85

CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1115-1 and 1115-2

FTV 1662, CR-15

Approved [redacted] Manager
Advanced Projects

Approved [redacted] Manager

FOREWARD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1662.

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 1115-1 and 1115-2 which was launched on 10 September 1971.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

This report presents the final performance evaluation of Missions 1115-1 and 1115-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the CR-15 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 not available at LMSC for this flight.

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

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

This report contains certain data summarized from [redacted] Processing Summary, [redacted] and from AFSPPF Processing summary, Report No. [redacted]

SECTION 1

MISSION SUMMARY

A. MISSION OBJECTIVES

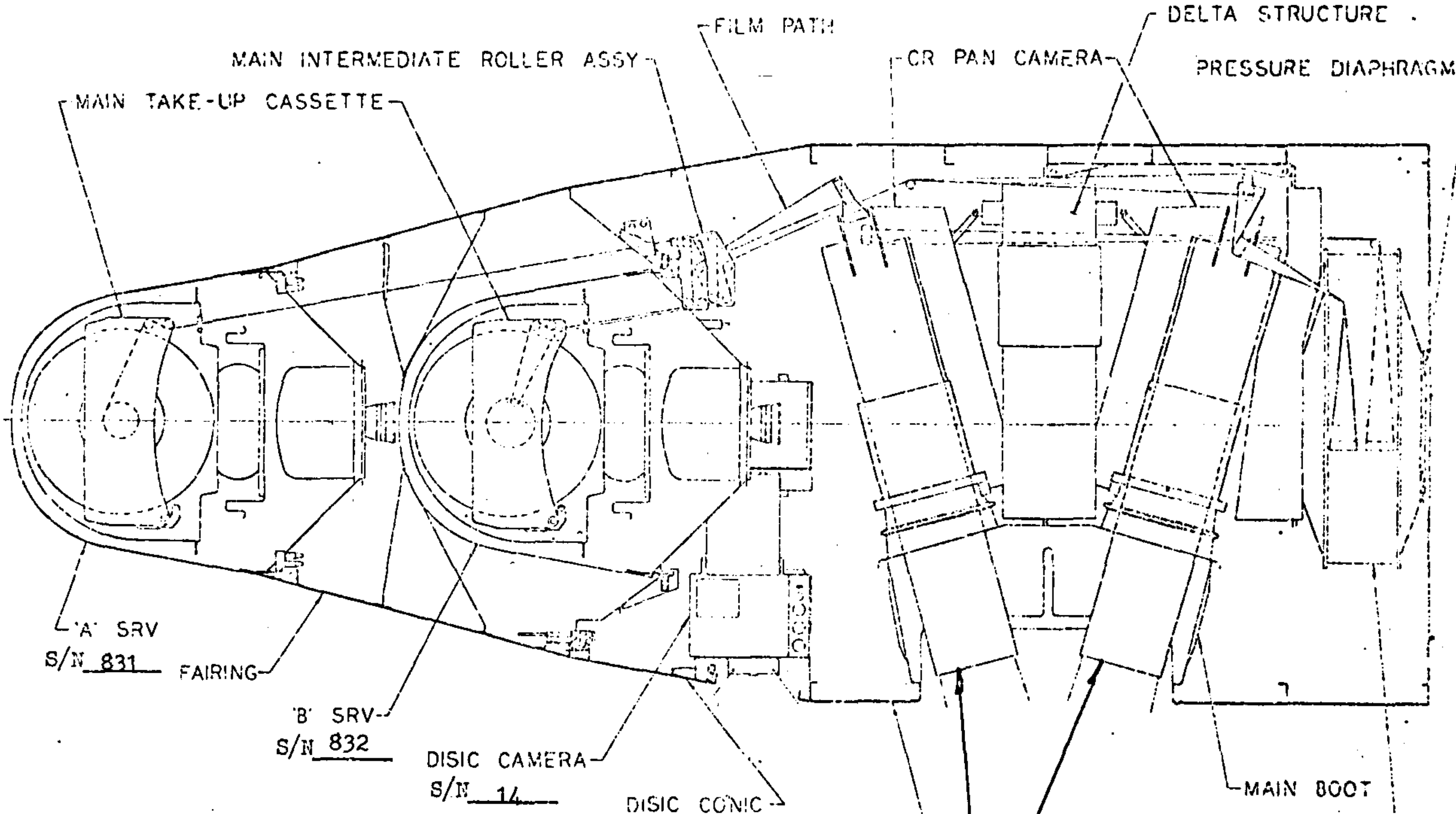
The payload section of Mission 1115, placed into orbit by Flight Test Vehicle 1662 and THORAD Booster #567, consisted of two panoramic cameras, one DISIC camera, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipment. Figure 1-1 presents an inboard profile of the CR-15 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 an eleven day -2 mission were planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2132:56Z(1432:56 PST) on 10 September 1971 from SLC-west pad. 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 1115-1 consisted of a 7-day operation and was completed by air recovery on Rev 115 at 1630 PDT on 17 September 1971. Mission 1115-2 was completed with an air recovery on Rev 309 on 17 September 1971 following a 12-day photographic operation.

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

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-15

TEST Flight Configuration

PMU S/N 1016

SLOPE PROGRAMMER S/N 212

CLOCK S/N 623

SWITCH PROGRAMMER S/N 218

TOP SECRET

HANDLE VIA [redacted]

ORBITAL PARAMETERS

Parameter	Predicted	Orbit 2 Actuals
Period (Min.)	88.43	88.53
Perigee (N.M.)	84.7	86.7
Apogee (N.M.)	137.0	136.3
Inclination (Deg.)	75.01	74.96
Eccentricity	0.0076	0.0071

DMU Operation. Ten DMU rockets were required during the mission life to maintain the orbit at the mean perigee altitude of 85 N.M. The rocket firings were selected to keep perigee between 82 and 88 N.M. and located between 23 to 63 degrees north descending. The ground track longitudinal error at the equator varied between 10 and 100 N.M. west of the nominal. The greatest ground track error occurred early in the mission as a result of the injection period of 88.53 minutes rather than the 88.43 nominally planned.

The rocket firings occurring in the second mission were largely selected with the objective of accessing a special target area.

C. PANORAMIC CAMERAS

Both panoramic cameras operated satisfactorily throughout both missions. The imagery from both cameras was rated as good for the -1 mission and retains its edge sharpness at 100 times magnifications. The conclusion was reached that instances of equally sharp imagery was produced in the -2 mission although it was generally of lesser quality than the -1 mission. It was felt that lack of the higher contrast, airfield/urban area scenes that facilitate image evaluation contributed to this conclusion. The film supply was 3414 material and was exhausted on Rev. 300 for both cameras.

D. DISIC CAMERA

The DISIC camera operated satisfactorily throughout both missions. Both the index and stellar films were exceptionally clean and free of anomalies. Approximately 10 to 15 port and 5 to 10 starboard point stellar images are present in most stellar frames and the image quality of the index record is generally good throughout both missions.

E. OTHER SUBSYSTEMS

The pressure make-up unit, the clock, command and instrumentation, and the thermal control subsystems performed satisfactorily throughout both missions.

The slope programmer which provides continuous V/h error correction failed to operate on passes 120 and 192 but was otherwise normal. V/h errors were maintained at less than ± 1% throughout 87% of the -1 mission and 70% of the -2 mission by the use of several flat ramps programmed throughout the mission.

The exposure control programmer operated satisfactorily throughout both missions. The tape recorder data from SRV-1 was unusable because of tape jitter. The tape recorder data from SRV-2 was extracted normally. The payload clock system performed normally throughout both missions with the tape recorder subsystem.

F. COMPONENT IDENTIFICATIONS AND SETTINGS

1. Forward Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	331
Main Camera Lens	I220
Supply Horizon Camera Lens	E40776
Take-up Horizon Camera Lens	E40785

Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Widths	
S_1	0.131"
S_2	0.167"
S_3	0.242"
S_4	0.334"
F/S	0.247"
Filter Types	
Primary	Wratten 25, 0.037" glass
Secondary	Wratten 25, 0.040" glass
Film Types	
Primary	Eastman Type 3414 (16,300 Ft.)

Supply (Port) Horizon Camera:

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

Take-up (Starboard) Horizon Camera:

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

2. Aft Looking Panoramic Camera

a. Component Assignment

Component	Serial Number
Main Camera	330
Main Camera Lens	I219
Supply Horizon Camera Lens	E40770
Take-up Horizon Camera Lens	E28517

b. Camera Data and Flight Settings

Main Camera:

Lens	24"f/3.5
Slit Widths	
S_1	0.122"
S_2	0.154"
S_3	0.204"
S_4	0.287"
F/S	0.200"
Filter Types	
Primary	Wratten 23, 0.037" glass
Secondary	Wratten 23, 0.040" glass
Film Types	
Primary	Eastman Type 3414 (16,300 Ft.)

Supply (Starboard) Horizon Camera:

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

Take-up (Port) Horizon Camera:

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

3. <u>DISIC Camera</u>

a. Component Assignment

Component	Serial Number
Camera	14
Index Reseau	115
Stellar Reseaus	
Port	15P
Starboard	13

b. Camera Data and Flight Setting

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.

After concluding the satisfactory performance of preliminary baseline adjustments to the camera systems and other flight systems; a light leak test and pre-chamber vibration test were successfully performed and the CR-15 flight system was prepared for environmental testing. Significant baseline levels and anomalies experienced during the environmental testing are as follows:

A. ENVIRONMENTAL TESTING

The CR-15 payload system was environmentally tested in the Sunnyvale HIVOS chamber between October 6 and October 16, 1970.

Pan Instruments. Two types of payload material (3400 and 3414) were used in the panoramic cameras. The normal 3400 and 3401 film was used in the DISIC Terrain and Stellar units respectively.

Both pan cameras demonstrated acceptable performance at all pressures on the 3414 material. However, there was excessive dendritic marking on the 3400 material which was used for special spot testing. The processed material from both units was virtually free of the spots found on mission 1110 and 1111 flight material. Because of this the results of the test using anti-stat on one instrument, but not the other are inconclusive.

All required data was present and satisfactory on the processed material from both instruments.

DISIC Camera System. The material from the DISIC instrument No. 14 contained no serious anomalies. The stellar material was continuously marked by the skew roller bead along one edge but not affecting the format area. There were minor dendritic marks along the SLP edge of the terrain material outside the format area.

Material from the DISIC 'terrain' unit was free of corona when the PMU was on. Approximately 10 frames of the total material had corona marking when the PMU was off.

The material from the DISIC 'stellar' unit was free of corona marking with the PMU on but with PMU off, there was unacceptable corona marking. A waiver was provided for this anomaly.

The DISIC unit performed satisfactorily throughout the -1 mission and appeared to fail near the end of the -2 mission. During a long operation of the DISIC unit, T/M indicated an apparent problem in the terrain take-up. This problem was also reflected in the terrain metering idler. The unit was disabled prior to completing the -2 mission per New York request. Post chamber investigation revealed no apparent failure had occurred; hence, both T/U units were sent to New York for a special thermal altitude test. Satisfactory results were achieved and the take-ups were returned for use in the flight system after necessary modifications were made.

Other Payload Subsystems. The command and instrumentation subsystems, slit-sequencing programmer, orbital function generator, A and B tape recorders and the payload clock subsystems all performed satisfactorily. The pressure make-up subsystem was modified for CR-15 to provide pressurization for the DISIC camera during independent operations.

B. DR. ASCHENBRENNER GRID TEST (A.G.T.)

On November 12, 1970, a separate A.G.T. test was performed on both instruments to determine the film flatness characteristics during the scan cycle. Point by point evaluation by both L.M.S.C. and ITEK personnel of the Dr. 'A' processed test film showed that the film flatness during the scan cycle was at an acceptable level within the ± 0.0007 specification limits.

C. RESOLUTION TESTS

Initial resolution and theodolite tests at L.M.S.C. were performed on November 20, 1970. Both pan instruments successfully passed the acceptance criteria at that time. However, both instruments were reshimmed and retested on the 27th of May 1971 to meet predicted thermal requirements for a June 1971 launch. Because the actual launch date was delayed until September 10, 1971, the pan instruments were reshimmed to meet the latter thermal prediction requirements. Low contrast target resolution values for all three dates are tabulated for comparison below. These values point out the shift in location from collimator 'zero' of peak resolution values between the .037" thick primary filter and the .040" secondary filter. These values also point out the shift in location from collimator 'zero' of peak resolution values when shims are added or removed from the platten assemblies of the main instruments. In addition, the final resolution test values for both instruments are shown in figures 2-1 and 2-2.

Resolution Test Data

	Inst. #330		Inst. #331	
	pri.	sec.	pri.	sec.
Filter	W-23	W-23	W-25	S-25
Thickness	0.037"	0.040"	0.037"	0.040"
Test Date 11-23-70				
1/mm	180	165	212	204
Location	0.000"	+0.001"	-0.0002"	+0.0008"
Test Date 5-27-71				
1/mm	145	150	180	190
Location	-0.0008"	+0.0002"	-0.0002"	+0.0007"
Test Date 8-10-71				
1/mm	168	175	175	172
Location	-0.0003"	+0.0008"	+0.0002"	+0.001"

PRE-FLIGHT DYNAMIC RESOLUTION

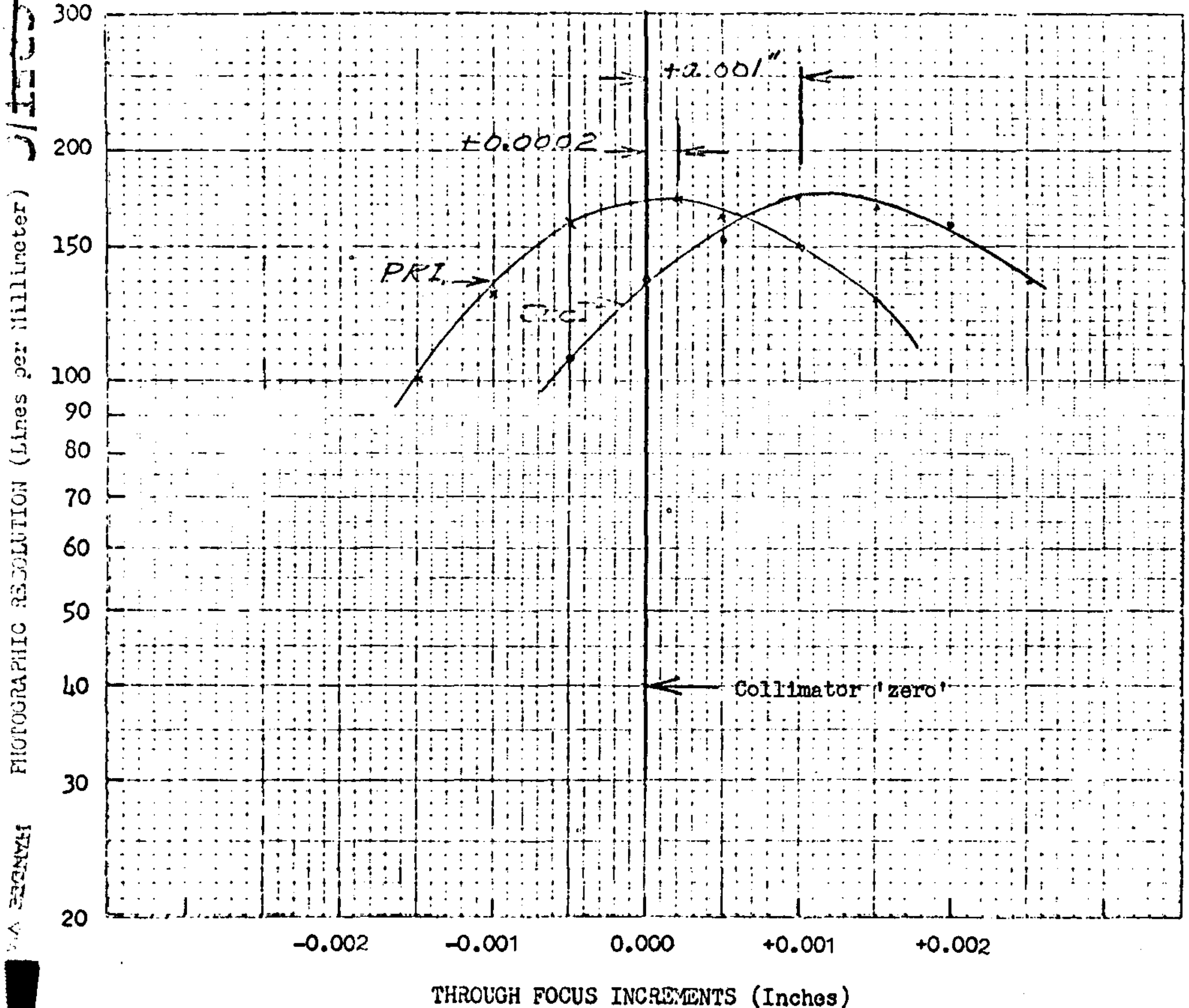


FIGURE 2-1

Camera No: 331

Payload No: CR-15

Resolution (1/mm)

High Contrast:

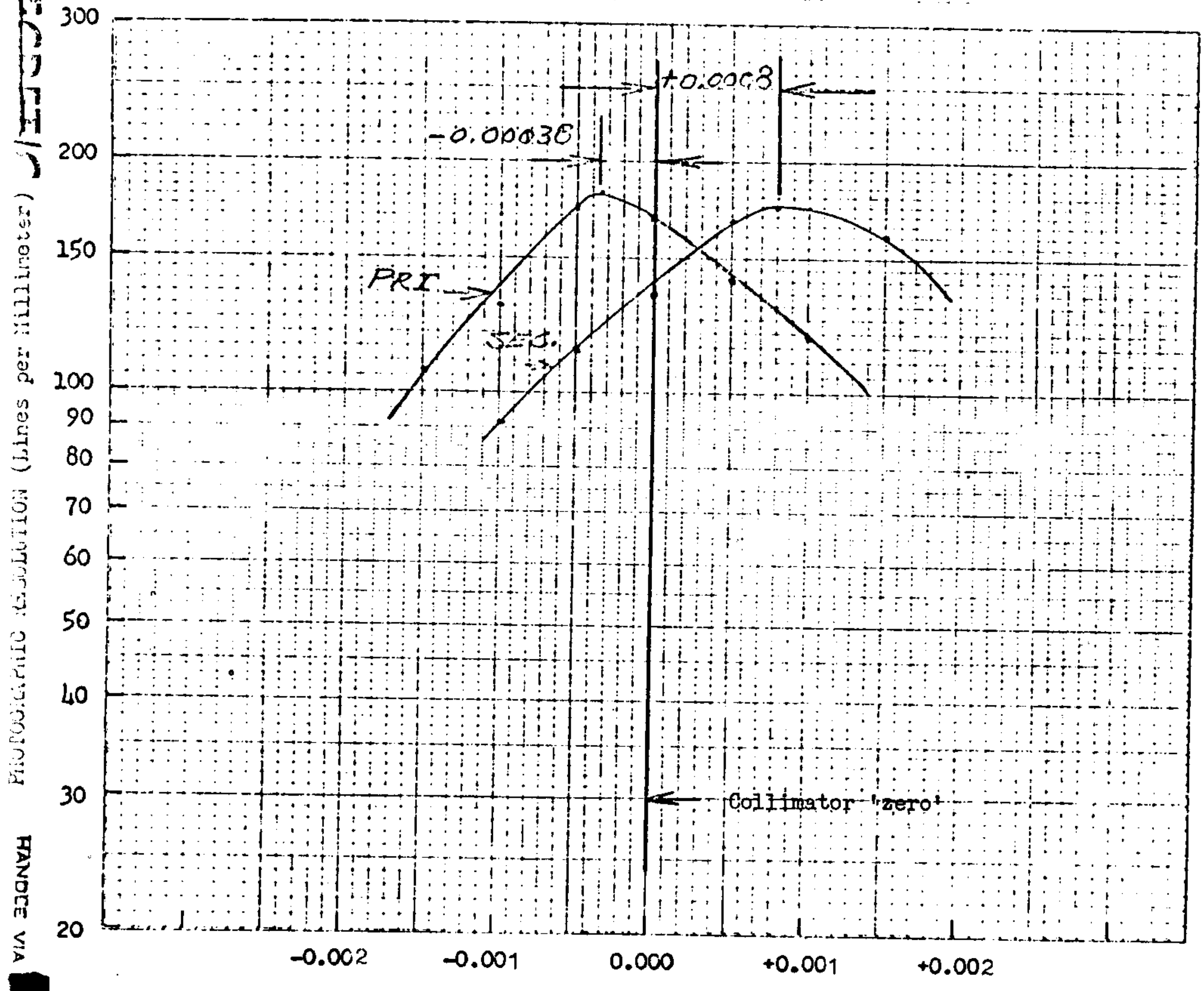
Low Contrast: Below

Film Type: 3414

Test Date: 8-10-71

pri. W-25,0.037" Glass
sec. W-25,0.040" Glass

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 330

Payload No: CR-15

Resolution (1/mm)

High Contrast: ----

Low Contrast: Below

Film Type: 3414

Test Date: 8-10-71

pri. W-23, 0.037" Glass

sec. W-23, 0.040" Glass

FIGURE 2-2

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Mission 1115 utilized a Thorad booster (SLV-2H) S/N 567, Agena Vehicle 1662, and payload system CR-15. The CR-15 payload system contained panoramic cameras S/N 330 and 331, and DISIC camera S/N 14.

Lift-off occurred at 14:32:56 PDT on 10 September 1971 from the Vandenberg SLC-3 west pad. All payload ascent events were normal with In-flight Reset (door ejection), AP to Orbit mode, instrumentation switchover, and panoramic camera transfer to orbit mode occurring as programmed. The orbit attained was within the three sigma of predicted.

Panoramic cameras S/N 330 and 331 performed normally throughout the flight. The film supply of both cameras was exhausted on Rev 300.

The DISIC camera system S/N 14 performed normally throughout the flight. This was the last DISIC camera system to be flown on the Corona program.

The panoramic camera A-to-B transfer sequence was performed on Rev 105 and the DISIC camera A-to-B cut and splice sequence on Rev 107. Both the panoramic and DISIC camera A-to-B sequences were normal. The -1 mission recovery capsule was recovered by air catch on Rev 115 at 1630 PDT on 17 September 1971. The -2 mission recovery capsule was recovered by air catch on Rev 309 at 1402 PDT on 29 September 1971. The Lifeboat recovery system was utilized for the -2 capsule recovery because the primary recovery select command decoder was locked out due to a diode failure in the +20 VDC converter. All Lifeboat systems performed normally.

The SRV-1 tape recorder data was unusable because of tape jitter during recording which prevented the AGE processor from syncing on the data. The SRV-2 tape recorder system performed normally with all data extracted.

The slope programmer eccentricity function failed to operate on passes 120 and 192 but was otherwise normal.

The clock system, command and instrumentation system, pressure make-up system, and the thermal environment were normal throughout the flight.

B. PANORAMIC CAMERAS

Panoramic cameras S/N 330 and 331 performed normally during the -1 and -2 missions. Film consumption and type were as follows:

Film Consumption	Frames	
	Pan 330	Pan 331
Sample	24	24
Pre-launch	191	191
-1 Mission	2950	2945
-2 Mission	3016	3019
Total	6181	6179

Film Supply Length and Type

Pan 330	Pan 331
16300 FT/3414	16300 FT/3414

C. DISIC CAMERA

The DISIC camera system performed normally throughout the -1 and -2 missions. This was the last DISIC camera to be flown on the Corona program. Film consumption and type were as follows:

Film Consumption

	Frames (Terrain)
Sample	12
Pre-launch	133
-1 Mission	2472
-2 Mission	2616
Total	5233

Film Supply Length and Type

Terrain	Stellar
2200 FT/3400	2000 FT/3401

D. COMMAND AND CONTROL SUBSYSTEMS

Command System. The stored Programmer Command brush 45 apparently shifted its index point during ascent. When utilizing a brush 45 as an "on" or "off" brush, the instrument operate command would occur approximately 2 seconds early. This resulted in some instrument operations to be either short or long in duration depending on whether brush 45 was used as an "off" or as an "on" brush. Due to normal "padding" required for orbital timer tape punching, this anomaly did not seriously degrade operational coverage.

Forward Motion Control (FMC) Generator. The ramp to orbit match was maintained satisfactorily throughout the flight. Approximately 87% of the first mission operations and 70% of the second mission operations were less than ± 1.0% mismatch error. The increase in the -2 mission mismatch error was caused by the utilization of flat ramps. The eccentricity programmer failed to start on two revs (120 and 192), thus necessitating the use of a flat ramp when the verification of the eccentricity programmer operation was not possible. A flat ramp was used on 21 of 73 operations after Rev 120. This particular kind of failure has not been experienced previously on any other system.

The most probable cause(s) of the programmer failure are (1) a dirty or bent brush on the orbital programmer, (2) the controller failed to start, (3) the control relay failed to respond, (4) a broken wire or loose connection.

Additional testing of the remaining flight programmers is being conducted in conjunction with the 400 cycle motor replacement to insure satisfactory operation.

Exposure Control Subsystem. The slit width control programmer performed satisfactorily throughout the -1 and -2 missions.

E. DATA SYSTEMS

Instrumentation. The instrumentation system performed satisfactorily throughout the -1 and -2 missions. The pan and terrain door separation telemetry monitor changed from a both "on" condition to the terrain "off" condition during "Pogo" in Ascent, and then changed to the proper position of both doors "off" later during Ascent. This condition was attributed to an adjustment of the microswitch.

Clock System. The payload clock system performed satisfactorily throughout the -1 and -2 missions. The third order fit was determined to be the most desirable for computations. The third order constants and coefficients are:

Third Order Fit

$$\text{System Time} = A_o + A_1 \text{ (Clock Time)} + A_2 \text{ (Clock Time)}^2 + A_3 \text{ (Clock Time)}^3$$

A_o = -0.2803944729530378 D 06

A_1 = +1.000000070220526 D 01

A_2 = -.1163614458769420 D - 12

A_3 = +0.2676357033049752 D - 19

Sigma = 0.00042562

Number of points = 330

<u>SRV Tape Recorder</u>. The -1 SRV tape recorder data was unusable because the AGE processor could not sync on the data. It was determined that a faulty drive belt produced excessive tape jitter thus preventing data retrieval. The -2 SRV tape recorder performed normally throughout the -2 mission with 104 minutes of data retrieved satisfactorily.

F. RECOVERY

<u>-1 Mission</u>. The -1 recovery capsule was successfully recovered by air catch on Rev 115 at 1630 PDT on 17 September 1971. All re-entry events were within tolerance with the impact 10 miles north of predicted.

	Actual	Predicted
Impact Location	$22^{\circ}44'N/160^{\circ}53'W$	$22^{\circ}58'N/160^{\circ}56'W$

<u>-2 Mission</u>. The -2 recovery capsule was successfully recovered by air catch on Rev 309 at 1402 PDT on 29 September 1971. All re-entry events were within tolerance with the impact within 5 miles of the predicted.

	Actual	Predicted
Impact Location	$22^{\circ}05'N/162^{\circ}41'W$	$22^{\circ}00'N/162^{\circ}34'W$

G. ORBITAL PARAMTERES

The orbit achieved was within the predicted 3 sigma dispersion. The following tabulation describes the orbital parameters based on Rev 2, both predicted and actual.

Orbital Parameters.

Parameter	Predicted	Tolerance	Actual(STC)	Actual(APF)
Period(Min.)	88.43	+.27,-.33	88.52	88.53
Perigee(N.M.)	84.7	± 7	86.1	86.7
Apogee(N.M.)	137.0	+9,-14	136.3	136.3
Eccentricity	.0076	+.0015,-.0024	.0071	.0066
Inclination(Deg.)	75.01	+.21,-.15	74.94	74.96
Arg. of Perigee(Deg.)	134	+71,-62	146.8	147

Orbital history of perigee altitude, perigee latitude, period error and longitudinal error are shown in graphs 3.1 and 3.2. The latitudes and altitudes of operations are shown on graph 3.3.

Figure 3.1

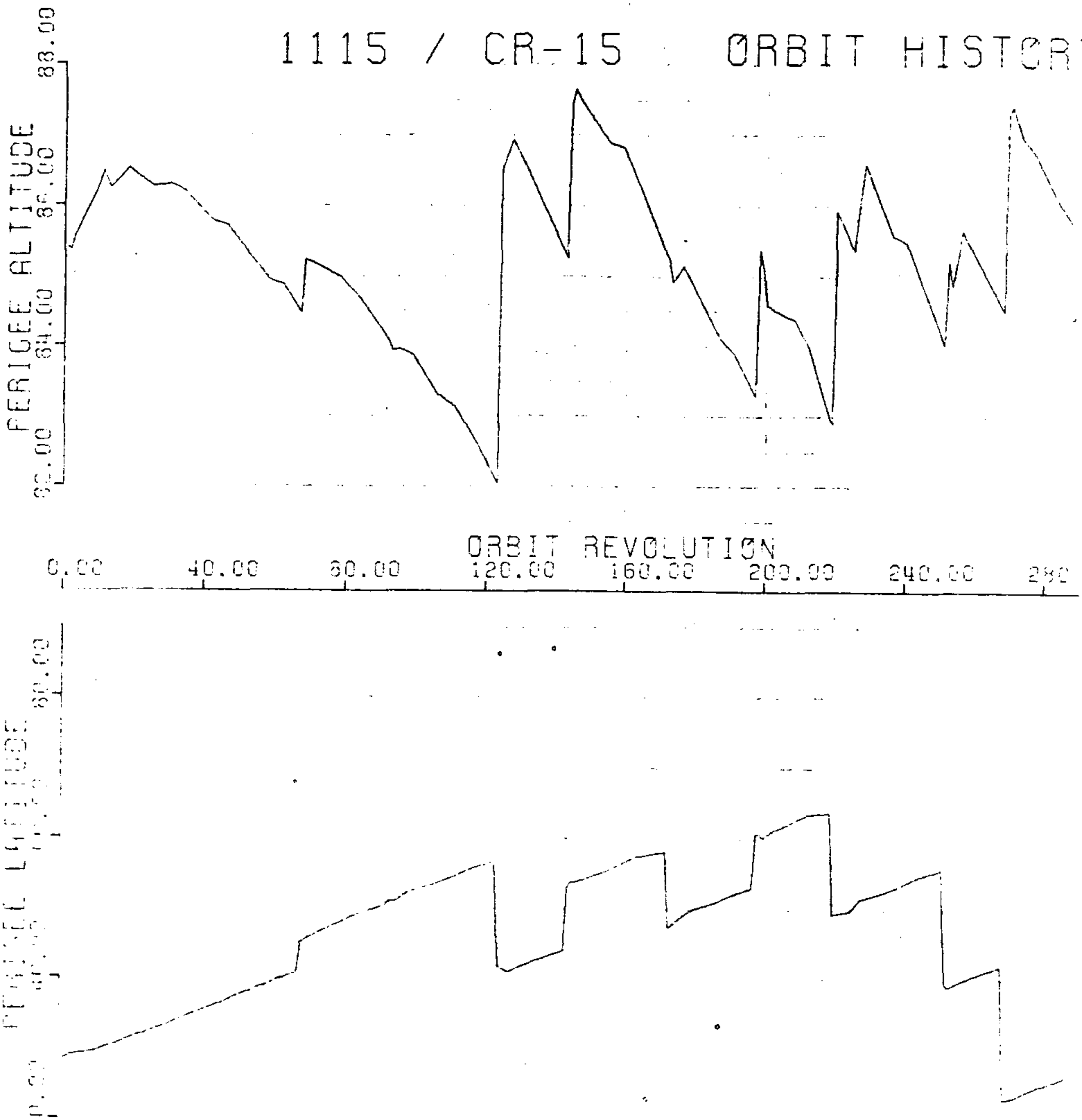
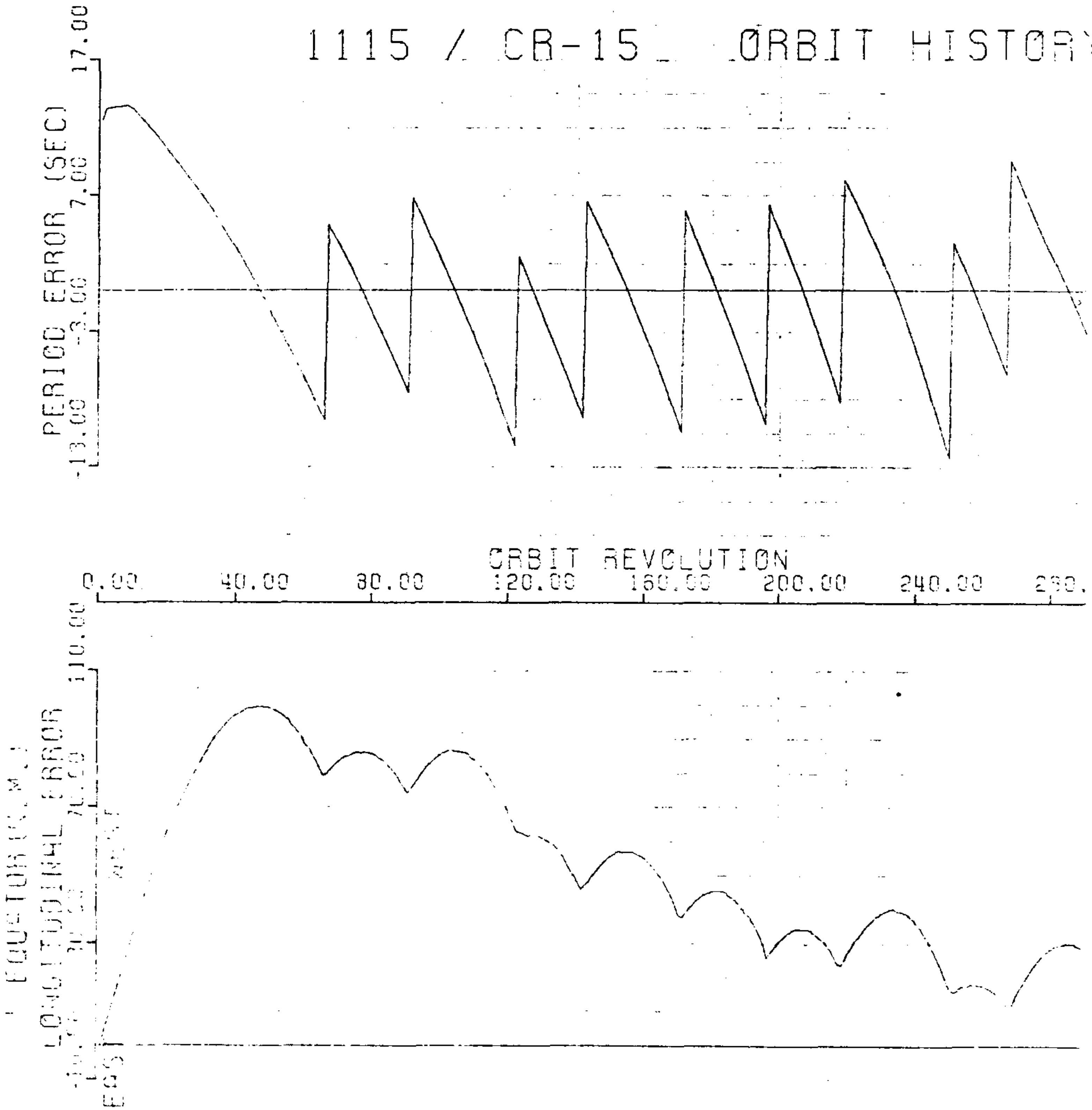
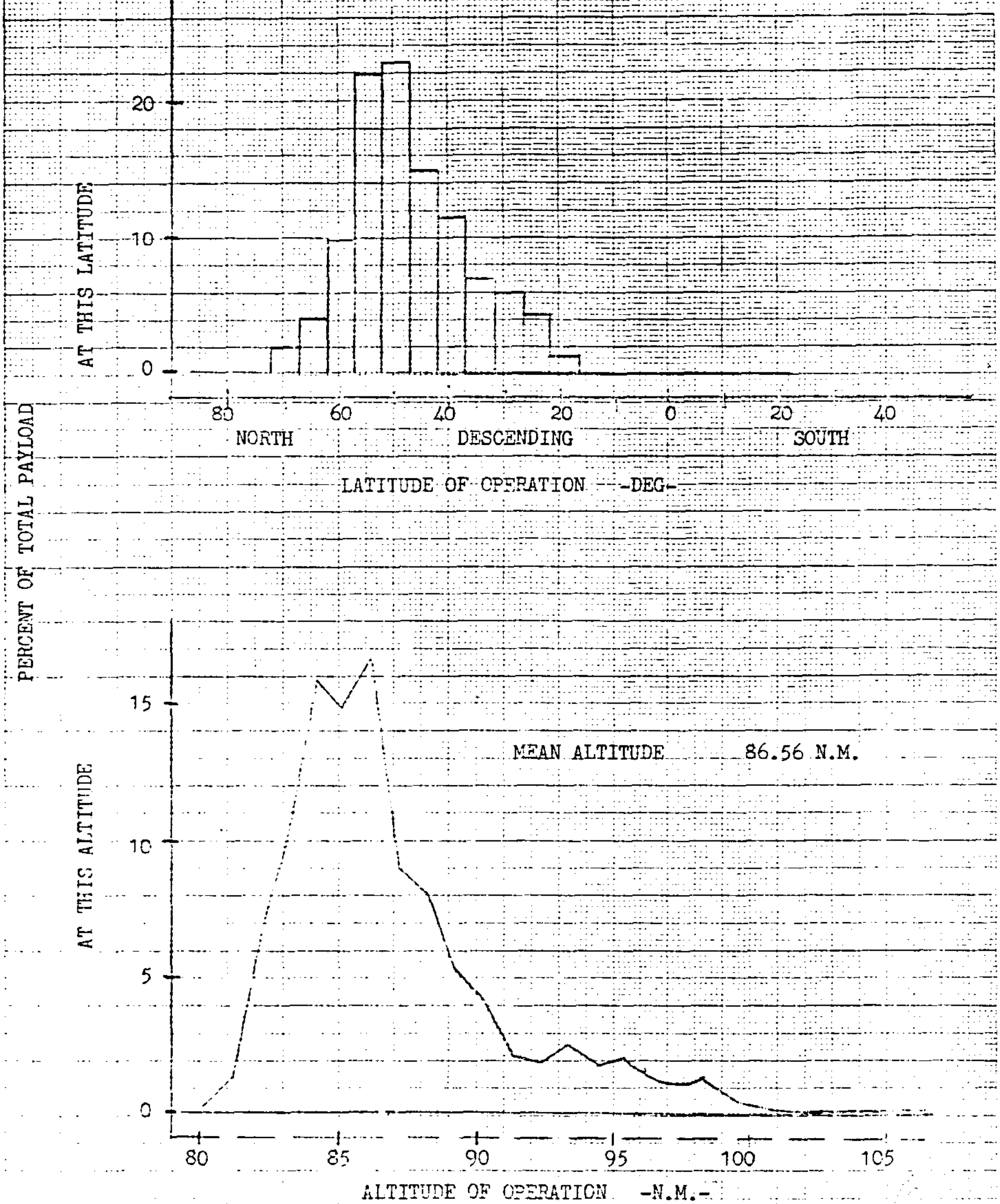

1115 / CR-15 ORBIT HISTOR
PERIGEE ALTITUDE
88.00
86.00
84.00
82.00
ORBIT REVOLUTION
0.00
40.00
80.00
120.00
160.00
200.00
240.00
28

Figure 3.2


1115 / CR-15 ORBIT HISTOR
PERIOD ERROR (SEC)
17.00
7.00
-3.00
-13.00
ORBIT REVOLUTION
0.00
40.00
80.00
120.00
160.00
200.00
240.00
110.00
70.00
30.00
LONGITUDINAL ERROR
EQUATOR (N. M.)
EAST
WEST

1115/CR15/1662

Figure 3.3



H. DMU OPERATION

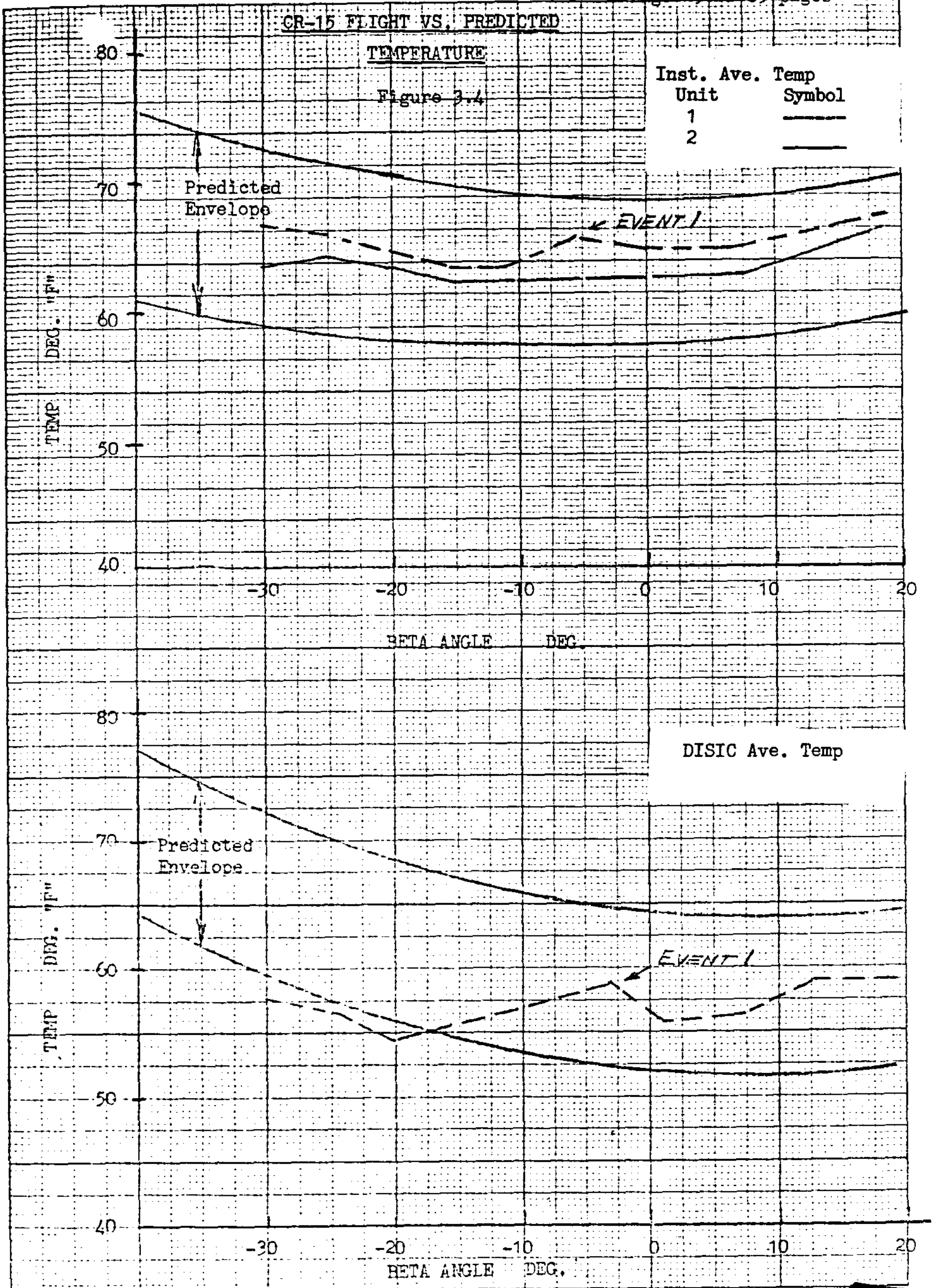
Ten DMU rockets were required during the mission life to maintain the orbit at the mean perigee altitude of 85 N.M. The rocket firings were selected to keep perigee between 82 and 88 N.M. and located between 23 to 63 degrees north descending. The ground track longitudinal error at the equator varied between 10 and 100 N.M. west of the nominal. The greatest ground track error occurred early in the mission as a result of the injection period of 88.53 minutes rather than the 88.43 nominally planned.

The rocket firings occurring in the second mission were largely selected with the objective of accessing a special target area.

DMU Performance.

Rocket No.	Rev No.	System Time (Sec)	Period Change (Sec)	Velocity Change (FT/Sec)	Period at Firing (Min)	Impulse (Lb/Sec)
1	66	81905	14.96	23.90	88.15	3088
2	91	41618	14.65	23.46	88.18	3014
3	122	34507	16.75	26.76	88.08	3075
4	142	52144	16.38	26.20	88.15	2987
5	171	33927	16.20	25.92	88.13	2918
6	197	84209	17.00	27.12	88.13	3052
7	218	24137	16.30	26.07	88.17	2929
8	250	20850	16.90	26.95	88.09	2999
9	267	24946	16.35	26.14	88.19	2890
10	292	69530	17.00	27.18	88.23	2989

NOTE: DMUs No. 11 and 12 were fired after Event II.



CR-15 FLIGHT VS. PREDICTED TEMPERATURE

Figure 3.4

I. ENVIRONMENTAL CONTROL

Pressure Make-up Subsystem. The pressure make-up system (PMU) operated properly throughout the flight. There were 123 panoramic camera operates for a total of 188.5 minutes which resulted in a gas consumption rate of 4.9 psi/min of operate time. There were 262 DISIC camera operates for a total of 692.7 minutes for an alternate level gas consumption rate of 1.5 psi/min of operate time.

Thermal Environment. The temperature data obtained during this flight indicated the temperature environment was within the pre-flight predictions for the duration of the flight. The averages of the panoramic camera temperatures ranged from 62°F to 68°F for S/N 330 and 62°F to 67°F for S/N 331 during the -1 mission and 64°F to 69°F for S/N 330 and 62°F to 68°F for S/N 331 during the -2 mission.

J. POST EVENT 2 TESTING

The panoramic and DISIC cameras were enabled at the end of the orbital timer tape in order to deplete the surplus vehicle power. No other payload testing was performed.

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

Both panoramic cameras were operational throughout both missions. The film supply for the forward-looking camera #331 was exhausted on frame 67 of Rev 300 and the aft-looking camera #330 supply was exhausted on frame 58 of Rev 300.

An MIP rating of 120 was assigned to frame 10 of Rev D016 from the forward-looking camera for the 1115-1 mission. The image quality of the forward-looking camera was comparable to that of Mission 1114. The image quality of the aft-looking instrument records for the -1 mission was also comparable to that of Mission 1114 although the overall image quality was assessed to be somewhat less than the quality of the forward records.

It was concluded that the image quality of the 1115-2 mission records was generally less than the -1 mission and an MIP rating of 110 was assigned to this segment. However, the best image quality of the -2 mission is comparable to the image quality of the -1 mission.

The DISIC terrain and stellar cameras were operational throughout both missions. The processed records were exceptionally clean and free of anomalies throughout both missions. The image quality of the terrain records was rated as generally good and most stellar frames revealed satisfactory point type images.

B. PANORAMIC INSTRUMENTS

The forward-looking camera produced 6179 frames and the aft-looking camera produced 6181 frames during both mission segments. No action items resulted from the PET meeting since only characteristic anomalies having a minor effect on performance were noted on the mission records. There were random intermittent plus density spots on the formats of both camera records on passes following the recovery on Rev D115. Also there were characteristic fog patterns on the 8th and 9th frames from the end of pass on the forward camera and similar patterns on the aft records on the 6th and 7th frames from the end of pass. These shadow-graphs result from light leakage in the payload system forebody. Occasionally the rail holes in the aft camera records were faintly imaged at the start of scan throughout both missions. The susceptibility of the aft camera to this problem was noted during systems test at which time the lamp intensity was diminshed to preclude 'blooming' on the film and consequently the lamp start-up was sometimes delayed because of low voltage on the rail lamp. A diagonal tear across the film web was detected during presplice on frame 190, Rev D104 of the aft camera record. Analysis of the tear specimen, only one side of which was available, showed proper exposure and imagery. There were extensive stress and tension lines in the immediate location of the tear. The conclusion was reached that the off-spooling operation was the most probable cause of the tear. The system cut and wrap function cinches approximately 100 inches of film that is double wrapped around the take-up hub by passing through a double set of rollers. This requires the spool to abruptly reverse directions during off-spooling and may damage the tag end of film if it is done without precaution.

A fog pattern was present on the latter part of frame 160 and start of frame 161 on pass D133 of the forward-looking camera. This one-time only probable light leak occurred during handling and processing. A fogged area extending $1\frac{1}{4}$ inches into the frame from the time word edge of frames 112, 113 and part of 114 of the aft camera pass D135 record. No apparent cause was determined for it. No imagery was degraded by this fogged area. No action items were assigned to any of the anomalies on this mission since all were considered to be minor and little, if any, degradation resulted from them.

C. DISIC CAMERA

The DISIC record from both missions returned a total of 5233 frames. 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. This last DISIC No. 14 on Mission 1115 produced exceptionally clean imagery. The stellar record produced 5 to 10 images on most starboard frames and 10 to 15 stellar images on most port frames.

D. CORN OPERATIONS

Corn target photography for Mission 1115 was limited to conserve film for operational use. This was done because more film than usual was used during pre-flight readiness testing in order to check out some payload subsystems.

SECTION 5

PANORAMIC EXPOSURE

A. INTRODUCTION

Exposure of the CR systems is a function of scan rate, filter, slit width and scene luminance. Since scan rate is adjusted in flight to compensate for forward image motion, exposure control is exercised during flight only by the selection of the filter and slit opening.

The Wratten filter is selected prior to flight and is therefore fixed for a given film type. The slit width is selectable by real-time command in flight. Four different slit widths may be selected by automatic sequencing or any one of five fixed slits may be selected.

B. EXPOSURE ANALYSIS

The filters for the forward-looking camera, #331, were both Wratten 25 and the filters for the aft-looking camera, #330, were both Wratten 23. The filters selected for both primary and secondary positions were all glass. The somewhat heavier light filtration of the shorter wave lengths below the red region provided by the W-25 filter reduced the amount of non-image forming haze light that appears to be more pronounced in the forward-looking camera. Since the W-25 filter provides more light filtration than the W-23, the slits selected for the forward camera are wider than the slits selected for the aft camera.

The exposure slits selected for the forward and aft-looking cameras were as follows:

Slit Width (inches)

Slit	Fwd (#331)	Aft (#330)
S4	0.334	0.287
S3	0.242	0.204
S2	0.167	0.154
S1	0.131	0.122
F.S.	0.247	0.200

Typical slit usage for mission 1115 is shown in figures 5-1 through 5-4. These figures show nominal exposure times of both panoramic cameras as a function of latitude on two representative passes; one of which employed automatic slit sequencing and the other utilized a fixed slit. Additionally, the figures show the nominal percentage of photography at all latitudes throughout both missions. It is observed that adequate exposure times resulted during both missions. The normal criterion used to determine proper exposure is that minimum scene density should range between 0.4 and 0.9. Only subjective analysis is available to this report and all exposures have been reported by the reviewers at NPIC and by the Performance evaluation team to be of medium density and medium to high contrast. Consequently the image quality was reported as good and produced sharp edges at magnifications to 100 diameters.

EXPOSURE POINTS

Mission No.: 1115 Payload No.: CR-15 Pass No: 105

Camera No.: 330 Launch Time: 1432:56 PST Launch Date: 10 Sept. 1971

Film Type: 3414 Slit Widths: Pos.1: 0.122 Pos 2: 0.154

Filter Type: W-23 Pos.3: 0.204 Pos.4: 0.287 F/S: 0.200

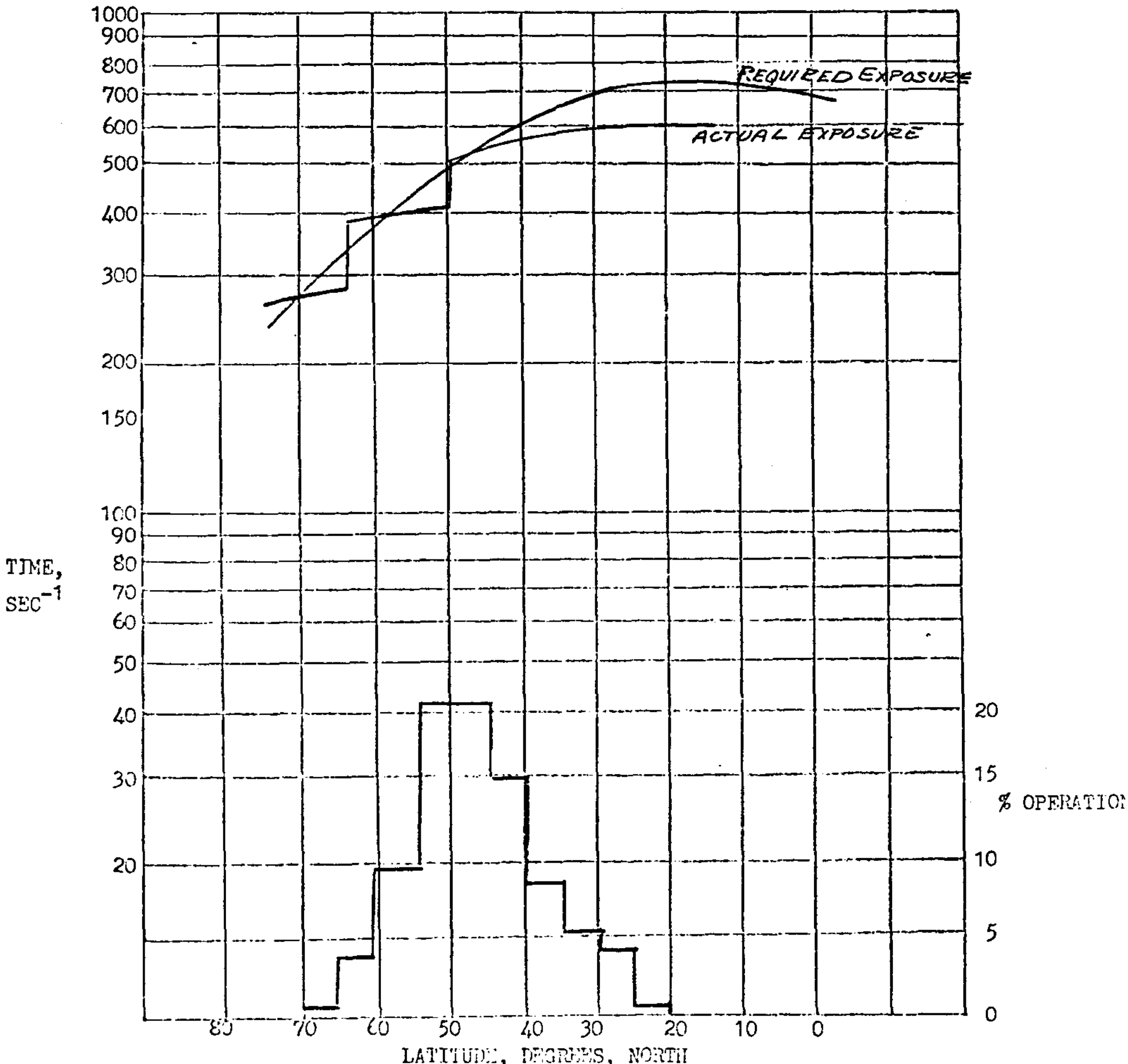


FIGURE 5-1 COMPARISON OF IDEAL/ACTUAL EXPOSURE TIME vs LATITUDE

EXPOSURE POINTS

Mission No.: 1115 Payload No.: CR-15 Pass No: 105

Camera No.: 331 Launch Time: 1432:56 PST Launch Date: 10 Sept. 1971

Film Type: 3414 Slit Widths: Pos.1: 0.131 Pos 2: 0.167

Filter Type: W-25 Pos.3: 0.242 Pos.4: 0.334 F/S: 0.247

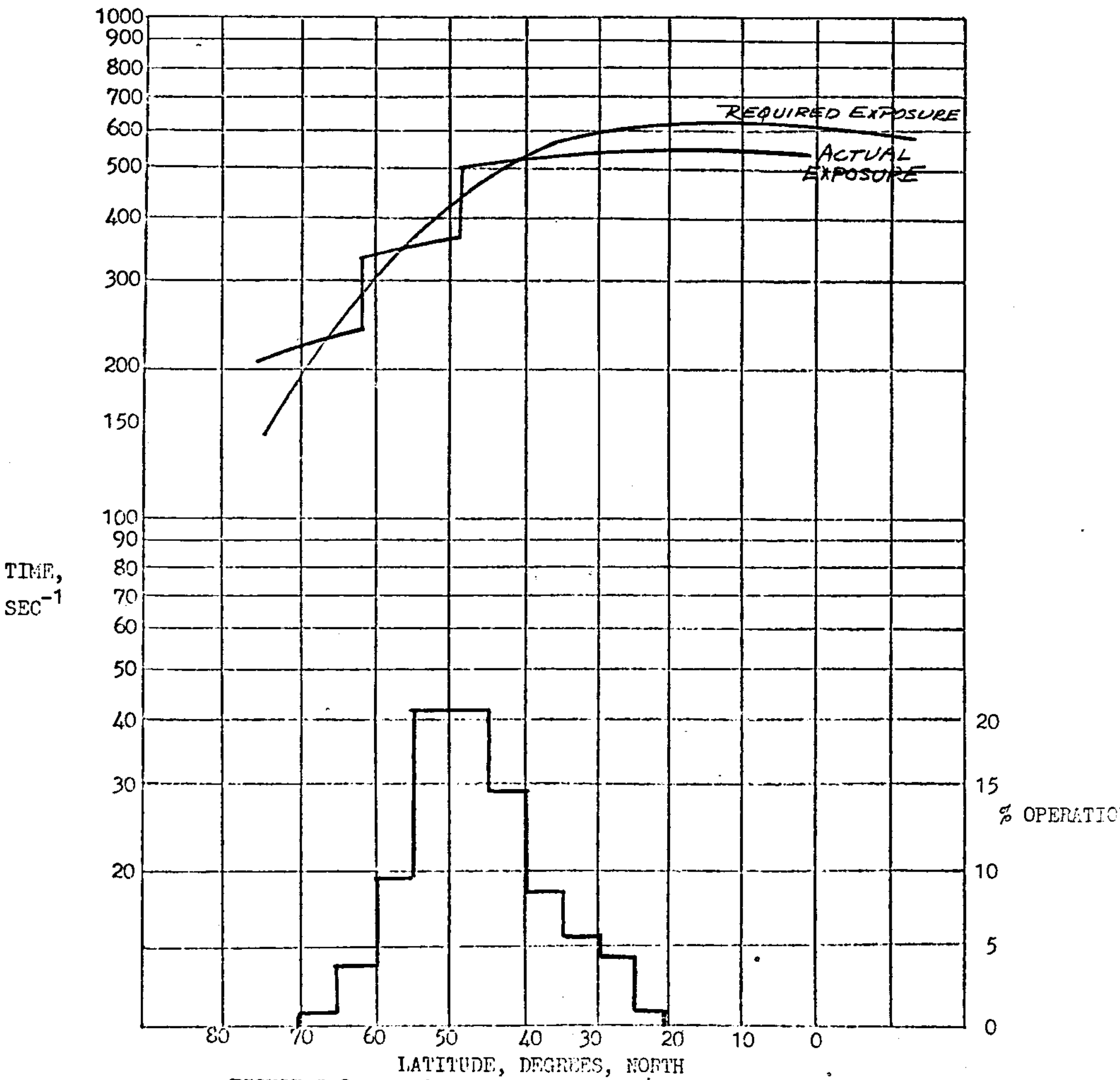


FIGURE 5-2 COMPARISON OF IDEAL/ACTUAL EXPOSURE TIME vs LATITUDE

EXPOSURE POINTS

Mission No.: 1115 Payload No.: CR-15 Pass No: 203

Camera No.: 330 Launch Time: 1432:56 PST Launch Date: 10 Sept. 1971

Film Type: 3414 Slit Widths: Pos.1: 0.122 Pos 2: 0.154

Filter Type: W-23 Pos.3: 0.204 Pos.4: 0.287 F/S: 0.200

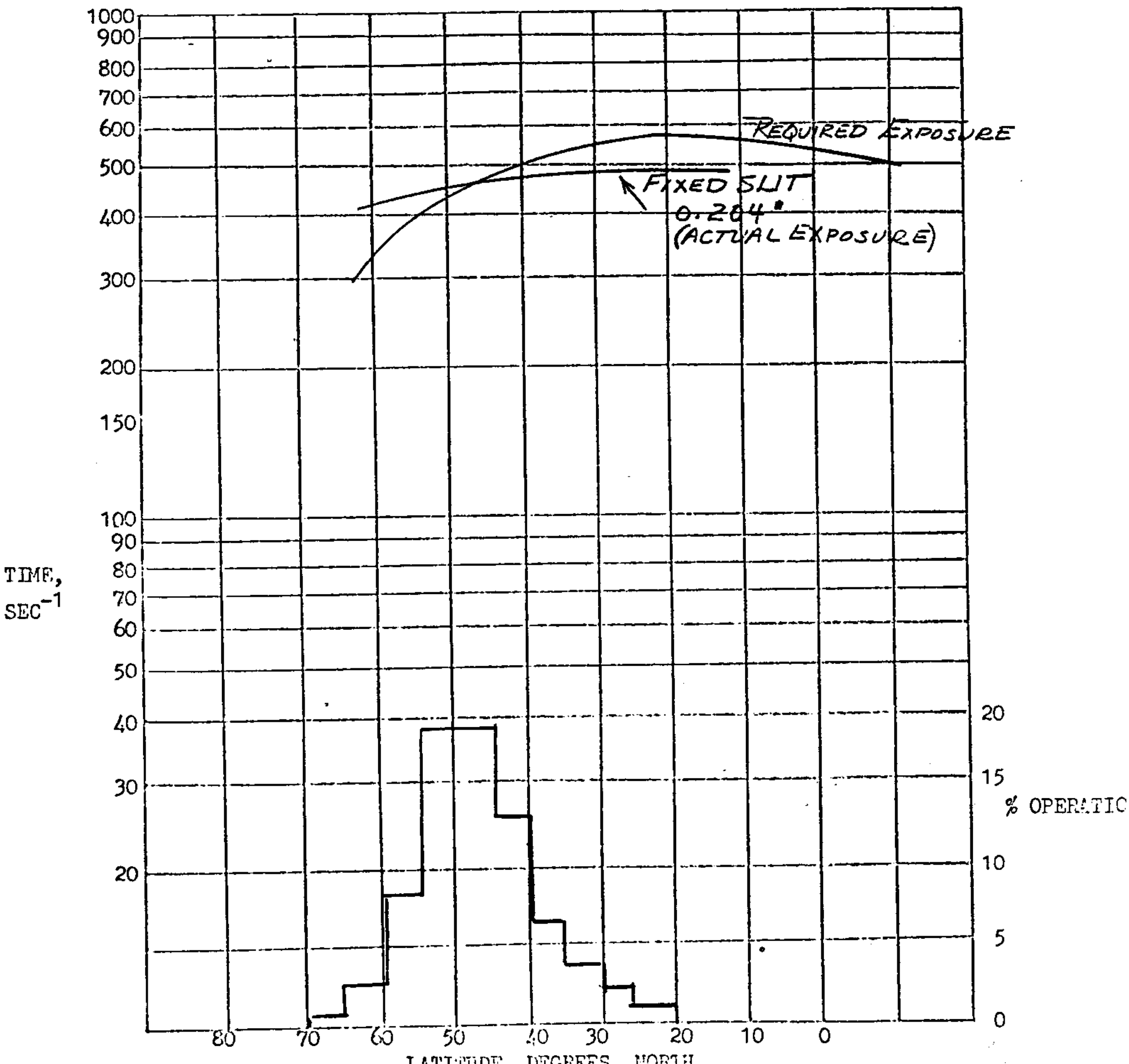


FIGURE 5-3 COMPARISON OF IDEAL/ACTUAL EXPOSURE TIME vs LATITUDE

EXPOSURE POINTS

Mission No.: 1115 Payload No.: CR-15 Pass No: 203

Camera No.: 331 Launch Time: 1432:56 PST Launch Date: 10 Sept.1971

Film Type: 3414 Slit Widths: Pos.1: 0.131 Pos 2: 0.167

Filter Type: W-25 Pos.3: 0.242 Pos.4: 0.334 F/S: 0.247

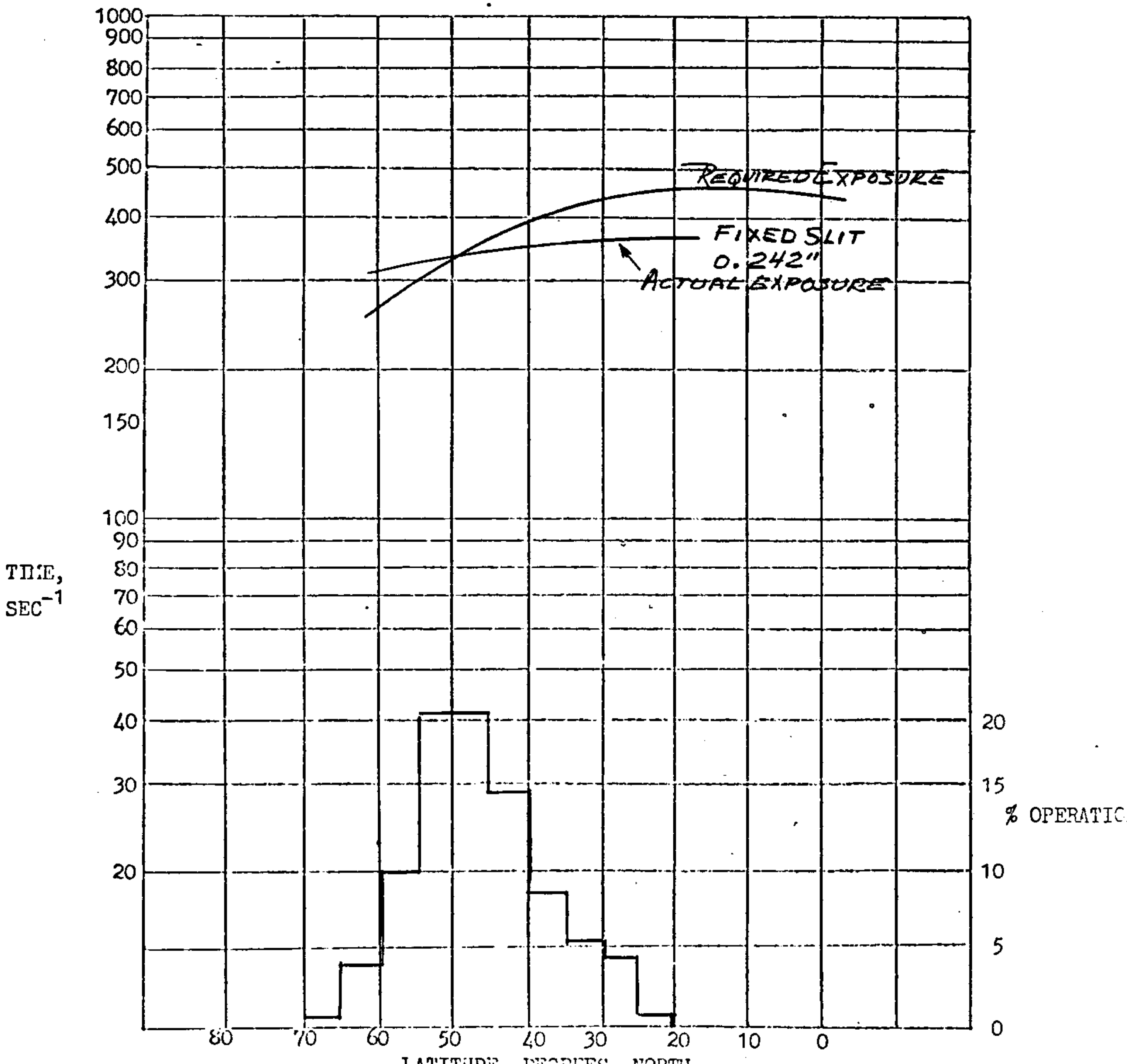


FIGURE 5-4: COMPARISON OF IDEAL/ACTUAL EXPOSURE TIME vs LATITUDE

SECTION 6

VEHICLE ATTITUDE AND IMAGE SMEAR

A. VEHICLE ATTITUDE

The vehicle attitude errors for both Mission 1115-1 and 1115-2 were derived from the reduction of the Stellar camera photography. This attitude data is supplied to A/P by NPIC.

The attitude errors for each frame and the attitude control rates are calculated at the A/P computer facility. The computer also plots the frequency distribution of the rates and errors. These plots are shown in Figures 6-1 thru 6-32.

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

TABLE 6-1

	Mission 1115-1		Mission 1115-2	
Value	90%	Range	90%	Range
Pitch Error (°)	0.28	0.00 to 0.40	0.62	-0.08 to 0.80
Roll Error (°)	0.22	-0.47 to 0.17	0.15	-0.26 to 0.22
Yaw Error (°)	0.58	-0.04 to 0.66	0.40	-0.02 to 0.64
Pitch Rate (°/hr)	28.48	-65 to +100	51.34	-95 to +100
Roll Rate (°/hr)	23.94	-45 to +90	26.69	-35 to +75
Yaw Rate (°/hr)	27.61	-55 to _90	31.77	-75 to +75

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

B. IMAGE SMEAR

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, Figures 6-25 thru 6-28, which is then combined with the vehicle attitude error and rate values of each frame and the crab error caused by earth rotation at the latitude of each frame. The program outputs the net IMC error and the total along track and cross track limit of ground resolution that can be acquired by a camera regardless of focal length and system capabilities.

The computer rejects the first three frames of all operations as the large V/h error induced by camera start-up is not representative of the overall system operations. The computer plotted frequency distributions of IMC errors and resolution limits are shown in Figures 6-29 thru 6-40.

The summary Table 6-2 presents the maximum IMC errors, resolution limits, and V/h ratio errors that existed during 90% of the photographic operations and the total range of values during all operations that were computed.

Mission 1115-1 was given an MIP rating of 120 and mission 1115-2 received an MIP of 110. The average image quality of the -2 mission was approximately 24% less than the image quality of the -1 mission. This was established by visual edge matching (VEM) techniques from cloud free photographic frames randomly spaced to provide data at the beginning, middle, and end of the film from each recovery vehicle. The summary table 6-2 reveals that larger Image Motion Control and V/h errors occurred throughout the -2 mission than occurred in the -1 mission. These larger errors are contributing factors to the reduced image quality produced in the -2 mission. However, occasionally imagery from the -2 mission had edges as sharp as the imagery from the -1 mission.

MISSION 1115

IMC RATIO AND RESOLUTION LIMITS

VALUE	UNITS	CAMERA	MISSION 1115-1 90%	MISSION 1115-1 Range	MISSION 1115-2 90%	MISSION 1115-2 Range
IMC Ratio Error	%	Fwd-Looking	1.4	-1.4 to 2.2	2.9	-2.0 to 4.6
		Aft-Looking	1.2	-1.8 to 2.0	2.4	-6.8 to 4.2
Cross Track Resolution Limit	Feet	Fwd-Looking	5.3	0.4 to 6.6	6.2	0.6 to 8.6
		Aft-Looking	4.4	2.6 to 5.6	5.2	1.0 to 8.0
Along Track Resolution Limit	Feet	Fwd-Looking	1.3	0.00 to 2.0	2.4	0.00 to 5.0
		Aft-Looking	1.0	0.00 to 1.60	1.7	0.00 to 5.0
V/h Ratio Error	%	Fwd-Looking	1.2	-1.4 to 2.2	2.7	-6.0 to 4.0
		Aft-Looking	1.4	-1.4 to 2.2	2.8	-6.0 to +4.2

TABLE 6-2