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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1106-1 and 1106-2

FTV 1630, CR-6

Approved [redacted], Manager
Advanced Projects

Approved [redacted], Manager
Program [redacted]

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FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1650.

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 1106-1 and 1106-2 which was launched on 5 February 1969.

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LIST OF ILLUSTRATIONS

INTRODUCTION

This report presents the final performance evaluation of Missions 1106-1 and 1106-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the CR-6 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], and from AFSPPF TERO Report, 101-1-126.

SECTION 1

MISSION SUMMARY

A. MISSION OBJECTIVES

The payload section of Mission 1106, placed into orbit by Flight Test Vehicle 1650 and THORAD Booster #519, 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-6 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 2159:53Z (1359:53 PST) on 5 February 1969. 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 1106-1 consisted of a 4-day operation and was completed by air recovery on 9 February 1969. Mission 1106-2 was completed with an air recovery on 15 February 1969 following a 5-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.)	88.77	88.7
Perigee (N.M.)	81.0	82.9
Apogee (N.M.)	156.7	155
Inclination (Deg.)	81.54	81.54
Perigee Latitude (Deg. N)	35.05	47.86
Eccentricity	.01055	0.0084

Two drag make-up rockets were fired during Mission 1106-1, and four during 1106-2. The remaining six rockets were fired after the second recovery.

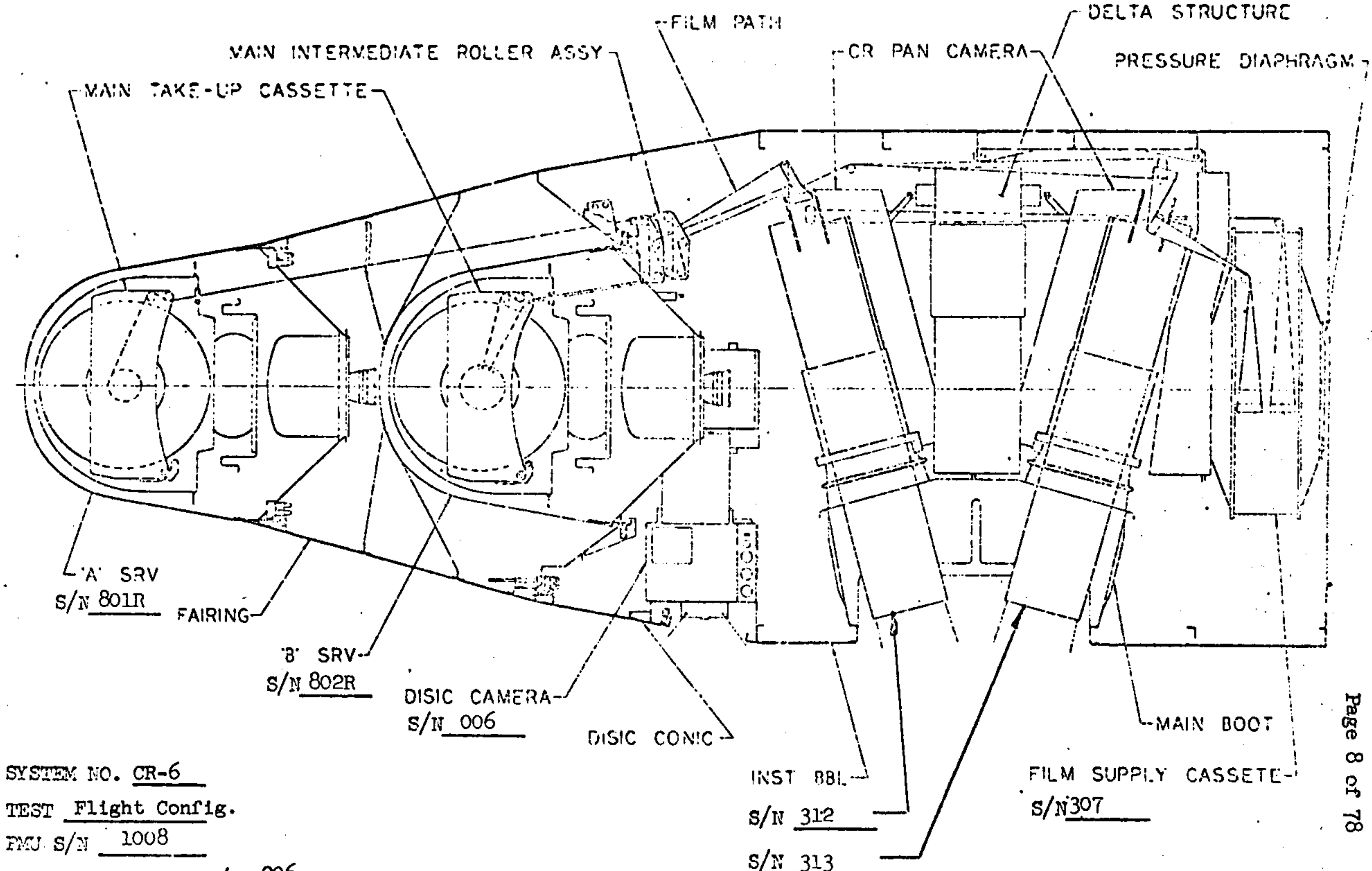
C. PANORAMIC CAMERAS

The forward instrument operated satisfactorily throughout both missions, and produced good to fair imagery except where degraded by atmospheric haze. The aft looking instrument operated satisfactorily throughout all of the 14,000 feet of the type 3404 material and approximately 911 feet of the SO-121 color material. The remainder of the 2000 feet of SO-121 which was on the end of the supply spool was not retrieved due to an anomaly. Good to fair imagery was produced and the SO-121 record showed good color balance. Both records evidenced degradation due to atmospheric haze.

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 75 port and 15 starboard point stellar images are present in most stellar frames and the

2. PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-6
TEST Flight Config.
PMU S/N 1008
SLOPE PROGRAMMER S/N 206
CLOCK S/N 627
SWITCH PROGRAMMER S/N 206

FIGURE 1-1

image quality of the index record is good and slightly better than that obtained from Missions 1103 and 1104.

E. OTHER SUB-SYSTEMS

The pressure make-up unit, the clock and the thermal control subsystems performed satisfactorily. The Digital Shift register portion of the command system generally performed satisfactorily but produced improper output on Revs. 9 and 22. The proper word was not shifted into the relay storage unit and the origin of the anomaly is still unexplained.

The slope programmer which provides continuous V/H error correction was inoperative after launch. Although the automatic section of the slope programmer was inoperative, real time command during acquisitions provided sufficient control to maintain V/H errors within $\pm$ 2%, usually less, over the primary target areas.

The exposure control programmer did not operate after Rev. 21. Failure mode analysis of the exposure control programmer indicates that either the relay controlling power to the subsystem failed or the relay was continuously inhibited by an accidental ground connection on the S.P.C. command line to the relay. Having lost the automatic slit sequencing feature, the programmer was operated by real time command during acquisition to provide the best possible exposure match over the areas of interest.

F. COMPONENT IDENTIFICATIONS AND SETTINGS

1. Forward Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	313
Main Camera Lens	I206
Supply Horizon Camera Lens	E23761
Take-up Horizon Camera Lens	E23797

b. Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Widths	
S_1	0.173"
S_2	0.197"
S_3	0.249"
S_4	0.311"
F/S	0.252"
Filter Types	
Primary	Wratten 23A
Secondary	Wratten 25
Film Types	
Primary	Eastman Type 3404 (16,300 Ft.)

Supply (Port) Horizon Camera:

Lens	45.4mm f/6.3
Aperture Setting	f/6.3
Exposure Time	1/100 second
Filter Type	Wratten 25

Take-up (Starboard) Horizon Camera:

Lens	45.4mm 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	312
Main Camera Lens	I 190
Supply Horizon Camera Lens	E 23783
Take-up Horizon Camera Lens	E 23782

   b. Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Widths	
S_1	0.144"
S_2	0.154"
S_3	0.187
S_4	0.234"
F/S	0.197"
Filter Types	
Primary	Wratten 21
Secondary	SP filter
Film Types	
Primary	Eastman Type 3404 (14,000 Ft.)
Secondary	Eastman Type SO-121 (2000 Ft.)

Supply (Starboard) Horizon Camera:

Lens	45.3mm f/6.3
Aperture Setting	f/8.0
Exposure Time	1/100 second
Filter Type	Wratten 25

Take-up (Port) Horizon Camera:

Lens	45.4mm f/6.3
Aperture Setting	f/6.3
Exposure Time	1/100 second
Filter Type	Wratten 25

3. <u>DISIC Camera</u>

a. Component Assignment

Component	Serial Number
Camera	006
Index Reseau	105
Stellar Reseaus	
Port	11P
Starboard	6

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.)

Index Camera:

Lens	3 in. f/4.5
Exposure Time	1/500 second
Filter Type	Wratten 12
Film Type	Eastman Type 3400 (2000 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. Signifcant baseline levels and anomalies experienced on CR-6 during pre-flight testing are as follows:

A. ENVIRONMENTAL TESTING

Payload system CR-6 was tested twice in the environmental HIVOS chamber; in standard configuration from August 23 through August 29, and, in Aschenbrenner Grid Test (AGT) configuration from September 16 through September 22, 1968.

1. <u>HIVOS Test No. 1</u>

<u>Pan Instruments</u>

The test was performed using SO-380, UTB material. Instrument system operation, from instrumentation analysis, was generally satisfactory throughout the test although two major anomalies occurred on the aft looking instrument records. The first 1000 cycles of operation produced 2 π corona during which time the pressure make-up subsystem was deactivated and the pressure ranged from 9 to 17 microns. The second anomaly was loss of most format data and H.O. fiducials on the aft looking instrument. This was traced to failure of the Dual Data Signal Conditioner which initiates these readouts.

The records from both instruments bore intermittent plus density stripes. The CR-5 records exhibited the same characteristic and it is attributed to sensitivity of the UTB payload to pressure deformations, i.e., buckling of the film web, as it traverses air twists in the payload path.

DISIC Camera

The material from the DISIC instrument No. 6 contained no serious anomalies. The stellar material was continuously marked by the skew roller bead along one edge but not affecting the format area. The port stellar formats were mottled by the pressure pad throughout the test. The pad was later adjusted and the marking greatly reduced in magnitude. There were minor dendritic marks along the SLP edge of the terrain material outside the format area.

Command System

CR-6 is the first system utilizing the new DSR command system which functioned properly with the exception of a minor anomaly. It failed twice to shift the first word into the output register. It later appeared normal and did not repeat the anomaly.

Pressure Make-up Subsystem

The pressure make-up subsystem failed to respond properly when the Pan and DISIC cameras were started simultaneously. This problem recurred in HIVOS test No. 2 and was traced to a delay module which was replaced by a more reliable flight tested module employed elsewhere in the system.

2. HIVOS Test No. 2

Pan Instruments

CR-6 was returned to the chamber in the AGT configuration which rendered the H.O. fiducials, 200 pps, and P.G. stripes inoperative throughout the test. The voltage to these data markers is interrupted by the test harness and is acceptable for this test.

The ITEK evaluation of the AGT test records reported that the maximum lift variance on the aft looking instrument was +.0006" and on the forward looking instrument was -.0008". The results warranted the conclusion that instrument #312 was very good, instrument #313 was good and that they both were acceptable.

An intermittent plus density stripe was present on much of the records from both pan instruments in the HIVOS test. The maximum density is approximately 0.015 above base fog which represents no significant degradation to the photography. In addition light start-up corona affecting one to three frames was present on both records. Density checks of these marks indicate $D_{max} = 0.35$ above base fog which is acceptable.

Near the end of the test, the material from the No. 1 instrument was severely torn on a wrap adjacent to the manufacturer's splice and the emulsion was lifted on the succeeding wrap. This was caused by adhesive bleed from the mylar splice. Consequently the superior Permacel splices are now being employed where possible. The No. 2 instrument record had 45 frames of 2π type corona during the final pressure sweep at the end of the test at a pressure range of 15 to 30 microns. Although this anomaly is not acceptable, a waiver was recommended.

<u>DISIC Camera</u>

The DISIC instrument No. 6 terrain material exhibited a minor corona stripe inside the format area on approximately 60 frames. The density of these marks was within specification limits. The characteristic skew bead roller marks were present on the stellar record which was otherwise acceptable.

System Performance

.Pan Instruments

The Pan instruments transported material normally throughout the test. The cycle rates on the No. 1 instrument were not acceptable after rev. 8B. The No. 2 instrument produced satisfactory cycle rates throughout the test.

DISIC Camera

DISIC performance was normal throughout testing except for dirty contacts on both stellar and terrain idlers which were cleaned subsequent to testing.

Subsystem Performance

The performance of the various subsystems was satisfactory with some minor anomalies. Adjustments were made at the conclusion of the test.

The exposure control and the V/H programmer performance was normal. The clock had a small offset and was later adjusted for better accuracy.

Noise was reported on a few open points of the T/M commutator. Operation of the remainder of the instrumentation was normal. The tape recorder failed to record segments of data during both "A" and "B" phases.

B. RESOLUTION TEST

Initial resolution and theodolite tests were performed 4 January 1969. The resolution performance in the FMC direction indicated that there was degradation and excessive variation in target-to-target performance at each focus position. These quality degradations were induced by a target/camera IMC mismatch of approximately $7\frac{1}{2}$ percent. The final resolution test verified that the IMC/scan performance disparity noted above had been corrected so that evaluation of system resolution performance was confidently performed.

Results of the thru-focus resolution tests on the pan instruments 312 and 313 show the following characteristics:

Aft-looking Instrument No. 312

Maximum low contrast resolution 125 lines/mm at -0.0007" peak focal position.

Fwd-looking Instrument No. 313

Maximum low contrast resolution 200 lines/mm at -0.0004" peak focal position.

The final test data for both instruments is shown in figures 2-1 and 2-2. Both instruments 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 any light leaks. Evaluation of the flight test specimens that were later retrieved and processed also showed that the system was light tight.

D. FLIGHT LOADING AND CERTIFICATION

The DISIC #6 was loaded and installed in the CR-6 system on 25 January 1969. The pan CR-6 system was loaded on 27 January 1969. Film samples taken from both DISIC and pan systems were processed and evaluated. They were free of physical defects and the photographic characteristics were satisfactory. All functions were normal, and as noted in the preceding paragraph, the light leak search test showed that the system was light tight.

[redacted]

PRE-FLIGHT DYNAMIC RESOLUTION

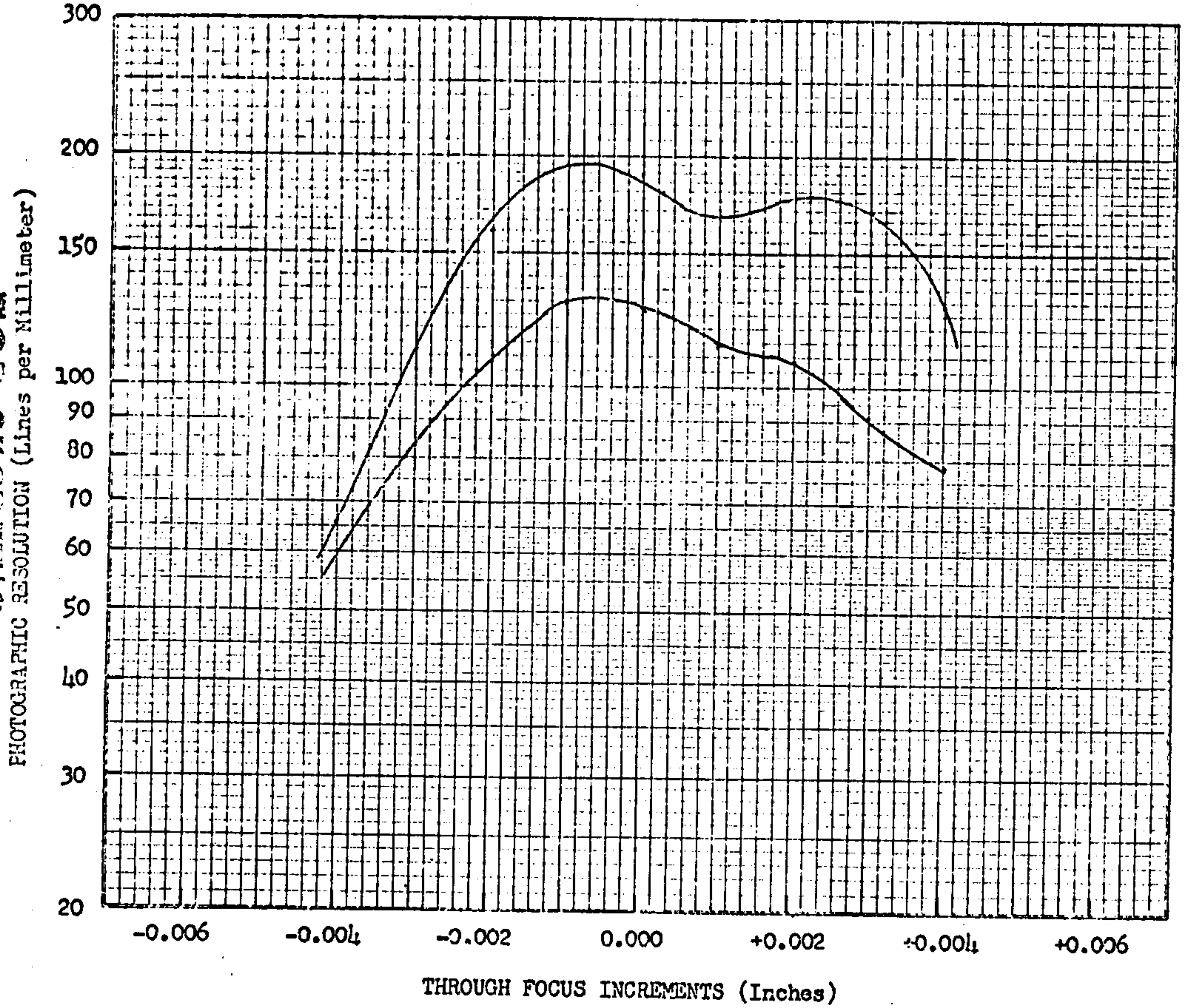


FIGURE 2-1

Camera No: 312

Payload No: CR-6

Resolution (1/mm)

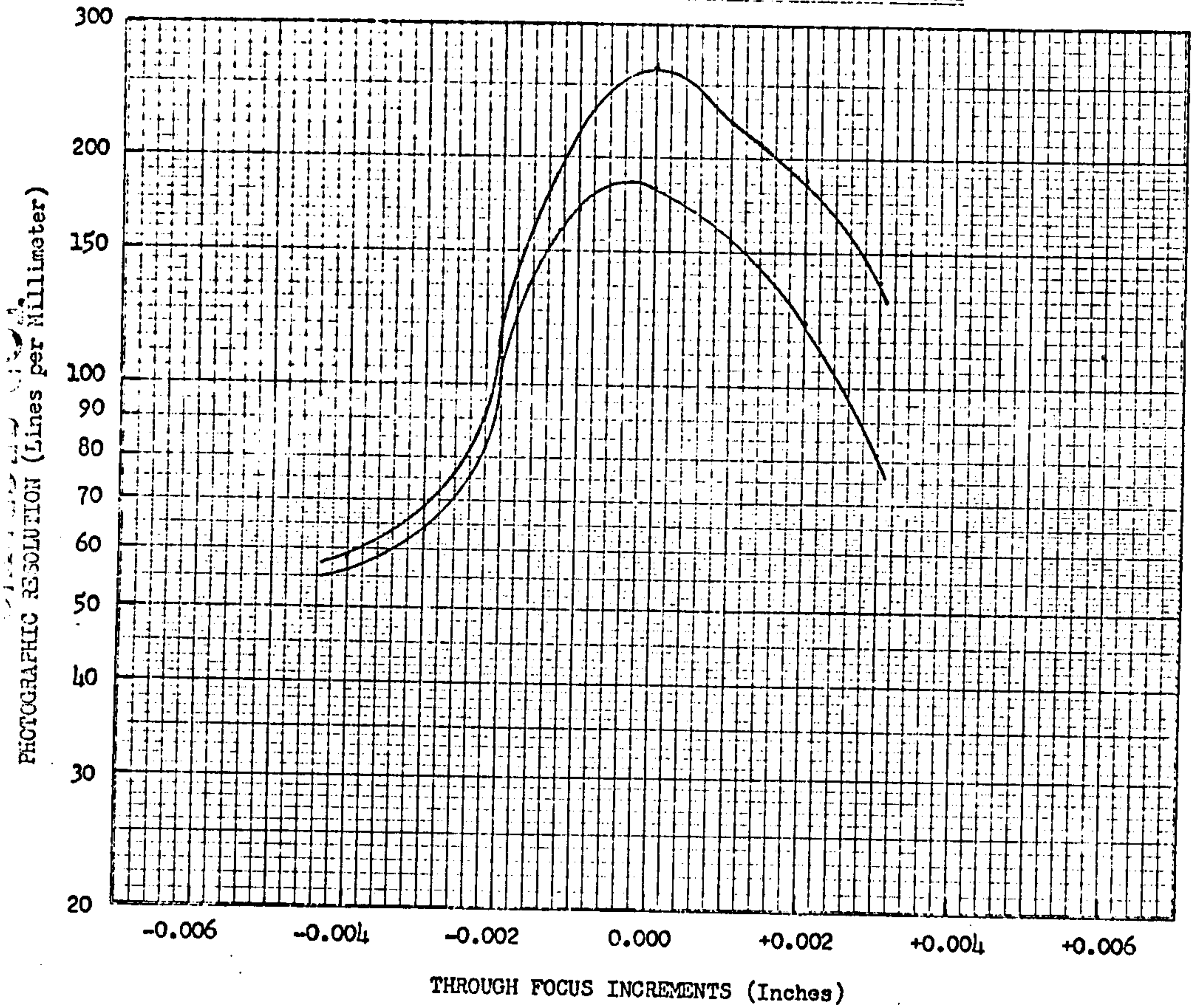
High Contrast: 194

Low Contrast: 130

Film Type: 3404

Test Date: 1-10-69

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 313

Payload No: CR-6

Resolution (1/mm)

High Contrast: 266

Low Contrast: 184

Film Type: 3404

Test Date: 1-10-69

FIGURE 2-2

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Lift off occurred at 21:59:53 GMT (System Time 74193.2) on 5 February 1969 from SLC-3 west pad. All launch, ascent and injection events occurred as programmed. The orbit achieved was within the 3 sigma predicted dispersions.

Panoramic camera 313 operated satisfactorily throughout the flight. Film wrap-up on the frame metering roller occurred at the end of the mission when the supply was exhausted. Panoramic camera 312 operated normally until a failure occurred in the -2 mission with approximately 409 cycles left on the supply. Indications are that the failure was a film separation that occurred at or very near a manufacturer's splice.

The DISIC system operated normally throughout the flight. Cut, splice and transfer transpired as programmed and were satisfactory.

The command system incorporated a Digital Storage Register (DSR) for primary operation of the camera system and included a two program (four rev. intermix capability for emergencies. This was the first DSR system to be utilized in flight. Performance of the DSR was considered satisfactory for a first flight article.

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

The exposure control programmer operated normally through Rev. 21. The programmer failed in position 1 at this time and no longer responded to Brush 51 or 52 commands. The slit widths were controlled by real time command (RTC), VHF 101, for the remainder of the flight.

The eccentricity function portion of the Forward Motion Compensation (FMC) generator was inoperative after launch but the oblateness function generator operated normally. FMC errors were minimized by selecting the the best match for a specific latitude range by RTC over acquisition stations to obtain a satisfactory FMC.

The pressure make-up system operated normally. Gas consumption was 6.06 psi/minute of operation and 2100 psi remained at the end.

The instrumentation system performed normally throughout the flight.

The thermal environment was within specification and very near the prediction.

The tape recorder in the -1 recovery system performed normally and all data was recorded and retrieved. The tape recorder in the -2 recovery system failed after approximately 6 minutes of operation.

Kik-Zorro 38 (Pan Camera A to B Switchover) was commanded on rev. 55. Cut and wrap and transfer to the second recovery was normal.

Kik-Zorro 39 (DISIC A to B Switchover) was commanded on rev. 56. Transfer to the second recovery was normal.

Both recovery systems were successfully recovered by air catch and all events were normal.

DMU Operation

Six DMU rockets were used for period control during the 147 revs of the flight to satisfactorily maintain the ground tracks. None were required for dispersions as the initial orbit was near nominal.

The ground track error was limited to 25 nautical miles east and 12 nautical miles west of nominal. The following is a summary of the DMU firings:

Rocket No.	Pass Fired	System Time	Period Change (Sec.)	Velocity Change Ft/Sec	Period at Firing
1	24	34539	10.3	16.6	88.56
2	40	33267	11.2	18.0	88.57
3	61	58650	14.3	22.7	88.57
4	97	77260	14.7	23.4	88.53
5	115	00371	15.7	25.0	88.58
6	139	42081	15.7	25.1	88.57

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

B. ORBITAL PARAMETERS

The following tabulation describes the orbital parameters based on rev. 2, both predicted and actual.

Orbit Parameter	Predicted	Actual
Period (Min)	88.77 (+0.24, -0.47)	88.70
Perigee (nm)	81.0 (+5, -5)	83.5
Apogee (nm)	156.7 (+10, -18)	154.9
Eccentricity	0.0108 (+0.0016, -0.0026)	0.0101
Inclination (Deg)	81.51 (+0.34, -0.16)	81.54
Arg. of Perigee (Deg)	141 (+43, -48)	132

C. PANORAMIC CAMERA PERFORMANCE

Instrument 312 was loaded with 14,000 feet of type 3404 film and 2000 feet of type SO-121 color film. Instrument 313 was loaded with 16,300 feet of type 3404 film.

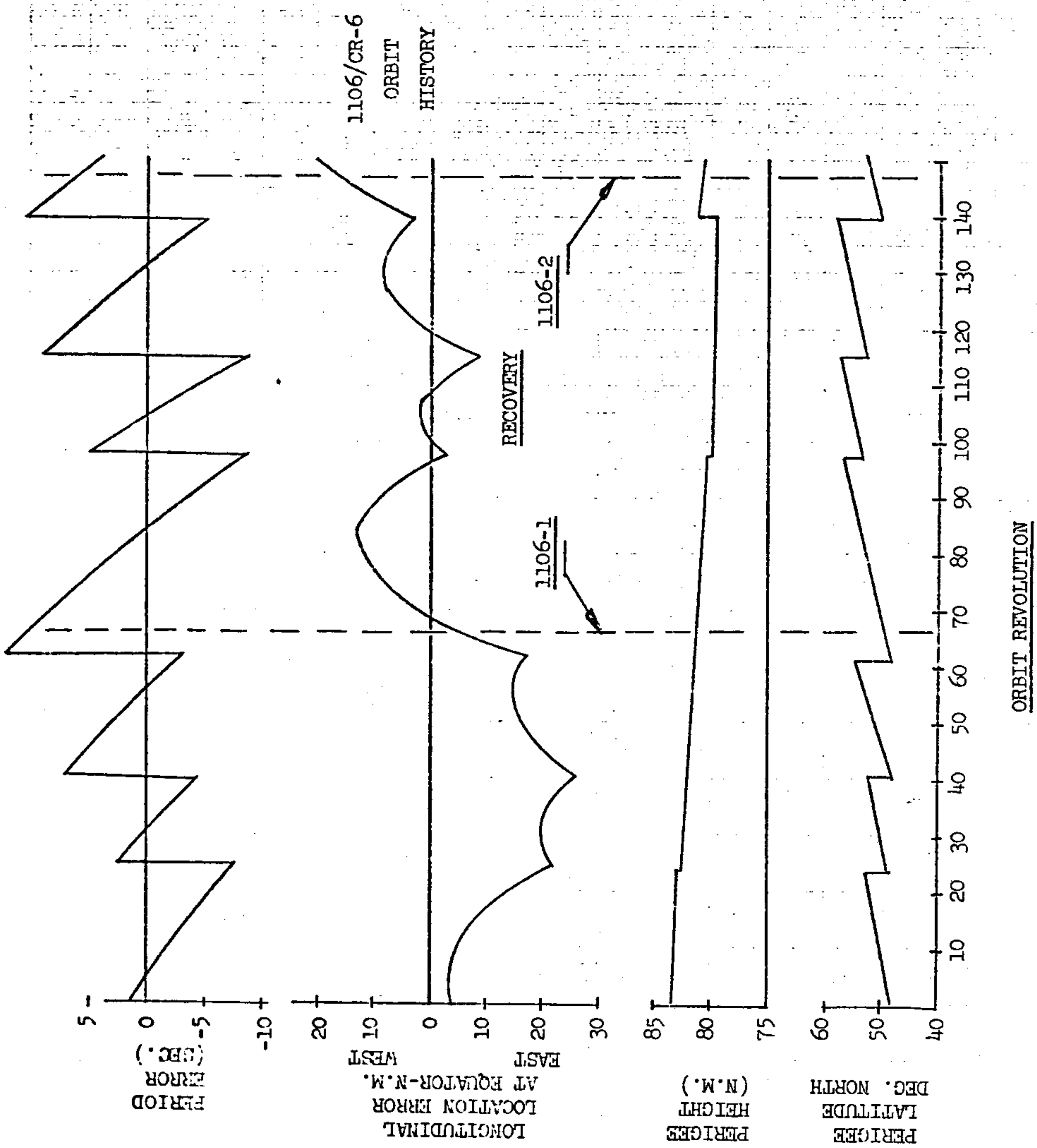

1106/CR-6
ORBIT
HISTORY
RECOVERY
1106-1
1106-2
ORBIT REVOLUTION
10 20 30 40 50 60 70 80 90 100 110 120 130 140
PERIOD ERROR (SEC.)
5 0 -5 -10
LONGITUDINAL LOCATION ERROR AT EQUATOR-N.M.
WEST
EAST
20 10 0 10 20 30
PERIGEE HEIGHT (N.M.)
85 80 75
PERIGEE LATITUDE DEG. NORTH
60 50 40

FIGURE 3-1

1106/CR-6 OPERATIONS

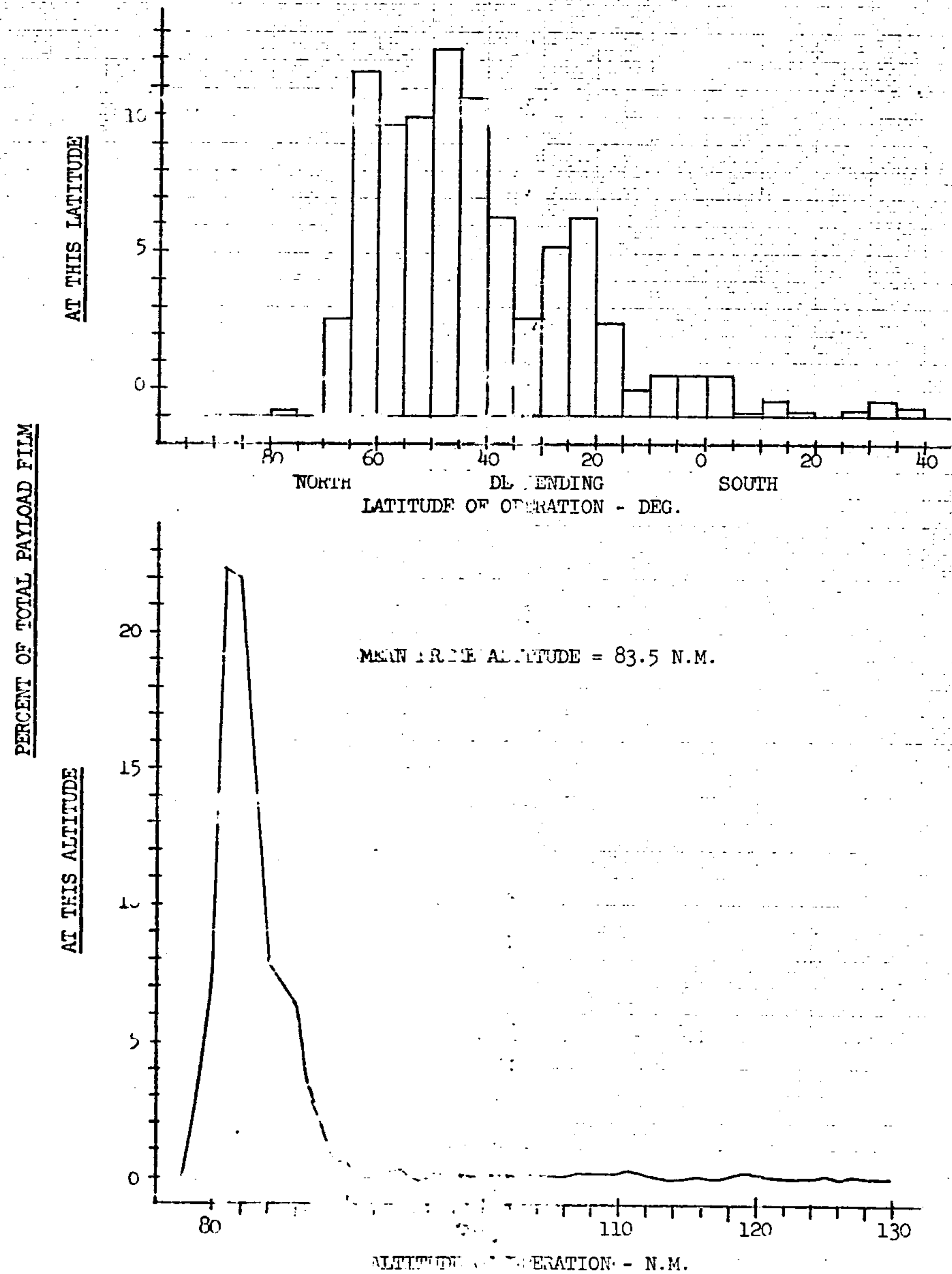


FIGURE 2-2

Film consumption (frames) is listed in the following tabulation.

	Pan 312	Pan 313
Sample	20	20
Pre-Launch	158	158
-1 Mission	2952	2950
-2 Mission	2188 (3404)	3054
	347 (SO-121)	
Total	5765	6172

Panoramic camera 312 operated normally throughout the -1 mission, through the 3404 film (2188 cycles), and 347 cycles into the 756 cycles of SO-121 (color) film in the -2 mission. At this time a failure occurred. Camera system dynamic operation, 99/101 percent clutch operation, start-up, shutdown, transport functions and response to the exposure control system and filter change mechanisms was normal until the failure occurred.

The failure was first noted on rev 106 by the filter change selector which had advanced 2 positions. On rev 106 the cycle counters only advanced 27 for a 35 cycle operation. An engineering pass was conducted on rev 109 and the failure was confirmed. The failure was such that the supply spool was free running, the input metering roller was operating, the frame metering roller and take-up were stopped, and the system was shut down by the 20 second delay. This indicates that the most probable cause of the failure was a separation of the film between the supply spool and the input metering roller, resulting in a jam-up of the instrument as the tag end was transported through the system. A manufacturer's splice was located near the point of failure suggesting the possibility that the splice may have failed.

Panoramic camera 313 operated normally throughout the flight with tag end wrap-up occurring at film depletion. Camera dynamics, 99/101 percent clutch operation, start-up, shutdown, film transport and response to the exposure control system were all normal. The wrap-up at film depletion had the same characteristics as other CR systems at film depletion.

D. DISIC PERFORMANCE

The stellar camera was loaded with 2000 feet of type 3401 and the terrain camera was loaded with 2000 feet of type 3400 film. Film consumption (frames) is listed below.

	Stellar	Terrain
Sample	95	73
Pre-Launch	120	118
-1 Mission	2146	2146
-2 Mission	2637	2393
Total	4998	4730

The DISIC system operated normally throughout the flight. Cut, splice and transfer to the second recovery system were commanded by KZ-39 on rev 56. All events occurred as programmed and were satisfactory.

The 1/250 second shutter speed was disabled prior to flight and all photography was taken at 1/500 second exposure time.

E. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

The instrumentation system operated normally throughout the flight.

CR-6 and up payload systems utilize UHF digital, S-band Analog and KIK-ZORRO Real Time Commands (RTC's) in conjunction with the Orbital Programmer Stored Program Commands (SPC's) for payload system operation and control. The basic command system utilized for camera enable/disable control includes a storage register, register decoder, H-timer stored commands using a cascade technique, redundant off commands and an emergency back-up system.

This is the first flight system to utilize the DSR command system. A brief description of this command system and the programming technique follows.

Primary Camera Control

The primary panoramic camera command system has the capability of controlling up to 16 camera operations between tracking station acquisitions.

The command system consists of a 32 word, 5-bit per word magnetic core storage unit that is interfaced directly with the Agena Type 22 Decoder. The command bits are 1's and 0's which form a word representing the command to be executed. The most significant bit designates the pan camera On/Off control - "0" for Off, "1" for On. The other four bits form a reverse binary number that specifies the Orbital Programmer track to be executed.

A real time command (UHF-109) enables the digital storage register for loading the 32 command words. The same load enable command disables the A/P register decoder logic, which puts the camera system in a disable mode. If the camera system is "On" when the load enable command is given, it will automatically perform a normal shutdown. The enable command sets the entire memory to zero and resets the word counter. A write command from the Type 22 decoder causes a 5-bit word to be loaded into the digital storage register.

Following the storage register loading, another real time command (ANA-9/UHF-110) disables the digital storage register loading and enables the A/P register decoder logic, putting the camera system into an enable mode. The load disable command causes the first word to be read into the output register for execution.

Readout of the digital storage register is sequential in the same order that the words are loaded. The word in the register will enable the corresponding execute punch on the Orbital Programmer tape. After execution, the storage register advances to the next word.

A cascade technique is used for programming the sixteen SPC tracks available on decks 3 and 4 of the Orbital Programmer for camera operate control. All sixteen SPC's are considered execute commands. A command from the digital storage unit enables one of the 16 execute SPC's and indicates whether the execute is to turn the camera system on or off.

The cascade technique consists of punching the 16 execute events in the Orbital Programmer tape at specified time intervals. The last 11 SPC's are punched consecutively at 6 to 10 second intervals. The first 5 SPC's punched at approximately 75 to 100 second intervals and are used to skip the intermediate cascades formed by the last 11 SPC's. This procedure is repeated for all required land masses between acquisition stations. A maximum of 32 usable cascades between tracking station acquisitions can be punched but a more practical number is 15 or 16. At least one command must be programmed for each four intermediate cascades.

When all of the 32 commands stored in the register are executed, the output register is placed in an all zero condition. Therefore, any subsequent cascades that remain before the next station acquisition will receive only camera Off commands. At the next station acquisition, a new set of commands can be stored in the digital register to control a new sequence of camera operations.

In addition to the sixteen execute SPC's used for controlling the pan camera system, an SPC is used as a redundant Off to turn the camera system off. A redundant Off SPC is included at the end of a series of cascades to assure that the camera system turns off.

Emergency Mode of Operations

An emergency backup system is provided on J-3 payloads using the Digital Storage Register system.

Two programs are provided for emergency operations. Associated "On" and "Off" events are punched on the Orbital Programmer tape. The programs provided on the Orbital Programmer tape are controlled by the Orbital Operation Intermix Select which provides control for four consecutive revs. The Intermix is stepped by SPC-14 once each rev. The operations for any rev are either all taken or all denied depending on the Intermix Logic.

The emergency backup capability is provided by the following real time command functions:

1) ANA 6/UHF-116 Emergency Program Select

   This is a two position selector used for selecting one of the two stored programs.

   Position 1 enables the Program 1 operations controlled "On" by SPC-28 and "Off" by SPC-29.

   Position 2 enables the Program 2 operations controlled "On" by SPC-46 and "Off" by SPC-47.

2) ANA 8/UHF-118 Emergency Intermix Operations Select

   This is a sixteen position relay matrix. Commanding to one of the sixteen positions provides a four rev sequence where all programmed operations for any rev will be all "taken" or all "denied" depending on the logic of the intermix. The logic for each position is as follows:

Pos.	Four-Rev Sequence Logic
1	0000
2	1000
3	0100
4	1100
5	0010
6	1010
7	0110
8	1110
9	0001
10	1001
11	0101
12	1101
13	0011
14	1011
15	0111
16	1111

Note: 1 = Execute "On", 0 = Execute "Off"

Once the position for a desired sequence is selected by ANA 8/UHF-118 the control position within the sequence is determined by a four step counter which is advanced once each rev by an SPC-14 command. The sequence will repeat until another ANA 8/UHF-118 command is given which reinitializes the counter.

3) ANA 10/UHF-120 Instrument Mode Select

This is a four position selector used for selecting one of the following panoramic camera operational modes:

Pos.	Function
1	Stereo operation - DSR
2	Mono 1 operation - DSR
3	Mono 2 operation - DSR
4	Emergency Mode Enable (Stereo)

Commanding to position 4 puts the panoramic camera system into the emergency mode. In position 4 power is removed from the digital storage register system and the emergency intermix (ANA 8/UHF-118) and emergency programs (ANA 6/UHF-116) are enabled.

All other command functions remain the same as CR-5.

During the active flight the Satellite Control Facility attempted to load the DSR 87 times. Load generation, transmission and verification were normal 33 times. DSR loading was successful an additional 48 times after repeated attempts and/or use of non-standard operational techniques. DSR loading was unsuccessful a total of 6 times. These were on revs 1[redacted] 2[redacted], 4[redacted], 6[redacted] 16[redacted] and 85[redacted]. Of these only revs 4 and 85 [redacted] had operational requirements and the emergency program was enabled, allowing camera operation over the area of interest. On revs 1 and 2[redacted] and 6[redacted] the loading was for checkout and loss of these loads did not impair the mission. The load for 16[redacted] was to allow for an engineering operation of the camera system over the tracking station. Loss of this operation was not detrimental to the mission.

Four additional anomalies occurred during the flight. The first occurred on rev 9[redacted] The load was completed and verified normally, however a 200 command remained in the output register when the load disable was given. This caused the desired operations to occur approximately 40 degrees south of the desired location. On rev 2 [redacted] a similar thing occurred except the command in the output register was a 203. The results were the same as on rev 9. On rev 50 [redacted] two operations were desired, one an engineering over [redacted] and one over denied territory on rev 51. On this pass the load was normal but the load disable was issued too early, resulting in execution of a command earlier than desired. The sequence of the following commands placed the third and fourth commands too close together, causing a timing circuit to inhibit the fourth command the first time it was encountered in the tape. This resulted in the load getting back in sync with the desired operation.

The fourth anomaly occurred on rev 57 at [redacted]. On this pass the register was loaded but not verified at [redacted]. At the [redacted] station the load was verified and a load disable command was issued. A T/M Off occurred between [redacted] and [redacted]. This closed the shift register but did not shift out the first word. This resulted in a 200 command remaining in the output register and in effect gave 33 commands. This anomaly was not recognized because the first word of the load was a 200 command. This is normal for the DSR and had not been documented before flight. The operation on this rev occurred 24 degrees south of the desired location.

In summary two loads were wrong due to a DSR malfunction, one load was wrong due to improper procedures, one load was wrong due to a human error, and six loads could not be verified due to a software malfunction. Only three of these resulted in loss of the desired targets.

On revs 9 and 22 where the DSR malfunctioned it appears the cause of the malfunction was due to a tolerance buildup which prevented the shift signal to effect a shift-out of the first word when the load disable command was given. Both of these anomalies could have been corrected by recognizing the error and retransmitting the load if the Auggie system had been operating properly. The Auggie software was corrected by rev 38 and further anomalies of this type would have been recognized and corrected had they occurred.

The anomaly on rev 57 proved to be a proper operational mode that had not been documented pre-flight. It was not recognized and corrected because both the word in the output register and the first word in the load were 200 commands. This pointed out a potential problem area that could affect future flights. That is the problem of loading a 200 command in the first position. This prevents recognition of the shift of the first word into the output register since the load "Enable" command clears the output register to a 200 command condition. To prevent this from occurring on future flights the command generation programs are being modified to prevent a 200 command from being loaded in the first position.

All other portions of the command system operated normally during the active portion of the flight and all commands issued were received and executed by the command system.

F. FORWARD MOTION COMPENSATION PERFORMANCE

The FMC programmer eccentricity function was inoperative after launch. The function output and position monitors indicated the motor was not driving the potentiometer used for function generation. The function output did respond to real time selection of the start level which allowed adjustments to obtain V/H match. The oblateness and yaw functions were normal and the On/Off monitor verified the start command (SPC 27) was being received. A post event 2 test was conducted on the FMC programmer by slewing the orbital programmer to allow the Brush 14 normally punched at 78°S northbound to occur over the [redacted] tracking station. This confirmed operation in the slew mode as the motor operated the potentiometer and end of cycle switch. From analysis of the available data the failure occurred either in the normal mode oscillator or the wire opened between K3 and the controller module.

The normal method of matching the pan camera operations with the V/H of the orbit could not be utilized during this flight due to the failure of the FMC programmer. All operations were run at start level cycle rates, which were nearly constant, being varied by the oblateness function only. Mismatch was minimized by adjusting the programmer start level with the Real Time Command function UHF-121.

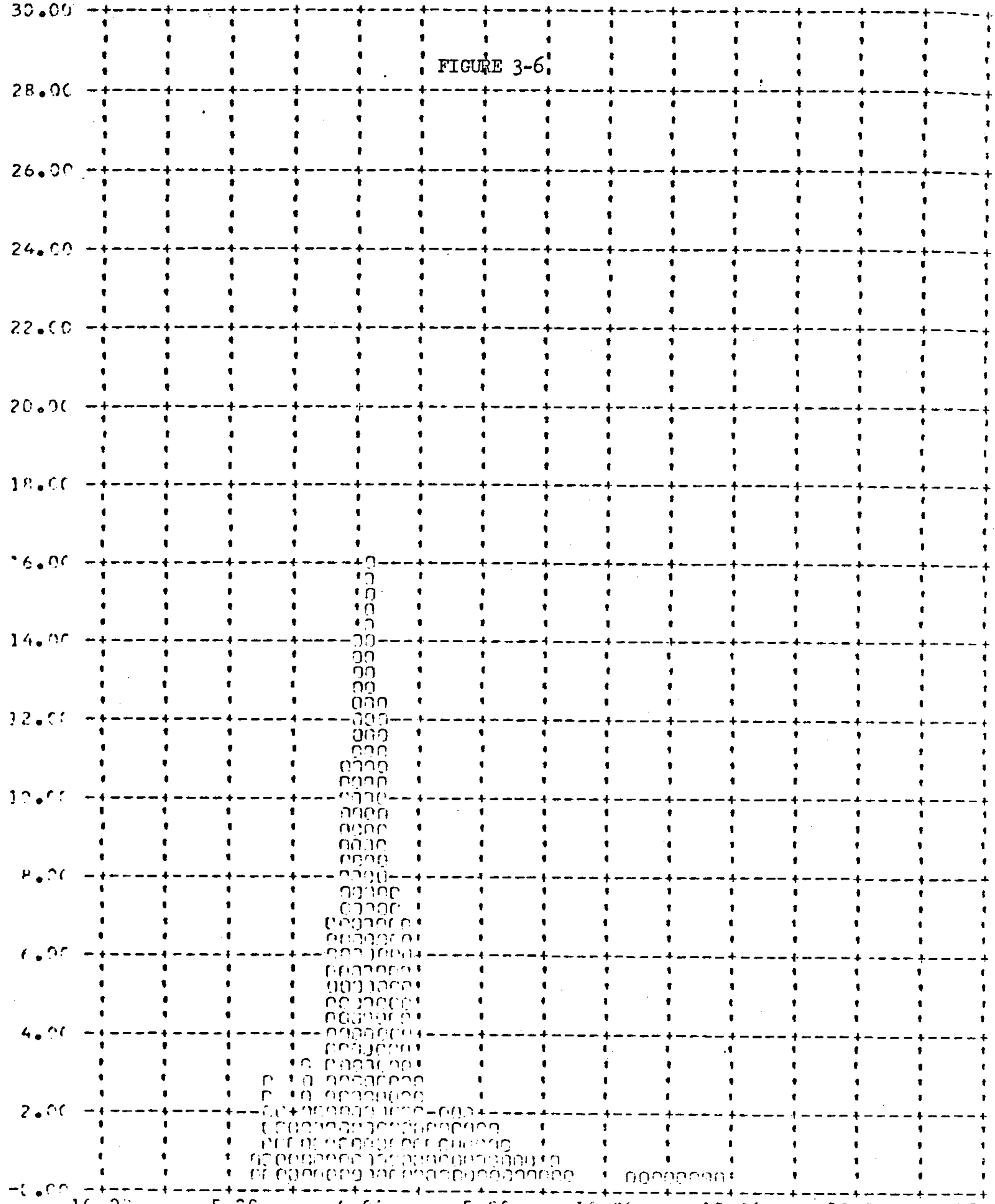
Operations on revs 1 thru 5 had a very large FMC mismatch as the ramp setting at the beginning of the mission was in a configuration consistent with normal programmer functioning. Once the exact nature of the programmer failure was determined information was provided for selecting the optimum start level position for the desired latitudes of operation. Start level selection was based mainly on obtaining the least mismatch over prime areas.

The V/H match performance is shown in figures 3-3 through 3-6. It can be observed from study of these V/H error plots, that good FMC match was achieved by real time command. Consequently image smear was held to a minimum as discussed in Section 6.

FRAMES 1-6 OF EACH OP OMITTED   90 PERCENT = 3.9

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

FIGURE 3-6



FRAMES 1-6 OF EACH OP OMITTED 90 PERCENT = 3.92

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

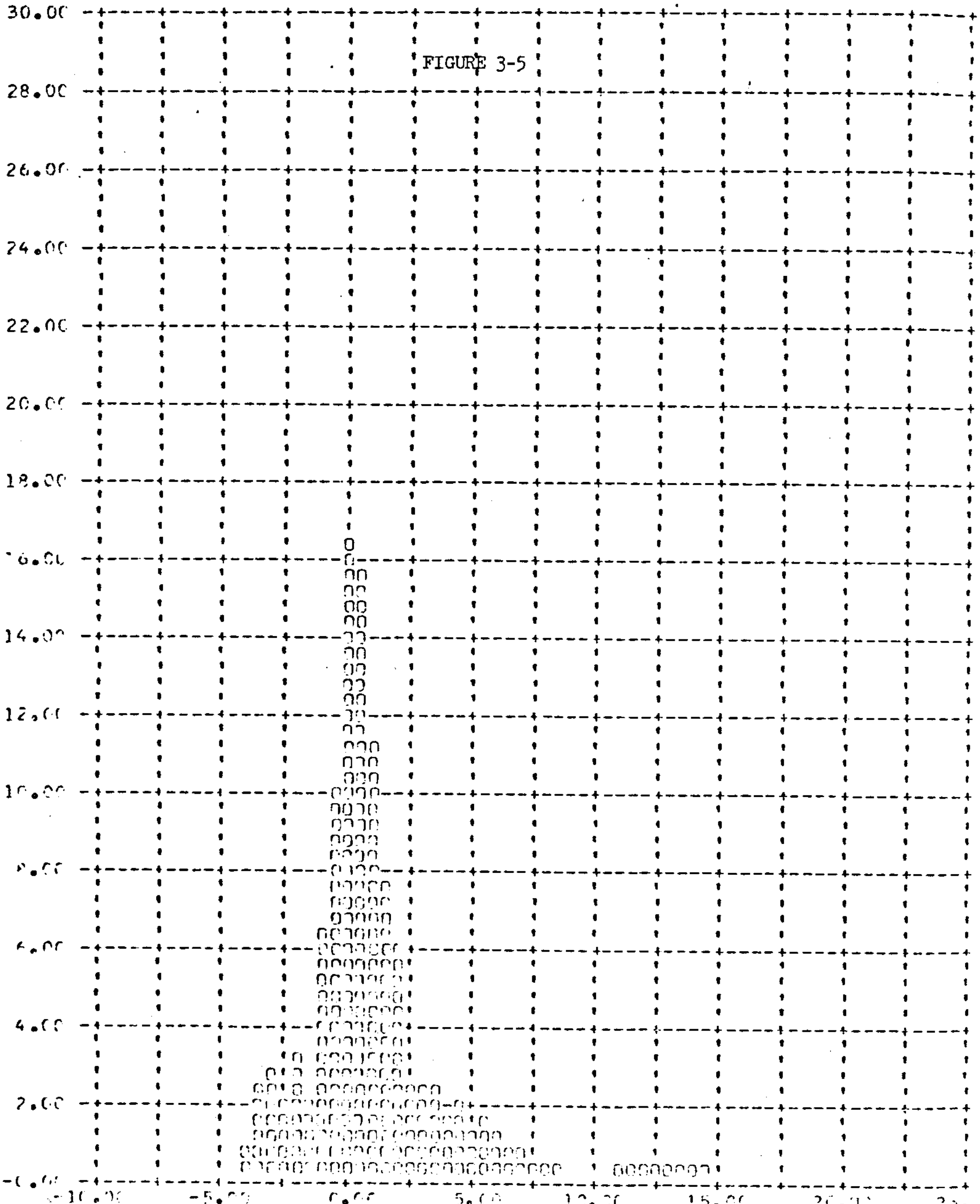


FIGURE 3-5

FRAMES 1-6 OF EACH OP OMITTED 90 PERCENT = 4.23

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

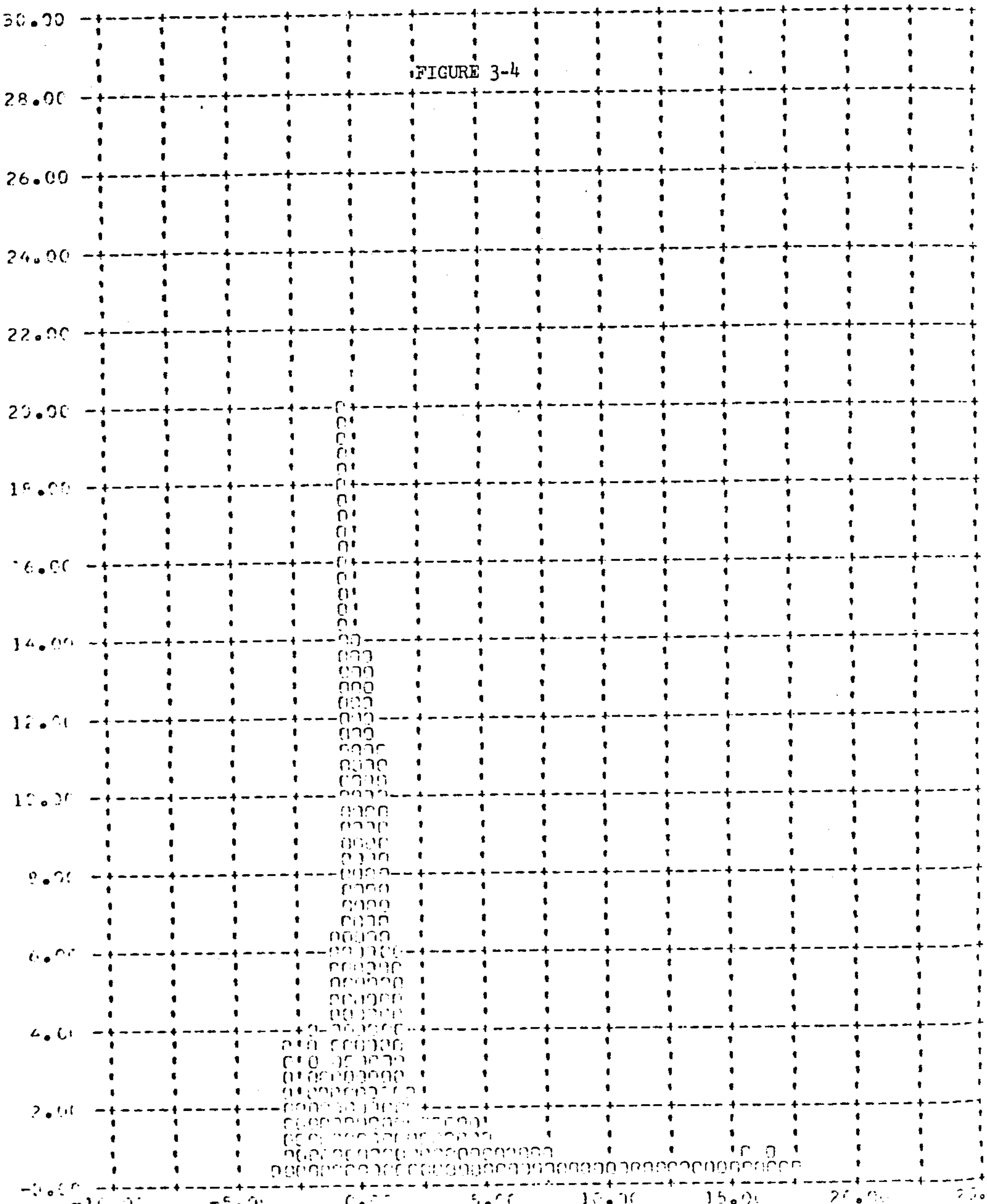
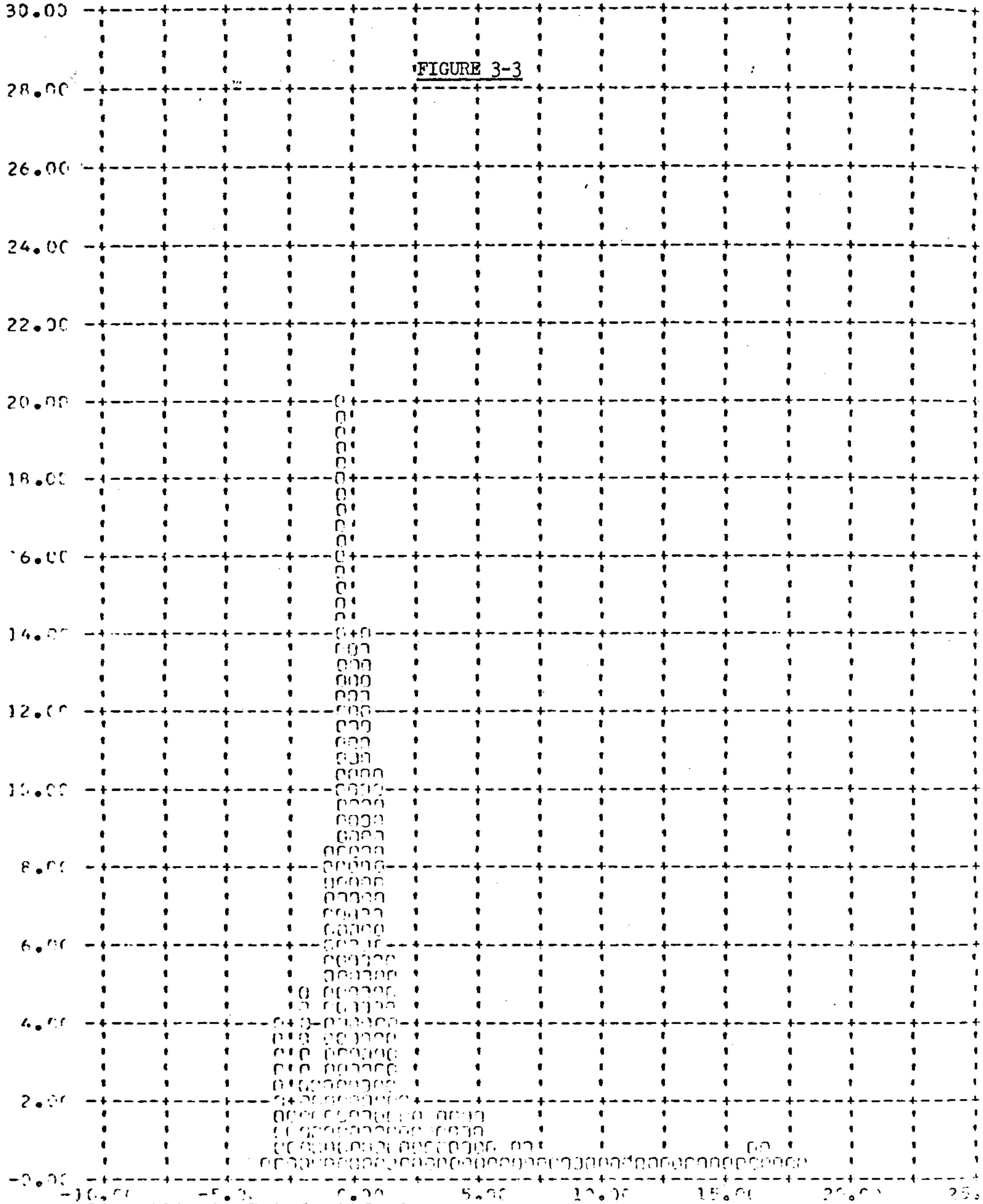


FIGURE 3-4

MISSION 1106A1 ~~TOP SECRET~~ C

FRAMES 1-6 OF EACH OP OMITTED 90 PERCENT = 4.1

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



G. EXPOSURE CONTROL SYSTEM PERFORMANCE

The exposure control programmer failed after rev 21. The programmer output was in position 1 at the time of failure and did not change after rev 21. The SPC monitor indicated the power was off at the programmer input. From an analysis of the data it was concluded that relay K-1 remained latched in the Off position due to a relay failure or a continuous ground on the SPC 17 line. Control of the slit widths was done by UHF-101 after failure of the programmer.

H. CLOCK SYSTEM PERFORMANCE

The clock system operated normally throughout the flight. Good correlation between clock and system time was obtained with the second order fit data recommended for time correlation. Correlation equations and constants are as follows:

First Order Fit

System Time = A0 + A1 (clock time)

where:

A0 = -90849.613166   A1 = 0.9999997184017

Sigma = 0.00392   No. of points = 259

Second Order Fit

System Time + A0 + A1 (clock time) + A2 $(\text{clock time})^2$

where:

A0 = -90849.632567   A1 = 0.9999998033169

A2 = 0.754381437580716 D-13   Sigma = 0.00123341

No. of points = 259

I. PMU SYSTEM OPERATION

The PMU was a dual bottle system. Operation was normal with a gas consumption of 6.06 delta psi/min for 166.75 minutes of operate time. There was 2100 psi remaining at the end of the flight.

J. THERMAL ENVIRONMENT

Temperature data acquired by the [redacted] tracking station show that panoramic camera temperatures were within the specified envelope. A modified paint pattern and increased lens insulation were utilized on this mission. The resulting thermal environment was the best ever obtained. The forward looking instrument had an average instrument temperature of 63 plus or minus 3 degrees F throughout both missions. The thermal gradient on the lens cell was approximately 4 degrees F and transients were plus or minus 1 degree F. The aft looking instrument had an average instrument temperature of 64 plus or minus 5 degrees F throughout both missions. The thermal gradient on the lens cell was approximately 2 degrees F and transients were plus or minus one degree. Figures 3-8 and 3-9 show each instrument's rail temperature for rev 8 and rev 137. Figure 3-7 shows a graphical plot of the actual average camera temperatures versus the predicted temperature as a function of the beta angle in degrees.

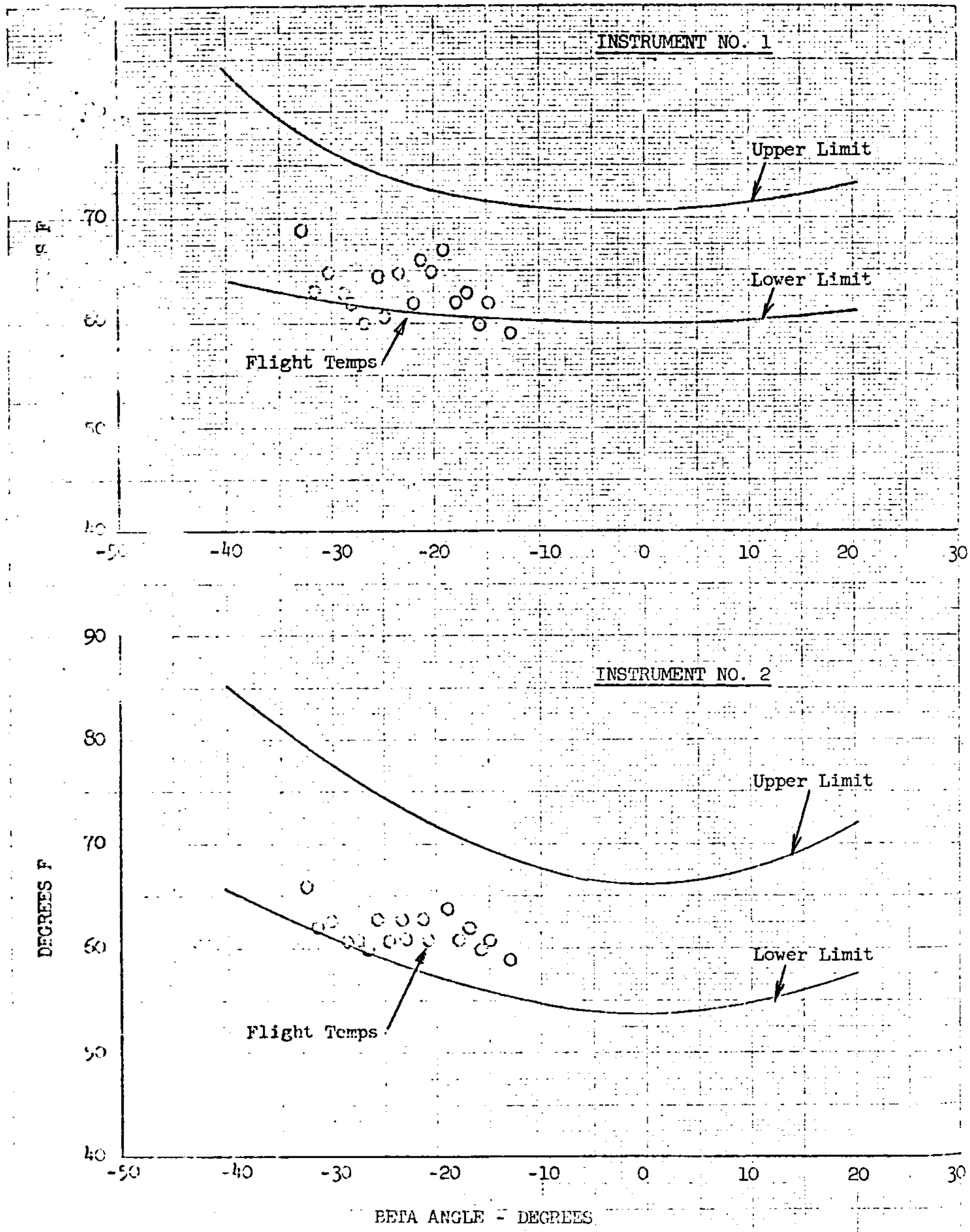
K. RECOVERY SYSTEM PERFORMANCE

12.1 <u>-1 Recovery System</u>

The -1 recovery capsule was successfully recovered by air catch on rev 66. All re-entry events and impact occurred within tolerance.

12.2 <u>-2 Recovery System</u>

The -2 recovery capsule was successfully recovered by air catch on rev 147. All re-entry events and impact occurred within tolerance.



AVERAGE INSTRUMENT TEMPERATURES VERSUS BETA ANGLE

FIGURE 3-7

RAIL TEMPERATURE DATA

MISSION 1106

FORWARD LOOKING INSTRUMENT

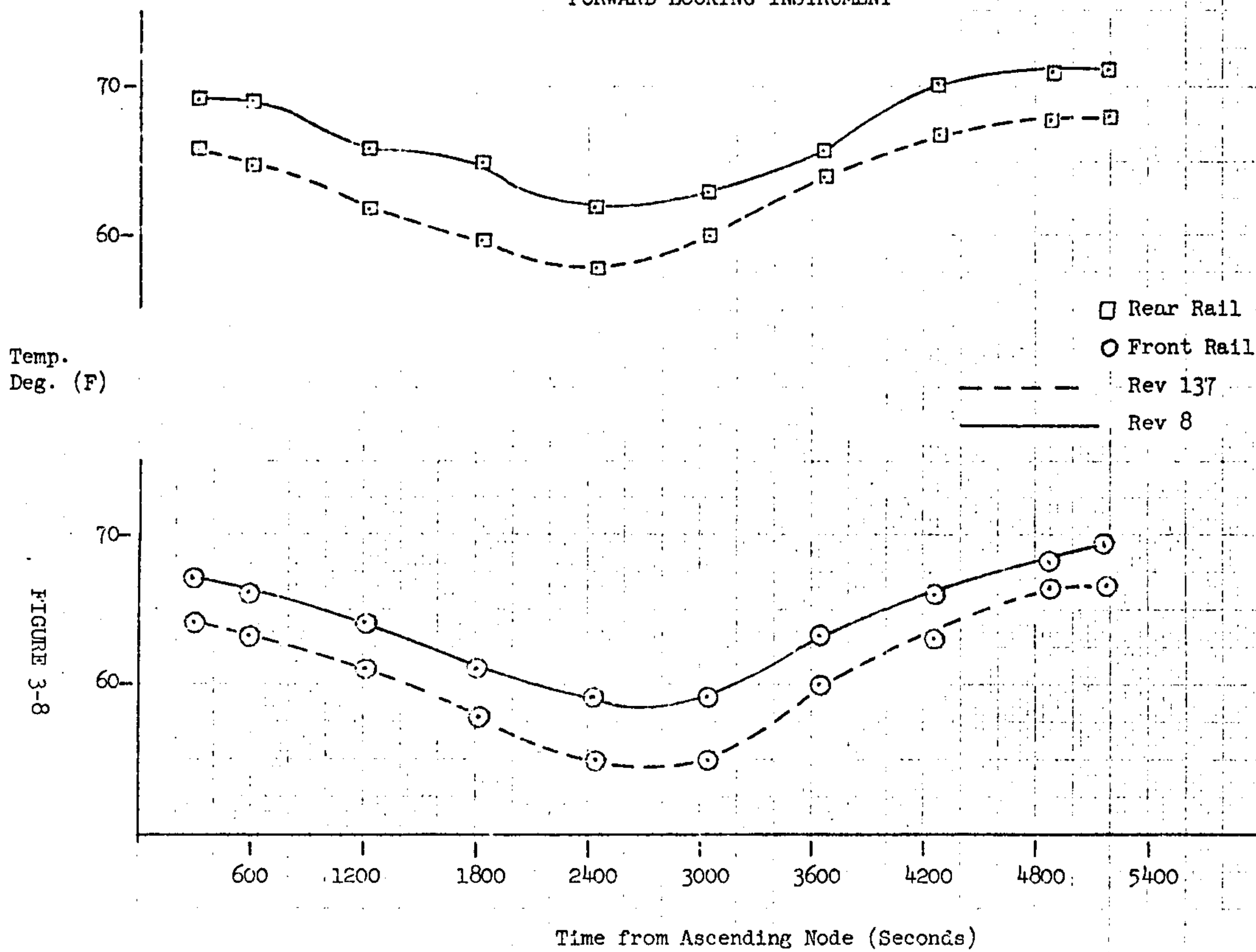


FIGURE 3-8

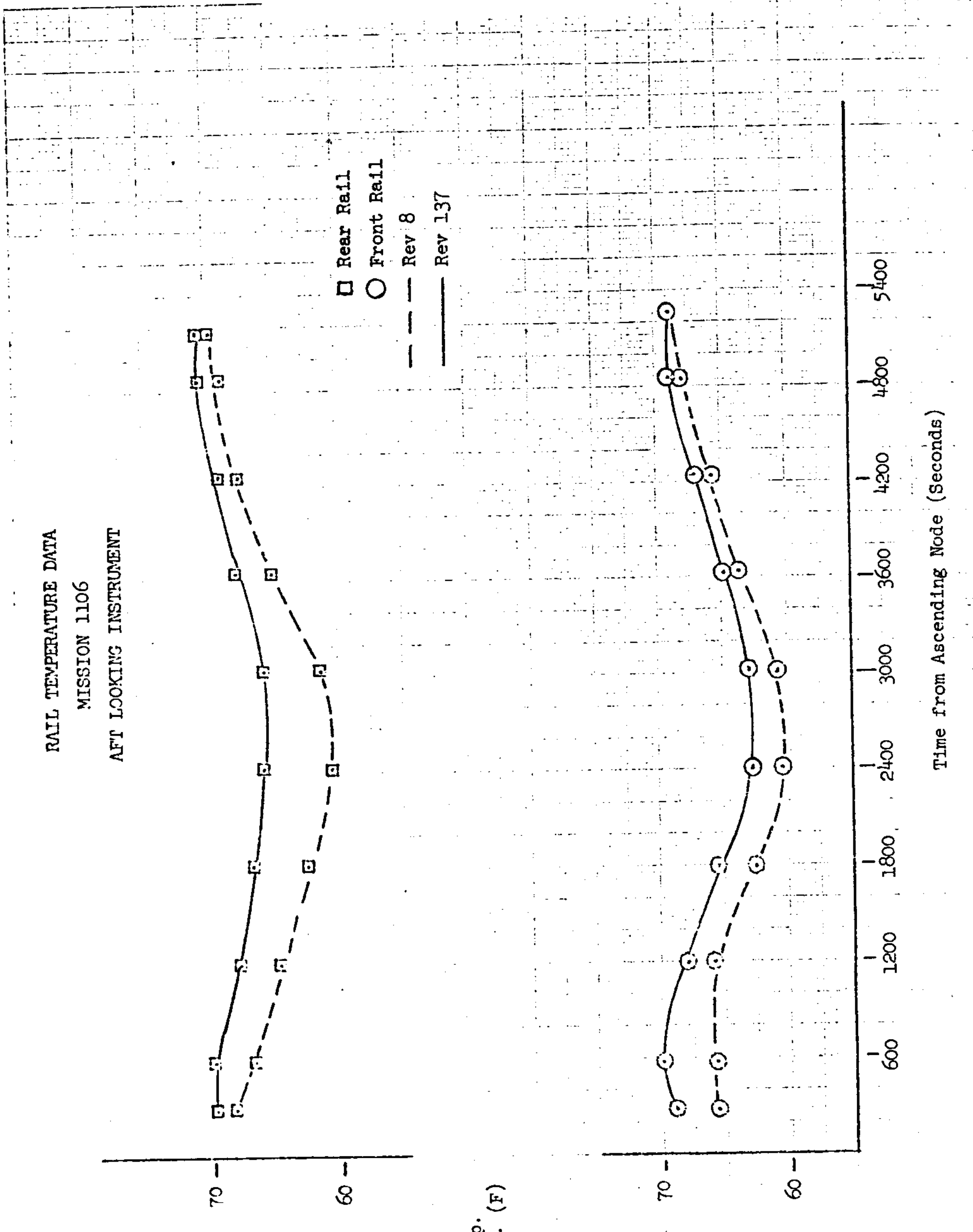

RAIL TEMPERATURE DATA
MISSION 1106
AFT LOOKING INSTRUMENT
Rear Rail
Front Rail
Rev 8
Rev 137
70
60
Temp.
Deg. (F)
600
1200
1800
2400
3000
3600
4200
4800
5400
Time from Ascending Node (Seconds)

FIGURE 3-9

L. SRV TAPE RECORDER SYSTEM

The tape recorder in the -1 recovery capsule performed normally and all data was recorded and retrieved. The tape recorder in the -2 recovery capsule failed to record during the flight after approximately six minutes. The tape recorder was stopped in track 1 and was inoperative after recovery. Analysis of the recorder indicated a transistor was burned open in the inverter module which powers one winding of the motor. The short circuit was apparently on the output lines or motor winding and could not be duplicated or found on disassembly.

M. POST EVENT 2 TESTING

Post event 2 testing included:

1. Slewing the orbital programmer to allow Brushes 14 and 27 to occur over a tracking station for analysis of the FMC programmer.
2. Operation of the instrument system in a stereo mode.
3. Loading and readout of the DSR manually and automatically both for DSR evaluation and tracking station experience in DSR procedures.

Post event 2 testing was successful with the Brush 14 and 27 checkout verifying the failure mode of the FMC programmer, the instrument operation verified camera failure, and experience was gained in DSR loading procedures and techniques by the tracking stations.

During post event 2 testing the DSR malfunctioned on revs 207, 234, 237, 224, and 255. In all cases the first DSR command was not shifted into the output register. These malfunctions are the same as occurred on revs 9 and 22, and are assumed to be due to tolerance buildup in the DSR logic components. With properly operating software this type of anomaly can be recognized and corrected, therefore they would not adversely affect an operational mission.

N. RADIATION DOSAGE

Each recovery system on Mission 1106 carried a sealed packet of types SO-102 and Royal-X Pan film to determine the total radiation received at the take-up cassette. Both film types had been irradiated by LMSC at various levels and the base plus fog densities plotted after controlled processing. Following recovery the film dosimeter packets were removed at A/P and processed with a pre-flight sample of the same film type and a sensitometric control film. The resulting base plus fog density measurement of the dosimeter strips was used to ascertain the total radiation level. The table below presents the base plus fog readings for the dosimeter strips and the radiation level equivalents.

	Mission 1106-1		Mission 1106-2	
Emulsion	B+F Density	Radiation	B+F Density	Radiation
SO-102	0.10	0.1R	0.14	0.4R
Royal Xpan	0.22	0.36R	0.27	0.52R

These levels are far below those which will degrade the photography.

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

Pan camera 313 was operational throughout the mission. The film supply was exhausted on frame 81 of pass D135. Pan camera 312 was operational through pass D105 at which time an anomaly described in the previous section under Flight Operations occurred.

Portions of the photographic imagery obtained during Missions 1106-1 and 1106-2 are considered to approximate the best obtained from the Corona series to date. However, the quality of the total mission records does vary from good to fair and the prime cause of this variation has been attributed to changing atmospheric conditions. Although the quality of the photography from the forward looking camera is rated somewhat better than from the aft looking camera, an MIP of 105 was assigned to both mission segments. A high percentage (80%) of cloud free photography is reported for this flight.

The DISIC terrain, starboard and stellar cameras were operational throughout both mission segments.

The DISIC terrain image quality is good and compares favorably with the image quality obtained from Missions 1103 and 1104. The Stellar photography recorded a full field of stars on both port and starboard cameras.

B. PANORAMIC INSTRUMENTS

The forward looking camera produced 2950 frames (7778 feet) of photography during Mission 1106-1, and 3046 frames (8027 feet) during Mission 1106-2. The aft looking camera produced 2952 frames (7842 feet) during Mission 1106-1 and

2182 frames (5765 feet) of 3404 material plus 347 frames (911 feet) of SO-121 color material on Mission 1106-2. The forward looking camera, utilizing a third generation lens, produced slightly better image quality by virtue of its superior resolution than the aft looking camera.

The MIP of 105 on the -1 mission was selected on pass 32 over Indian Springs, Nevada. The MIP of 105 on the -2 mission was selected on pass 113 over Palo Alto, California.

The imagery on the first five (5) passes on Mission 1106-1 was severely smeared on both pan cameras due to a V/H mismatch previously discussed in the flight operations section 3. Some instances of smear (discussed in Section 6) are present in other portions of the records but much less severe.

A malfunction of the starboard horizon camera shutter on the aft looking instrument caused it to remain open during the film metering cycle four times on the 1106-1 mission and once on the 1106-2 mission. The result was heavy fogging in two frames for each occurrence of the anomaly. This is the normal failure mode for this device, i.e., to fail open for one horizon camera shutter cycle (equal to two main instrument cycles) and to close on the next H.O. shutter command. Consequently the probability of a long term "open" failure is contrary to the failure mode.

Minus density spots were present in localized areas of a small number of frames from the records of both cameras on revs 1 and 2. The spots vary from pin point size to approx. 1/16 inch diameter and are repetitive on a three and one-eighth inch pattern. This indicates that it is caused by transfer from a one inch roller of a substance affecting film sensitivity or developability. Although the anomaly affects only a small area of the records, the same anomaly occurred on Mission 1104 and an investigation of the source and substance of the contaminating material will be made.

Plus density pressure marks of a minor nature are present on the Horizon imagery. This is caused by a design change in CR-6 and up which required that the platens be notched to provide clearance for the new format end rollers. Consequently this provides several points of contact with the payload. It will be characteristic of future systems for the H.O. records to exhibit several plus density pressure marks instead of the single mark seen on previous systems.

The binary data recording was imaged properly and operational throughout the mission on both pan cameras. Some plus density bleeding between bits occurred on all data blocks of the forward records but no problems were experienced with the automatic data reader because of it.

Frequency markers, scan lines and rail holes were present and satisfactory throughout both missions.

C. SO-121 COLOR RECORD

This was the first Corona system employing color material to satisfy a specific intelligence requirement. Due to the film separation at frame 129 of pass D105 this requirement was not fulfilled. The 911 feet of SO-121 recovered was exposed on revs D103, D104 and D105. The overall image quality is better than was obtained from 1105 color records although Mission 1105 had some areas of better quality. The ground resolution was estimated to be 20 to 25 feet. Color balance and exposure are good except over snow covered terrain at higher solar elevations where the photography was considered to be overexposed. There were minor corona and dendritic static markings on the imagery.

The data from in-flight T/M indicated that on pass D105, frame 137, pan #1 supply spool was free running in a direction opposite to normal rotation which indicates a separation of the film while because of the close proximity of the film separation and the splice, the possibility of the mylar splice contributing to this anomaly cannot be overlooked. The in-flight T/M film depletion signature produced on Instrument No. 2 is identical to the signature produced by the end of the color material on Instrument No. 1. This indicates that the last few feet of material on both instruments remained in orbit.

Experience has shown that mylar splices exhibit adhesive bleeding, causing successive film wraps to stick together, resulting in shock loading and tension transients in the system. CR-6 underwent a similar experience in Hivos testing. As noted earlier, a similar splice tore the material severely on a preceding wrap and lifted the emulsion from the succeeding wrap. To eliminate the sticky splice problem, all single emulsion type flight loads are spliced with permacel instead of mylar. Since, however, the present CR system splice detector will not operate properly with permacel splices it is necessary to use mylar splices on all mixed emulsion flight loads. Investigation of improved splices including permacel and ultrasonic types is in process.

D. DISIC CAMERA

The DISIC record from 1106-1 consisted of 606 feet of stellar photography (2146 port frames and 2146 starboard frames), and 1019 feet (2146 frames) of index material. The 1106-2 mission produced 658 feet of stellar record (2499 port frames and 2500 starboard frames) and 993 feet (2262 frames) of index record.

Both the stellar and index cameras functioned properly throughout both missions. Several normal and characteristic markings are present on the records but they are minor anomalies contributing little or nothing that significantly degrades the usefulness of the photography. The typical fog pattern, in many instances more dense than normal, is present along both edges of the entire stellar record outside the format area with occasional spurs projecting towards the center of the film near the time word. Approximately 75 port and 15 starboard point-type stellar images can be detected throughout the missions.

The index record contains very minor edge static intermittently throughout both missions and there is evidence of some corona static present on the record from the -2 mission. Some slight minus density spots which appear to be caused by dirt or film emulsion particles on the reseau plate were present on the record and imply continued attention must be given to cleanliness procedures prior to flight. Particles carried by film cannot be completely eliminated.

E. CORN OPERATIONS

Controlled Range Network (CORN) operations were conducted over three of the six scheduled mobile and one of the five instrumented fixed corn targets on Mission 1106. Three targets were not photographed because of inclement weather and four targets were not photographed because the camera system was not activated over the display areas. The resultant ground resolution values obtained from the Military Standard 3-Bar and 51/51 "T" Bar Targets by subjective analysis are tabulated below:

Location/Coverage	Line-of-Flight Orientation	Target	Bar Target Resolution Range	Average
Indian Springs, Nevada	Across	C	6.0'	6.0'
Pass D32, Frame 003 (Forward)	With	C	6.8'	6.8'
Pass D32, Frame 009	Across	C	6.0' - 6.8'	6.5'
(Aft)	With	C	7.6' - 8.6'	8.3'
Las Vegas, Nevada				
Pass D32, Frame 008	Across	51/51	8.0'	8.0'
(Forward)	With	51/51	7.1'	7.1'

Location/Coverage	Line-of-Flight Orientation	Target	Bar Target Resolution Range	Average
Pass D32, Frame 014	Across	51/51	8.0'	8.0'
(Aft)	With	51/51	8.0'	8.0'
Mesa, Arizona				
Pass D48, Frame 007	Across	51/51	12.0'	12.0'
(Forward)	With	51/51	6.4'	6.4'
Pass D48, Frame 013	Across	51/51	16.0'	16.0'
(Aft)	With	51/51	12.0'	12.0'
Palo Alto, California				
Pass D113, Frame 005	Across	51/51	12.0'	12.0'
(Forward)	With	51/51	5.7'	5.7'

SECTION 5

PANORAMIC EXPOSURE ANALYSIS

The primary variables on the panoramic camera exposure are scan rate, slit width and filter attenuation. Since scan rate is adjusted to fit the required forward motion compensation employed at the vehicle altitude, only the slit width and filter remain to be selected for setting the nominal exposure.

Since it was desired to maintain good photographic coverage as far north as 60° latitude, the settings and filter selections were chosen using a computer analysis of the nominal orbit parameters and illumination characteristics. The forward-looking camera contained a Wratten 23A primary filter and a Wratten 25 secondary. The aft-looking camera contained a Wratten 21 primary filter and a special purpose (W 2E + 2C + 0.5 N.D.) filter for the secondary position to accommodate the required exposure for the SO-121 color film on the tail end of the type 3404. The slits selected are as follows:

	Fwd Looking	Aft Looking
S4	0.311"	0.234"
S3	0.249"	0.187"
S2	0.197"	0.154"
S1	0.173"	0.144"
F.S.	0.252"	0.197"

The nominal exposure times of the panoramic cameras are shown as a function of latitude for passes D23, D67 and D113 in Figures 5-1 to 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 plot. The automatic exposure control sequence programmer failed on rev 21 and the slit for rev 23 was in the failsafe position. Thereafter the programmer was commanded during acquisition by Real Time Command. The exposures achieved as shown by analysis of AFSPPF macrodensity data are comparable to exposures achieved on other missions. The criterion used to determine proper exposure is that minimum scene density should range between 0.4 and 0.9. The measurements are tabulated below:

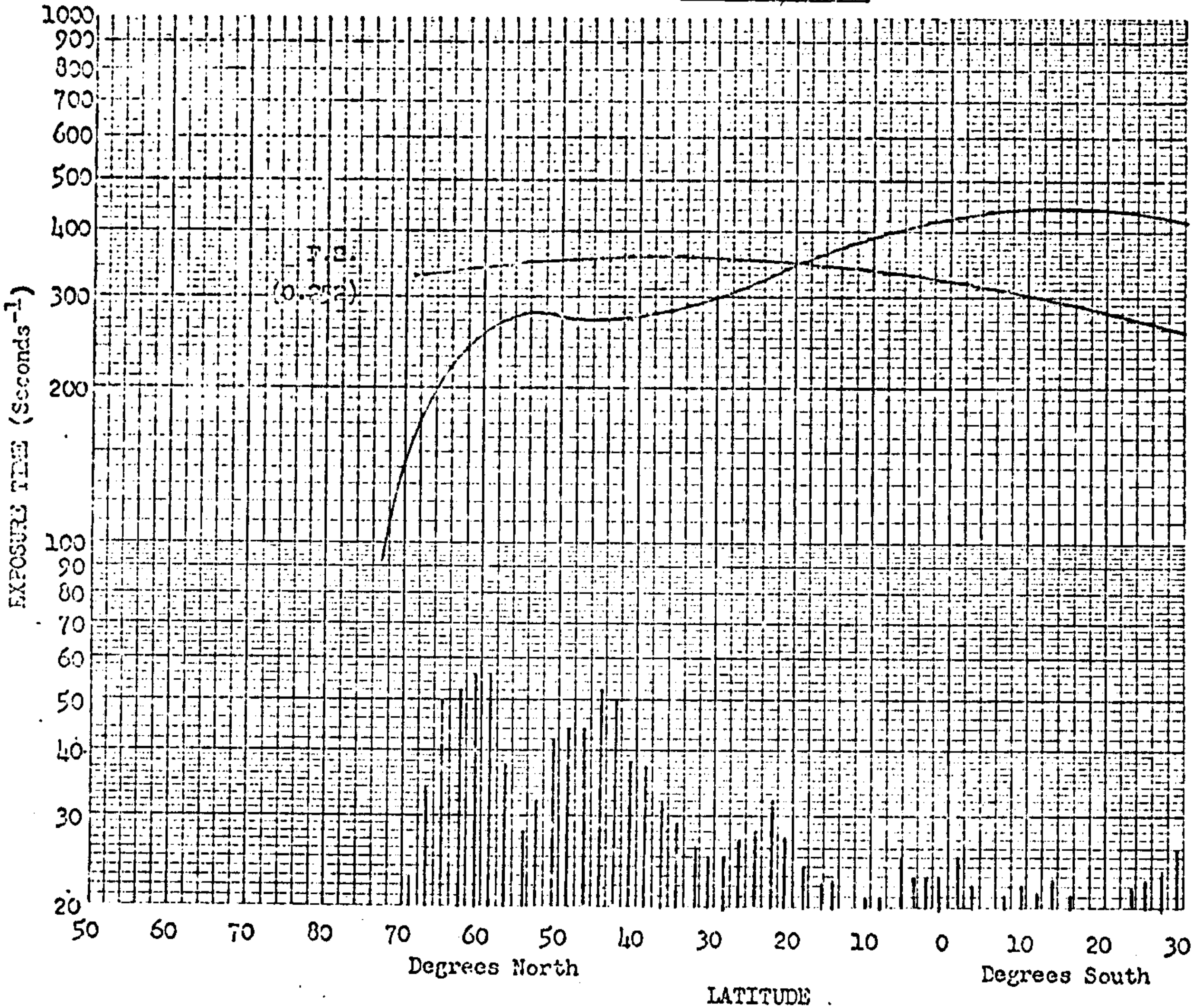
Terrain Density Analysis of Exposure

	1106-1		1106-2	
	Fwd	Aft	Fwd	Aft
Correct Exposure (0.4 to 0.9 D min)	71.17%	77.10%	65.87%	68.97%
Overexposed (> 0.9 D min)	13.52%	9.09%	18.43%	17.73%
Underexposed (< 0.4 D min)	15.31%	13.81%	16.70%	13.30%

The percentages of correct exposures is somewhat less than normal which is indicative of the failed slit programmer problem. Nominal correct exposures for other CR systems have ranged from 70 percent to 85 percent of the total samples.

Macrodensity measurements supplied by AFSPPF are processed by computer at A/P 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.

EXPOSURE POINTS



Mission No: 1106

Payload No: CR-6

Camera No: 313

Pass No: D-23

Launch Date: 2-5-69

Launch Time: 2159 GMT

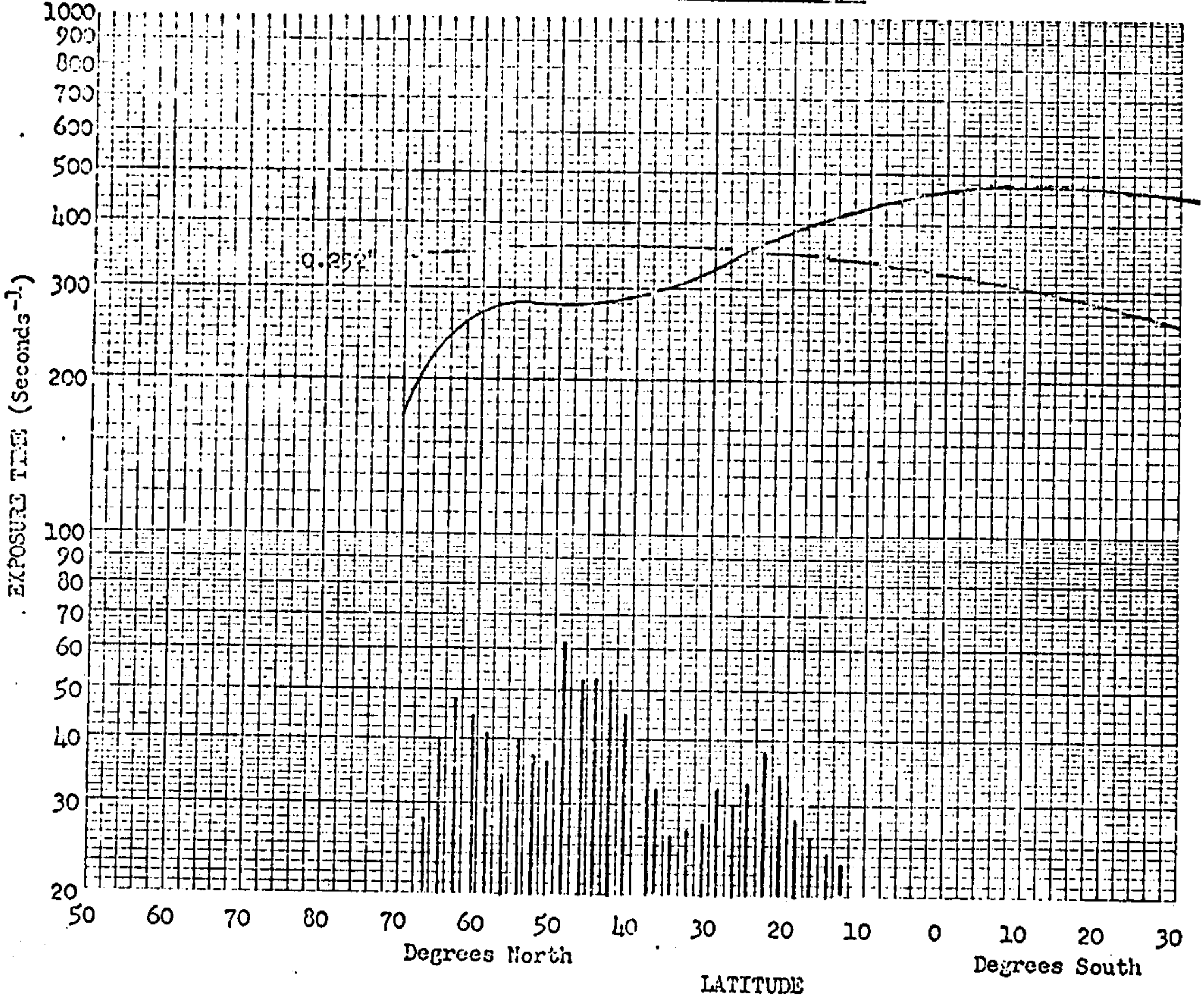
Slit Width: 0.252

Filter Type: W-23A

Film Type: 3404

FIGURE 5-1

EXPOSURE POINTS



Mission No: 1106

Payload No: CR-6

Camera No: 313

Pass No: D-66

Launch Date: 2-5-69

Launch Time: 2159 GMT

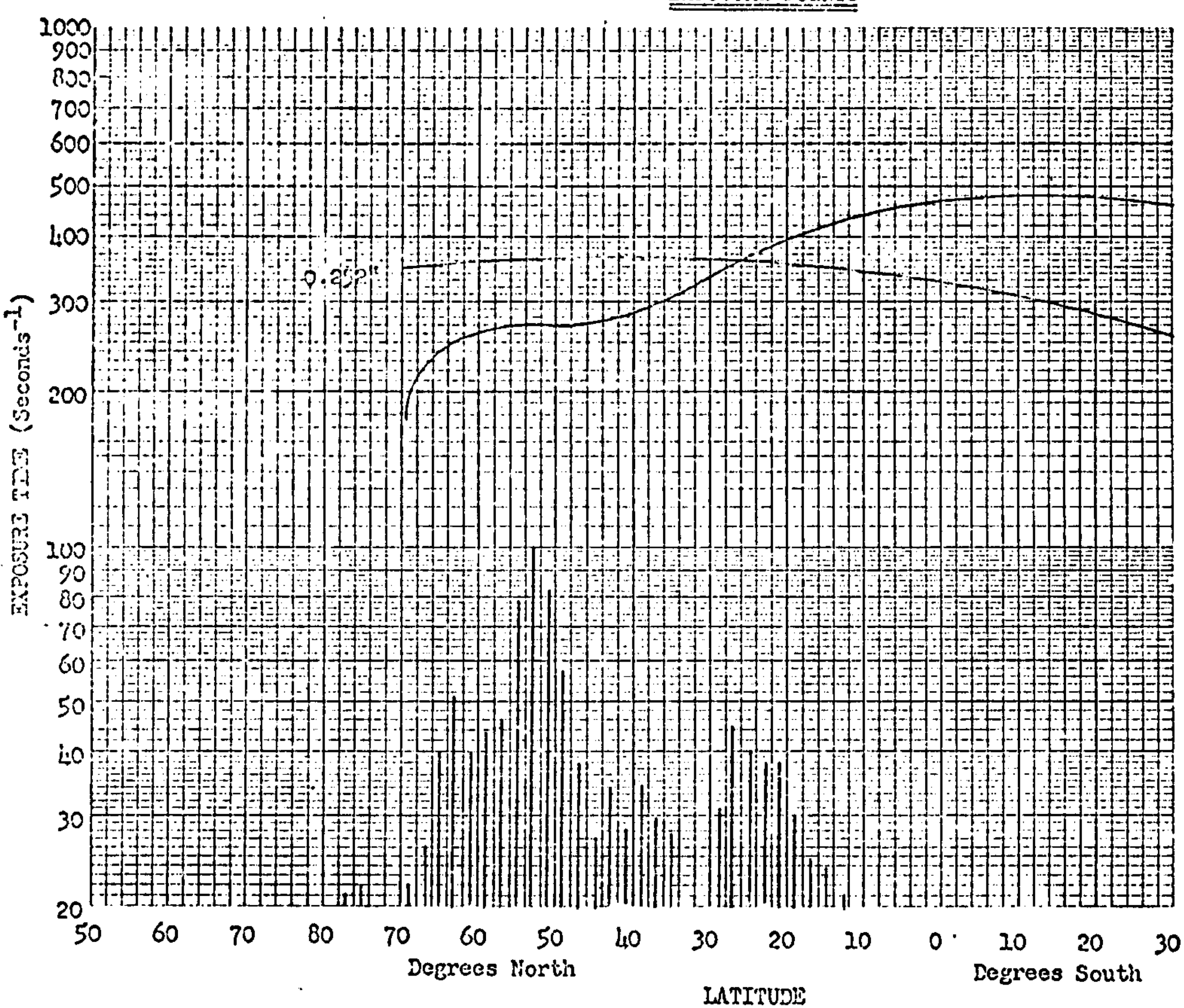
Slit Width: 0.252

Filter Type: W-23A

Film Type: 3404

FIGURE 5-2

EXPOSURE POINTS



Mission No: 1106

Payload No: CR-6

Camera No: 313

Pass No: D-113

Launch Date: 2-5-69

Launch Time: 2159 GMT

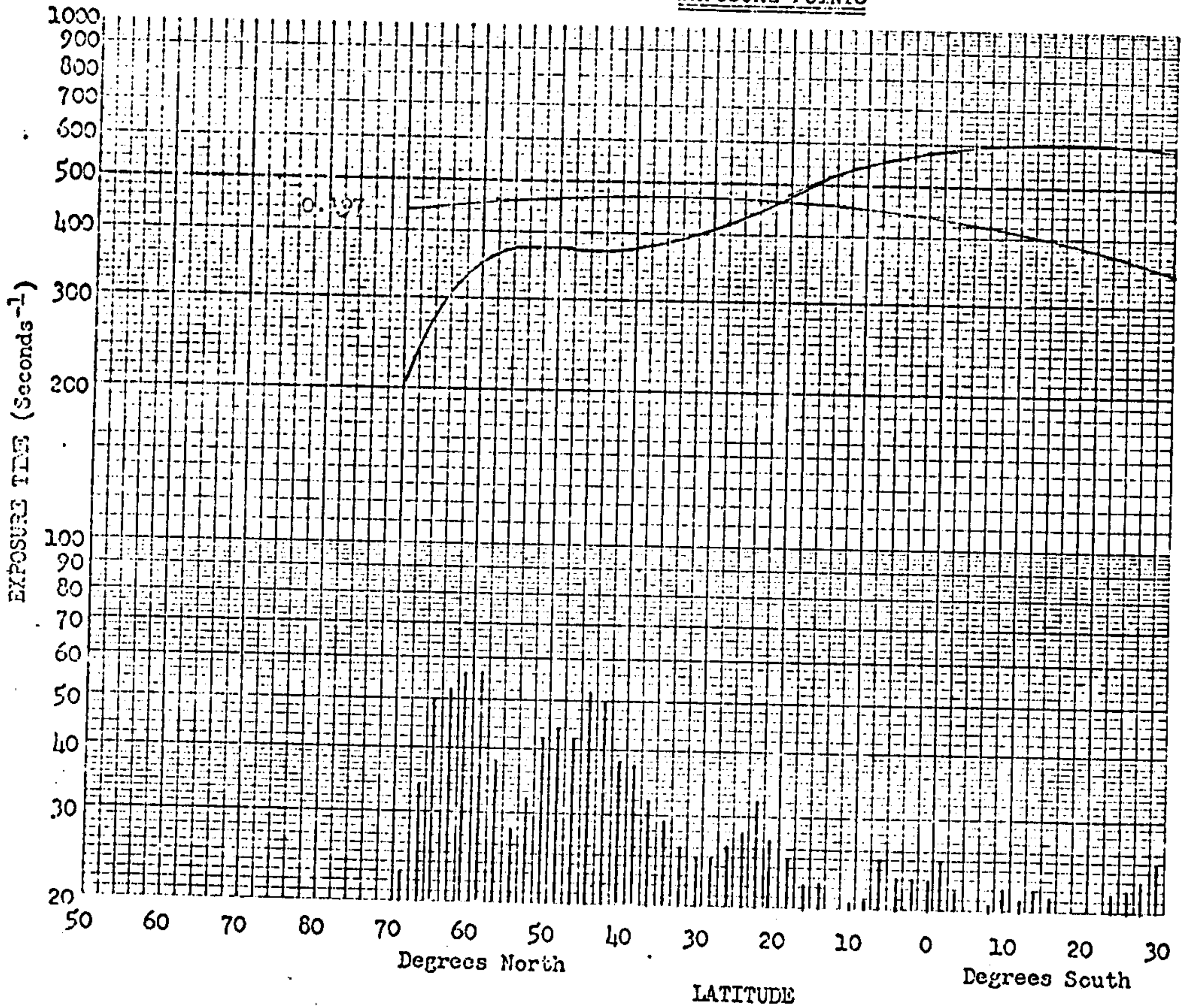
Slit Width: 0.252

Filter Type: W-23A

Film Type: 3404

FIGURE 5-3

EXPOSURE POINTS



Mission No: 1106

Payload No: CR-6

Camera No: 312

Pass No: D-23

Launch Date: 2-5-69

Launch Time: 2159 GMT

Slit Width: 0.197

Filter Type: W-21

Film Type: 3404

FIGURE 5-4

EXPOSURE POINTS

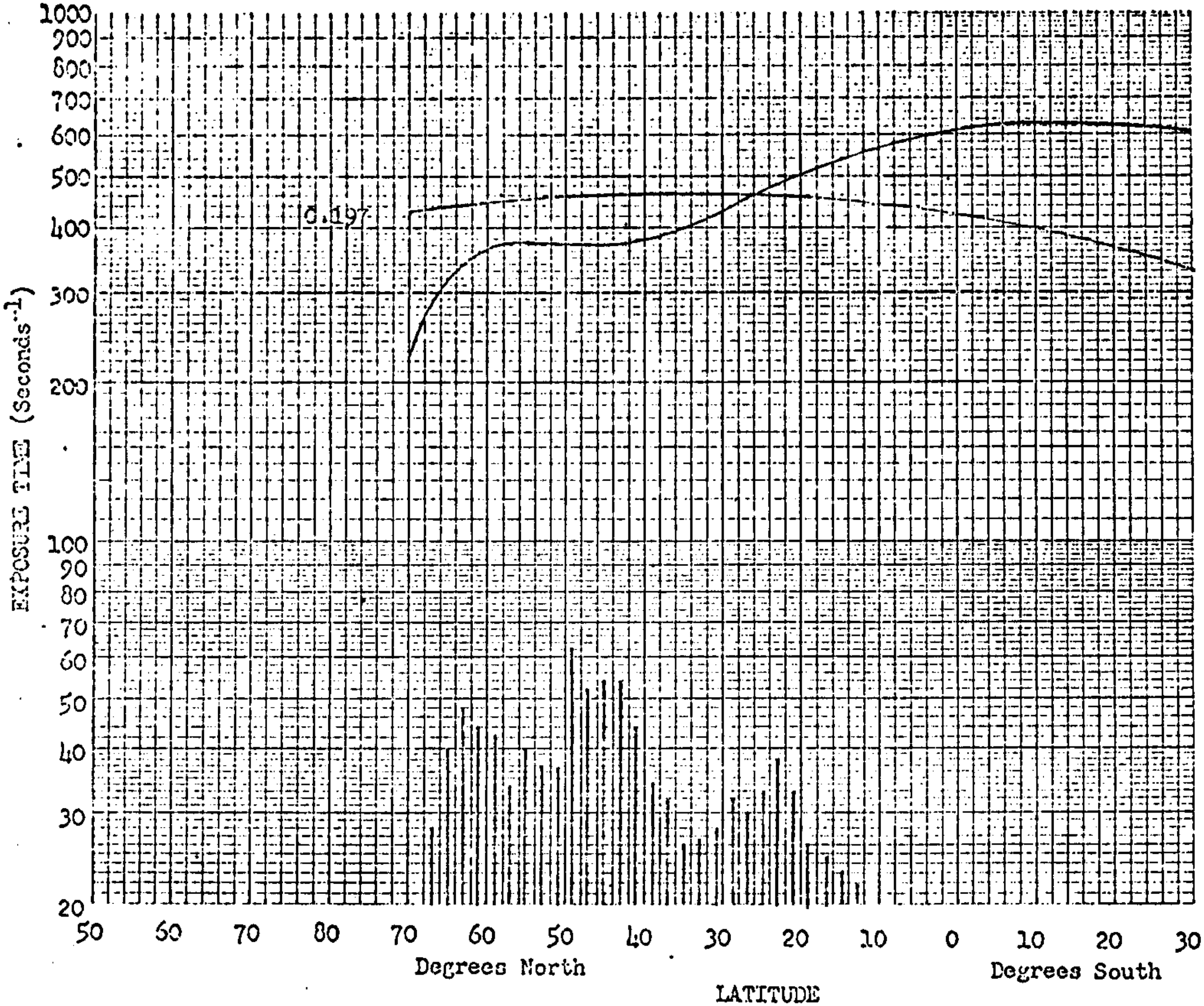


FIGURE 5-5

Mission No: 1106

Payload No: CR-6

Camera No: 312

Pass No: D-66

Launch Date: 2-5-69

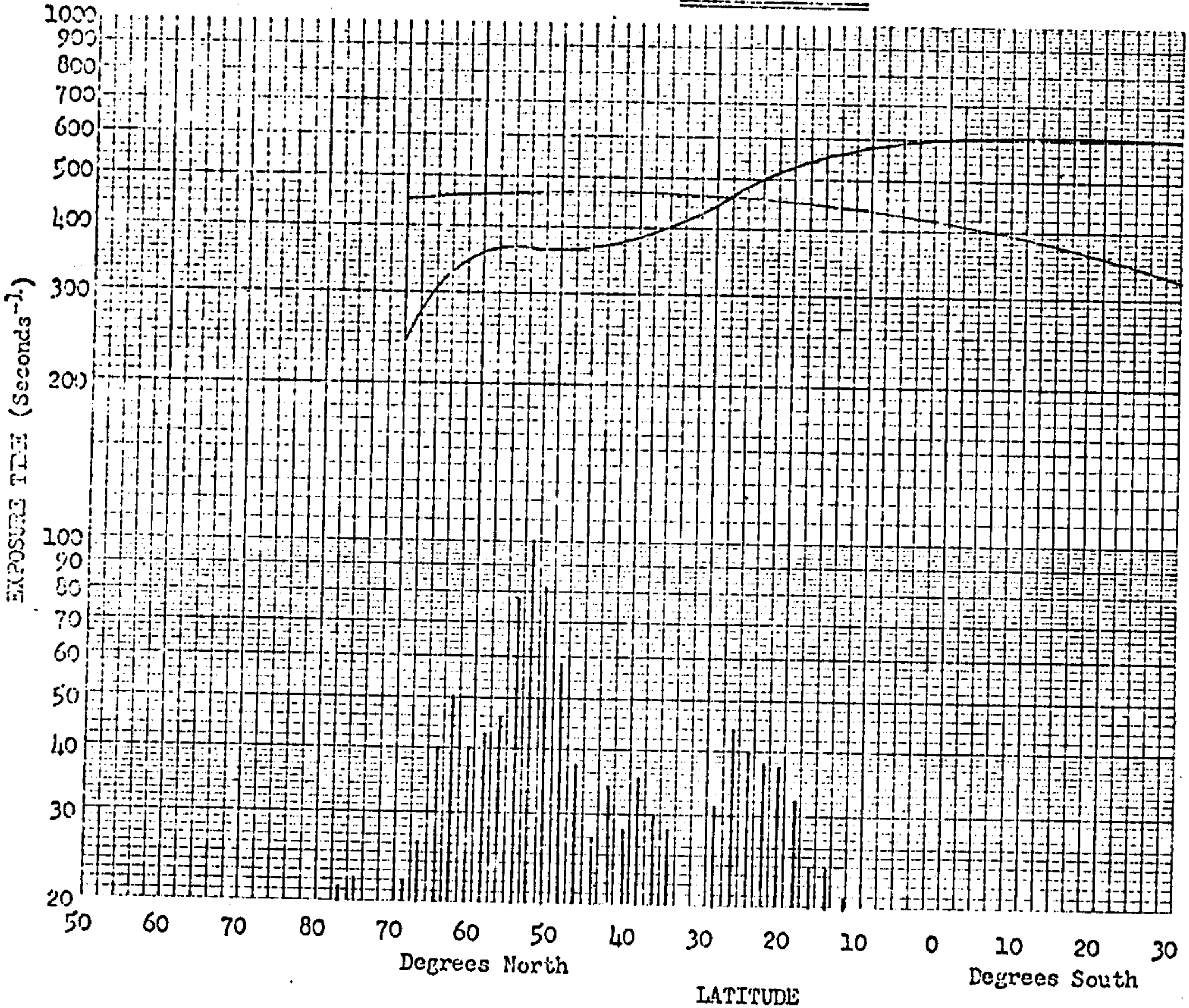
Launch Time: 2159 GMT

Slit Width: 0.197

Filter Type: W-21

Film Type: 3404

EXPOSURE POINTS



Mission No: 1106

Payload No: CR-6

Camera No: 312

Pass No: D-109

Launch Date: 2-5-69

Launch Time: 2159 GMT

Slit Width: 0.197

Filter Type: W-21

Film Type: SO-121

FIGURE 5-6

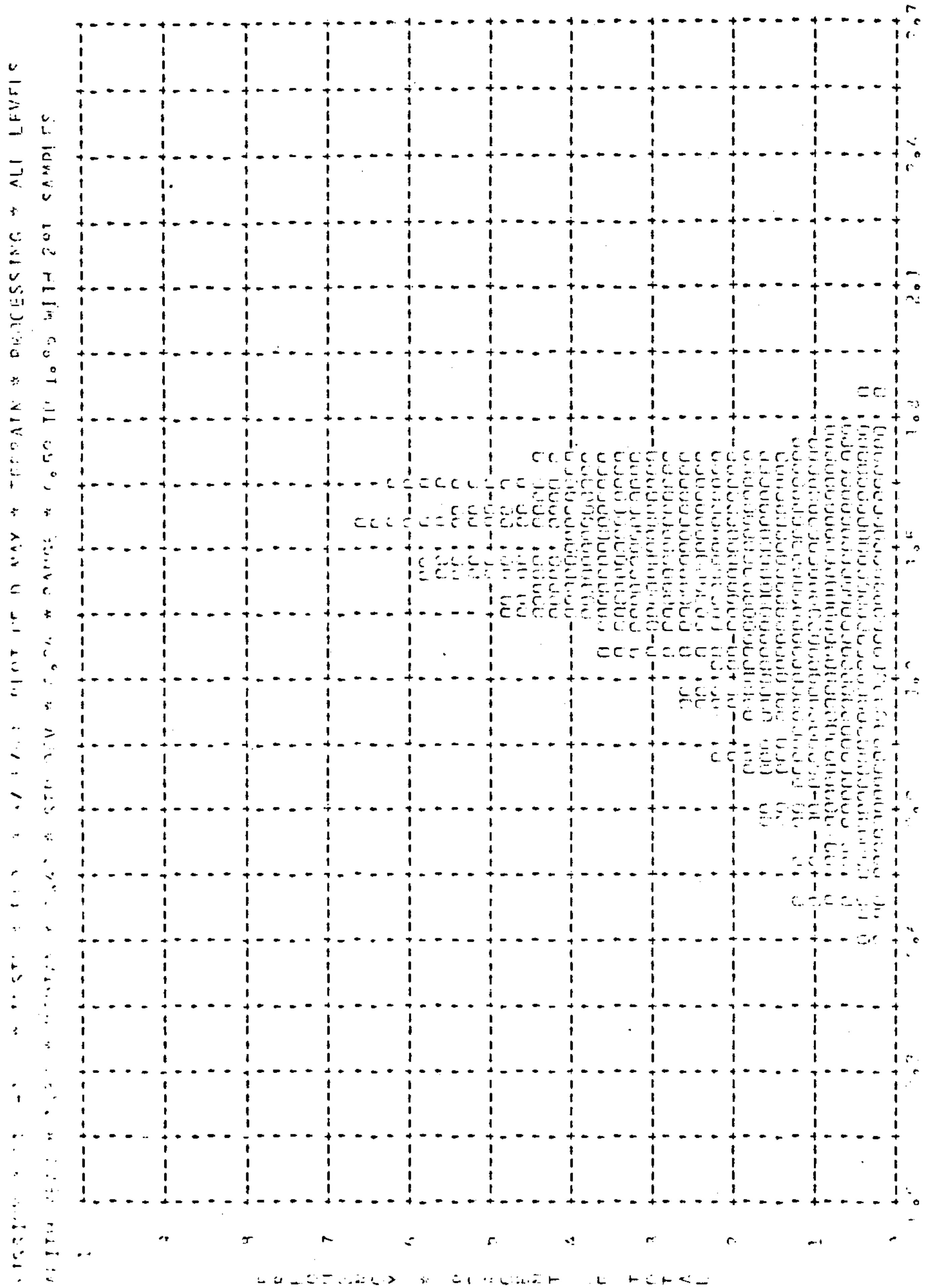

PLOT OF D MAX * TERRAIN * PROCESSING * ALL LEVELS
WITH 291 SAMPLES
* DENSITY *
1.8
2.1
2.4
2.7

FIGURE 5-7

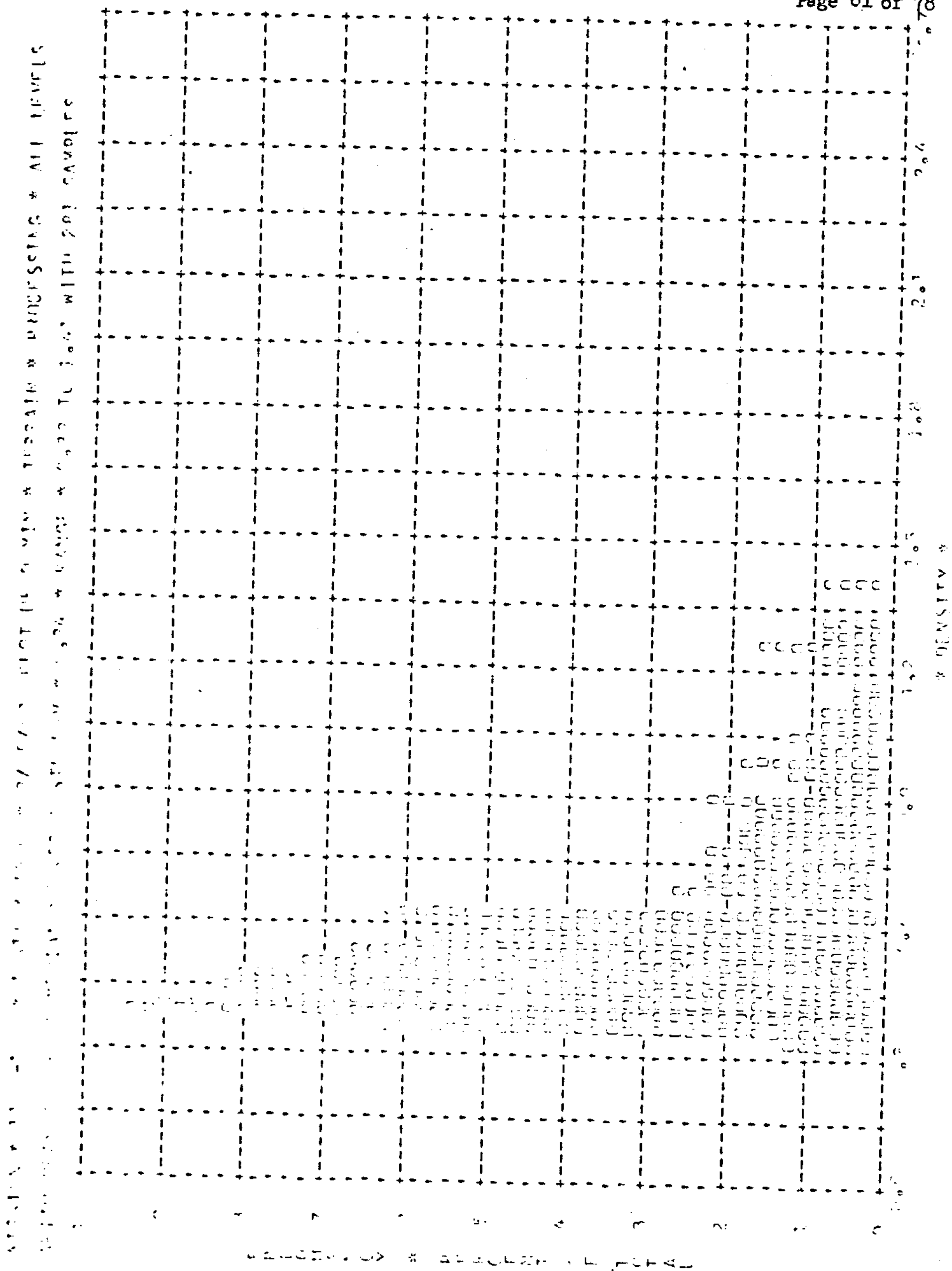


FIGURE 5-8

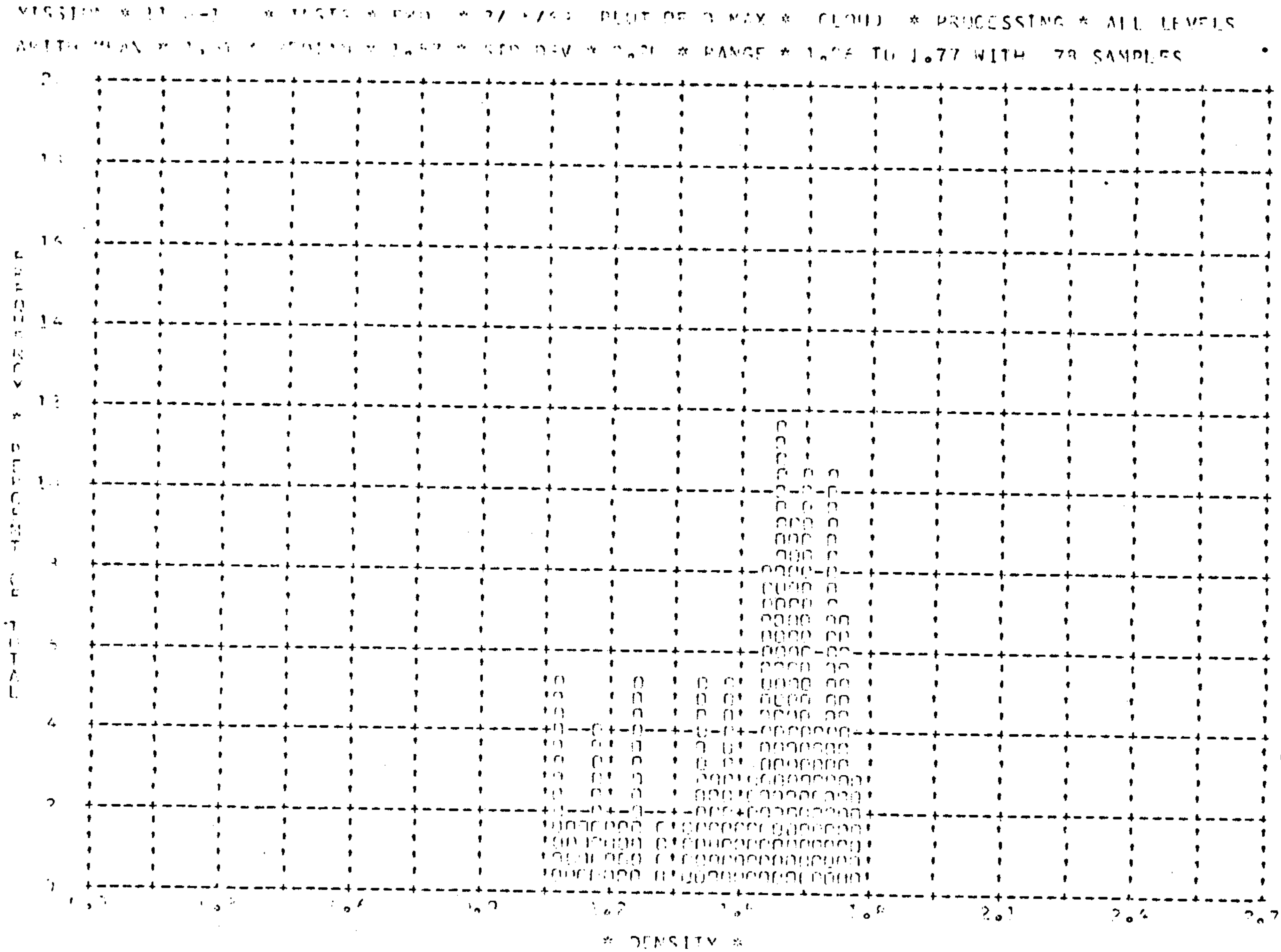

PLOT OF D MAX * CLOUD * PROCESSING * ALL LEVELS
TO 1.77 WITH 78 SAMPLES
* DENSITY *
1.8
2.1
2.4
2.7

FIGURE 5-9

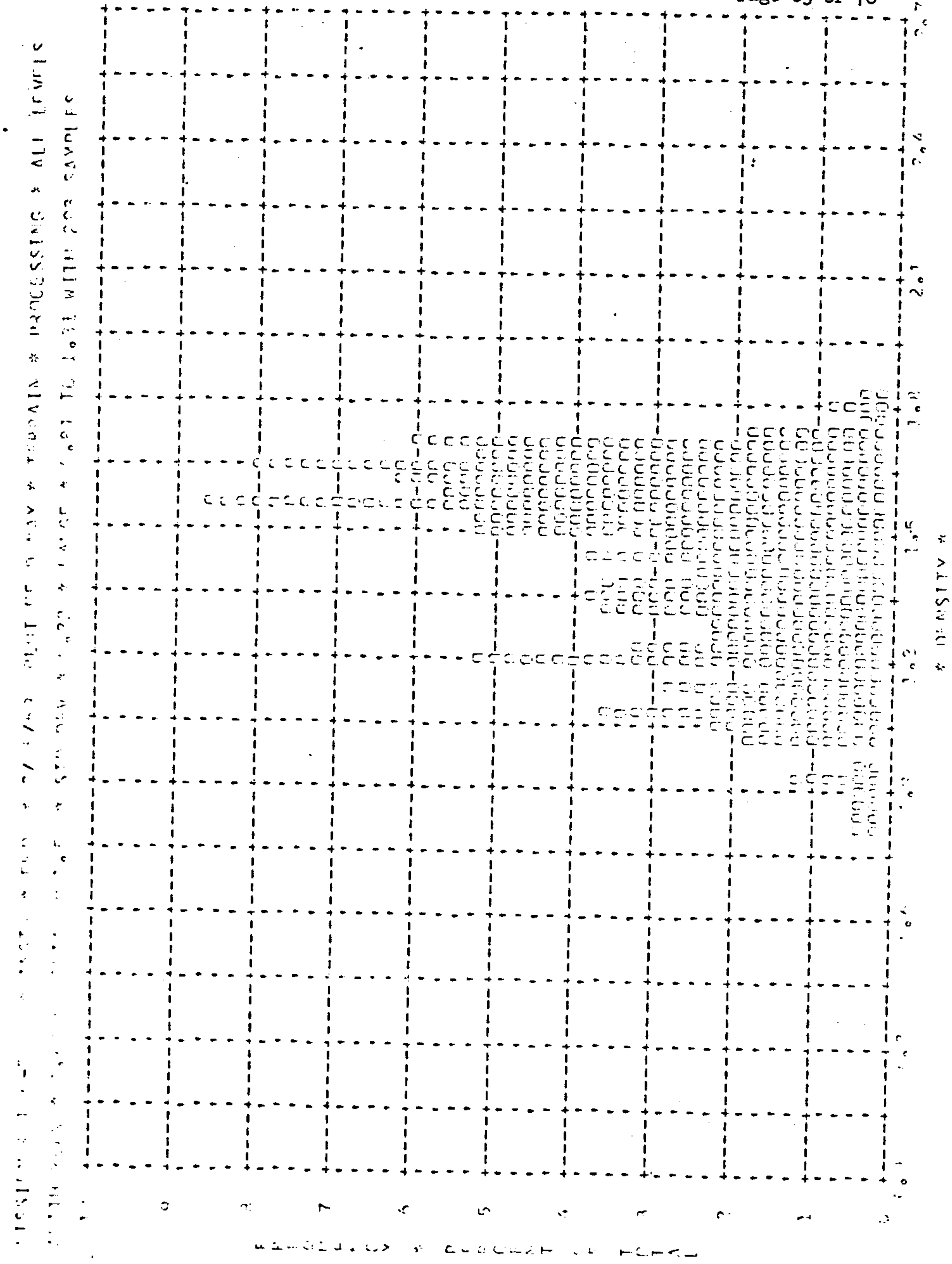


FIGURE 5-10

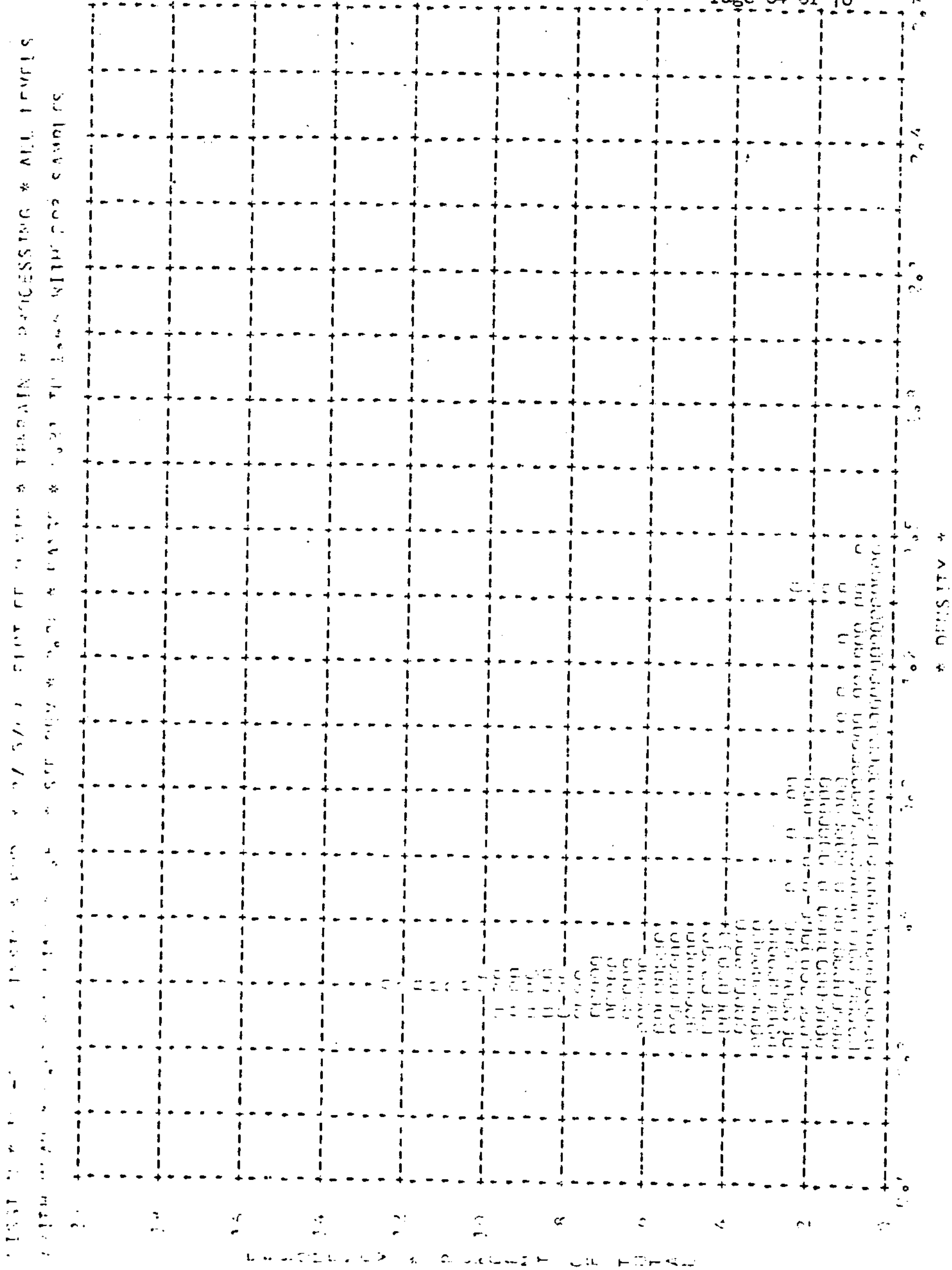


FIGURE 5-11

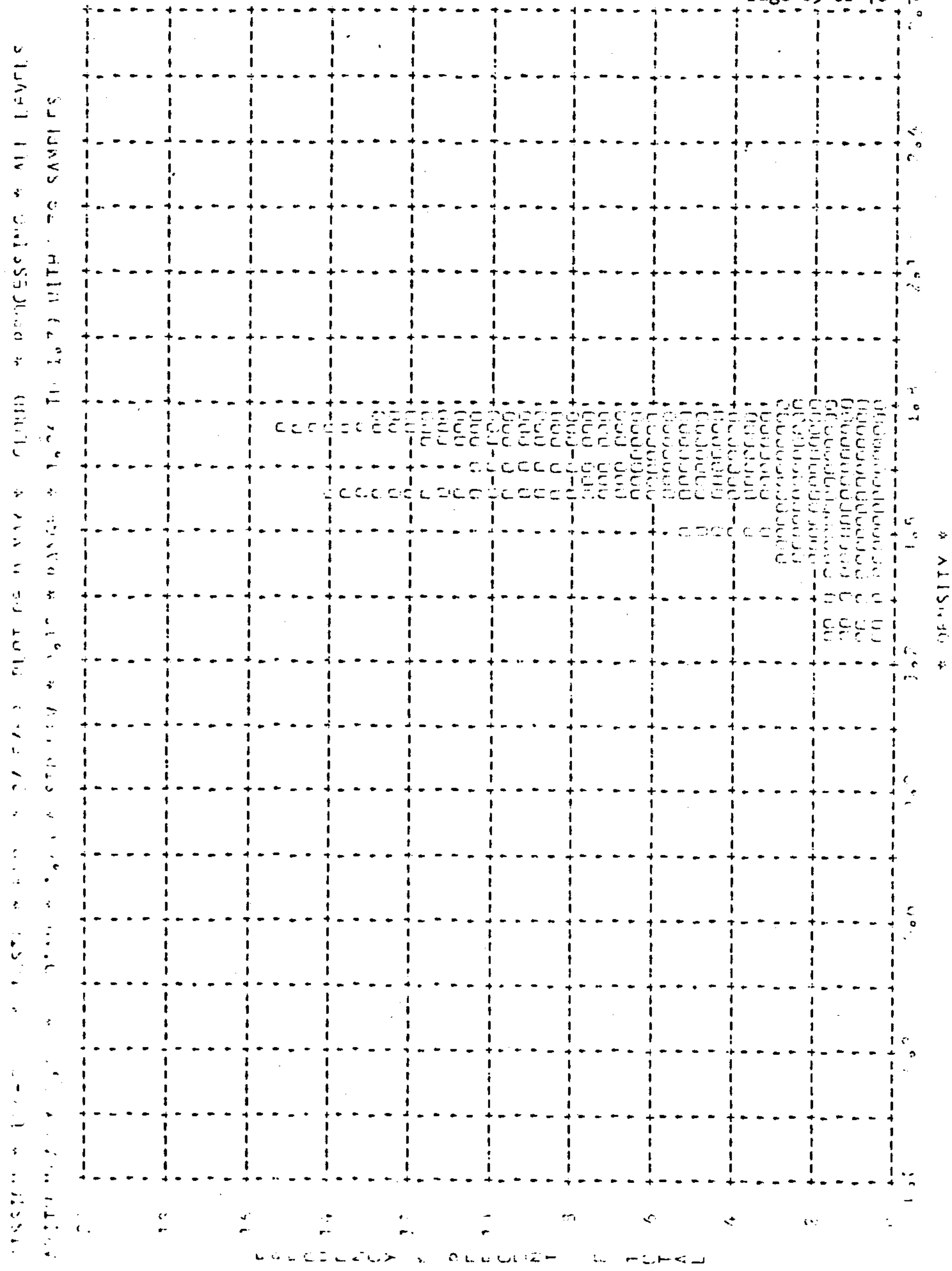


FIGURE 5-12

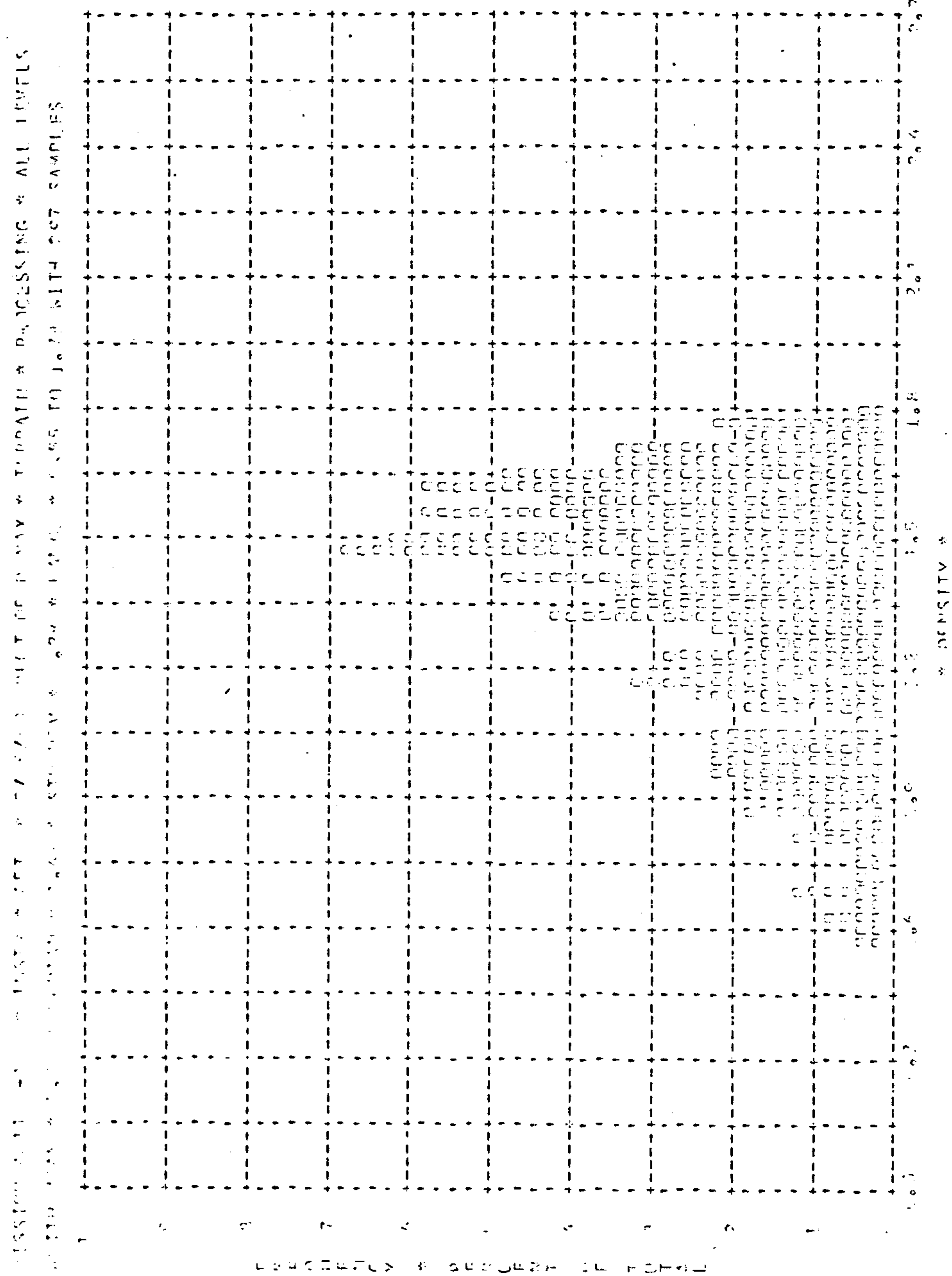


FIGURE 5-13

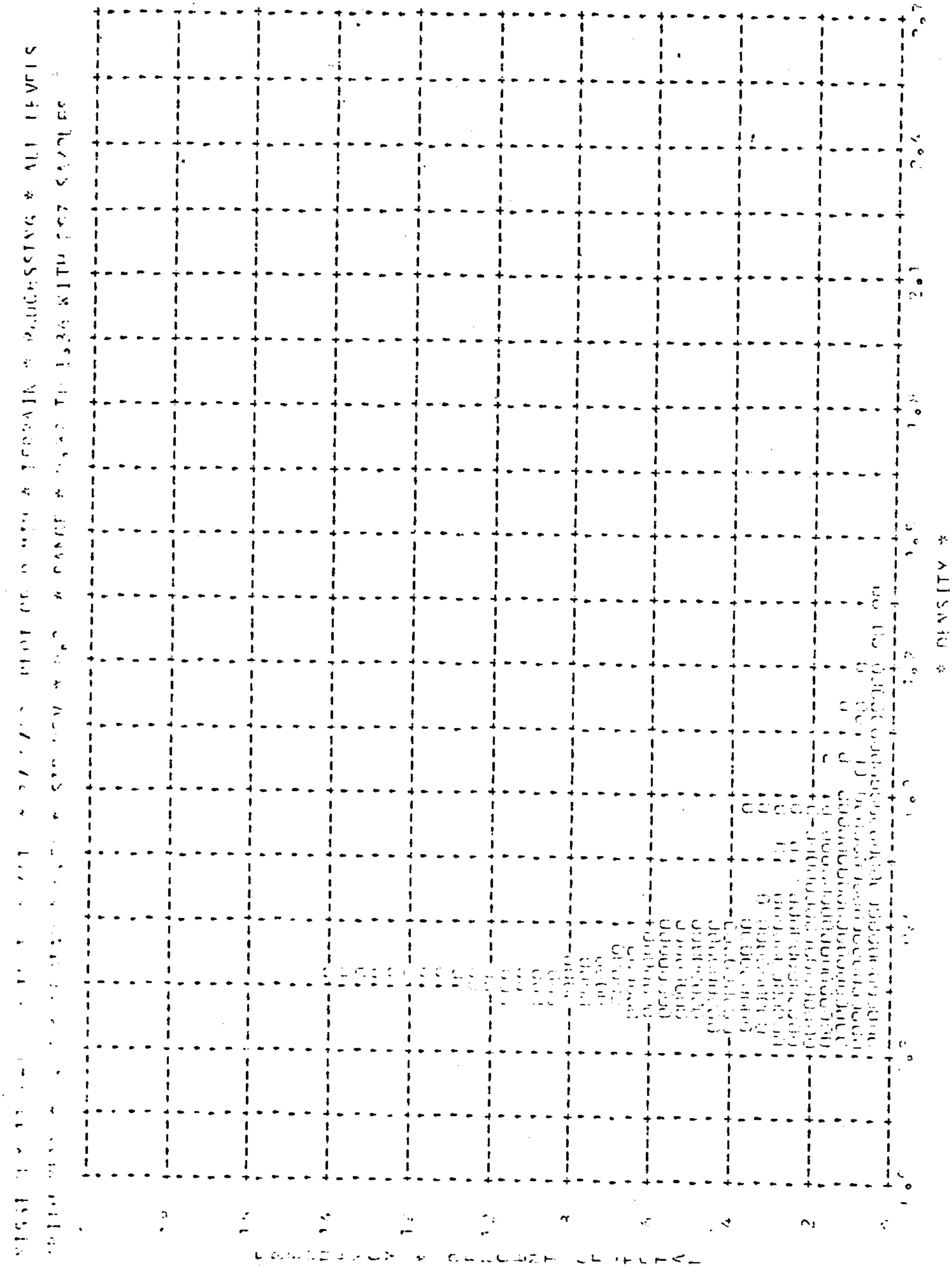


FIGURE 5-14

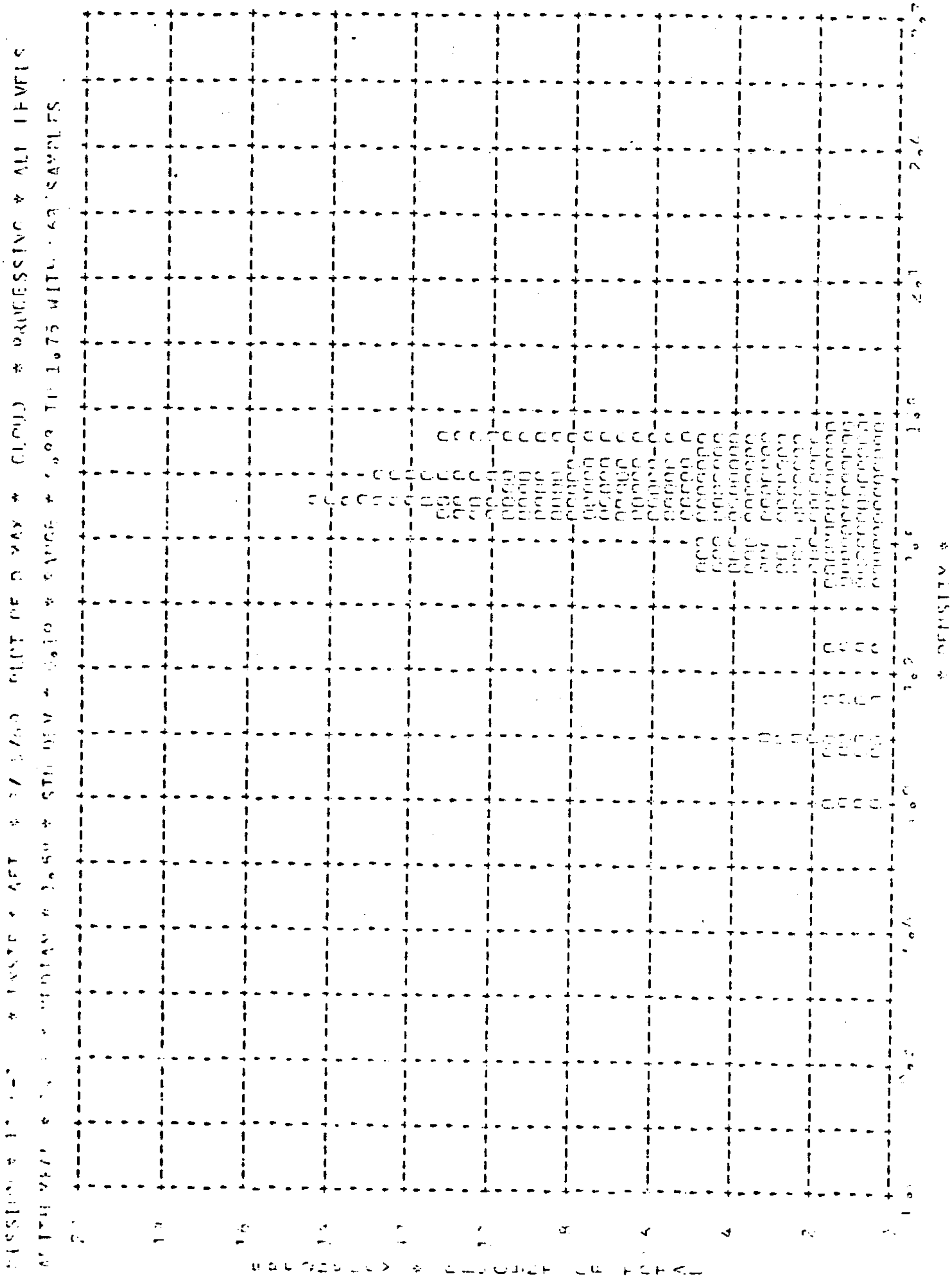


FIGURE 5-15

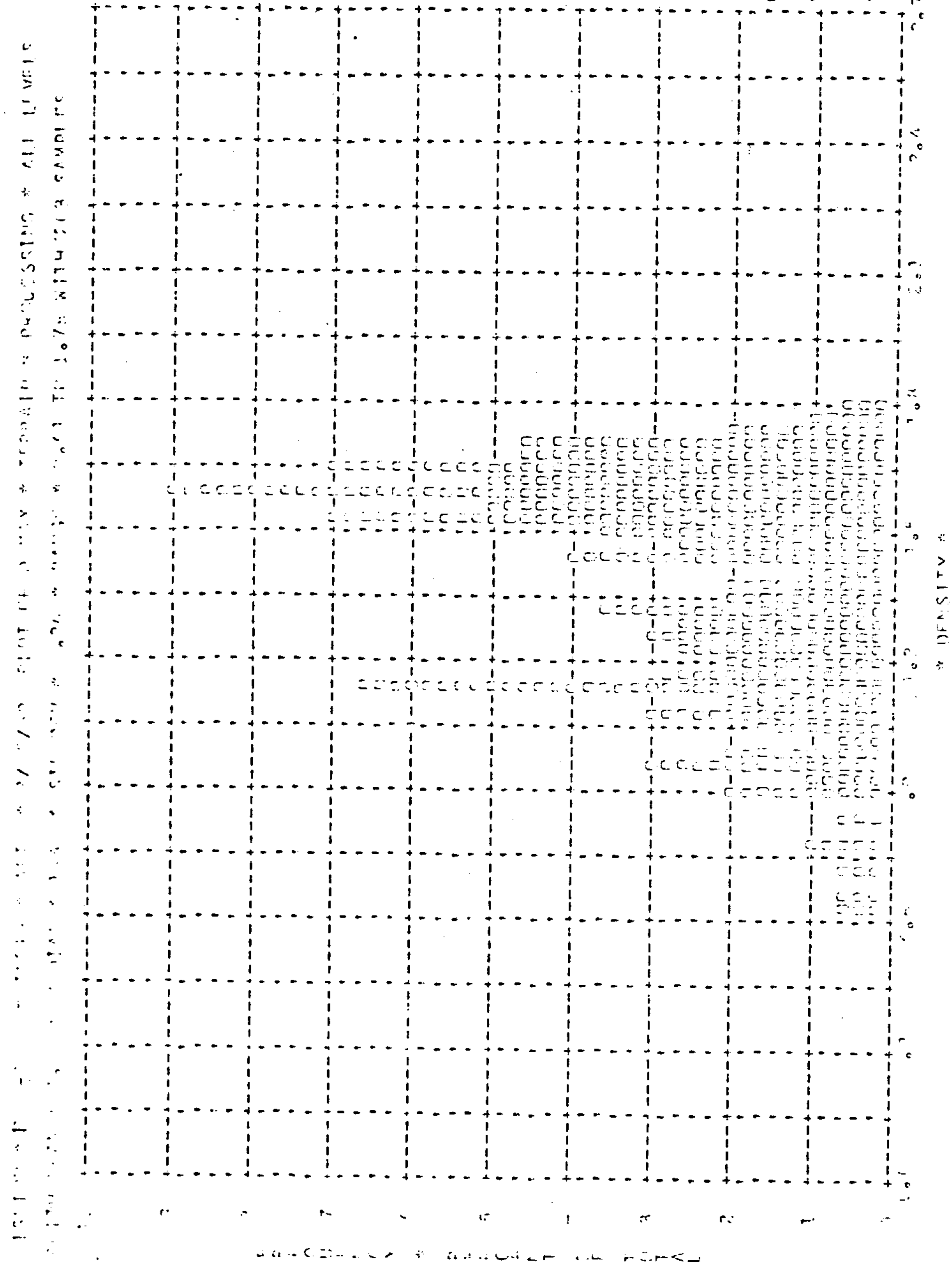


FIGURE 5-16

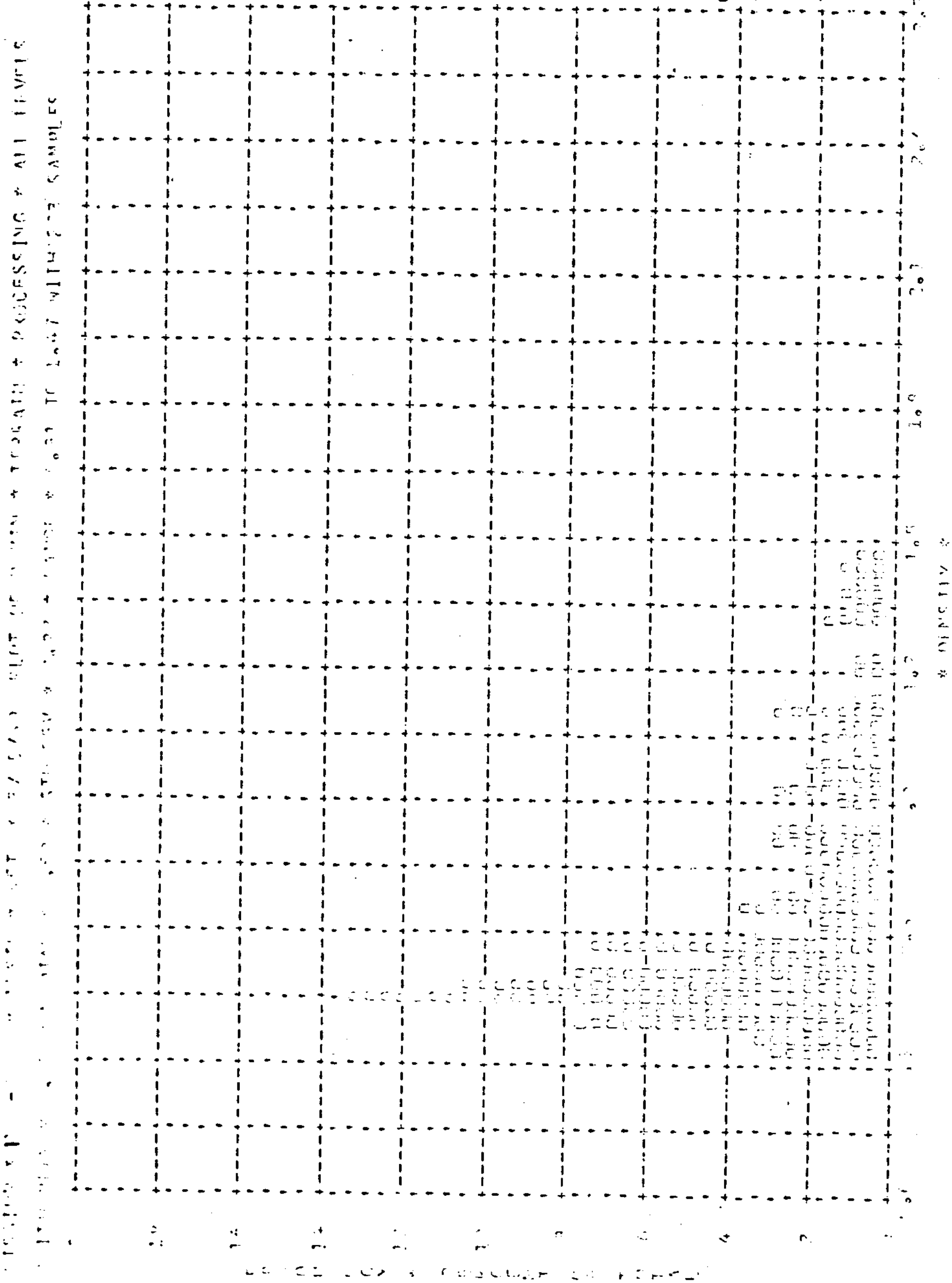


FIGURE 5-17
TOP SECRET/C

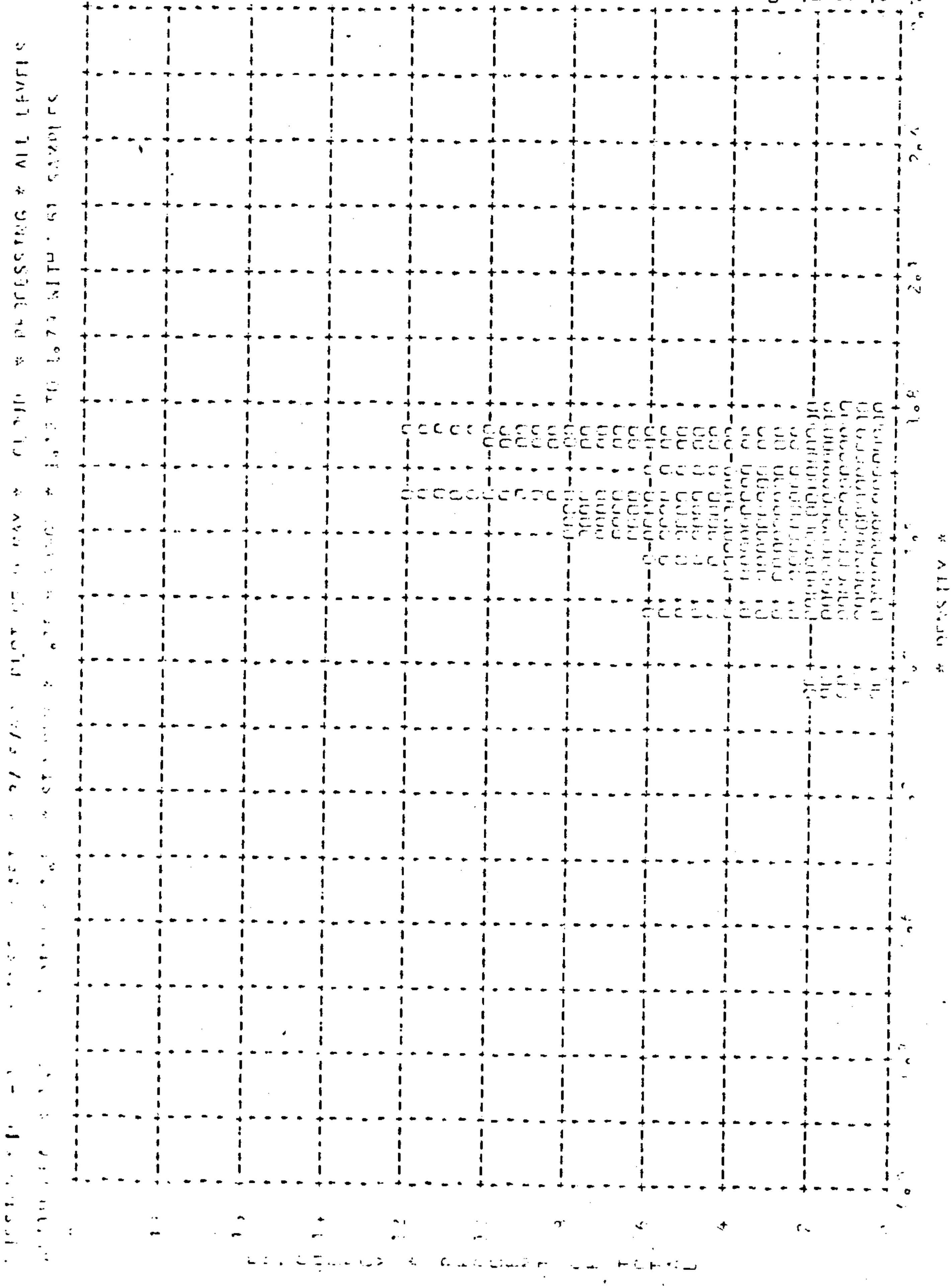


FIGURE 5-18

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

The summary table 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 cross track resolution limits are nominal but the IMC ratio error and the along track resolution limits are not within the normal performance limits. As discussed in Section 3, Flight Operations, the V/H programmer failed at the start of the mission and introduced a large V/H mismatch on revs 1 through 5, consistent with normal programmer functioning. Smear was present on these revs and thereafter was minimized by real time command during acquisition of the V/H programmer. This is the primary cause of the above normal IMC error and along track resolution limit errors, and is not attributable to vehicle attitude errors.

IMC RATIO AND RESOLUTION LIMITS

VALUE	UNITS	CAMERA	MISSION 1106-1 90%	MISSION 1106-1 RANGE	MISSION 1106-2 90%	MISSION 1106-2 RANGE
IMC Ratio Error	%	Fwd	4.00	-3.5 to +17.0	4.15	-4.5 to +8.5
		Aft	4.68	-2.7 to +17.7	4.18	-4.0 to +9.0
Along Track Resolution Limit	Feet	Fwd	3.20	0.2 to 13.5	3.22	0.2 to 5.6
		Aft	4.75	0.2 to 18.0	4.07	0.2 to 8.5
Cross Track Resolution Limit	Feet	Fwd	0.65	0.2 to 1.20	0.68	0.2 to 1.2
		Aft	0.97	0.2 to 2.15	1.08	0.2 to 2.0

TABLE 6-1

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

	1106-1		1106-2	
	90%	Total Range	90%	Total Range
Angle Deviation (deg.):				
Pitch	0.71	-0.10 to +0.86	0.74	-0.06 to +0.92
Roll	0.26	-0.16 to +0.42	0.23	-0.44 to +0.38
Yaw	0.50	-0.45 to +0.85	0.57	-0.5 to +0.90
Rate Deviation (deg/hr):				
Pitch	23.6	-40 to +70	27.1	-60 to +95
Roll	23.9	-65 to +80	24.0	-95 to +95
Yaw	24.8	-50 to +85	32.9	-55 to +100

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

Vehicle attitude control is concluded to have been within the normal performance envelope for both mission segments. Attitude deviations or rates did not contribute significantly to reduction of panoramic photographic quality. A comparison of ideal to actual yaw can be observed in Figure 6-2.

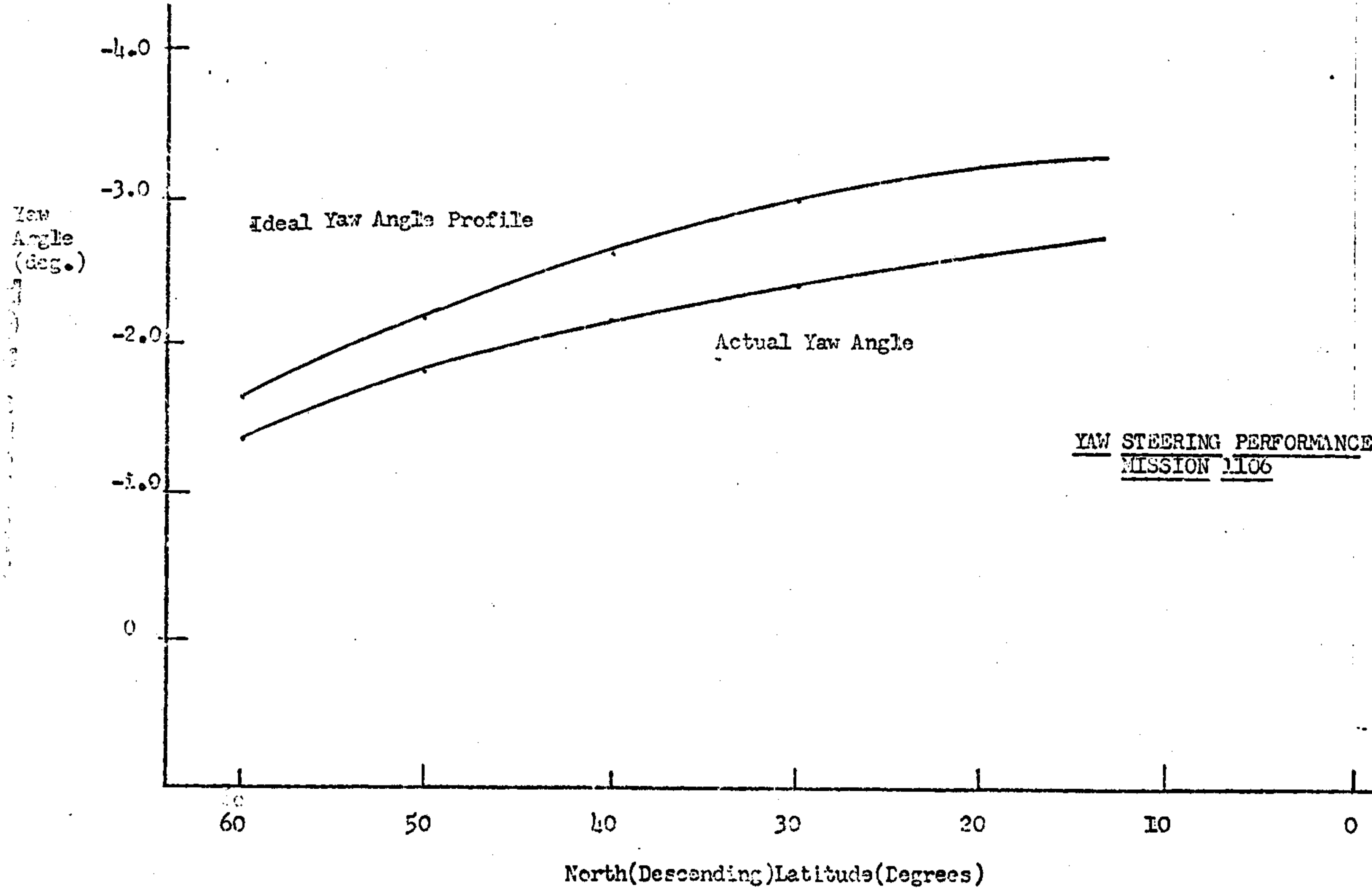

YAW STEERING PERFORMANCE
MISSION 1106
Yaw Angle (deg.)
-4.0
-3.0
-2.0
-1.0
0
Ideal Yaw Angle Profile
Actual Yaw Angle
60
50
40
30
20
10
0
North(Descending)Latitude(Degrees)

FIGURE 6-2

SECTION 7
RELIABILITY

Reliability estimates presented 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 "J" program have been included in the reliability analysis. The DISIC camera (1100 series missions) is treated separately from the Stellar-Index camera (1000 series missions).

Reliability estimates are shown for the primary category that includes the panoramic cameras, main panoramic door ejection, payload command and control, payload clock, and overall payload functioning on orbit. The secondary reliability category includes the auxiliary camera functions such as the DISIC and Horizon cameras.

Reliability estimates deal entirely with the payload. Only electrical and mechanical functions are considered. Vehicle failures are not included. Early recovery is treated as a complete mission provided that early termination was not caused by payload malfunction.

The following tabulation summarizes the reliability estimates for Mission 1106. A 50 percent confidence level is used.

Primary Function (M-7 and Up)	Opportunities To Operate	Failures	Estimated Reliability
Panoramic Cameras	234	3	98.4%
Panoramic Camera Doors	138	0	99.5%
Command and Control	14760 (Hrs)	2	96.8%
Clock	14760 (Hrs)	0	99.2%
Total Combined Functions Above	-	-	96.7%
Recovery System	109	1	98.4%