[redacted]

CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1111-1 AND 1111-2

FTV 1654, CR-12

Approved [redacted]
Manager
Advanced Projects

Approved [redacted]
Manager
Program [redacted]

[redacted]

TOP SECRET/C

[redacted]

18 November 1970

To: [redacted]

Thru: [redacted]

From: [redacted]

Subject: MISSION 1111 FINAL REPORT (CR-12)

Enclosed is the final evaluation report for Mission 1111.

[redacted]
Manager
Advanced Projects

IF ENCL... THE CLASSIFICATION
OF THIS ... Unclassified

TOP SECRET/C

[redacted]

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1654.

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

This document constitutes the final payload test and performance evaluation report for Mission 1111 which was launched on 23 July 1970.

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INTRODUCTION

This report presents the final performance evaluation of Corona Mission 1111. The purpose of this report is to define the performance characteristics of the CR-12 payload system and to evaluate the technical aspects of the Mission, including analysis of in-flight 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 pre-flight mission parameter planning, preparation of the flight program, in-flight operations support and data analysis, and mission reporting to the community. The initial evaluation of the recovered film was made by NPIC personnel at the processing facility. The Performance Evaluation Team (PET) meeting at NPIC included representatives of LMSC, ITEK Corporation, Eastman Kodak Company, and cognizant government organizations. Off-line evaluation was performed at facilities of individual contractors, using engineering photography acquired over the United States.

The quantitative data summarized in this report is originated by governmental and contractor organizations. Diffuse Terrain Density measurements are produced by the Air Force Special Projects Production Facility. The processing Summary report and Ground Density measurements are provided 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, limiting ground resolution, and exposure/processing data.

SECTION 1

MISSION SUMMARY

A. MISSION DESCRIPTION

Corona Satellite Mission 1111 was planned to acquire cartographic and reconnaissance photography of selected terrain areas. Two mission segments were planned to total approximately eighteen days of orbital operation. Each mission segment would return approximately 6000 panoramic frames and each frame would nominally cover 1360 square miles.

The flight configuration included a THORAD booster and AGENA satellite vehicle. The on-orbit support provided by the Agena includes real time command and telemetry links, electrical power, stored payload program timer, and attitude stabilization and control.

The payload was a J-3 configuration, consisting of a space structure containing two panoramic cameras and associated control/support equipment and recovery subsystems for each mission segment. In addition, a DISIC Stellar-Terrain camera was incorporated as part of the overall flight system.

The flight system was launched into the planned orbit from Vandenberg AFB at 01:25 GMT on 23 July 1970.

The panoramic cameras operated throughout both mission segments. Both cameras demonstrated acceptable operation during Missions 1111-1 and -2 until film depletion.

Mission 1111-1 was successfully completed, after 7 days of flight, with an air-catch of the recovery capsule. The second mission segment was similarly terminated after 12 days of orbital flight.

Photographic performance of the panoramic cameras varied from good to fair. An MIP of 105 was assigned to Mission 1111-1 and an MIP of 105 was assigned to 1111-2. Various CORN targets were acquired on this mission and are discussed in Section 4.

B FLIGHT CONFIGURATION

Mission No.	1111
Vehicle No.	1654
System No.	CR-12
Forward Looking Camera Serial No.	325
DISIC Camera Serial No.	2R
Lens Data	
Forward Looking Camera (Main Lens)	
Lens Serial No.	I-213
Measured Slit Width (Inches)	
Position 1	0.131
Position 2	0.176
Position 3	0.234
Position 4	0.287
Failsafe	0.189
Optics Filter Type	
Primary	W-25 Gel 4 Mils
Alternate	W-25 Glass 7 Mils
E.O. Focal Length (Inches) (Vacuum)	.0027

Resolution

Static (Lines/Millimeter)

Filter	W-25
High Contrast	N/A
Low Contrast	201

Dynamic (Lines/Millimeter)

ITEK Post-Vibration

Filter	W-25
High Contrast	285
Low Contrast	185

A/P Test

Filter	W-25
High Contrast	266
Low Contrast	192

Distortion/Pincushion (Microns)

Angle Off Axis (Deg.)	
3	2
2	1
1	0
0	0
359	0
358	2
357	3

Aft Looking Camera (Main Lens)	
Lens Serial No.	I-184
Optics Slit Width (Inches)	
Position 1	0.080
Position 2	0.110
Position 3	0.155
Position 4	0.195
Failsafe	0.135
Optics Filter Type	
Primary	W-21 Gel 4 Mils
Alternate	W-21 Glass 7 Mils
E.O. Focal Length (Inches)(Vacuum)	.0035
Resolution (Lines/MM)	
Static	
Filter	W-21
High Contrast	N/A
Low Contrast	158
Dynamic (Lines/MM)	
ITEK Post-Vibration	
Filter	W-21
High Contrast	253
Low Contrast	139
A/P Test	
Filter	W-21
High Contrast	243
Low Contrast	120

Distortion/Pincushion (Microns)

Angle Off Axis (Deg.)	
3	1
2	0
1	0
0	0
359	0
358	2
357	5

Horizon Optics

Forward Looking Camera

Take-up (Starboard)

Lens Serial No.				40784			
Exposure Time (Sec.)				1/100			
Aperture				F/8.0			
Filter Type				W-25			
Oper. Focal Length (MM)				55.0			
Radial Distortion (MM)							
10 Deg. Off Axis				0.01			
20 Deg. Off Axis				0.03			
Tangential Distortion				0.012			
Resolution (Lines/MM)							
Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	187	186	184	113	124	106	25
(Tangential)	166	164	144	98	93	61	35

Supply (Port)

Lens Serial No.	40794
Exposure Time (Sec.)	1/100
Aperture	F/6.3
Filter Type	W-25
Oper. Focal Length (MM)	55.0
Radial Distortion (MM)	
10 Deg. Off Axis	0.00
20 Deg. Off Axis	0.03
Tangential Distortio n	0.012

Resolution (Lines/MM)

Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	187	186	163	160	156	119	25
(Tangential)	166	164	161	138	116	109	49

Aft Looking Camera

Take-up (Port)

Lens Serial No.	23771
Exposure Time (Sec.)	1/100
Aperture	F/6.3
Filter Type	W-25
Oper. Focal Length (MM)	55.0
Radial Distortion (MM)	
10 Deg. Off Axis	0.005
20 Deg. Off Axis	0.03
Tangential Distortion	0.025

Resolution (Lines/MM)							
Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	187	165	163	143	124	95	25
(Tangential)	187	147	128	123	93	86	55

Supply (Starboard)

Lens Serial No.	40777
Exposure Time (Sec.)	1/100
Aperture	F/8.0
Filter Type	W-25
Oper. Focal Length (MM)	55.0
Radial Distortion (MM)	
10 Deg. Off Axis	0.01
20 Deg. Off Axis	0.05
Tangential Distortion	0.018

Resolution (Lines/MM)							
Angle Off Axis (Deg.)	0	5	10	15	20	25	30
(Radial)	166	186	184	100	139	119	29
(Tangential)	166	147	144	138	103	96	55

DISIC Camera

Port Stellar Camera

Lens Serial No.	5P
Reseau Serial No.	5P
Aperture	F/2.8
Exposure Time (Sec.)	1.5
Nominal Focal Length (In.)	3
Filter	None

Starboard Stellar Camera

Lens Serial No.	5
Reseau Serial No.	5
Aperture	F/2.8
Exposure Time (Sec.)	1.5
Nominal Focal Length (In.)	3
Filter	None

Terrain Camera

Lens Serial No.	111		
Reseau Serial No.	111		
Filter Type	W-12		
Aperture	F/6.3		
Exposure Time (Sec.)	1/500		
Nominal Focal Length (In.)	3		
Resolution (Hi Contrast L/MM)			
Angle Off Axis (Deg.)	0	7.5	15
Radial	102	100	108
Tangential	102	96	75
Film Type	3400		
Filter	W-12		

Film Types

Forward Looking Camera

Split Load	No
Film Type	3414
Length (Ft.)	16300
Splices	3
Length Between Splices (Ft.)	2795-4455-4580-4470
Emulsion Data	8-62-70
Payload Weight (Lbs.)	80.1
Spool No.	68AT
Box Serial No.	38

Aft Looking Camera

Split Load	No
Film Type	3414
Length (Ft.)	16300
Splices	4
Length Between Splices (Ft.)	2000-3545-4455-4585-1715
Emulsion Data	8-62-7-0
Payload Weight (Lbs.)	80.6
Spool No.	172B
Box Serial No.	38

DISIC Camera

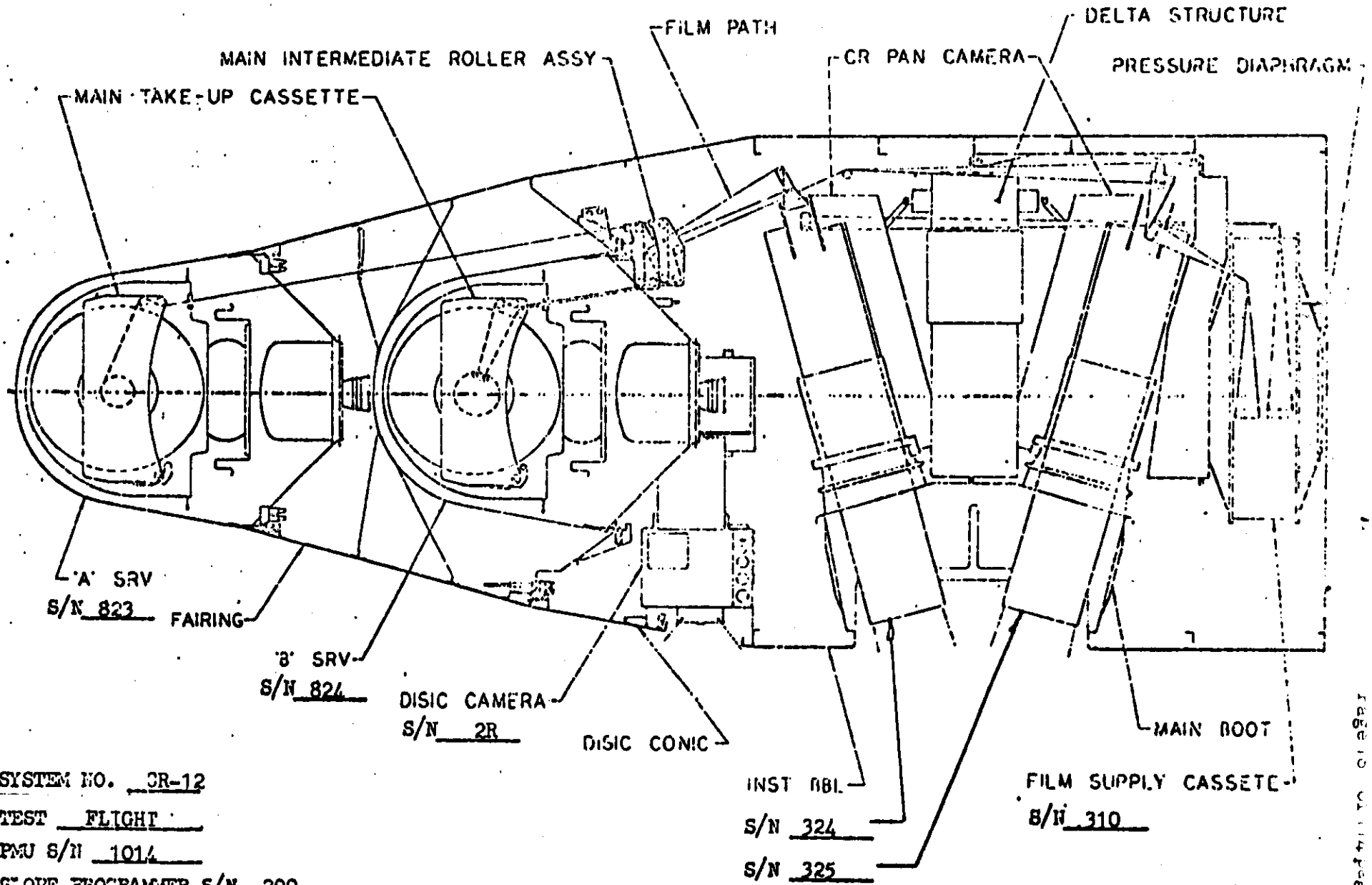
Stellar Camera

Split Load	No
Film Type	3401
Length (Ft.)	2000
Splices	None
Length Between Splices (Ft.)	None
Emulsion Data	349-8-5-0
Payload Weight (Lbs.)	5.3

Terrain Camera

Split Load	No
Film Type	3400
Length (Ft.)	2200
Splices	None
Length Between Splices (Ft.)	None
Emulsion Data	223-1-5-0
Total Film Weight (Lbs.)	20.2

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-12
TEST FLIGHT
PMU S/N 1014
SLOPE PROGRAMMER S/N 200
CLOCK S/N 625
SWITCH PROGRAMMER S/N 211

FIGURE 1-1

SECTION 2

PRE-FLIGHT SYSTEMS TEST

A. SUMMARY

As a standard procedure, the J payload systems are subjected to a series of tests with flight type film which demonstrate that the system will perform as required during flight. The principal tests include the following:

1. Exposure of the J payload to a thermal/altitude environment that approximates flight conditions.
2. A system light leak test that ascertains the light tight integrity of the J system.
3. A dynamic resolution test that determines the high and low contrast resolution characteristics of each panoramic camera. Also an AGT - Aschenbrenner grid test for film lift determination.
4. A flight readiness test that assures that the payload is acceptable prior to loading with flight film.
5. A flight certification that establishes the flight worthiness of the complete payload including the flight film.

The CR-12 system successfully passed all phases of the testing operations providing acceptable performance and a high degree of operational confidence.

B. ENVIRONMENTAL TEST

The CR-12 system was subjected to environmental testing from 15 thru 22 December 1969.

The primary purpose of the environmental test was to determine the corona marking characteristics of the panoramic cameras and operational performance of the system at altitude. The pan cameras were configured for AGT testing.

The system was subjected to internal system pressures at altitude that ranged between 1 and 80 microns by programmed On and Off use of the Gas Pressure Make-Up system. One special pressure sweep that occurred during the "B" SRV portion of the test extended the internal camera pressure range of the panoramic cameras during operation to approximately 104 microns.

The panoramic camera payload (film type SO-380 UTB) was processed to the intermediate level prior to analysis.

The CR-12 system operations during the altitude test produced the following film consumption:

Test-Film Consumption (Cycle Counter)

Operation	Panoramic Camera No.	
	324 (#1)	325 (#2)
A SRV Frames	4121	4120
B SRV Frames	4359	4357
Total Frames	8480	8477

Evaluation of the processed film indicated there was no corona marking by either panoramic camera.

Preliminary Dr. A analysis indicated that there was unacceptable film lift on some frames of Instrument #324 film. However the camera was recalibrated, and subsequent AGT testing indicated conditions were acceptable.

Auxiliary data recording was acceptable. Visual analysis of film from panoramic cameras #324 and #325 revealed that imagery of the serial number, time track, H.O. fiducials, start of pass mark, PG traces, and rail holes were acceptable. Microdensitometer measurements revealed that imagery of the time word from both main cameras was acceptable.

Evaluation of telemetry data indicated system performance as follows: (all anomalies were corrected or bought off as acceptable prior to flight.)

Evaluation of the telemetry data indicated that No. 1 camera performance was satisfactory. All start-up, shutdown and transport functions were normal. The No. 2 camera had reduced tension at shutdown, failed to stow on numerous occasions, had uneven film motion after unclamp, experienced a marginal cut and wrap with a loose wrap on the -2 take-up, and had a 12-15 H_z signal on the motor voltages intermittently throughout the test. The start-up and shut-down times were out of spec. The cycle periods for both instruments were unacceptable using the latest slope programmer calibration data. Evaluation of the programmer performance indicated a short circuit in the FMC return during the first 6 revs of the test and a shift in the eccentricity programmer period from the calibrated value of 3591 to 3620 seconds. All cycle period data for the first 6 revs were discarded and the programmer period input was changed to 3620 seconds. This resulted in cycle periods within $\pm$ 1% which is acceptable.

The DISIC operation was normal. However the Terrain shutter monitor failed to function and the Stellar film idler was noisy. The A to B transfer (KZ-39) command was normal with all transfer functions occurring as programmed. The DISIC Terrain and Stellar film had a minimal amount of unacceptable corona marking. DISIC corona marking was accepted on a waiver by the user.

All timer start and delay functions were normal.

The exposure control system performed satisfactorily with all start and delay functions occurring normally.

The PMU operation was normal, however the "A" and "C" timers were set incorrectly resulting in an operating pressure of 82 microns. The consumption rate was 8.2 psi/min.

The clock accuracy test indicated the clock lost 0.071 seconds during a 4-day period, which was out of tolerance. The clock was subsequently replaced and functioned normally.

The instrumentation system performance was normal.

The command system was normal except once during the negative checks in rev 8B. The A/P Data Enable command caused the DSR to execute, resulting in an instrument operate. The DSR was reloaded. This condition was traced to a mispatch in the GSE patchboard and was subsequently repatched.

The SRV tape recorder performed satisfactorily with the exception of Digital Data 1 on track 5 of the SRV-A recorder which was unusable because of excessive noise and a higher loss of sync rate than with previous recorders tested.

The cut and wrap sequence resulted in severe damage to the film of both instruments. This was attributed to the system vertical position and UTB film. The sequence of events, timer events, and transfer functions were normal.

The cut and splice sequence was normal. All timer events and transfer functions were within tolerance.

C. LIGHT LEAK TEST

The CR-12 system was tested for light leaks on 13 July 1970. Both instruments were threaded with film type 3401, placed in flight configuration, and exposed to external illumination for 90 minutes per side. At the conclusion of the test the film was retrieved, processed to full level, and evaluated. Results were acceptable.

D. RESOLUTION TEST/AGT

Resolution Testing

The CR-12 system was subjected to through focus dynamic resolution testing for the originally planned use of UTB film for flight, 3404 film, and for the now assigned 3414 film.

The sequence and results of resolution testing are presented in the following Table 2-1, and further substantiated in the graphical presentations in Figures 2-1 through 2-6.

TABLE 2-1

CR-12 RESOLUTION TESTING

Inst. #	Date	Film Type	Max. Low Contrast Reso. Focal Pos.	L/MM	Results
324	1-31-70	SO-380	-.0015	130	Acceptable
325	1-31-70	SO-380	-.0005	188	Acceptable
324	3-18-70	3404	-.0015	126	Acceptable
325	3-18-70	3404	-.001	187	Acceptable
324	6-16-70	3414	0.000	120	Acceptable
325	6-16-70	3414	0.000	192	Acceptable

AGT - Aschenbrenner Grid Test

The CR-12 system was subjected to AG Tests on 10 and 15 June 1970. The tests consisted of at least 24 cycles of usable material from each camera. Film type 3414 was used throughout the test. The cycle rate was set at 3 seconds per cycle.

A representative format from each camera was evaluated for film lift relative to the scan head rollers. Eighty-one points throughout the usable portion of each format were sampled for film lift. Figure 2-7 presents an AGT orientation sketch for the lift points selected. The resulting film lift measurements in inches (mils) above the scan rollers are shown in the attached table and graphical plots, Figures 2-8 and 2-9.

The current acceptance criteria were used to determine camera film lift compliance. The criteria used are such that 90% or more of the film lift measurements must be within $\pm$ 0.7 mils of the center of format film lift for the camera to be acceptable.

With these acceptance criteria applied, both cameras were deemed acceptable.

E. FLIGHT READINESS TEST

The CR-12 Flight Readiness test was conducted on 10 July 1970. All information on the processed DISIC Terrain and Stellar film was present and satisfactory. Both processed and unprocessed film were free of scratches.

Rail scratches on both Panoramic instruments were heavier than customary. The SLP on Inst. 324 had 4 marginally acceptable bits.

The CR-12 cam/slit sequence end slit width values were verified as part of the first Readiness test. Evaluation of the processed 3414 film revealed that the exposure cams do provide exposure slit widths in the correct sequence.

Measurements of processed slit images revealed the following slit values:

TABLE 2-2 SLIT WIDTH (INCHES)

Slit No.	Camera 324 AFT		Camera 325 FWD	
	Requested	Actual	Requested	Actual
1	.083	.075	.132	.120
2	.114	.079	.176	.166
3	.154	.145	.235	.255
4	.202	.189	.314	.295
Failsafe	.123	.132	.190	.188

It was recommended that the system be prepared for flight.

F. FLIGHT CERTIFICATION

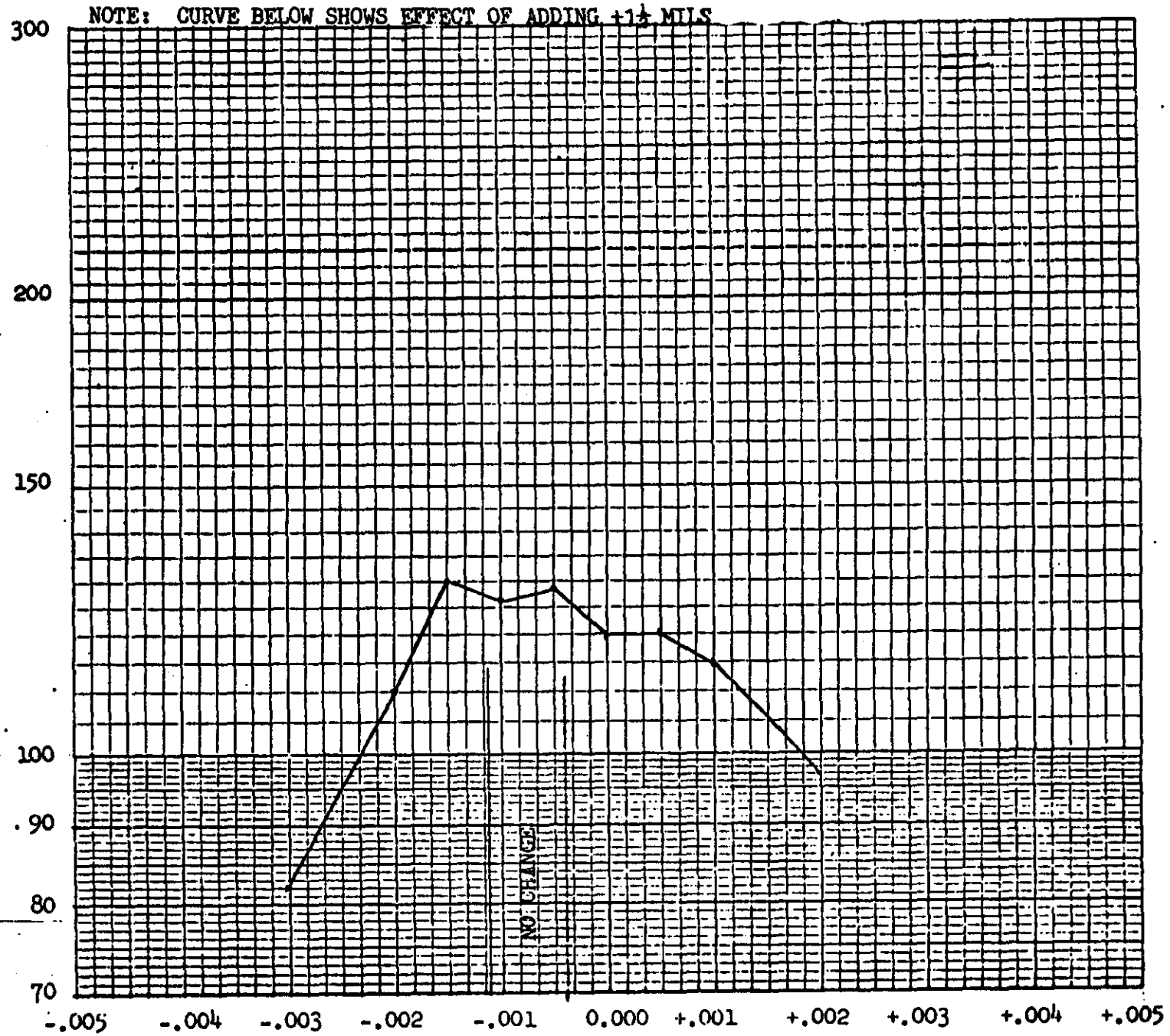
Flight film loading of the CR-12 Panoramic Cameras occurred 17 July 1970. Sensitometric examination of samples of the flight film verified satisfactory photographic characteristics.

The confidence run, to certify the CR-12 system for flight, was conducted on 20 July 1970. Rail scratches were continuous but very heavy on the emulsion side of both panoramic payloads. More than 14 fine continuous scratches were present on the backing side of the film installed in Instrument #325.

The CR-12 system was checked for light leaks following the last camera operation of the confidence run. The space structure proved to be light tight as indicated by the photomultipliers employed in the light leak test.

The CR-12 system was accepted for flight on 21 July 1970.

PRE-FLIGHT DYNAMIC RES_ TION



Camera No. 324

Payload No. CR-12

Filter W-21

Resolution (l/mm)

High Contrast: -

Low Contrast: 2/1

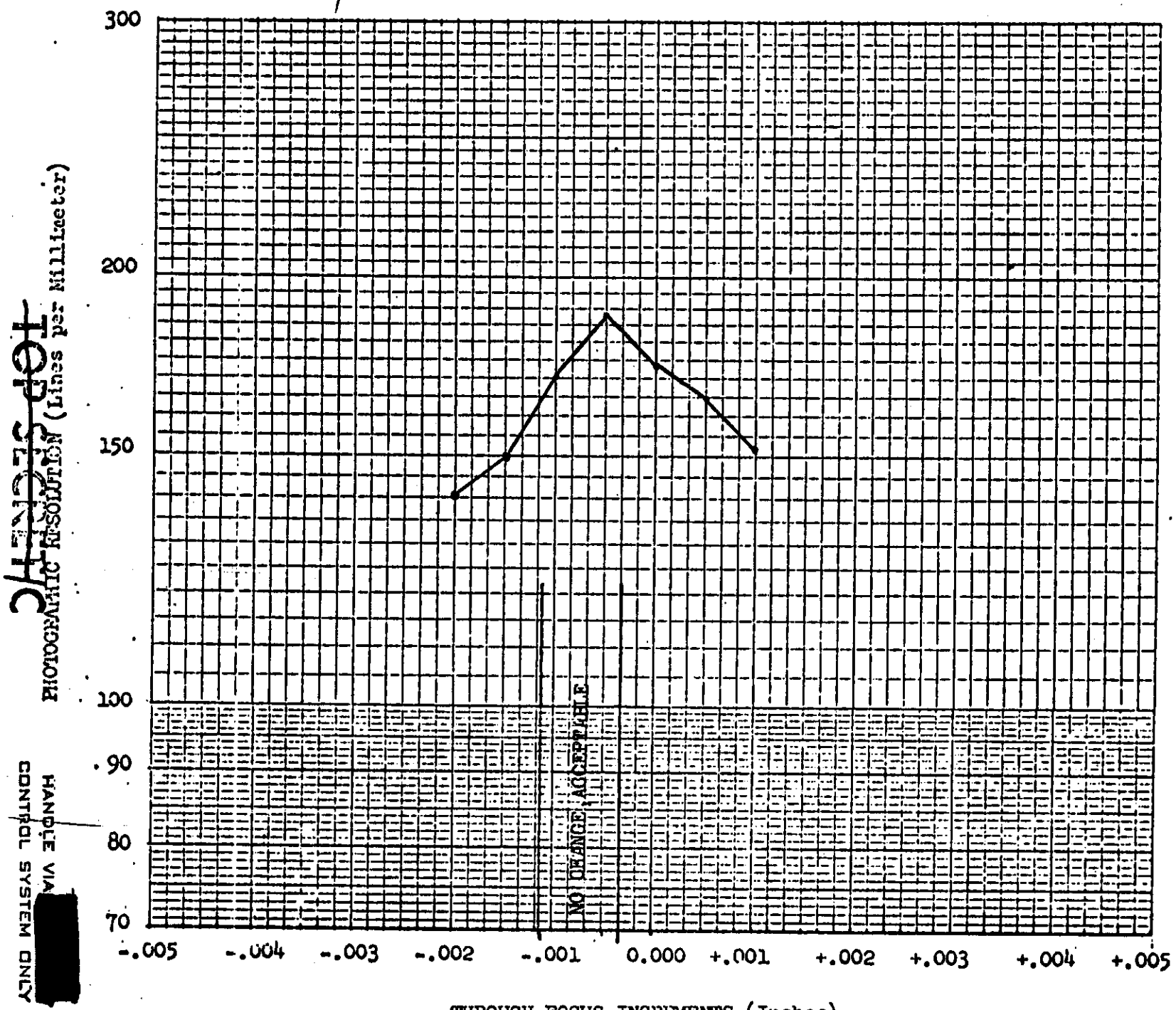
Film Type: SO-380 UTB

Test Date: 1-31-70

Prepared By: [redacted]

Date: 1-31-70

[redacted]



Camera No. 325

Filter W-23

Payload No. CR-12

Resolution (1/mm)

High Contrast: -

Low Contrast: 2/1

Film Type: SO-380 U

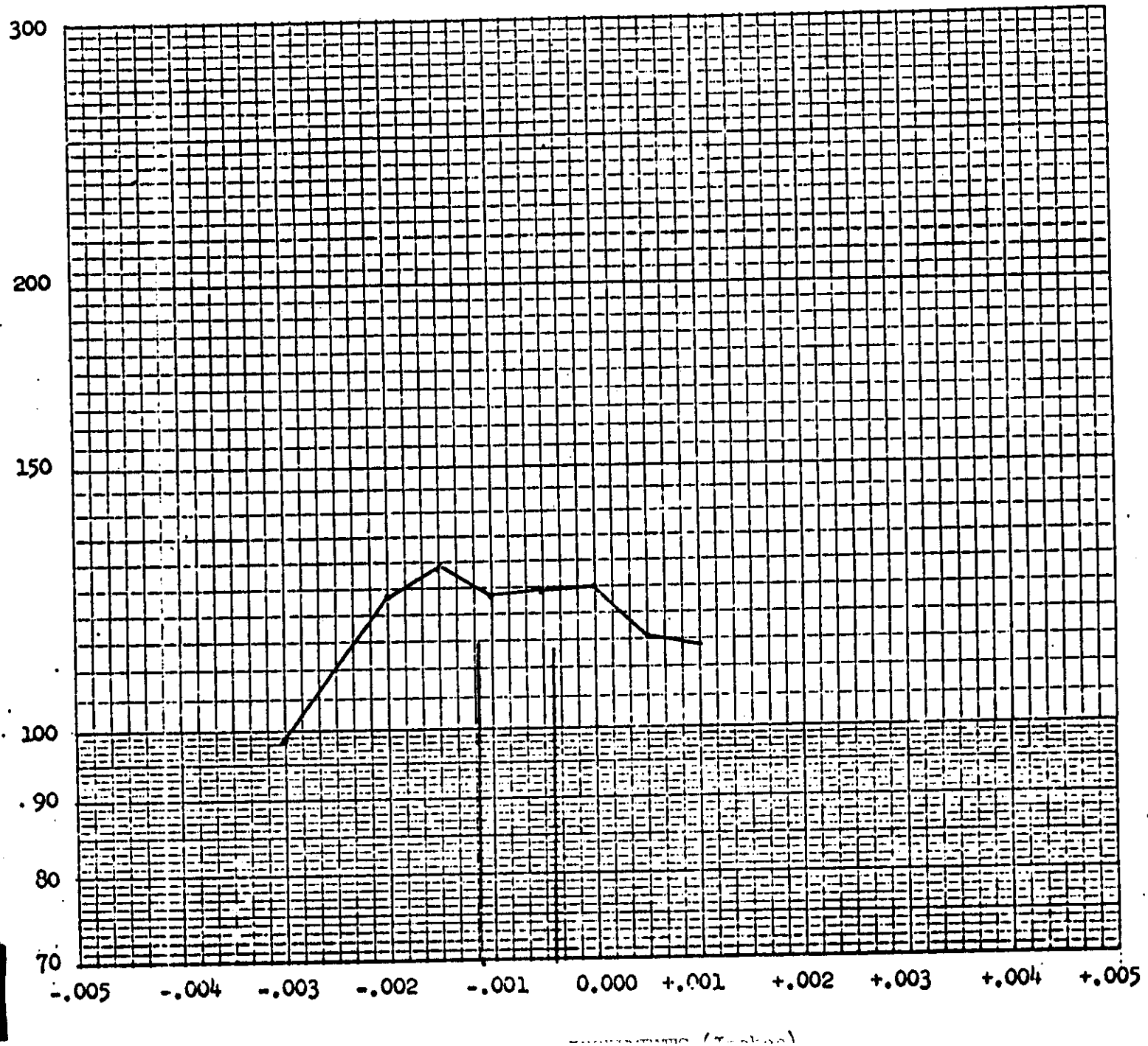
Test Date: 1-30-70

Prepared By: [redacted]

Date: 1-30-70

FIGURE 2-2

PRE-FLIGHT DYNAMIC RES[illegible]TION



Camera No. 324

Payload No. CR-12

Resolution (l/mm)

High Contrast: -

Low Contrast: 2/

Film Type: 3404

Test Date: 3-17-70

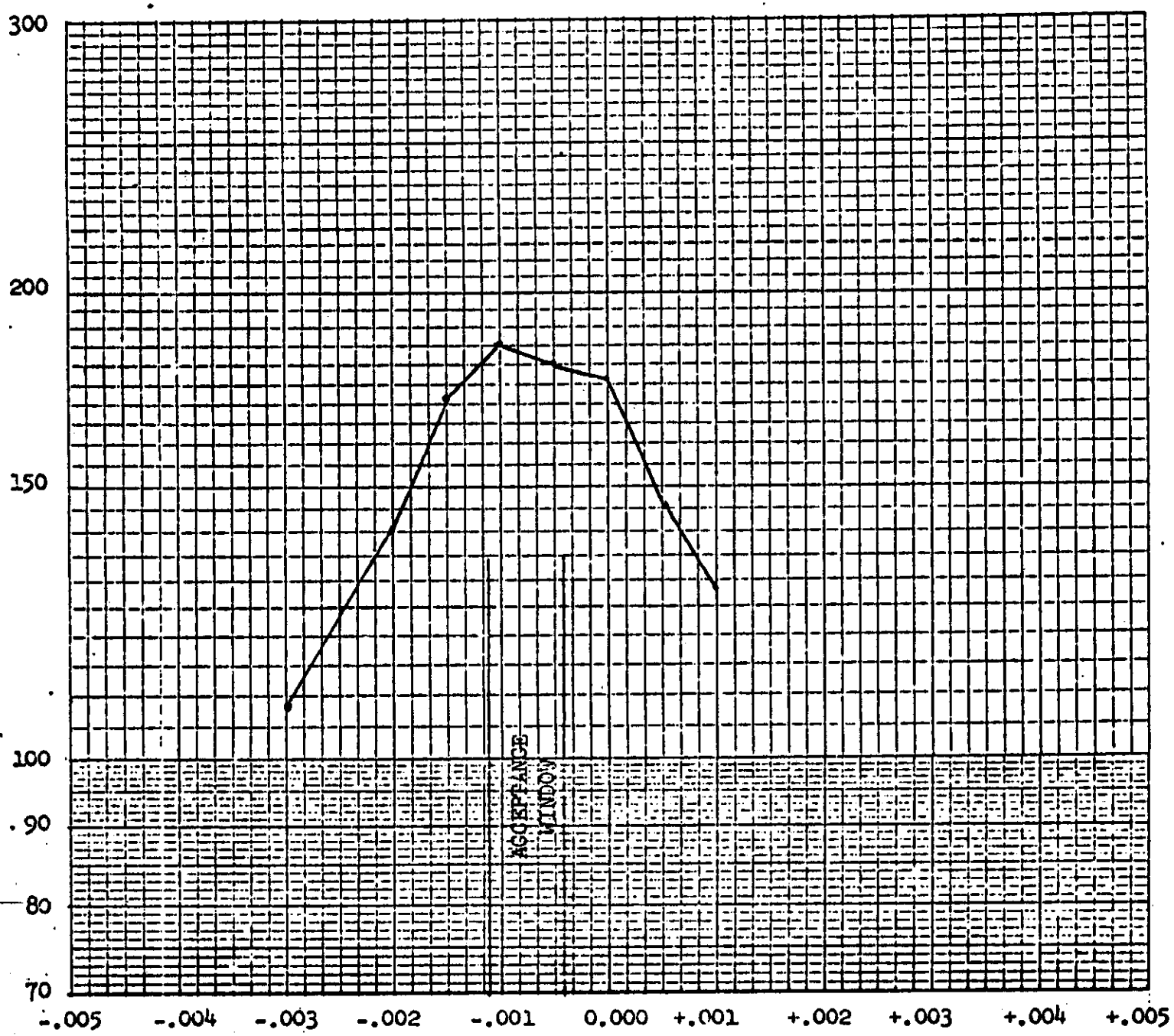
Prepared By: [redacted]

Date: 3-18-70

[redacted] CONTROL SYSTEM ONL

HANDLE VIA

PRE-FLIGHT DYNAMIC RES[illegible]TION



Camera No. 325

Payload No. CR-12

Resolution (l/mm)

High Contrast: N

Low Contrast: 2/

Film Type: 3404

Test Date: 3-16-70

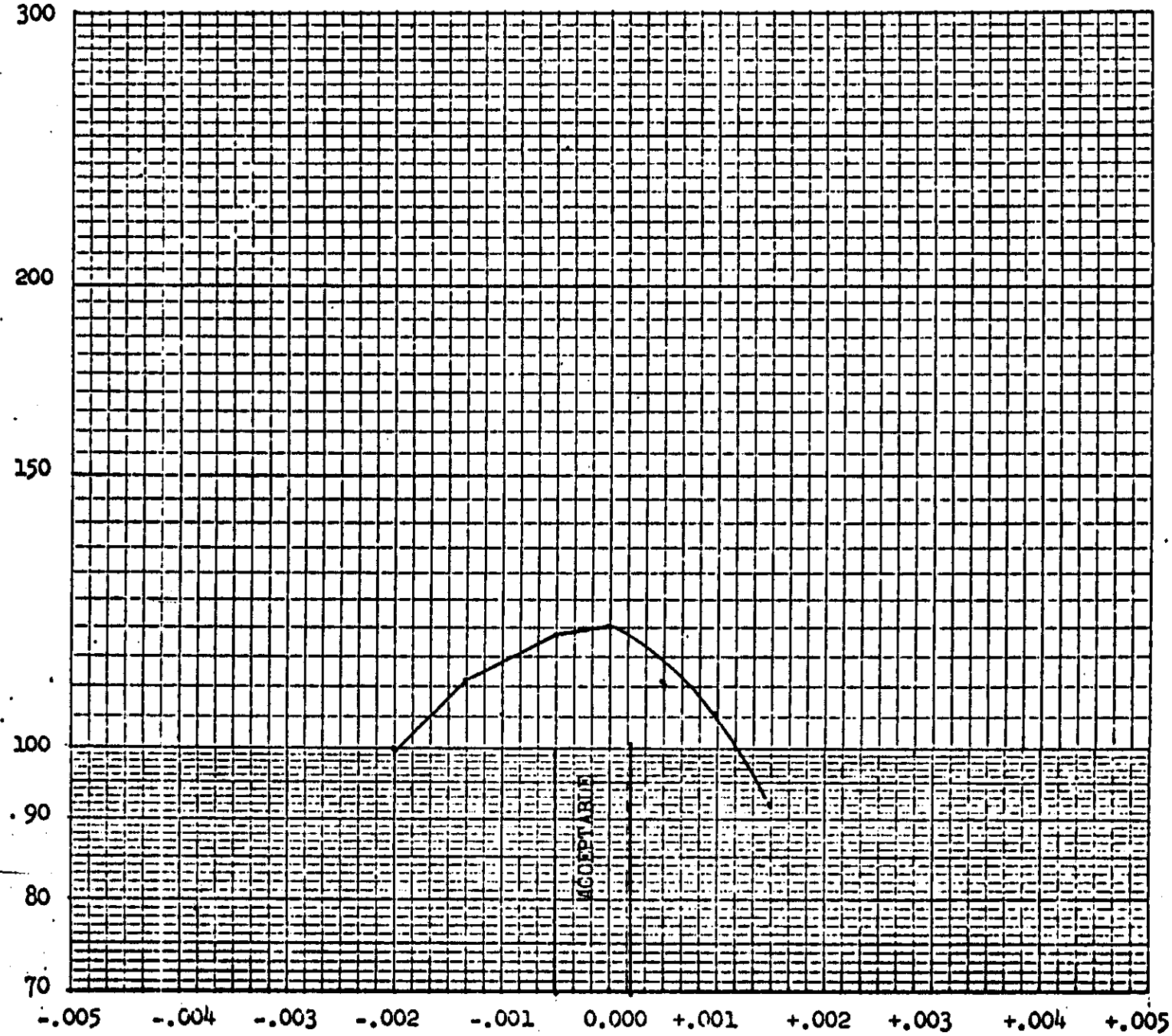
Prepared By: [redacted]

Date: 3-16-70

CONTROL SYSTEM D[illegible]

HANDLE VIA [redacted]

PRE-FLIGHT DYNAMIC RESO[illegible]TION



Camera No. 324

Payload No. CR-12

Resolution (l/mm)

High Contrast: -

Low Contrast: 2/1

Film Type: 3414

Test Date: 6-16-70

Prepared By: [redacted]

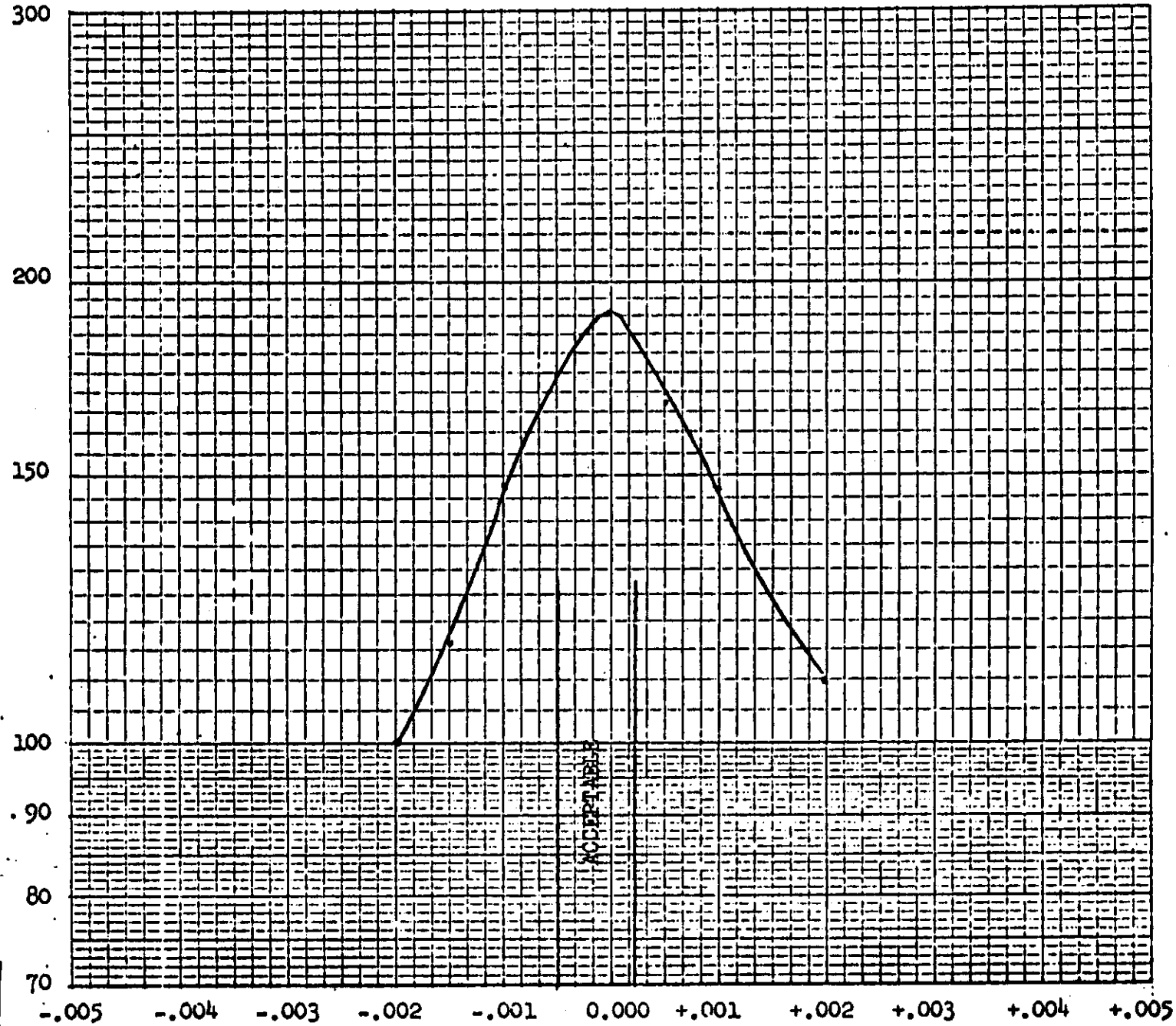
Date: 6-16-70

Process #3677

TOP SECRET

HANDLE VIA [redacted] CONTROL SYSTEM ONLY

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No. 325

Payload No. CR-12

Resolution (l/mm)

High Contrast: -

Low Contrast: 2/1

Film Type: 3414

Test Date: 6-16-70

Prepared By: [redacted]

Date: 6-16-70

Process #3677

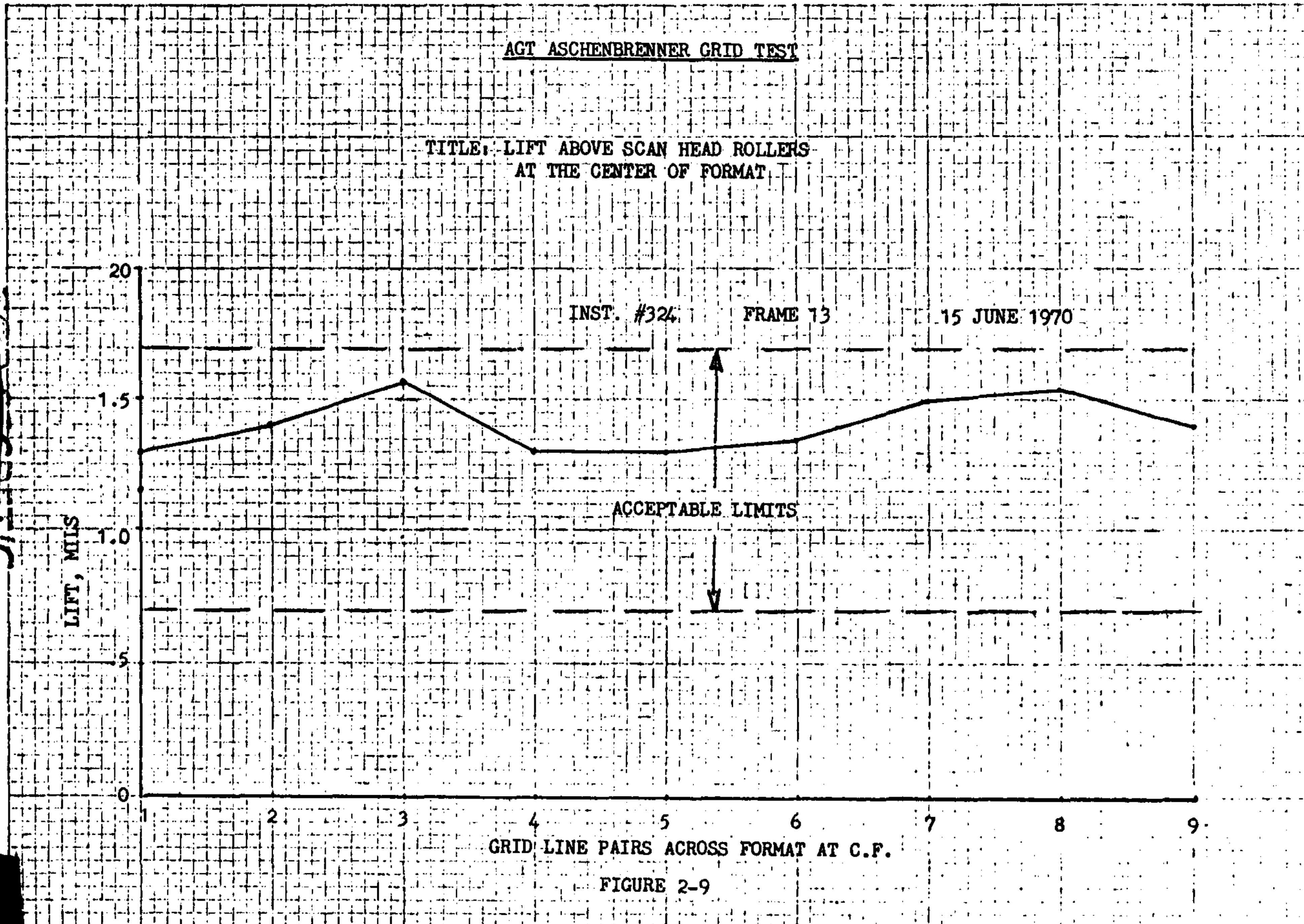

AGT ASCHENBRENNER GRID TEST
TITLE: LIFT ABOVE SCAN HEAD ROLLERS
AT THE CENTER OF FORMAT
INST. #324
FRAME 13
15 JUNE 1970
ACCEPTABLE LIMITS
LIFT, MILS
20
1.5
1.0
.5
0
1
2
3
4
5
6
7
8
9
GRID LINE PAIRS ACROSS FORMAT AT C.F.

FIGURE 2-9

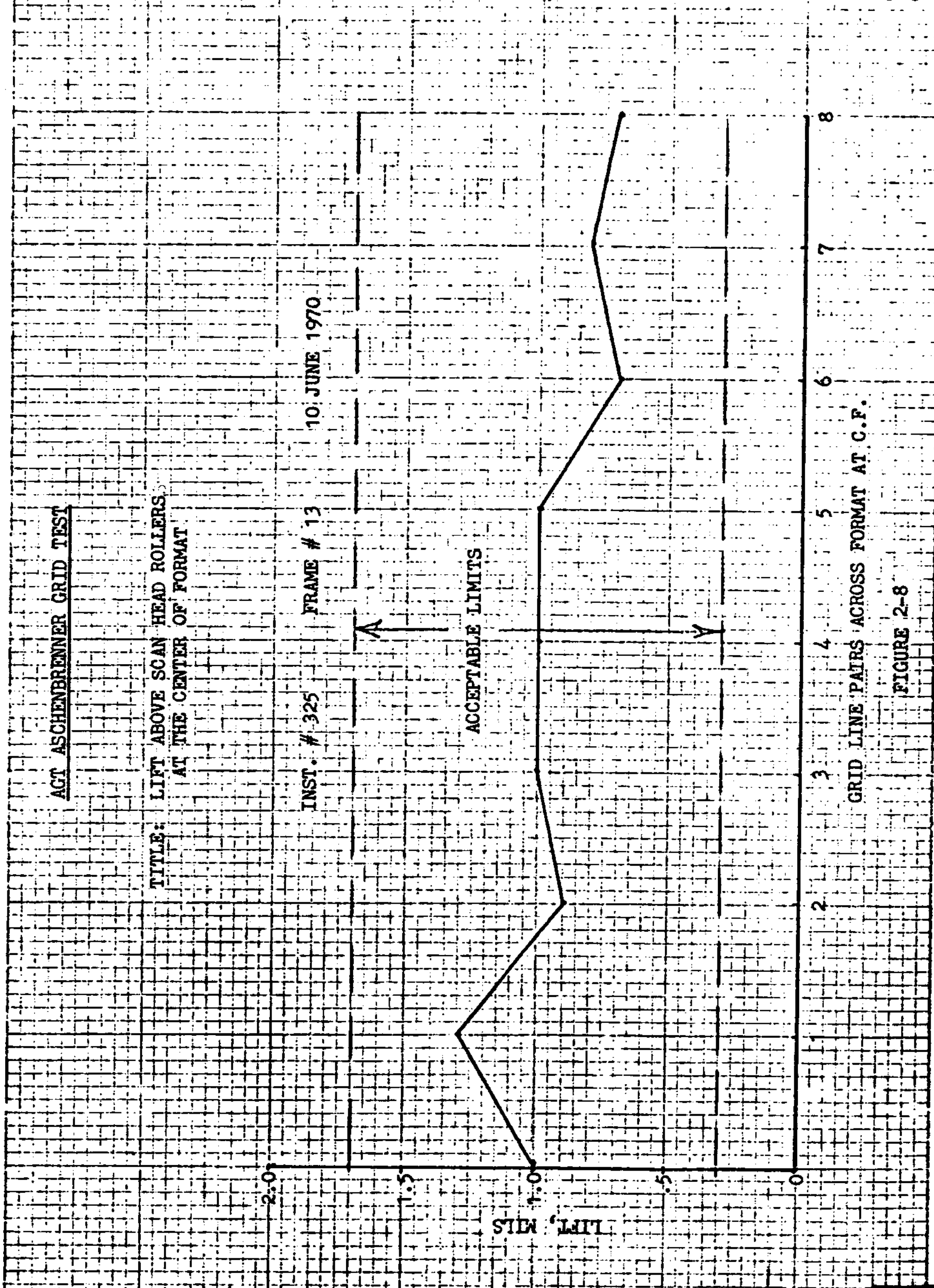
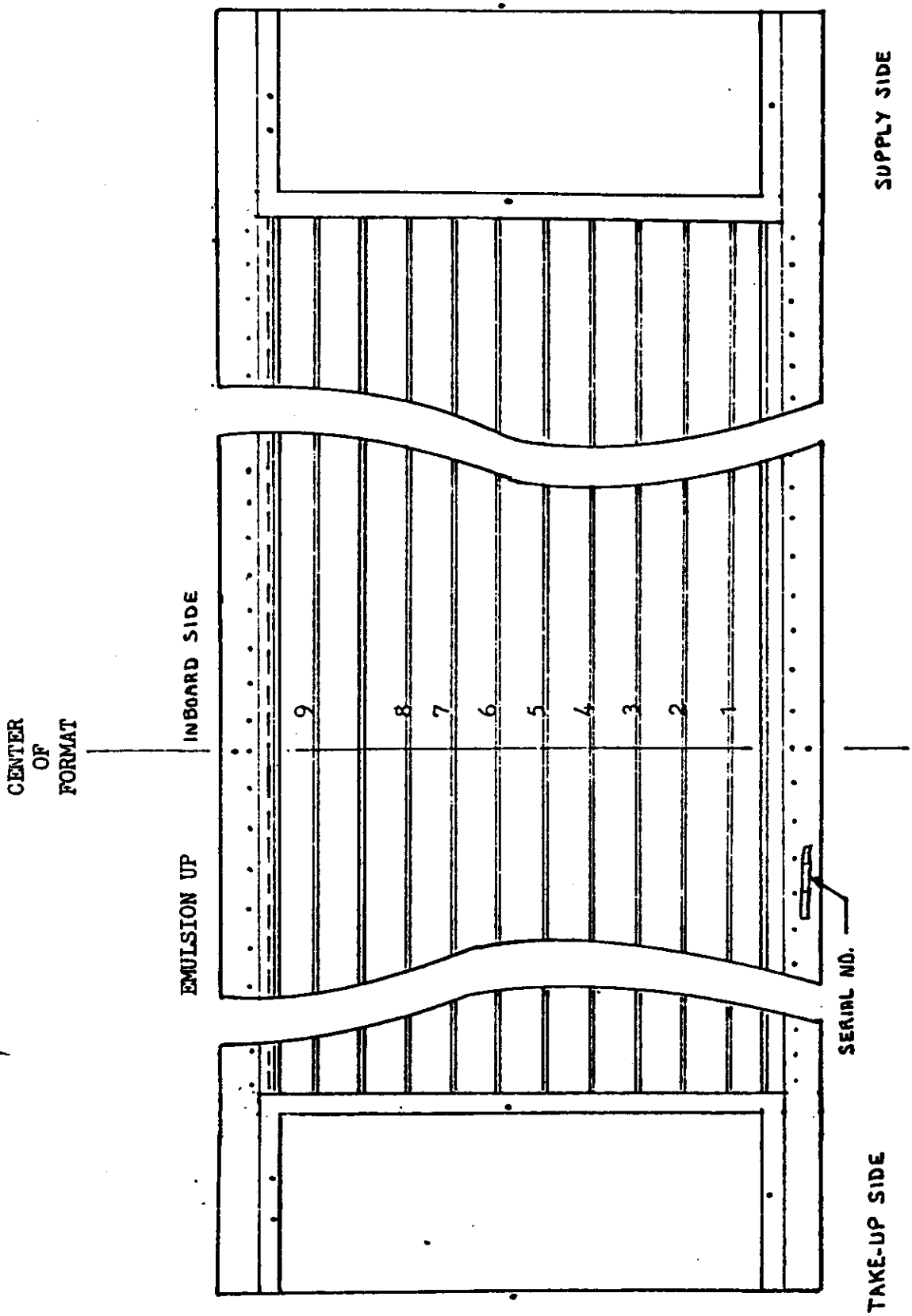

AGT ASCHENBRENNER GRID TEST
TITLE: LIFT ABOVE SCAN HEAD ROLLERS
AT THE CENTER OF FORMAT
INST. # 325
FRAME # 13
10 JUNE 1970
ACCEPTABLE LIMITS
LIFT, MILS
2.0
1.5
1.0
.5
0
1
2
3
4
5
6
7
8
GRID LINE PAIRS ACROSS FORMAT AT C.F.

FIGURE 2-8



AGT ORIENTATION SKETCH

FIGURE 2-7

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Mission 1111 was launched normally into the planned orbit without incident. All ascent and injection events occurred as programmed. The orbit achieved was within the 3 sigma predicted dispersions. The total mission lasted for 19 days with a 7-day first segment and a 12-day second segment.

The panoramic cameras operated satisfactorily throughout the flight. The panoramic camera film supply for both instruments was depleted prior to the -2 mission recovery. Photographic performance varied from fair to good. The DISIC camera operated properly throughout the -1 and -2 missions.

B. LAUNCH

The flight was launched at 01:25 GMT on 23 July 1970 from Satellite Launch complex 3 west at Vandenberg AFB.

Mission 1111 was composed of Thorad booster (SLV-2H) S/N 69-046, Agena vehicle 1654, and payload system CR-12. The CR-12 payload system contained panoramic cameras S/N 324 and 325 and DISIC camera S/N 2R.

All ascent events were normal with inflight reset (door ejection), A/P to orbit mode, instrumentation switchover, and panoramic camera transfer to orbit mode occurring as programmed.

C. ORBIT

Mission 1111 was launched into the planned orbit. All orbit parameters attained were well within the specified tolerances.