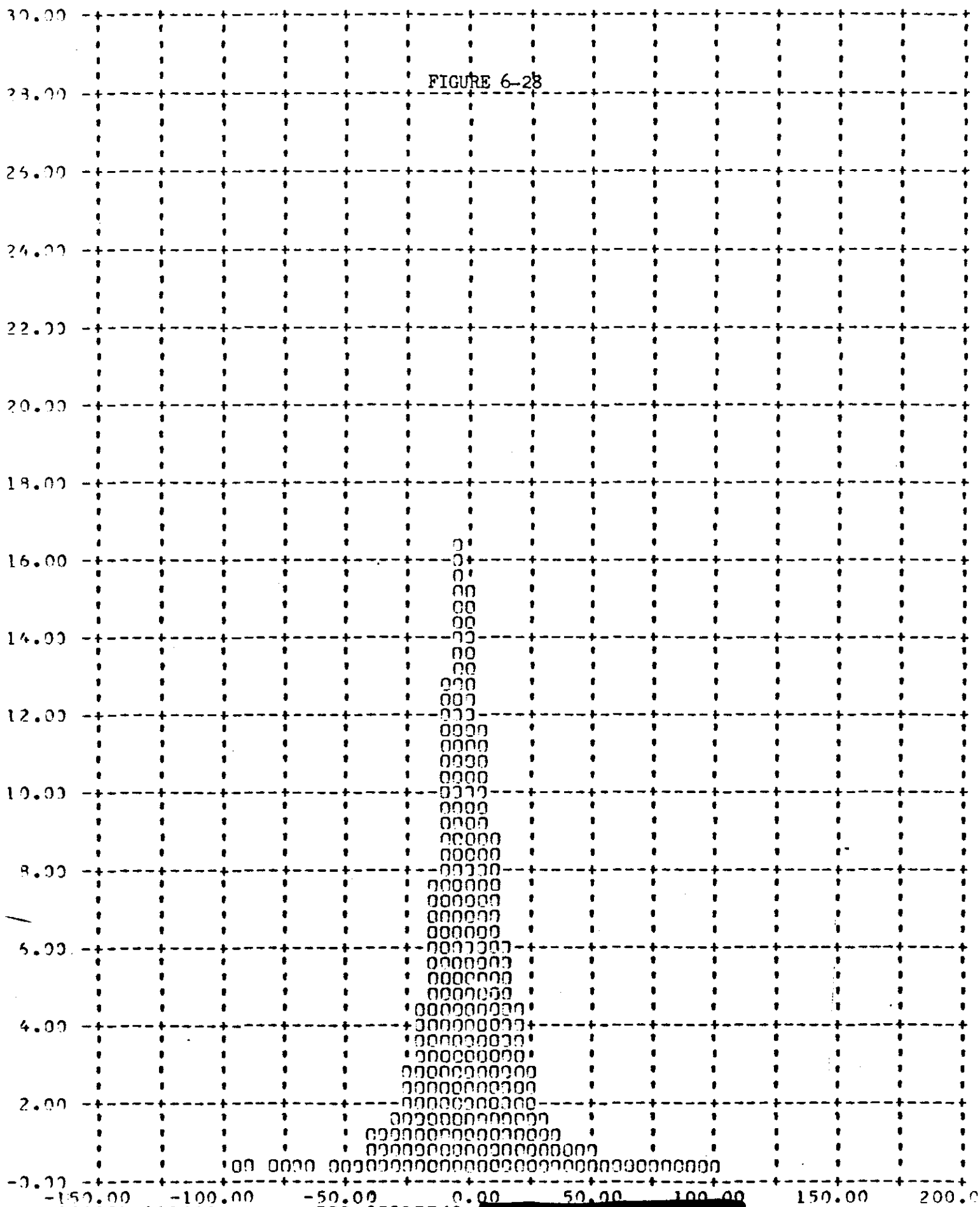


FIGURE 6-28

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 22.03

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

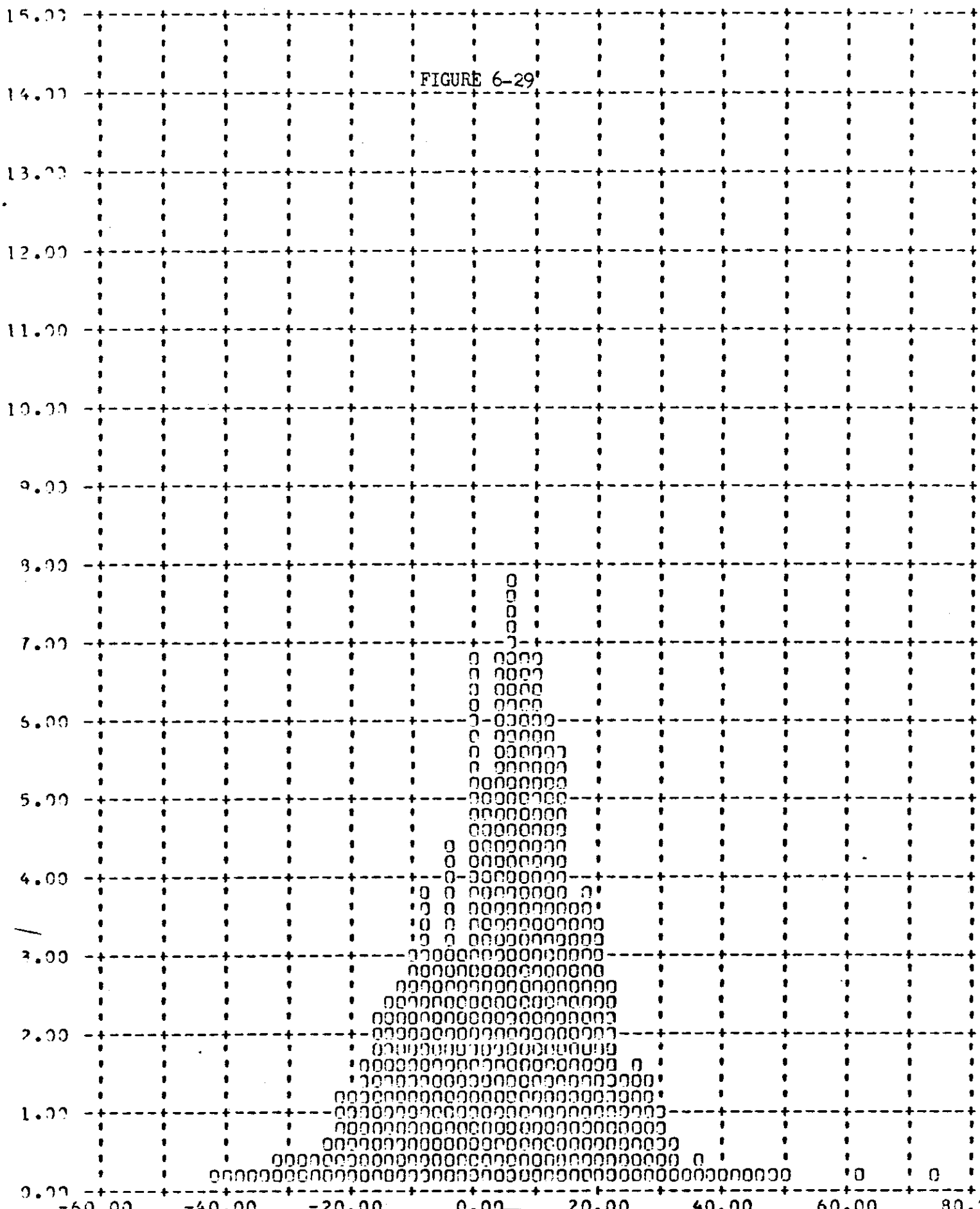


FIGURE 6-29

FRAMES 1-3 OF EACH 20 OMITTED 20 PERCENT = 65.03

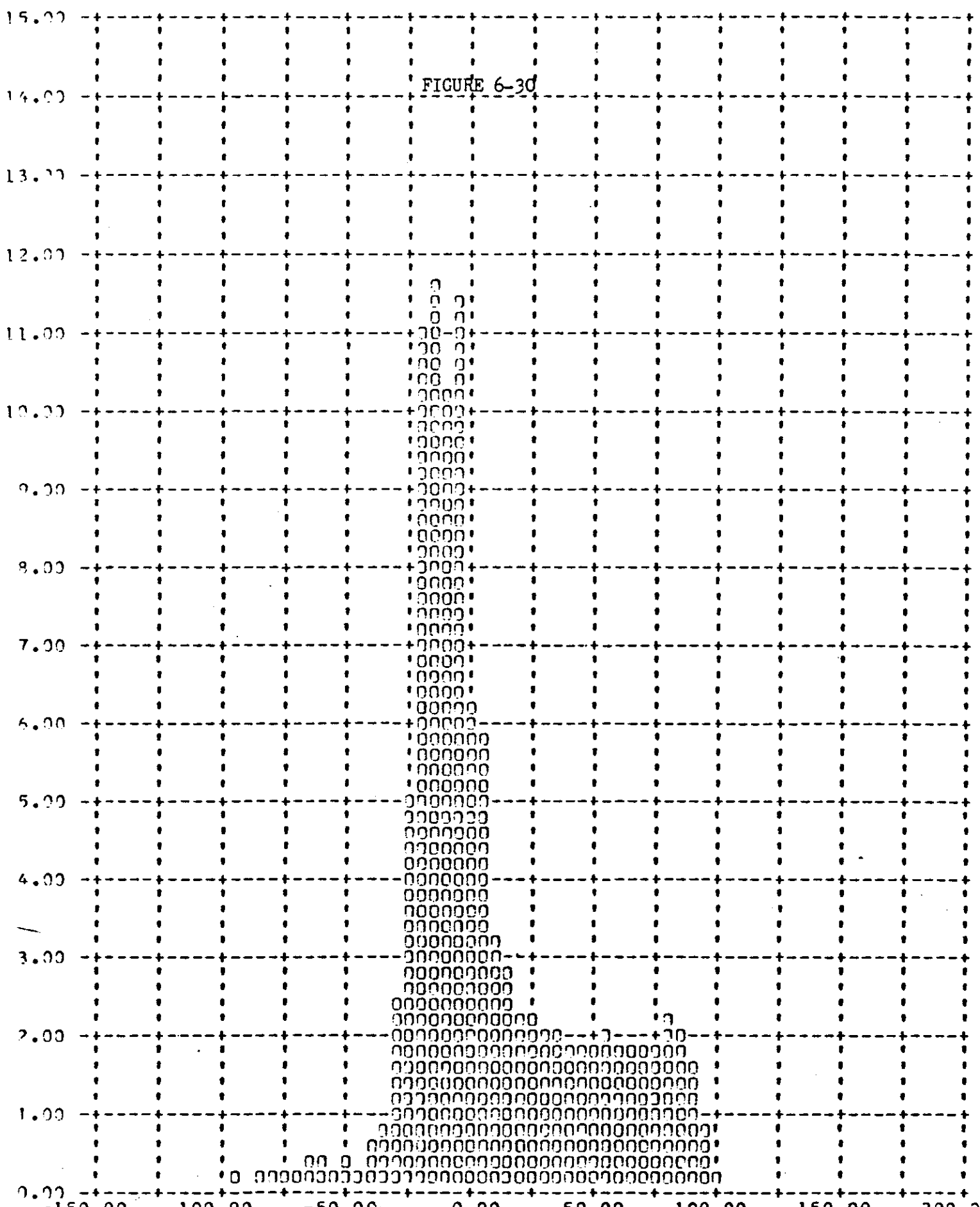


FIGURE 6-30

FRAMES 1-3 OF EACH DP OMITTED 90 PERCENT = 40.29

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

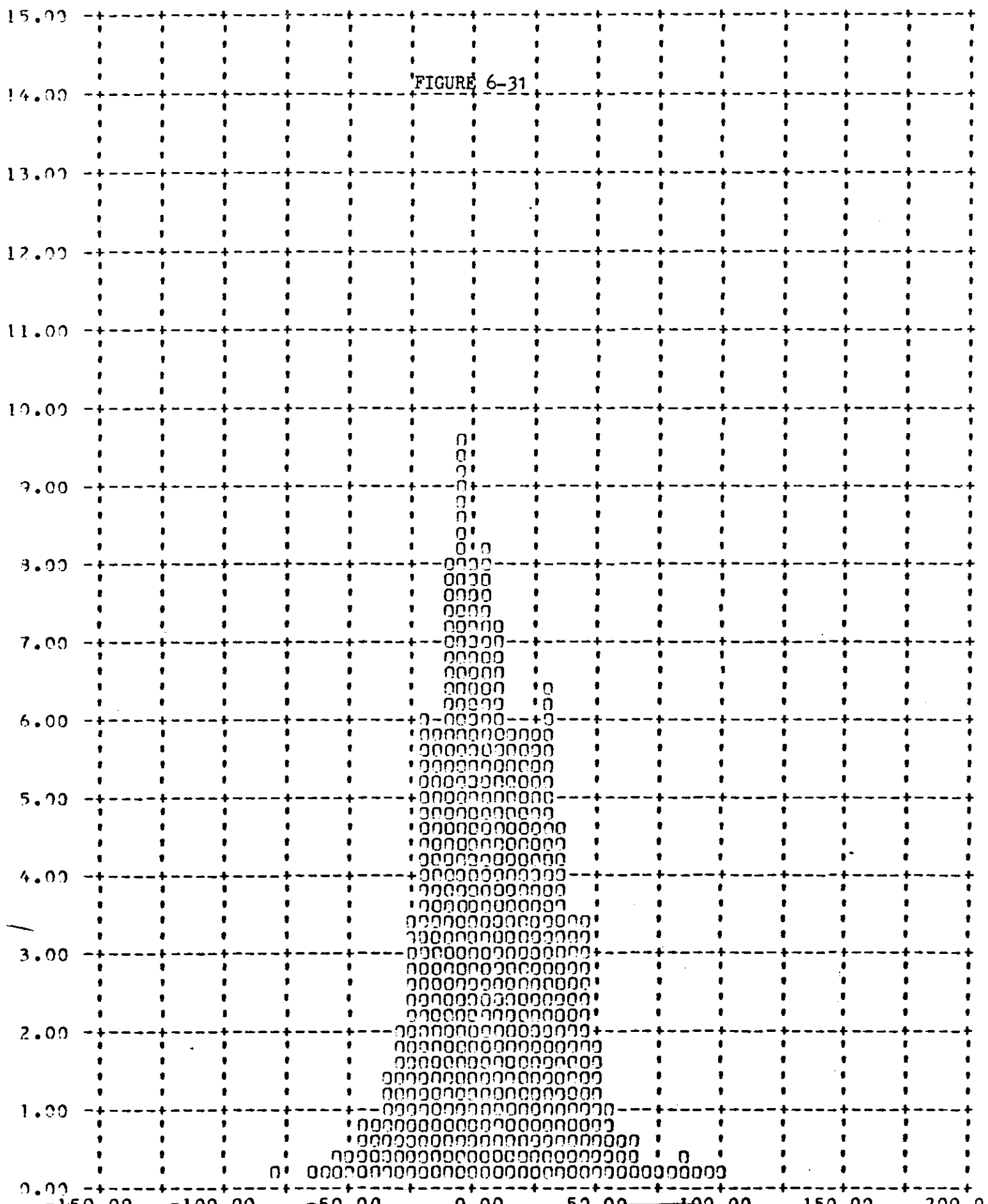


FIGURE 6-31

FRAMES 1-3 OF EACH OP OMITTED 20 PERCENT = 21.84

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

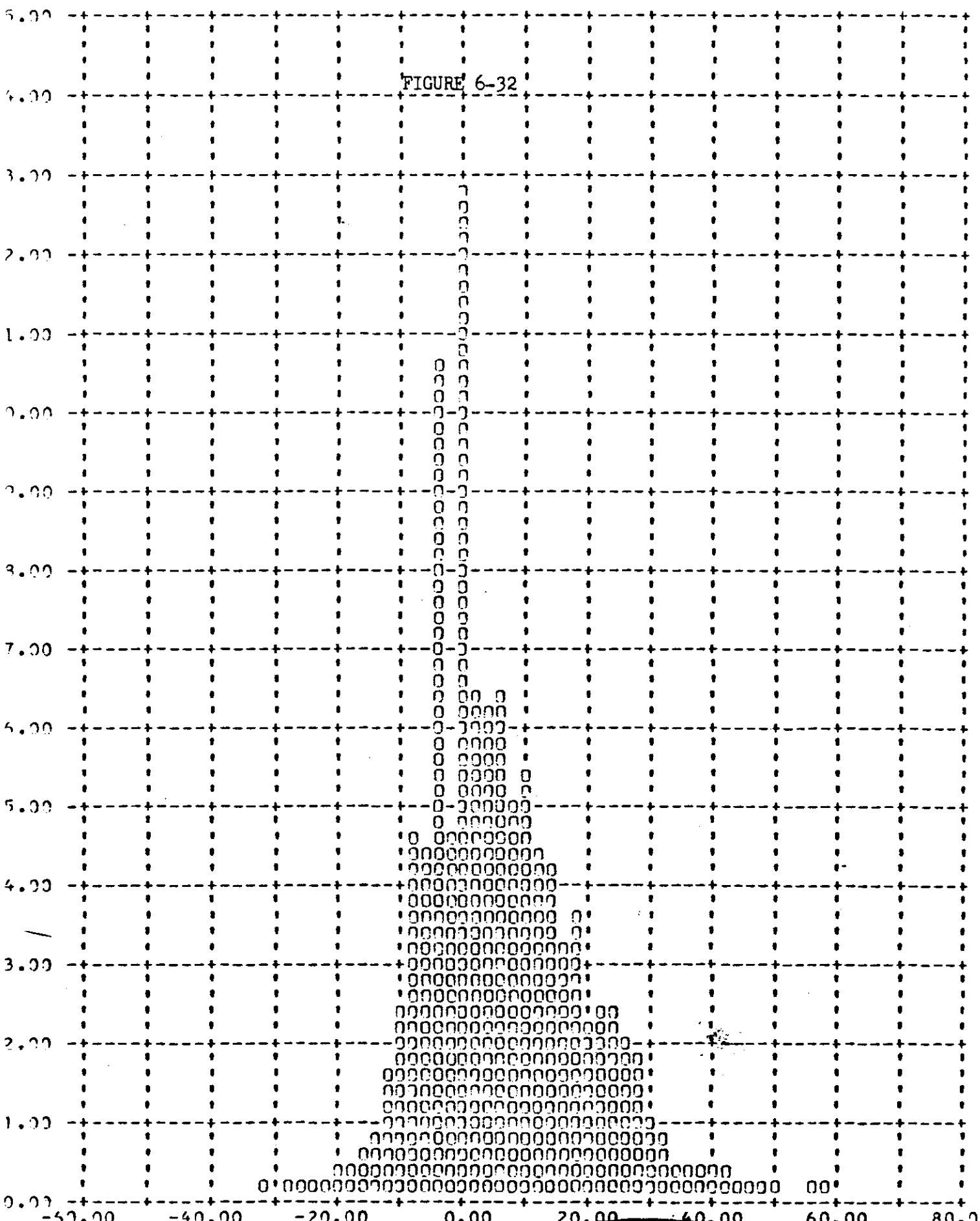


FIGURE 6-32

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 55.44

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

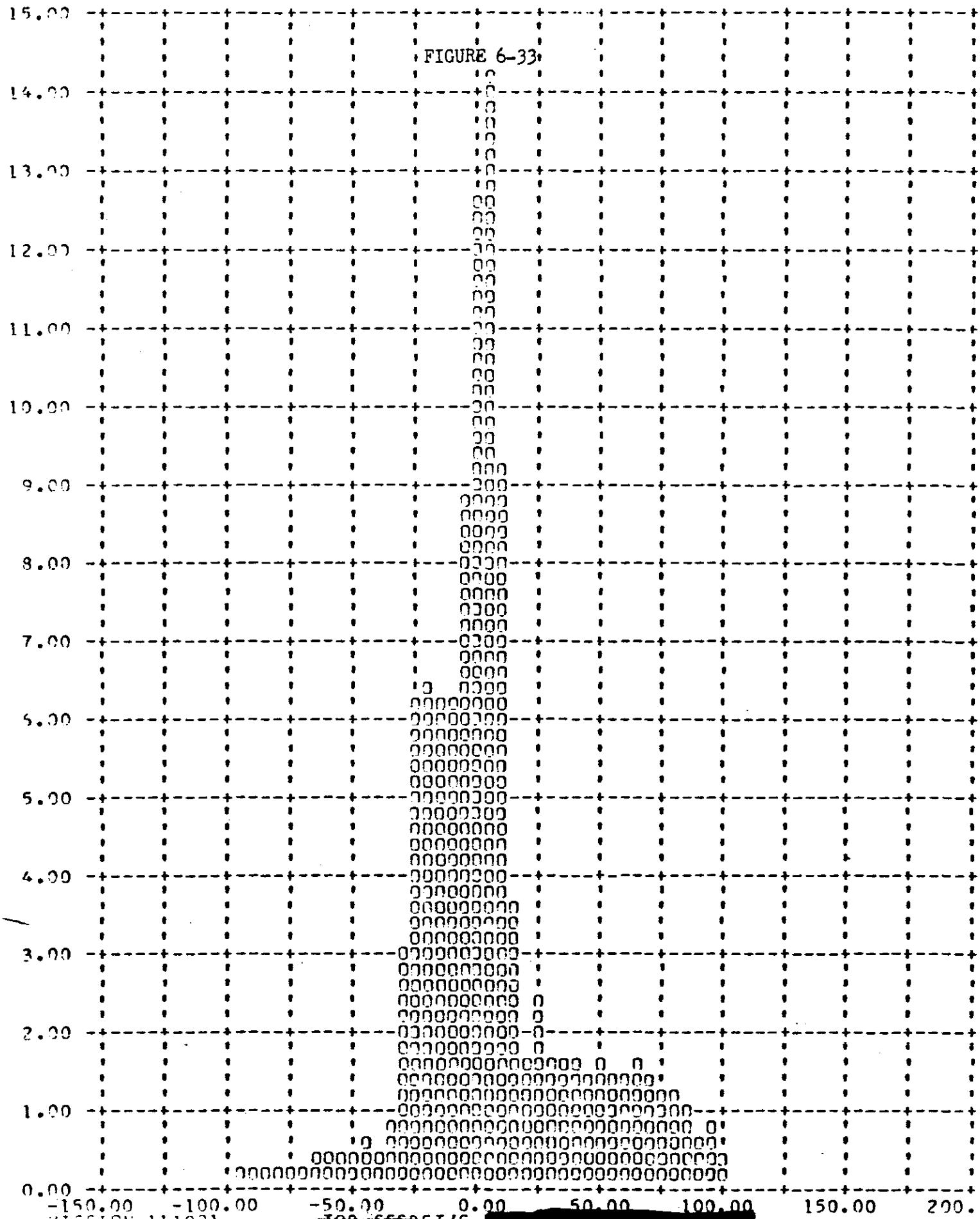


FIGURE 6-33

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 33.76

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

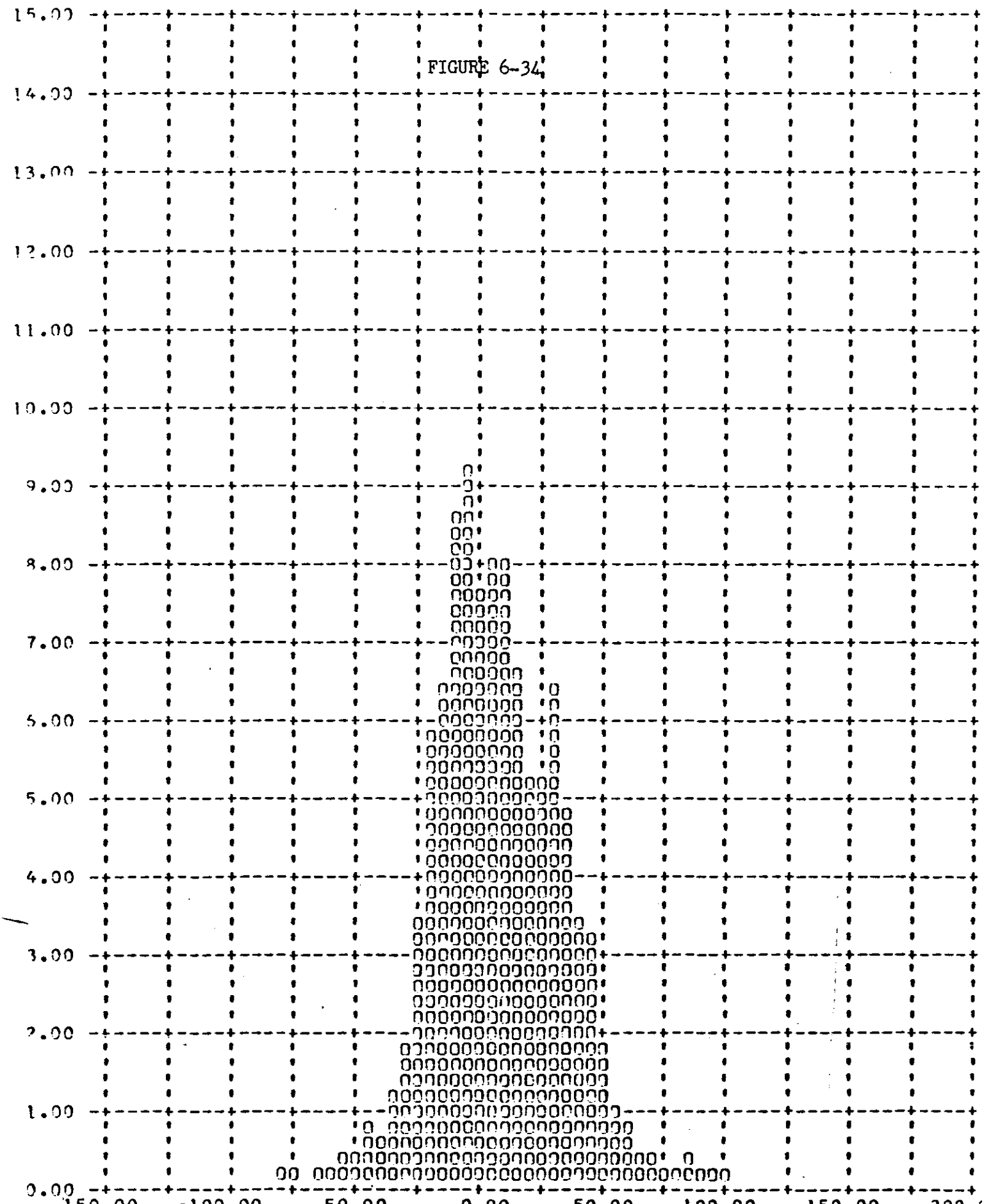


FIGURE 6-34

FRAMES 1-3 OF EACH OR OMITTED 90 PERCENT = 21.79

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

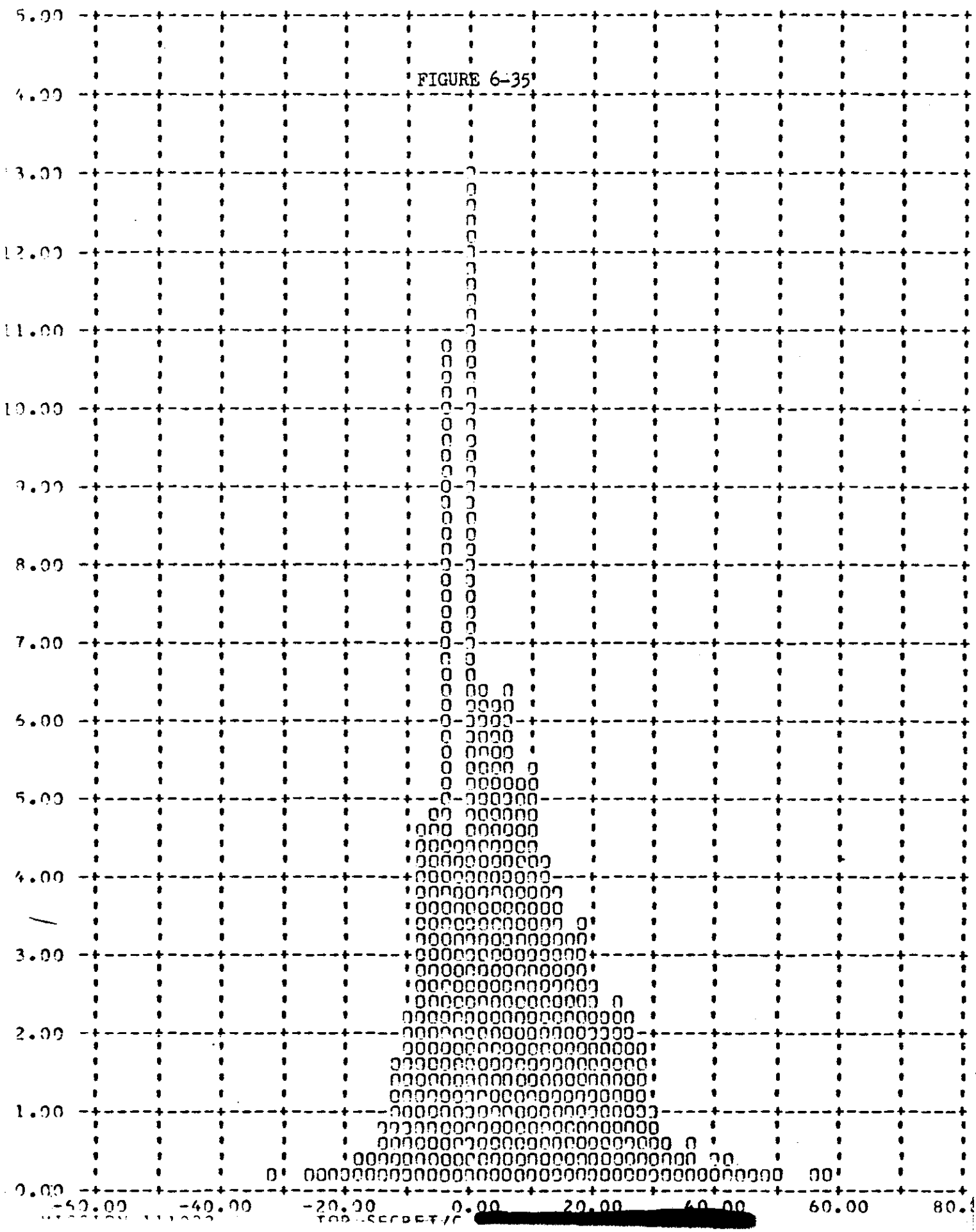


FIGURE 6-35

FRAMES 1-3 OF EACH OP OMITTED 90 PERCENT = 57.41

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

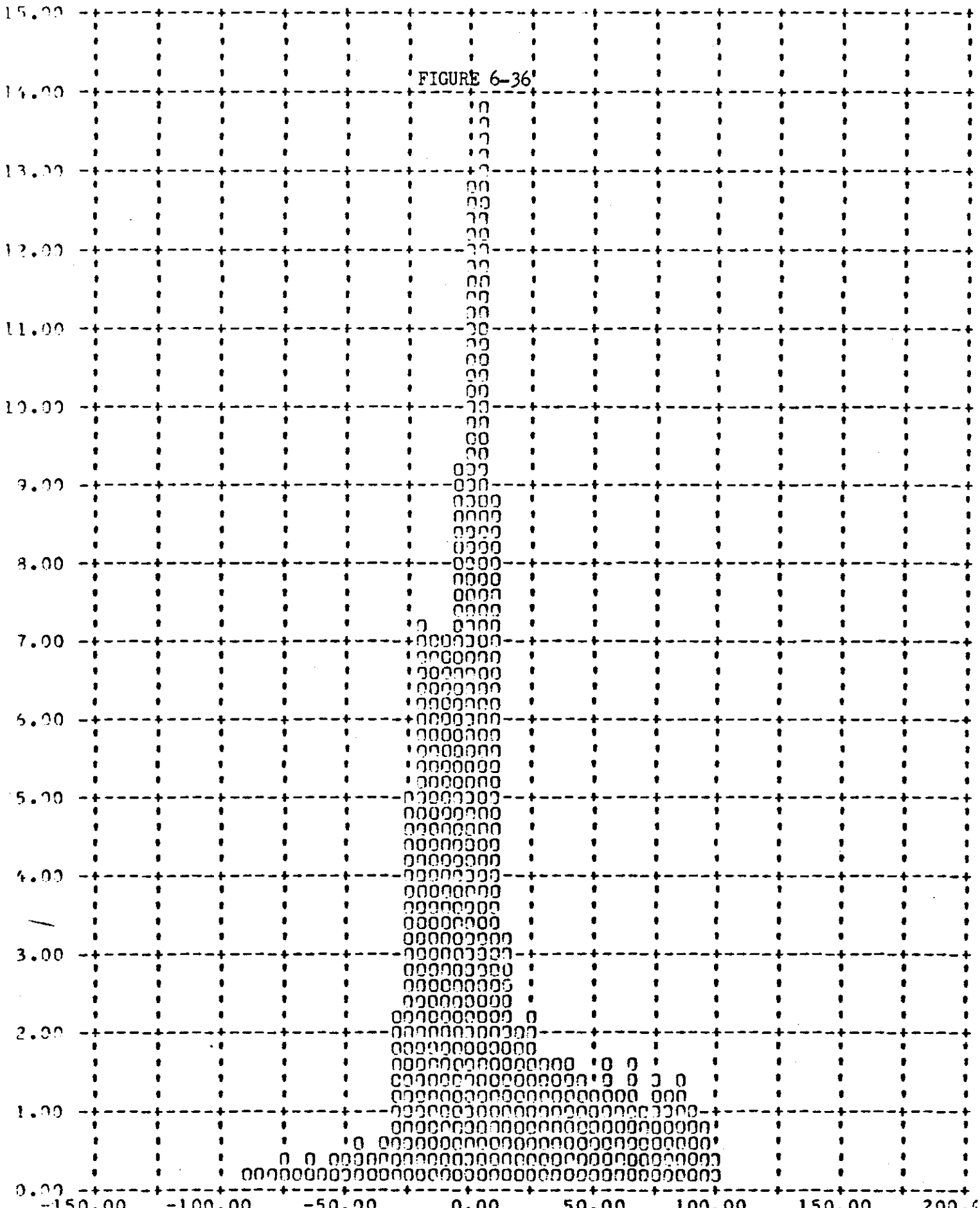


FIGURE 6-36

SECTION 7

SYSTEM RELIABILITY

Reliability calculations for the payload are based on a sample beginning with M-7. Hence both the major part of the Mural program and the "J" program are covered in the calculation. The sample size for the primary mission function is consistent with reliability reporting for the vehicle.

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

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

Panoramic Camera Reliability

Sample Size - 260 opportunities to operate

Four Accumulated Failures

Assume - 3000 cycles per camera per mission

Estimated Reliability = 98.23% at 50% confidence level

Main Camera Door Reliability

Sample Size - 152 opportunities to operate

Estimated Reliability = 99.55% at 50% confidence level

Payload Command and Control

Sample Size - 17,322 hours operation in sample

Two failures

Estimated Reliability = 97.46% at 50% confidence level

Payload Clock Reliability

Sample Size - 17,322 hours operation in sample

No failures

Estimated Reliability - 99.32% at 50% confidence level

Estimated Reliability of Payload Functioning on orbit = 94.66% at

50% confidence level

Recovery System Reliability

122 opportunities to recover

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

Estimated Reliability - 98.63% at 50% confidence level

DISIC Camera Reliability

Sample begins with CR-1 (does not include S/I units in 1000 series systems)

Sample Size = 50,325 cycles

One failure

Estimated Reliability = 77.55% at 50% confidence level

Horizon Camera Reliability

Sample begins with J-5 - Total Cycles = 217,266

Estimated Reliability of Single Camera - 99.36% at 50% confidence level

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