155 Pages

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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1101

VEHICLE 1641

PAYLOAD CR-1

Approved: [redacted]
Advanced Projects

Approved: [redacted]
Program [redacted] Manager

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1641.

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

This document is the final payload test and performance evaluation report for Mission 1101, System CR-1 which was launched on 15 September 1967.

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INTRODUCTION

This report presents the final performance evaluation of CORONA Mission 1101. The purpose of this report is to define the performance characteristics of the CR-1 payload system and to evaluate the technical characteristics of the Mission, including analysis of any inflight anomalies.

The payload system was assembled, tested, and certified for flight at the Advanced Projects (A/P) facility of Lockheed Missiles and Space Company (LMSC). A/P also provided services including preflight mission parameter and configuration planning, flight program preparation, inflight operations support and telemetry analysis, and mission reports to the community. The initial evaluation of the recovered film was made by NPIC personnel at the processing facility. The full Performance Evaluation Team (PET) meeting at NPIC included representatives of LMSC, ITEK Corporation, Fairchild Camera Company, Eastman Kodak Company, and cognizant government organizations. Off-line evaluation, using engineering photography acquired over the United States, was performed at facilities of individual contractors.

The quantitative data summarized in this report is obtained from several organizations. The Diffuse Density measurements and MTF/AIM resolution data are produced by the Air Force Special Projects Production Facility. Vehicle attitude readings and frame correlation times are provided by NPIC. The Processing Summary report is published by [redacted]

These quantitative data are used by A/P computer programs to provide processed information allowing correlation of operational photographic conditions with image quality. Analyses are made of image smear components and limiting ground resolution, and also of illumination/exposure/processing components in order to investigate exposure criteria.

SECTION 1

MISSION SUMMARY

A. MISSION OBJECTIVES

The CORONA/J3 payload CR1 was designed and programmed to provide improved search, cartographic, and reconnaissance photography of selected areas of the earth, from orbital altitudes. Two seven-day mission segments were planned, each nominally to return over 5900 panoramic frames of photography covering approximately 1130 square nautical miles apiece.

The payload section was the first of the new J3 configuration, consisting of a space structure containing two "Constant-Rotating" (CR) panoramic cameras and associated control/support equipment, a "Dual Improved Stellar-Index Camera" (DISIC), and recovery subsystems for each mission segment. Figure 1-1 presents an inboard profile of the CR1 configuration, and Table 1-1 provides a record of component assignments and performance.

On-orbit support was provided by the Agena satellite vehicle. These functions included real-time command and telemetry links, electrical power, stored payload program timer, attitude stabilization and control, and a Drag Makeup rocket system. In contrast to the normal J1 flight, the J3 systems are operated in a nosefirst on-orbit configuration.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base at 1941Z on 15 September 1967, on a THORAD booster. All launch, ascent, and injection events occurred as programmed. The orbit parameters achieved were well within the three sigma predicted dispersions.

Both panoramic cameras operated satisfactorily throughout the flight. Average cycle periods for both cameras were within 1 percent of the pre-flight calibrations.

The DISIC system operated normally throughout the flight.

The FMC and exposure control systems were sensitive to noise generated by the command system during the "time-out" portions of their cycles. Command restrictions imposed during the flight precluded early time-out during the majority of the flight.

The command system operated normally with correct responses to all Analog and Uncle commands issued with the exception of a single tracking station problem when 26 transmissions of a command were required for 12 verifications.

The clock system serial output was normal and good clock/system time correlation was obtained.

The pressure make-up (PMU) system operated normally throughout the flight. The total consumption was 9.98 ΔPSI/min. with a supply of 900 PSIA remaining at the end of the flight.

The instrumentation system operated normally with the exception of the horizon camera platen position monitor on the No. 2 unit which indicated an intermittent unclamped condition.

Ascent vibration data appeared normal and within qualification levels.

The thermal environment was approximately 20°F lower than nominal and 10°F lower than predicted for the flight.

Panoramic film switchover from first to second recovery system was commanded on Rev. 86. Cut and wrap, and transfer from the first to the second recovery system occurred normally. DISIC Camera Switchover was commanded on Rev. 88. Cut and splice, and switchover to the second recovery system was normal.

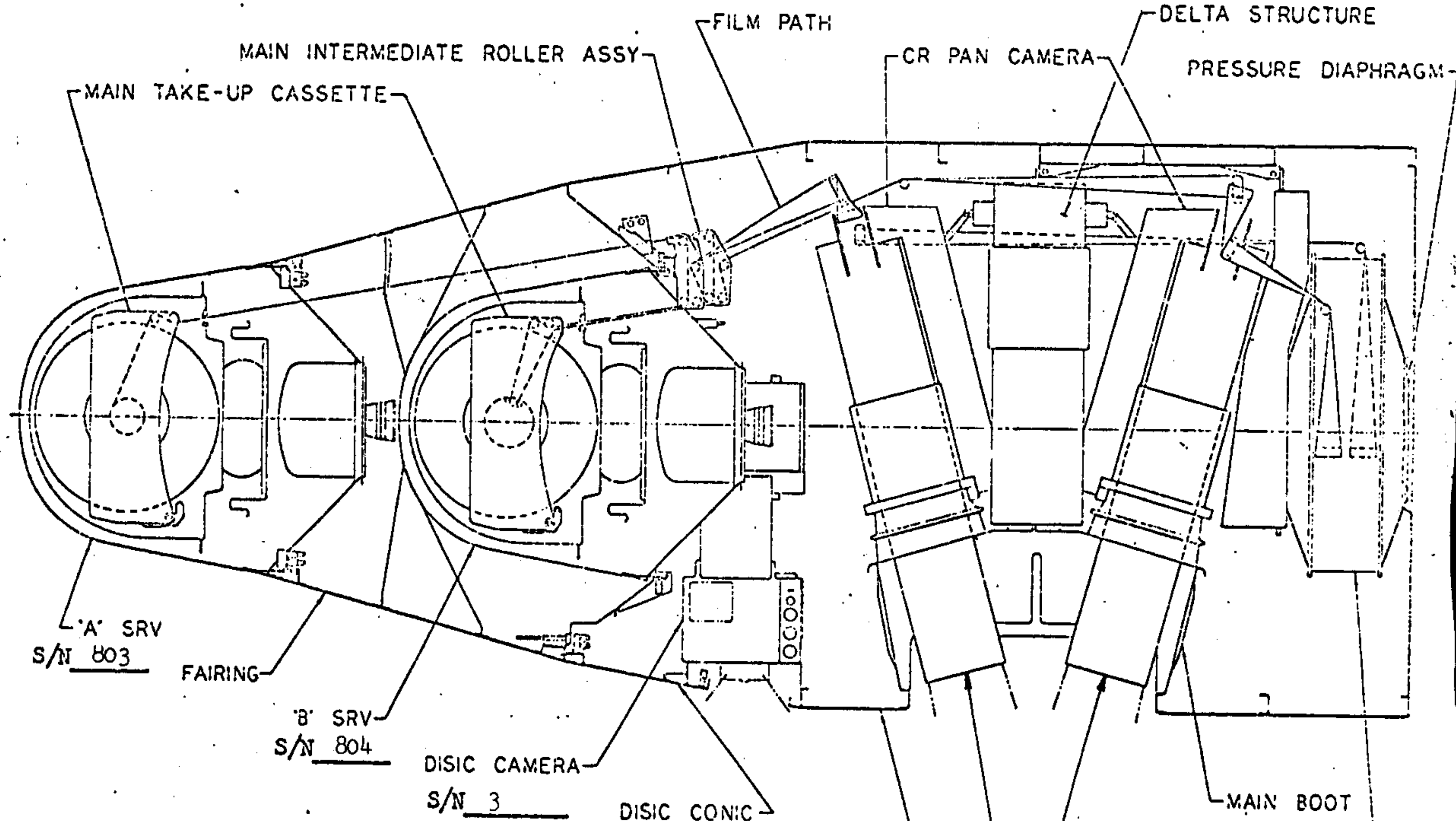
The tape recorder systems in both SRV's operated normally and all recorded data was retrieved.

All six DMU rockets were fired and maintained the orbital period within 5 seconds of nominal.

Tracking and control support was effected by the Air Force Satellite Control Facility, under central control of the Satellite Test Center at Sunnyvale, California. Tracking and command stations are located at [redacted]

Mission segment 1101-1 consisted of a six-day operation followed by air recovery of the capsule. Mission segment 1101-2 was completed with an air recovery following a seven-day photographic operation.

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-1
TEST Flight
PMU S/N 1001
SLOPE PROGRAMMER S/N 201
CLOCK S/N 616
SWITCH PROGRAMMER S/N 202

FIGURE 1-1

TABLE 1-1

COMPONENT ASSIGNMENT

Mission No.	1101
Agena Vehicle No. (SS01B)	1641
THORAD Booster No. (SLV-2G)	512
Payload System No.	CR-1
Forward Looking Camera Serial No.	303
Aft Looking Camera Serial No.	302
DISIC Camera Serial No.	3

PANORAMIC CAMERAS	Fwd. Looking Unit 303		Aft Looking Unit 302	
Lens Serial No.	I-172		I-167	
Slit Width (Inches)	Nom.	Meas.	Nom.	Meas.
Position 1	.150	.150	.134	.135
Position 2	.171	.157	.134	.132
Position 3	.218	.220	.175	.170
Position 4	.272	.268	.225	.208
Failsafe	.250	.246	.200	.192
Optics Filter Type				
Primary	W-23A (Gelatin)		W-21 (Gelatin)	
Alternate	W-25 (Gelatin)		W-23A (Gelatin)	
E.O. Focal Length (Inches)	24.001		24.000	
Resolution/Film Type				
Static (Lines/Millimeter)				
Filter	W-21 (Gelatin)		W-21 (Gelatin)	
High Contrast	Not Available		263	
Low Contrast	145		150	

Dynamic (Lines/Millimeter)

ITEK Post-Vibration

Filter	W-21 (Gelatin)	W-21 (Gelatin)
High Contrast	209	195
Low Contrast	130	122

A/P Test

Filter	W-21/W-23A	W-21 (Gelatin)
High Contrast	213 (W-21)	207
Low Contrast	118 (W-23A)	118

Distortion/Pincushion (Millimeters)

Angle Off Axis, Degrees		
3	.001	.002
2	.000	.001
1	.000	.000
0	.000	.000
359	.000	.000
358	.002	.000
357	.003	.001

HORIZON OPTICS

Forward Looking Camera 303

	Takeup (Starboard)	Supply (Port)
Lens Serial No.	E23764	E23784
Exposure Time (Sec.)	1/100	1/100
Aperture	F/8.0	F/6.3
Filter Type	W-25	W-25
Operational Focal Length MM	55	55

Radial Distortion (MM)		
10 Degrees Off Axis	.02	.02
20 Degrees Off Axis	.05	.05
Tangential Distortion	.01	.03

Resolution (Lines/Millimeter)

Angle Off Axis (Degree)		0	5	10	15	20	25	30
Takeup	(Radial)	209	208	206	202	175	150	45
	(Tangential)	187	207	181	155	116	96	62
Supply	(Radial)	209	200	206	143	139	150	81
	(Tangential)	166	185	181	138	103	96	62

Aft Looking Camera 302

	Takeup (Port)	Supply (Starboard)
Lens Serial No.	E23806	E23788
Exposure Time (Sec.)	1/100	1/100
Aperture	F/6.3	F/6.3
Filter Type	W-25	W-25
Operational Focal Length (MM)	55	55
Radial Distortion (MM)		
10 Degrees Off Axis	.02	.02
20 Degrees Off Axis	.04	.04
Tangential Distortion	.017	.018

Resolution (Lines/Millimeter)

Angle Off Axis (Degree)		0	5	10	15	20	25	30
Takeup	(Radial)	187	186	184	143	139	150	64
	(Tangential)	187	164	181	109	103	96	62

Angle Off Axis (Degree)	0	5	10	15	20	25	30
Supply (Radial)	187	186	184	101	99	150	81
(Tangential)	166	164	144	88	73	96	62

DISIC CAMERA #3

Stellar Cameras	Port	Starboard
Lens Serial No.	1P	1
Reseau Serial No.	1P	1
Aperture	F/2.8	F/2.8
Exposure Time (Sec.)	1.5	1.5
Nominal Focal Length (Inches)	3.0	3.0
Filter	None	None

Terrain Camera

Lens Serial No.	102
Reseau Serial No.	102
Filter Type	W-12
Aperture	F/4.5
Exposure Time (Sec.) Commandable	1/250 or 1/500
Nominal Focal Length (Inches)	3.0

Resolution (High Contrast Lines/Millimeter)

Angle Off-Axis (Deg.)	0	17	34
Radial	77	79	77
Tangential	72	74	57

Film Type 3400

Filter W-12

FILM TYPES

Forward Looking Camera No. 303

Split Load NO

Film Type	3404
Length (Ft.)	16000
Splices	2
Length Between Splices (Ft.)	5555-4640-5805
Emulsion Data	292-2-8-7
Payload Weight (Lbs.)	88.8-79.2
Spool No.	131T
Box Serial No.	30
Aft Looking Camera	No. 302
Split Load	NO
Film Type	3404
Length (Ft.)	16000
Splices	3
Length Between Splices (Ft.)	2970-5300-5910-1820
Emulsion Data	292-2-8-7
Payload Weight (Lbs.)	88.3-79.8
Spool No.	50B
Box Serial No.	30
DISIC Camera	No. 3
Stellar Camera	
Split Load	NO
Film Type	3401
Length (Ft.)	2000
Splices	0
Length Between Splices (Ft.)	0
Emulsion Data	231-9-7-7

Terrain Camera

Split Load	YES
Film Types	3400/SO-230
Length (Ft.)	1800/200
Splices	1
Length Between Splices (Ft.)	1800-200
Emulsion Data	3400-156-9-8-7/SO-230-6-1
Total Film Weight (Lbs.)	20.0/2.4

SECTION 2

PREFLIGHT SYSTEM TESTS

A. ENVIRONMENTAL TESTING

1. Test Objectives

As a standard procedure, the "J" payload systems are subjected to thermal/altitude testing to simulate the orbital environment. The purpose is to demonstrate proper electrical and mechanical function under operational conditions, and to provide confidence in system capability to produce acceptable data throughout a mission. One of the test objectives is to determine susceptibility of the system to corona discharge, which fogs the film and would degrade operational photography.

2. Testing Summary

CR-1 was the first J-3 system to be tested in the thermal/altitude chamber. Three tests were necessary because of corona fogging manifested on both Panoramic and DISIC record. These tests on 8-16 June, 14-17 July, and 2-6 August 1967, were alternated with similar chamber tests of the J-3 qualification system, designated QR-2.

The major environmental problem encountered in these tests was corona marking. Problems not directly related to environment included erratic Panoramic time word recording and irregular 200-cycle time trace, extensive emulsion buildup clogging rail holes and fiducial apertures, and DISIC system transport mismetering. Resolution of these problems was satisfactorily achieved either between, or subsequent to the tests.

3. Panoramic Cameras

CORONA, during the first test, occurred principally on the #2 unit at the frame metering roller, which marked along one edge of the film at pressures from 16 to 35 microns. Post-test inspection indicated a mechanical restraint of the pressure roller on the frame metering unit, which caused it to exert uneven pressure on the film. The assembly was modified and no further marking problems were found due to this cause. Corona marking was light on the #1 unit, occurring only during the pressure sweeps between 40 and 48 microns.

Major corona fogging during the second test occurred on the #1 unit during operations with the Pressure Makeup System (PMU) enabled, at pressures from 25 to 30 microns. Minor marking was also noted between 44 and 48 microns. Because of these markings, and data from QR-2 system qualification tests, the orifice of the PMU was modified to maintain a 50 micron steady-state level for the third test.

The only corona marking noted on the third test record was a light startup type at the #1 unit. From the corona aspect, the system was considered as acceptable. Some very minor corona occurred inflight along the edge of the material from the #1 camera.

TIME recording was not acceptable on all three tests due to several problems with the Silicon Light Pulser (SLP) clamps, the SLP signal conditioner, and the Dual Data Signal Conditioner (DDSC).

The time word appearance was not satisfactory for both units during the first test and for the #2 unit on the second test. The imagery was "soft" in various areas of the word, because of improper clamping of the film to the SLP head. These clamps were reworked, and the third test demonstrated the #1 word imagery as good, and #2 as adequate although not as sharp as #1.

The times indicated by the SLP were grossly irregular during the first two tests. Comparison of time words recorded on the film and on the recoverable tape recorder indicated unacceptable discrepancies, with the apparently correct words on the tape recorder. Investigation revealed the SLP conditioner to be excessively sensitive to noise; the circuitry was modified for the third test.

Time recording on the third test presented a good appearance, but minor irregularities were noted when the words were reduced in order to verify camera cycle period. It became evident that the DDSC was not synchronizing the time word with the 200 PPS time trace. This also accounted for the small, nonincremental variations in the tape-recorded time words from all three tests; these variations had been previously blamed on the tape recording system.

Time words were missing on the last two frames of every operation thruout the tests. This was a characteristic of early CR systems, where the time recording was disabled by the turnoff command.

The 200 PPS time trace of the #1 unit appeared consistently good, while that of the #2 unit was intermittently erratic during the first and third tests. Its display ranged from no trace, to the normal 200 cycles, to 800 PPS, to a solid line. This problem was also traced to the DDSC, which was reworked extensively by the camera contractor and returned for further, more successful tests.

<u>AUXILIARY DATA</u> recording was generally adequate thruout the tests, excepting rail holes and horizon camera fiducials which tended to fill with emulsion particles.

The slur pulse was mislocated or missing on several frames in each test. This was always coincident with missing fiducials, but seldom with an anomalous time word.

The start-of-pass mark was sensitive to power supply voltage during the first test, not appearing below 24 volts. Performance was adequate during the last two tests, and no further problems were experienced.

The serial number appeared adequate thruout the tests. There was a characteristic dimming on alternate frames, with horizon data. The serial number was occasionally multiple-printed during transport, especially at instrument startup.

The horizon camera fiducials were marginally acceptable thruout the tests. However, they showed a tendency to fill with emulsion particles during each test, but imagery was always visible.

The lens scan lines were generally adequate thruout the tests. A double image was noted on the #2 unit during the first test. The assembly was adjusted, and subsequent tests demonstrated satisfactory performance.

An excessive number of rail hole images were unacceptable on all three tests, as the holes in all four rails tended to become plugged with emulsion particles. Intensive cleaning subsequent to the third test produced more acceptable images, but the problem continued thruout the test sequence.

PHYSICAL MARKING of the test film was not considered severe. Horizon camera clamp marks were evident on both units, the heavier marks being from the #1 unit. Rail scratching ranged from light to heavy, with several changes in magnitude evident on some single frames, especially at startup. Numerous scratches and abrasions were noted in the format areas on all material from the tests, apparently caused primarily by the scan head rollers. It was anticipated that most of this marking would be reduced with instrument cleaning after the third test, however some scratching in the format area was noted in the flight material.

OPERATIONS during the tests proceeded, for the most part, according to procedures. Some operational problems did develop, involving camera controls, exposure control, and the instrumentation system.

A "runaway" of the #1 unit occurred during the first test; the unit failed to shut down at the command to end an operation. A power-down sequence was required to stop the instrument. After the test chamber returned to ambient pressure, a confidence operation indicated normal function. The chamber was re-evacuated, and the unit functioned normally for the remainder of the test. Inspection later revealed a misaligned scan switch, which was corrected.

Also during the first test, the slit position programmer in the exposure control was noted to step spontaneously. Data from the second test confirmed adequate function after circuit modification, but revealed an intermittent timer malfunction. This was corrected prior to the third test; no further exposure control anomalies were indicated.

Cycle rates of both units were consistently one to two percent slow relative to the calibrated values, thruout the tests. This was attributed to a noisy trim potentiometer, which was discovered after the third test. Subsequent calibration data indicated proper operation.

Some difficulty was experienced in analysis of the test data because of instrumentation system noise and various sensor malfunctions. Most problems were eventually adequately resolved.

4. DISIC Cameras

CORONA was evident on material from all three tests, exceeding the maximum specified allowable incidence and magnitude.(1) Improvement was noted, however, on the third test, both in general appearance of the record and in its projected utility.

(1) not more than 10% of the formats marked; none to a net density greater than 0.4.

Stellar Corona marking, during the third test, was first noted at ambient pressure during a confidence run prior to chamber pumpdown where the metering roller caused static marking. During the test proper, metering roller corona affected 15 percent of the legal formats, marking only the starboard side, to a maximum net density of 0.41. This marking occurred at internal pressures from 20 to 69 microns; it had not been observed on material from the two previous tests.

Corona from other sources affected 9 percent of the formats to a maximum net density of 0.68. These corona forms, which were similar to the first two tests, were noted only at pressures less than 45 microns.

Skew bead marking between the active format and film edges affected 99 percent of the frames. Light dendritic static, noted only at 45-47 microns, occasionally extended into the format area from the film edges. It should be noted that frequency of corona marking tended to increase as the test progressed, suggesting a film environmental conditioning factor.

Terrain Corona marking, during the third test, affected 14 percent of the formats to a maximum net density less than 0.4; one-third of this was considered minor. This marking, also typical of previous testing, consisted of two bands parallel to the film edges extending thru the formats of operations also showing a high incidence of stellar corona marking. Correlation with PMU operation appears good; this marking occurred only at pressures less than 36 microns.

Very light marking, along the edges outside the format, affected most frames; these marks have been attributed to the skew beads. Dendritic static was noted occasionally at 25 to 47 microns, often associated with the termination of a corona display.

MECHANICAL problems affected all three tests. A metering cycle was missed at a change from slave to independent mode during the first test, resulting in a short frame on both Stellar and Terrain. A few frames of two operations early in the second test were severely mismetered because of a short-duration clutch command. A microswitch controlling the function was replaced, and no subsequent problems were encountered.

A Stellar capping shutter malfunction was noted during the third test on one independent operation. This operation started properly, with the starboard unit commanded to be capped; this command remained on throughout the operation. The last active port frame (before two shutdown frames) was noted to have a corresponding normal-appearing starboard format. This was followed by two normal shutdown frames with both sides capped. The source of the apparent uncapping signal was not determined.

TIME RECORDING appeared adequate during the first two tests, although spurious "ghost" bits appeared frequently in the Stellar time word; these were of much less density than the real time bits, and easily detectable. Accuracy of the time words was verified for the second test, because of the problem with the pan time words.

Similar harness connectors to the Terrain and Stellar SLP blocks were inadvertently reversed during assembly for the third test. This caused the Stellar time words to record on the Terrain film, and vice versa. These connectors were subsequently color-coded on this and other DISIC units, so as to help prevent improper time word recording on future operations.

There were two missing time words on material from both the Stellar and Terrain units during the second test. One each on the pretest confidence runs did not correlate, and occurred independently. One each on the test material did occur simultaneously, indicating an intermittent clock interrogate problem. This anomaly was not observed during subsequent testing, or in flight.

AUXILIARY DATA was generally good thruout the testing. Fogging lamps were too bright during the first two tests, making evaluation of the format areas difficult. The Stellar reseau illumination level was dissimilar for the two units. The port side was measured at a typical net density of 0.32-0.38, and the starboard side at 0.46-0.56. The specified range is 0.2 to 0.4. A contributing factor to the excessive density on the starboard side may be pre-sensitization by the pressure pads, as described below.

PHYSICAL MARKING was slight on most material from the tests. Excessive pressure marking and film scratches were noted throughout the Stellar material from the second test. The source was determined by New York to be improper threadup; a guide roller had been missed, allowing the film to drag against the chute. Correct threading was verified prior to the third test, and scratching was significantly reduced.

During the third test, most Stellar formats were affected by a density variation which conformed to the texture of the platen pressure pads. This mottling involved between 40% and 100% of the format area, and appeared accentuated on the starboard formats. Usually only the format area was involved; however, the pattern extended beyond the format area on a few startup frames. The mottling, which is caused by mechanical or electro-static sensitization of the film, did not appear to be associated with internal pressure; it has progressively less effect during the test. While the density variation was usually less than 0.1, it could produce difficulty in timely automatic data reduction. This was the first time this anomaly had been observed during A/P testing.

OPERATIONS were generally normal thruout the testing, except for the short clutch command. Minor problems were experienced in analysis of data from the second and third tests because of some inoperative instrumentation sensors.

B. RESOLUTION

Resolution tests at A/P demonstrated a variety of CR1 optical performance anomalies. Because of this, an intensive study was conducted to define the causes of performance variability and to determine the optical acceptability of the panoramic cameras.

1. Resolution Criteria

The sole requirement at the time of testing was that each camera should demonstrate a minimum dynamic resolution of 110 lines per millimeter, utilizing low contrast (0.30 Δ Density) targets under standard conditions. No criterion was stated concerning location of the peak focus.

In flight, the peak focal position would be expected to vary from the film plane in a manner partially predictable with temperature changes. The "zero" focus position, at that time, represented the best estimate of optimum flight performance with normal temperatures (70° ± 30°).

2. Test History

Acceptance testing of panoramic camera resolution was performed at ITEK-Boston on the 120-inch collimator. Both cameras used Wratten 21 gelatin filters and 0.140 inch slits. The resulting high and low-contrast data were typical for a J-type system, demonstrating unquestionably acceptable performance. The low-contrast data showed a wide range of focal positions where resolution exceeded the requirement.

There were four series of resolution tests at A/P. The first was run after the first environmental test in a similar configuration to the Boston Acceptance Test, with Wratten 21 filters and 0.134 inch slits. The results showed comparable resolution, but there was an apparent peak focal position displacement of approximately one mil, for both cameras.

The second A/P test was conducted after the second environmental test. At this time, the eight drum rollers in front of each scan head had been raised, although the scan heads were not shimmed. Both cameras used 0.134 inch slits and gelatin filters; a Wratten 21 was on #302 and a Wratten 23A on #303. Again resolution values were comparable to previous tests, but both cameras showed an additional peak position shift of approximately one mil. The resulting peaks were at plus one-half mil for #302 and at plus two mils for #303 ("plus" designates behind the emulsion).

The third A/P resolution test was run after the last environmental test. A two mil shim had been added to #303 scan head to compensate the apparent focal shift. Glass equivalents to Wratten gelatin filters were installed for the first time: A type 21 in #302 and a type 23A in #303. In general, the resulting data showed #302 as marginally acceptable and #303 as definitely unacceptable.

By the time of the fourth A/P test series, the flight plan had been defined, specifying types 21 and 23A filters in #302, and types 23A and 25 in #303. Therefore, both glass and gelatin filter types were tested in the appropriate cameras. Preliminary data indicated unacceptable performance in some cases, as well as extensive variation between data readers.

3. Data Analysis

The results of the fourth A/P test were reanalyzed with rigorous application of MIL-STD-150, and with controls to minimize variability among the readers. Some factors tending to degrade the test results included lack of target image sharpness, target underexposure, and defective target strips; these were compensated, insofar as possible, and are not significant factors in the overall results. Smear, target drive irregularities, image motion matching, and camera vibration were not noted as degrading elements. One factor which partially accounted for reader variability was the presence of spurious target resolution. There were numerous instances where a large target would be unresolved, but several smaller targets in the group were resolvable; this did not appear to be caused by defective targets.

Results of the evaluation indicated adequate system performance with gelatin filters. The glass filters produced uniformly unacceptable results, and were returned to the contractor for re-evaluation. Camera #302 produced the better resolution values using the Wratten 21, with a 118 lines/millimeter peak near the estimated optimum location. Camera #303 met the minimum requirement, but was predicted to produce poorer inflight results.

4. Conclusions

As a result of the study, it was concluded that the panoramic camera resolution was acceptable for flight only with gelatin filters. All tests in that configuration were substantially satisfactory according to established criteria.

5. Sequel

Subsequent to the CR-1 flight, additional information available to the ITEK company for certain lens systems, including CR-1, indicated that focal shift in vacuum, and the back focus, was less than previously computed. As a result, the scan heads of remaining systems were shimmed, and resolution was retested to verify the peak focus location.

Inflight optical performance is discussed in detail in Section 4 (Photographic Performance). In general, performance of #303 was very good, despite preflight predictions. Performance of #302 was poor because it was out of focus.

As a result of the CR-1 resolution problems, the J3 collimators have been adjusted to reflect the changes in focal shift. Performance criteria have been revised to include the location of peak focus.

C. LIGHT LEAK TESTING

The CR-1 system was given a preliminary light leak test on 24 May 1967. Evaluation indicated one major and two more minor leaks at the horizon camera boots. The #1 unit input side had a small leak. The #2 unit input side had a severe leak, which marked the film in several places. There was also a small leak on the output side. The horizon camera boots were repaired, and no further leaking at that location was noted during test.

The second live-film light leak test indicated a small leak only affecting film from the #1 unit. This leak was probably located in the main door seal area, near the #2 unit. Correction was verified by photomultiplier tests. Although the photomultipliers showed substantial instrument leaks, the payload was generally unaffected.

Light search testing was conducted as part of the final loading procedure. Special photomultiplier sensors were installed in the top of the conic structure and at the aft of the barrel, as well as in both port and starboard access doors. All aspects of the search were considered normal and acceptable.

D. SPECIAL TESTS

Extensive special testing was necessary with CR-1, in order to clarify certain component problems. These problems included time word recording and 200-cycle time trace irregularities on the panoramic record.

1. SLP Tests

Thruout component testing, problems had been encountered with the quality of the time words as recorded by the panoramic cameras. Poor payload contact was responsible for movement during exposure, variable density, size, and sharpness. The clamps also caused physical damage to the mylar covering of both SLP heads. Spurious bits were probably caused by current leakage within the SLP.

The clamps were redesigned and replaced by ITEK, during early system testing. The new design yielded improved images, with good apparent payload contact, but additional damage to the SLP heads was apparent.

During the first and second environmental tests, some variation in dot density was observed, again related to payload contact problems. Continuing physical damage to the heads necessitated replacement, and a subsequent lamp verification test. This material had dots of good size and density, but variations in sharpness demonstrated obviously poor contact.

Samples from the lamp verification test were sent to the Fairchild Company for evaluation using the new Multiformat Data Block Reader. Several problems were found; the original negatives were readable, but the duplicate positives were unreadable because of dot size variation in the duplicated material, and because of tracking difficulties in the reader. Missing time words (typically, for the first and last frames of each operation) caused the reader to stop, forcing a complete restart sequence.

The clamps were readjusted for the third environmental test, and time word appearance was improved. Film samples from this and a subsequent special test, taken at various exposures on each instrument, were sent to the [redacted] for flight-type processing at the three standard levels. The negatives were returned to A/P for evaluation of conformance to specification, while duplicate positives were sent for further testing on the Data Block Reader.

A special test, coincident with the second light leak test, verified the exposure settings and established that clamping was adequate.

2. Time Tests

Many of the problems associated with time word accuracy have been reviewed in the environmental test section of this report. Numerous additional special tests were necessary, both to isolate the problems in the SLP conditioner and DDSC, and to verify the hardware modifications. Clock accuracy was consistently good thruout all testing.

E. PREFLIGHT PREPARATION

1. Flight Readiness

The Flight Readiness Test was the first performed on a J-3 system, and consisted of several separate operations.

Verification of flight settings to the SLP Signal Conditioner was performed on 25 August. Test payload was processed to both "full" and "intermediate" levels. Microdensitometer records of samples from both main cameras at both processing levels showed that all SLP images met the requirements of MIL-STD 782C. Except for the microdensitometer samples, the entire test film was forwarded to the processing facility to provide duplicates for adjustment of the automatic data reader. This material provides approximately ten cycles at each processing level for each instrument.

The main camera readiness test was run on 29 August. The test film showed acceptable data recording. The following anomalies were considered within acceptable levels: Both cameras produced a narrow low-density band of fog near the time word edge of the main formats due to stray light from the rail hole lamps; and instrument 303 showed one instance of a spurious slur pulse and one instance of a spurious serial image, both occurring on startup. Both of the instrument 303 anomalies were traced to the Dual Data Signal Conditioner. DDSC synchronization of time words with 200 cycle marks was verified and found correct throughout the test.

An exposure slit measurement test was also conducted on 29 August. The test method, consisting of measuring slit silhouettes imaged on film by extremely short stoboscope flashes, had not been fully validated for accuracy. However, the test did show that the correct control cams were installed and all widths were within ten percent of the specified nominal values.

The DISIC readiness test was run on 30 August. Both Stellar and Terrain films showed acceptable data recording with two exceptions. One exception was multiple columns of SLP time words affecting both stellar and terrain records at starts of operates. This anomaly is caused by bench test conditions and is never observed in system tests. The second exception was excessive fogging density on the starboard Stellar unit during independent mode operation. After adjusting the lamp controls, a second Stellar readiness run showed acceptable density values.

2. Loading Sequence and Acceptance

Loading of DISIC flight film was accomplished without incident on 1 September. Sensitometric samples of both the type 3400 Terrain film and the type 3401 Stellar film showed normal characteristics. The Terrain flight load contained 200 feet of SO-230 film at the supply core and no sensitometric sample or data was available for this material.

Loading of the main camera supply cassette was accomplished on 5 September. Although new J-3 fixtures were used, the loading procedure was essentially the same as for J-1 systems and was completed in a routine manner. Sensitometric samples of type 3404 film for both main cameras showed normal characteristics.

The final loading procedure was completed on 7 September. During these operations emulsion scratches on film from both main cameras was noted. The extent of scratches on instrument 303 film was very slight and well within normal levels. Scratches on instrument 302 film were larger and more extensive. While appearing continuously for several cycles, they did not affect all frames. The source of scratching could not be determined under the conditions of this test. While the scratches may have been sufficient in some cases to produce slight plus and/or minus density marks in processed film, it was decided that no further attempts to correct the condition were warranted. All other aspects of final loading including light leak search were normal and acceptable.

Customer review and acceptance of the system was completed on 8 September.

3. Final Operations

The system was transported by van to Vandenberg AFB, where a premate receiving inspection operation and functional checkout indicated no problems. The system was then taken to the west pad of Satellite Launch Complex 1.

After mating the system to the Agena, a successful confidence operation was run, and repeated on launch day as a routine sequence in the countdown procedure.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Mission 1101 utilized AGENA satellite vehicle No. 1641, boosted by THORAD launch vehicle No. 512. The AGENA, the first of a series, was programmed for nosefirst on-orbit configuration, and had the following additional features:

- Low altitude capability (85 N.M. perigee)
- 6 drag makeup rockets
- Fourth telemetry link for payload data
- "UNCLE" command system (additional UHF link)
- Pyro battery diode bypass (by real-time command)
- Additional control gas sphere (3 total)
- Augmented battery configuration (5 type 1H, 2 type VI, and 2 type 1H for pyros)

The payload was the first J3 camera system flown, consisting of ITEK stereo panoramic cameras and Fairchild terrain/indexing and dual stellar cameras. Major payload components were identified in Table 1-1. Special payload features included:

- Constant-Rotating (CR) panoramic cameras
- CR Exposure Control with commandable slits (4) and filters (2)
- CR FMC programmer with eccentricity and oblateness control
- DISIC system for stellar and index data
- Cut and splice device to transfer DISIC film between SRV's
- Tape recorder in each SRV to monitor functions during camera operations

Ascent instrumentation for vibration and temperature

Sixteen real-time commands (RTC) for system control (8 analog and 8 UHF)

Seven days operation was planned for each mission segment. The first mission actually operated for six days, and the second for seven. Both recoveries terminated in air catches, with all of the film supply successfully transferred.

B. ASCENT

Liftoff occurred on 15 September 1967 at 1241 PDT (system time 70875). All ascent events were normal with In-Flight Reset (door ejection), A/P to Orbit Mode, instrumentation switchover, and panoramic camera transfer to orbit mode occurring on time and as programmed. There was no indication of panoramic camera rotation during ascent; this was considered possible because of rotation observed during preflight vibration tests. The pyro current monitor showed a maximum of 18 amps at the time of door ejection.

Ascent vibration was monitored by 8 sensors, reading out on telemetry link 4. Observed vibration levels were within the qualification levels:

ASCENT VIBRATION

Accelerometer Location	Station	G's (O-P)
Instrument Fwd Barrel Ring	86	2.6
Instrument Delta, Mounting Fitting	114	3.4
Instrument Delta, Plus Y Apex	114	2.5
Agena IRP	255	2.2

A maximum longitudinal ("pogo") frequency of 17.5 CPS occurred during the last 10 seconds of THORAD main engine burn.

Ascent temperatures were monitored by 49 sensors, also reading out on telemetry link 4. The observed temperature ranges were within predicted limits:

ASCENT TEMPERATURES (deg. F.)

Area		# Sensors	Range °F
CR units:	camera #1; lens, rails, head, AO, motor	5	63-69
	camera #2; lens, rails, head, AO, motor	6	66-73
	delta structure	2	63-79
	supply cassette	1	77-78
FMC programmer, PMU, Main elect. unit		3	69-73
DISIC		2	64-69
A SRV; skin and battery		2	94-109
takeup and retro		2	67-78
B SRV; takeup and retro		2	71-101
Blast shield		2	66-83
Structure*; barrel		10	68-320
conic		6	60-437
fairing		6	60-486

* peaking 225-250 seconds after launch

Camera system operation during [redacted] station acquisition on rev. 1 indicated normal functions. Reconnaissance operation commenced on rev. 5.

C. ORBIT CONTROL

The orbit parameters achieved were very close to nominal. Planned and actual parameters are compared in the following table:

REV. 2 ORBIT PARAMETERS

	Predicted	Actual
Period	90.04	90.04
Perigee (N.M.)	84.8	84.8
Apogee (N.M.)	215.1	213.8
Eccentricity	0.0182	0.0180
Inclination	80.00	80.08
Argument of Perigee	162	174.3

The DMU rockets were used to maintain the desired ground track throughout the flight. Five of the six rockets were utilized during the photographic mission. The last rocket was used for AGENA deboost after the second recovery. Operation of the DMU rockets was normal, for all firings:

DMU ROCKET OPERATION

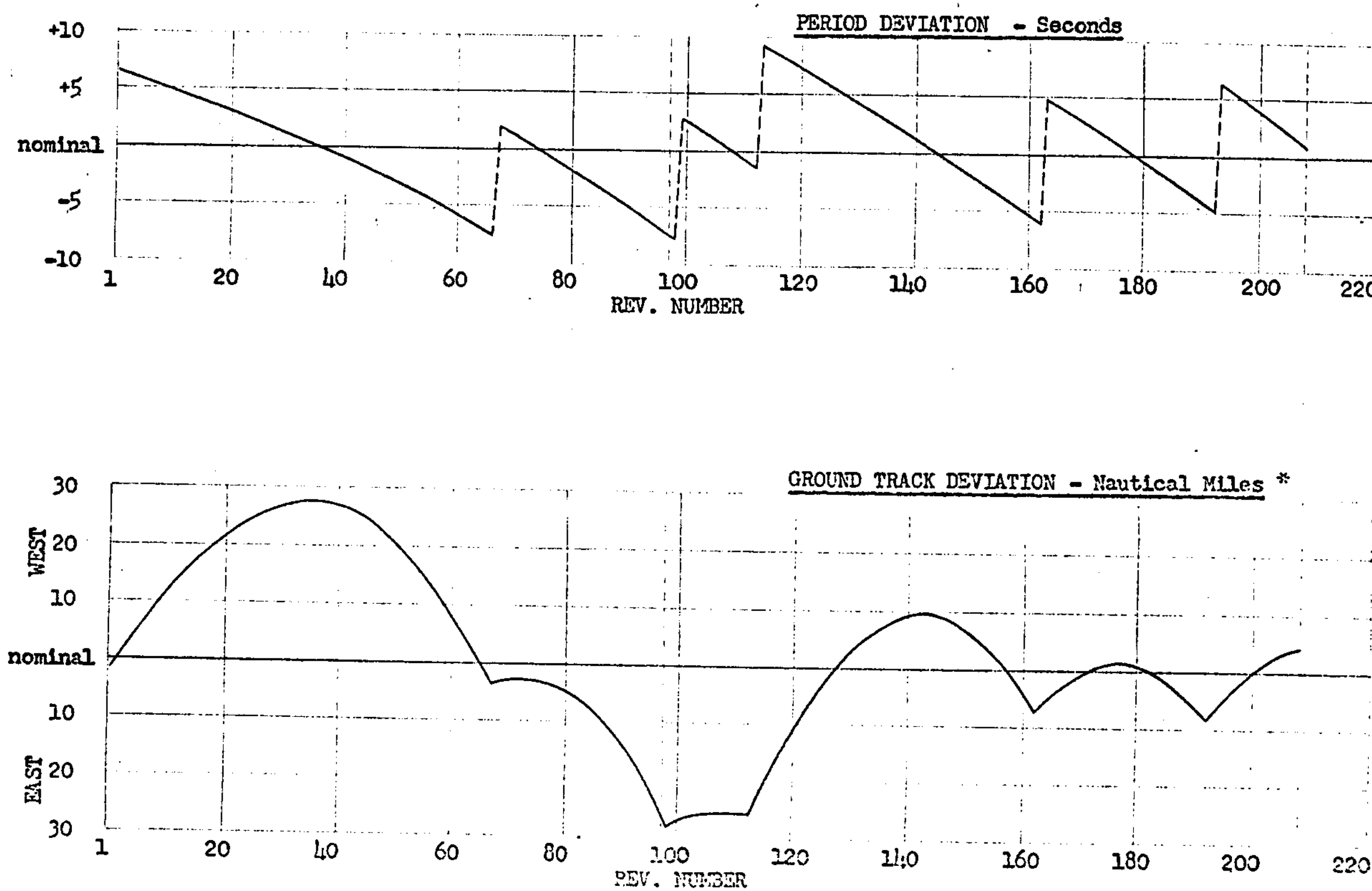
Rev.	Rocket No.	Velocity Change (FPS)	Period Change (Sec)
66	1	+15.35	+ 9.8
98	2	+16.8	+10.7
112	3	+17.6	+11.2
162	4	+17.6	+11.2
192	5	+17.45	+11.1
230	6 (Deboost)	-20.5	-13.0

Figure 3-1 shows the period variations and ground track deviations for the mission.

D. PANORAMIC CAMERA PERFORMANCE

Both panoramic cameras operated normally throughout the flight. Camera system dynamic operation, 99/101 percent clutch operation, start-up, shut-down, and transport functions were normal for all passes with telemetry data available. Response

Figure 3-1



* at equator; maximum values

to the exposure control system commands appeared normal, however Pan No. 1 response to slit width commands was not as rapid as Pan No. 2. Response to filter change commands was comparable. Cycle period data for the eleven engineering operations within range of [redacted] tracking station indicated both units cycling within 0.9 percent of preflight calibration, and within 0.5 percent of each other.

1. Film Consumption

The film supply was exhausted by both cameras during operation on rev. 200.

	Frames	
	Unit #1	Unit #2
Preflight samples	19	19
Prelaunch operations	165	164
First mission	2848	2836
Second mission	3034	3042
Total	6066	6061

2. FMC Programmer Operation

The FMC Programmer settings were generally good throughout the mission. Early in the flight, unexpected difficulty was experienced; the programmer started from 200 to 500 seconds earlier to the time anticipated according to the command settings. Correlation of apparent start times, telemetered power data, and flight command history revealed early starts to occur only on those revs. when real-time commands were transmitted during the interval the Delay Timer was operating, between the timer start brush command from the Orbit Timer and the actual programmer start. Real-time commanding was immediately restricted during that interval. Subsequent checks on non-photographic revs. demonstrated that the programmer was started by severe EMI noise on the unregulated 28 volt D.C. buss, which occurred at the time of command transmission. Tests at A/P with identical hardware duplicated the problem, showing noise spikes up to 180 volts causing premature shutdown of the Delay Timer. Circuit modifications to prevent recurrence of this problem have been incorporated for all subsequent CR systems.

Operations during revs. 1, 5, 6, 8, 9, and 22 were affected by the FMC Programmer start anomaly. Resulting FMC errors ranged as high as 29 percent.

3. FMC Match to Orbit

The FMC rate match to the orbit was generally adequate thruout the flight. During the first mission, over 73 percent of the frames from both cameras were taken with FMC rate errors of one percent or less. If the frames affected by the FMC Programmer delay start anomaly are disregarded, that value would rise to over 85 percent.

For the second mission, somewhat fewer frames were taken at FMC errors of one percent or less; over 42 percent of the forward-looking photography and 65 percent of the aft were within that limit. The lower trend is largely the result of operations near the equator or below. FMC match is normally optimized for coverage of the primary northern areas, and for perigee. As perigee rotated northwards, northern area coverage was not compromised by attempting to optimize southern area FMC match.

The difference between the two cameras during the second mission, as noted above, resulted from a slight reduction in the peak data values and a slight spreading of the values about the peak. However the 1.65 sigma level for the forward camera (2.12 percent) indicates a comparable data dispersion to the level for the aft (2.15 percent). The cause of the irregularities in the operating rates of the forward-looking camera are not yet known.

Plots of the V/H match, arrayed by camera and mission segment, are presented in figures 3-2 to 3-5.

4. Exposure Control

The exposure control programmer operated normally until rev. 159. On rev. 159 a command was issued during the time-out of the delay timer. This resulted in the delay timing out 43 seconds early. The same thing occurred again on rev. 175 resulting in a 23 second early time-out of the delay. These were the only two passes where the command was issued during the time-out or where an apparent anomaly occurred during the flight.

E. DISIC CAMERA PERFORMANCE

The DISIC system operated normally throughout the flight. All transport and internal camera control monitors indicated normal operation. Response to the exposure control and mode select commands were normal. Cut and splice and transfer to the second mission configuration was successfully commanded on rev. 88.

1. Film Consumption

The Terrain film supply was exhausted during the Stateside engineering operation (northbound) on rev. 200. Approximately 150 feet of film remained on the Stellar supply at the end of the second mission.

	Stellar Frames		Terrain
	Port	Stbd	Frames
Prelaunch operations			153
First mission	3572	3578	2098
Second mission	3800	3805	2446
Total	7372	7383	4697

FIGURE 3-2

MISSION 1101A1 ~~TOP SECRET~~ C[redacted] - CONTROL NO. [redacted]

FRAMES 1-6 OF EACH CP OMITTED 90 PERCENT = 3.2

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

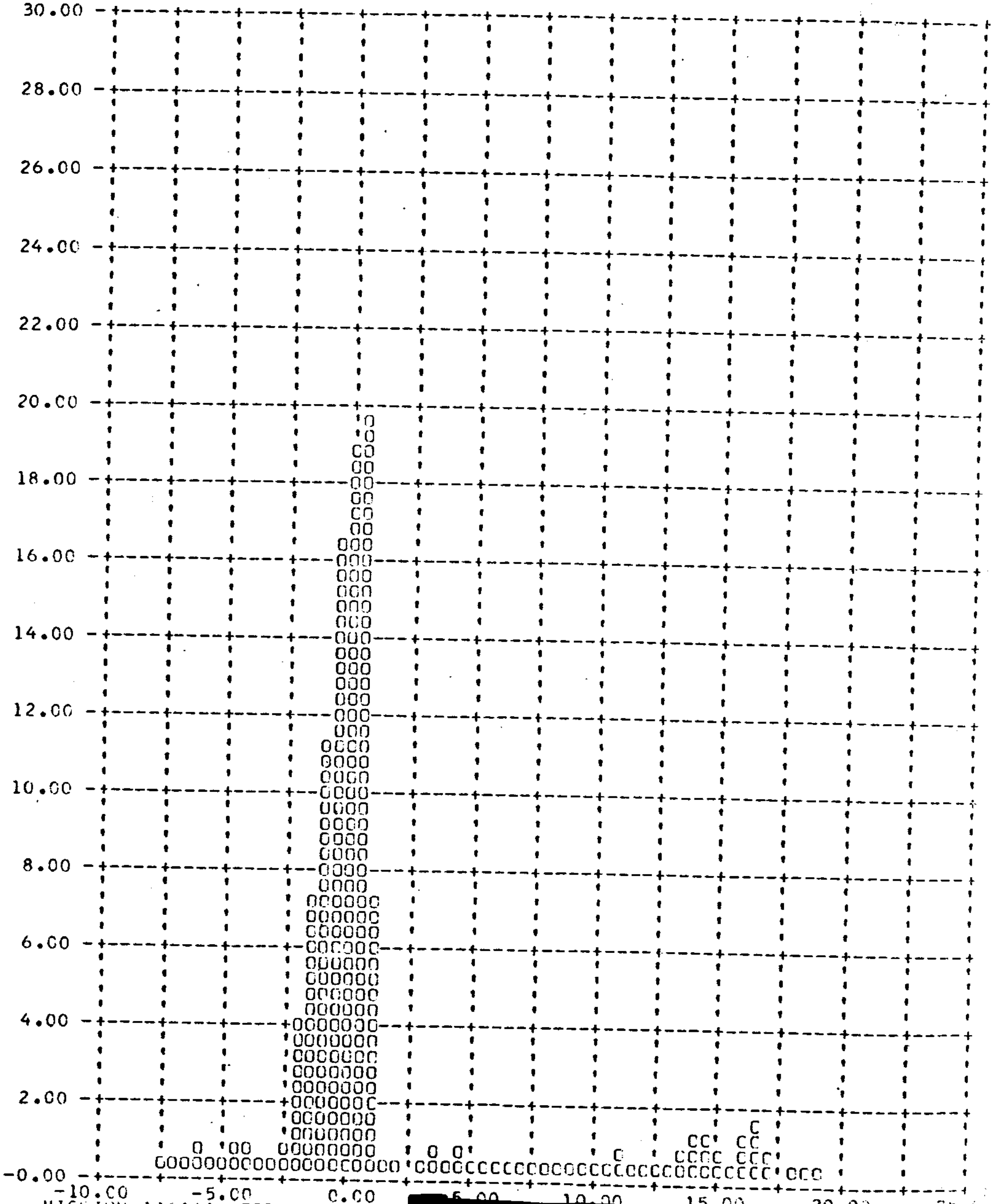


FIGURE 3-3

MISSION 1101A2 TOP SECRET C[redacted] - CONTROL NO. [redacted]

FRAMES [redacted] OMITTED 90 PERCENT = 8.31

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

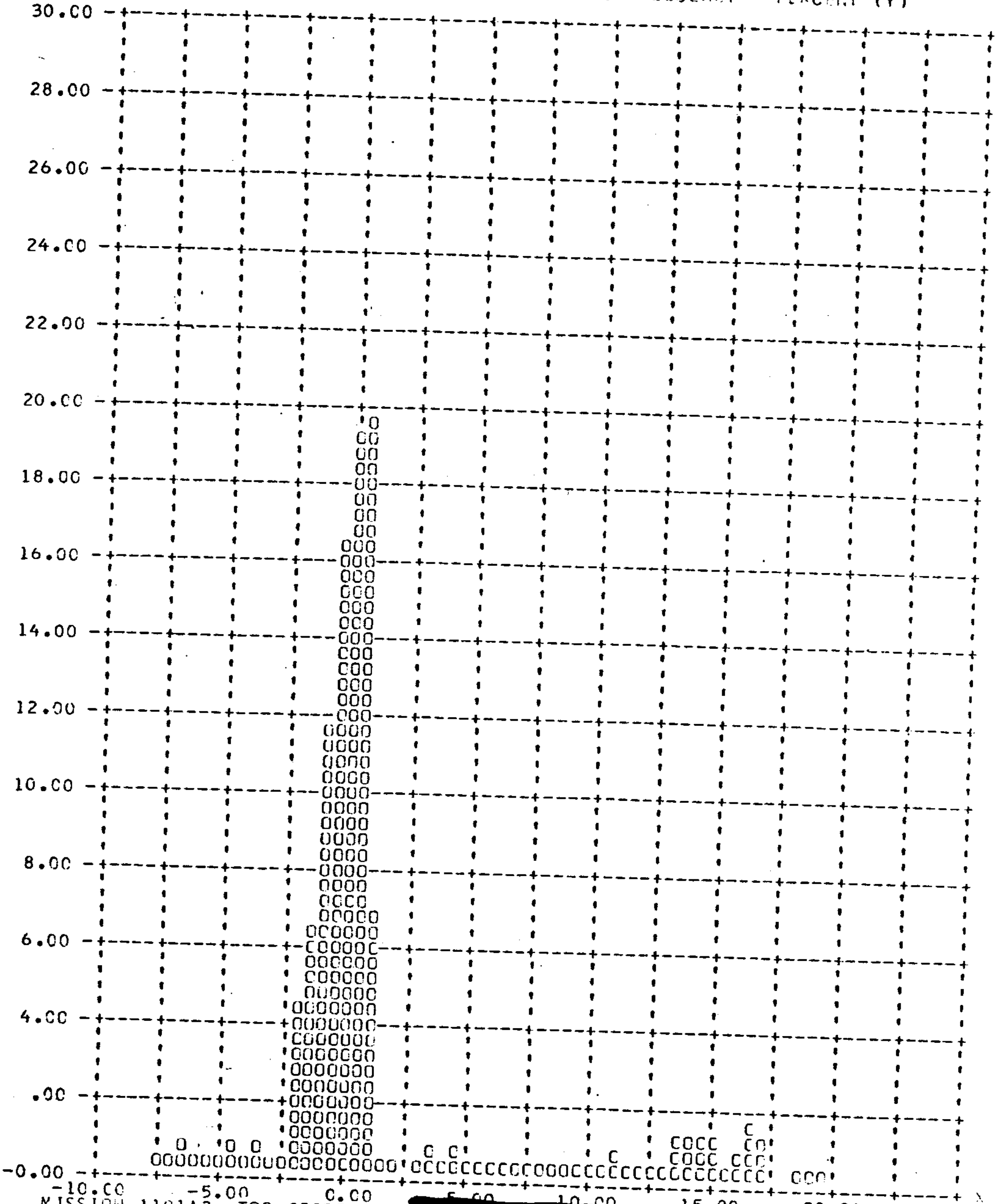
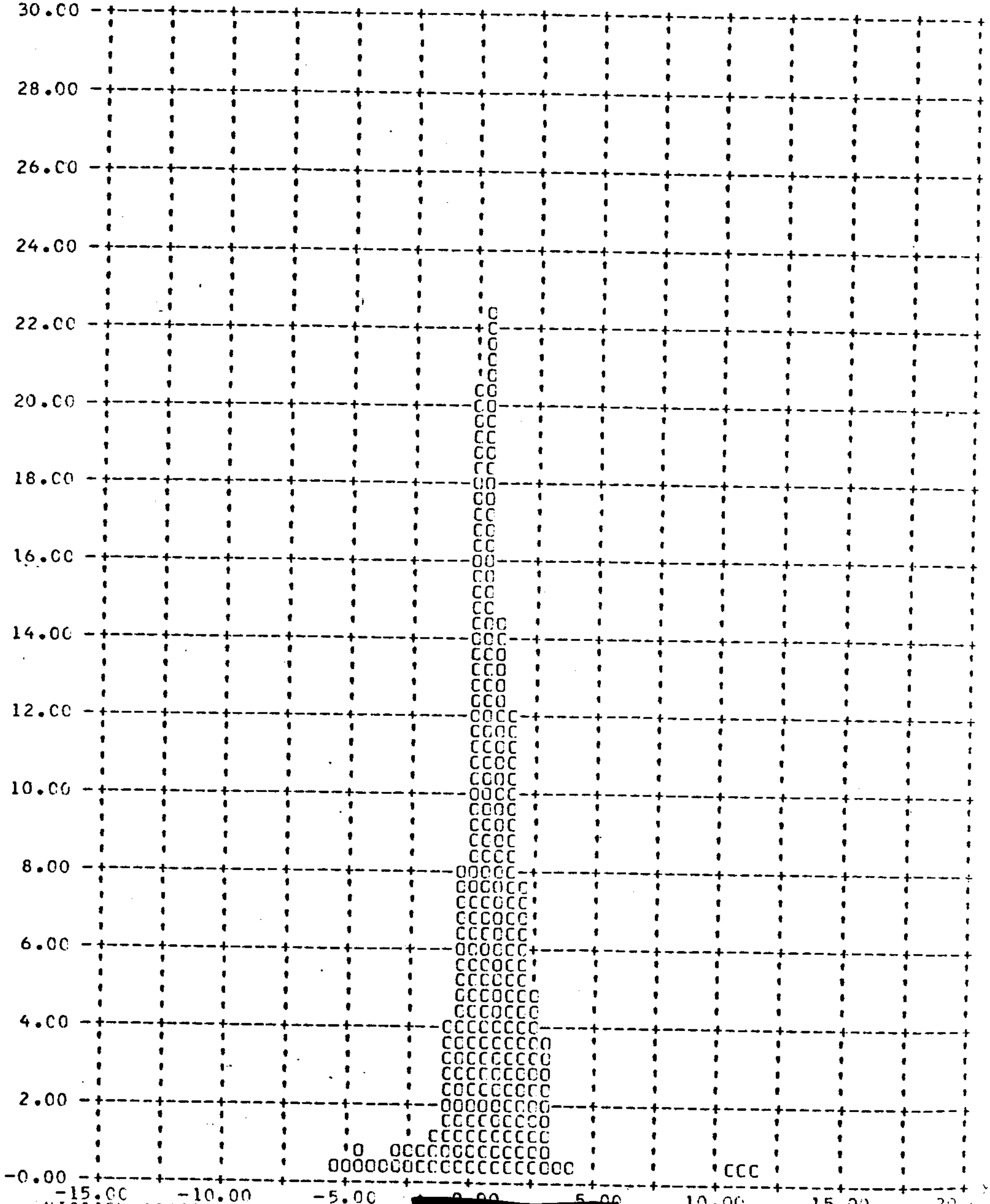
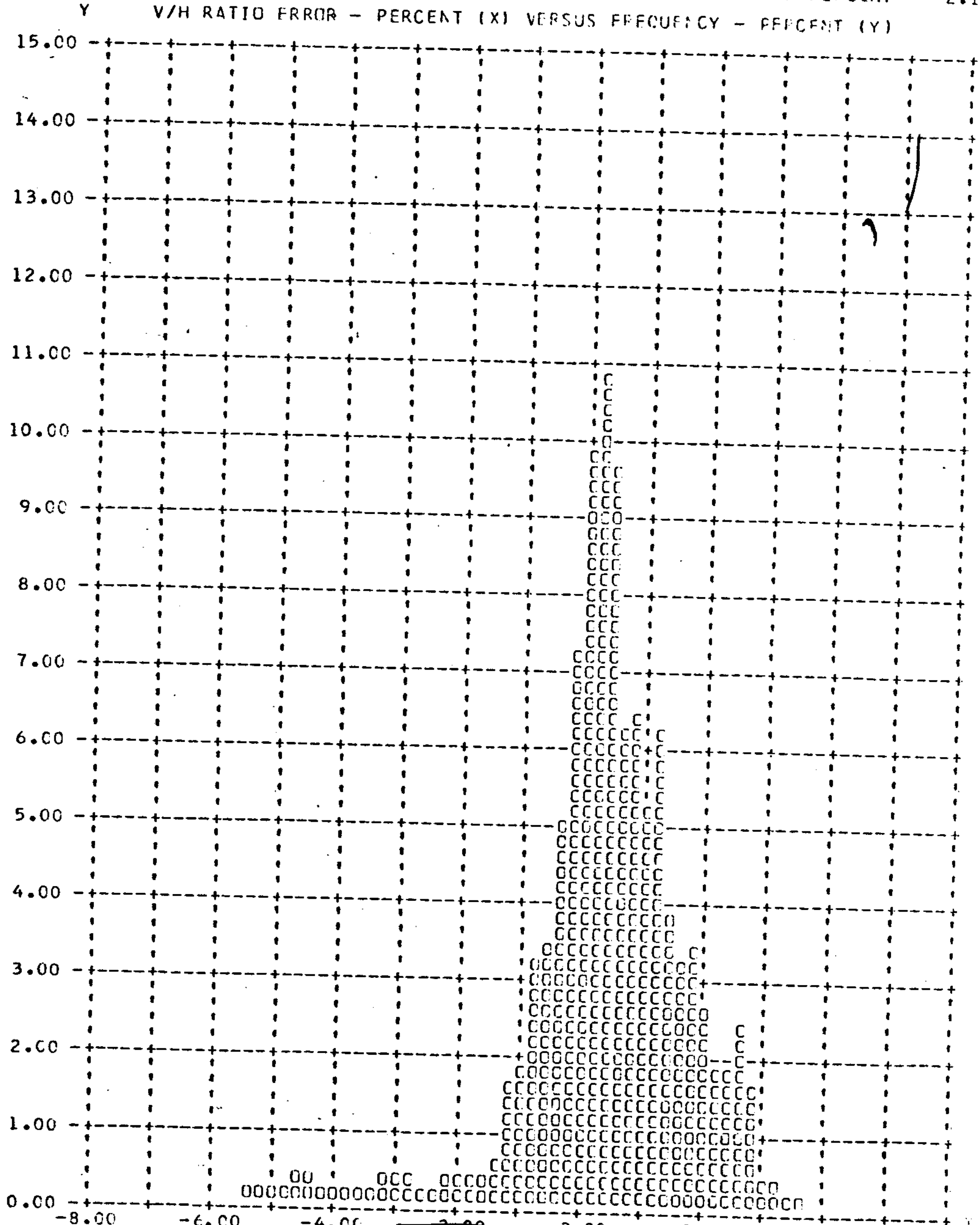


FIGURE 3-4

FRAMES 1-6 OF EAC[redacted] OP OMITTED 90 PERCENT = 2.15

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




Y
V/H RATIO ERROR - PERCENT (X) VERSUS FREQUENCY - PERCENT (Y)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-8.00
-6.00
-4.00
2.00