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207 Pages

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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1102-1 and 1102-2

FTV 1642, CR-2

JULY 1, 1968

Approved [redacted]
Advanced Projects

Approved [redacted]
Program

~~TOP SECRET~~ C [redacted]

8 August 1968

TO: [redacted]

THRU: [redacted]

FROM: [redacted]

SUBJECT: MISSION 1102 FINAL REPORT (CR-2)

Enclosed is the Final Evaluation Report for Mission 1102.

[redacted]

Advanced Projects

FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1642.

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 Missions 1102-1 and 1102-2, which was launched on 9 December 1967.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1102-1 and 1102-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the CR-2 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 using Corona engineering photography acquired over the United States was performed at the individual contractors plants.

The quantitative data used for this report is obtained from government organizations. The diffuse density data, and MTF/AIM resolution are produced by AFSPPF. The vehicle attitude error values, 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.

SECTION 1

SYSTEM PERFORMANCE

A. MISSION OBJECTIVES

The payload section of Mission 1102, placed into orbit by Flight Test Vehicle #1642 and the THORAD Booster, 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-2 payload system. This Corona "J" system was designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. A seven day -1 mission and a seven day -2 mission was planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2226Z on 9 December 1967. 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 1102-1 consisted of a 6-day operation and was completed by air recovery on 14 Dec. 1967. Mission 1102-2 was completed with an air recovery on 22 Dec. 1967,

following an 8-day photographic operation.

The comparison of the planned and actual orbit parameters is shown in Table 1-1.

TABLE 1-1

ORBITAL PARAMETERS

Parameter	Predicted	Actual (Rev. 1)
Period (Min)	88.66	88.56
Perigee (N.M.)	84.7	86.4
Apogee (N.M.)	141.8	135.3
Eccentricity	0.0080	0.0070
Inclination (Deg.)	81.5	81.64
Arg of Perigee (Deg.)	161	161

C. PANORAMIC CAMERAS

Both cameras demonstrated exceptionally high resolution performance in Missions 1102-1 and -2. Each mission was given an MIP rating of 100, the highest rating in the history of the Corona program. However, image smear principally in the scan direction was apparent in some of the photography from both cameras. Image smear in the scan direction was more noticeable in photography from the forward looking camera. Program objectives were attained.

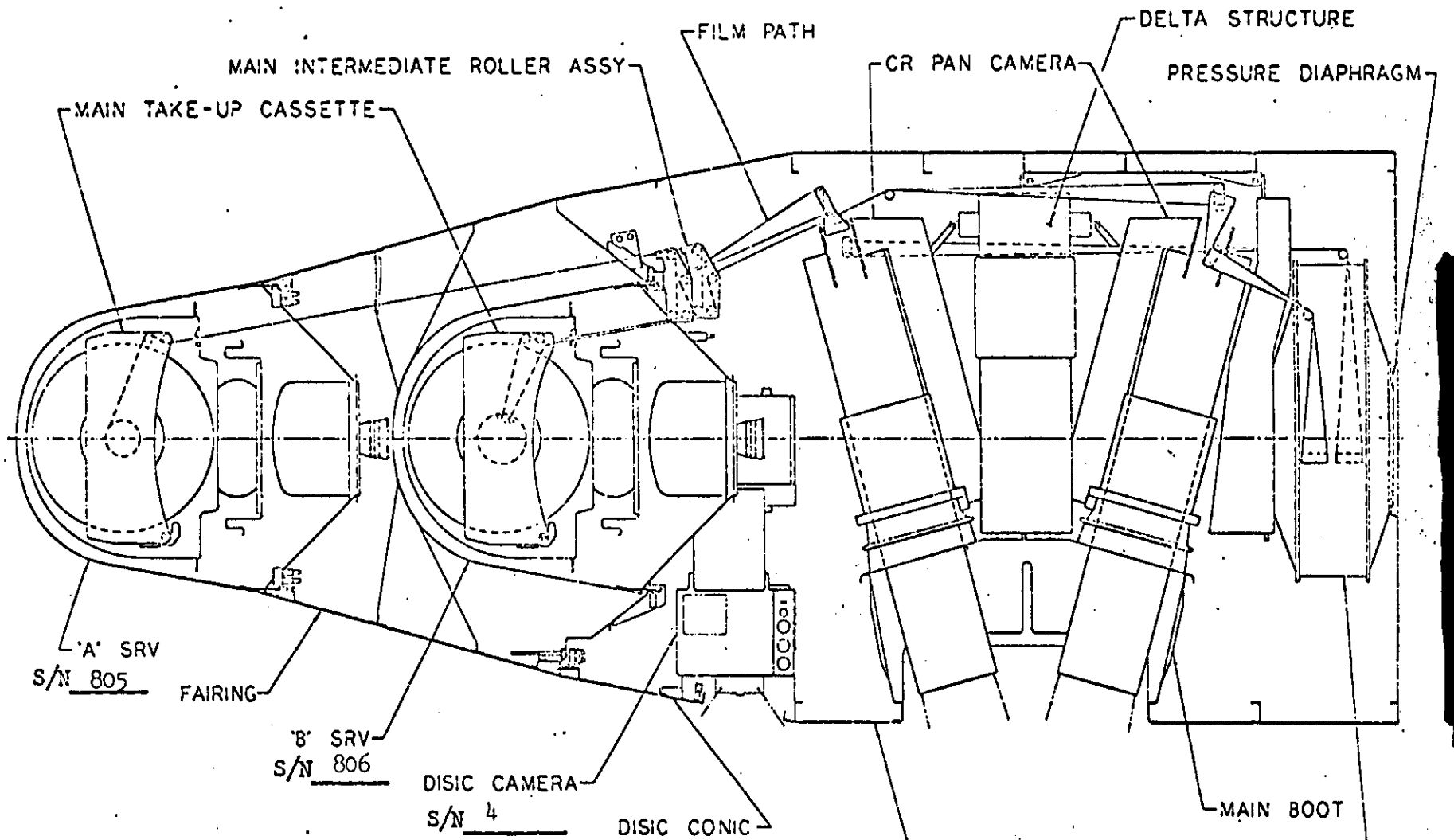
D. DISIC CAMERA

Image detail recorded by the terrain camera during Mission 1102-1 and -2 was noticeably better than that recorded during Mission 1101-1 and -2. Stars through 6.5 magnitude were recorded. Stellar format flare fog was significantly less on Mission 1102-1 and -2 relative to Missions 1101-1 and -2. The reduction of flare fog on Mission 1102 stellar photography is attributed to improved stellar baffles. The basic terrain and stellar program objectives were attained

E. OTHER SUB-SYSTEMS

The clock, instrumentation, pressure make-up, command and thermal control subsystems performed satisfactorily.

PAYLOAD PROFILE AND SERIAL NUMBERS



SYSTEM NO. CR-2

TEST Flight

PMU S/N 1004

SLOPE PROGRAMMER S/N 202

CLOCK S/N 626

FIGURE 1-1. INBOARD PROFILE

F. TABLE 1-2 COMPONENT IDENTIFICATION AND ASSOCIATED DATA

1. GENERAL FLIGHT DATA	
MISSION NO.	1102
VEHICLE NO.	1642
SYSTEM NO.	CR-2
FORWARD LOOKING CAMERA SERIAL NO.	305
AFT LOOKING CAMERA SERIAL NO.	304
DISIC CAMERA SERIAL NO.	4
2. LENS DATA	
FORWARD LOOKING CAMERA (MAIN LENS)	305
LENS SERIAL NO.	I-181
NOMINAL SLIT WIDTH (INCHES	
POSITION 1	.215
POSITION 2	.270
POSITION 3	.340
POSITION 4	.340
FAILSAFE	.340
OPTICS FILTER TYPE	
PRIMARY	W-25 (GELATIN)
ALTERNATE	SF09 POLARIZER +20° GLASS
E.O. FOCAL LENGTH (INCHES)	24.000
RESOLUTION/FILM TYPE	
STATIC(LINES/MILLIMETER)	
FILTER	W-21
HIGH CONTRAST	256
LOW CONTRAST	156

DYNAMIC (LINES/MILLIMETER)	
ITEK POST-VIBRATION	
FILTER	W-21 GELATIN
HIGH CONTRAST	213 at 0.000
LOW CONTRAST	139 at 0.000
A/P TEST	
FILTER	W-21 GELATIN
HIGH CONTRAST	205 at-0.002
LOW CONTRAST	137 at-0.002
DISTORTION/PINCUSHION (MICRONS)	
ANGLE OF AXIS, DEG.	
3	0
2	0
1	0
0	0
359	0
358	1
357	1
AFT LOOKING CAMERA (MAIN LENS)	304
LENS SERIAL NO.	I-165
OPTICS SLIT WIDTH (INCH)	
POSITION I	.134
POSITION 2	.170
POSITION 3	.215
POSITION 4	.270
FAILSAFE	.250

OPTICS FILTER TYPE	
PRIMARY	W-21 GELATIN
ALTERNATE	SF05 GLASS
E.O. FOCAL LENGTH (INCH)	24.001
RESOLUTION (LINES/MM)	
STATIC	
FILTER	W-21 GELATIN
HIGH CONTRAST	248
LOW CONTRAST	149
DYNAMIC (LINES/MM)	
ITEK POST-VIBRATION	
FILTER	W-21 GELATIN
HIGH CONTRAST	198 at 0.000
LOW CONTRAST	128 at 0.000
A/P TEST	
FILTER	W-21 GELATIN
HIGH CONTRAST	185 at -0.002
LOW CONTRAST	122 at -0.002

DISTORTION/PINCUSHION (MICRONS)

ANGLE OFF AXIS DEG.	
3	2
2	1
1	0
0	0
359	0
358	2
357	3

2. LENS DATA (Cont'd)

HORIZON OPTICS

FORWARD LOOKING CAMERA 305

TAKE-UP (STARBOARD)

LENS SERIAL NO.	E23793
EXPOSURE TIME (SEC)	1/100
APERTURE	F/8.0
FILTER TYPE	W-25
OPERATIONAL FOCAL LENGTH MM	55
RADIAL DISTORTION (MM)	
10 DEG. OFF AXIS	.02
20 DEG. OFF AXIS	.05
TANGENTIAL DISTORTION	.018

RESOLUTION (LINES/MILLIMETER)

ANGLE OFF AXIS (DEG.)	0	5	10	15	20	25	30
(RADIAL)	187	208	206	181	162	150	72
(TANGENTIAL)	187	207	181	155	130	121	62

SUPPLY (PORT)

LENS SERIAL NO.	E23774
EXPOSURE TIME (SEC)	1/100
APERTURE	F/6.3
FILTER TYPE	W-25
OPERATIONAL FOCAL LENGTH MM	55
RADIAL DISTORTION (MM)	
10 DEG. OFF AXIS	.02
20 DEG. OFF AXIS	.06
TANGENTIAL DISTORTION	.01

RESOLUTION (LINES/MILLIMETERS)

ANGLE OFF AXIS (DEG.)	0	5	10	15	20	25	30
(RADIAL)	166	186	184	143	78	119	81
(TANGENTIAL)	148	164	161	123	103	96	62

AFT LOOKING CAMERA 304

TAKE-UP (PORT)

LENS SERIAL NO. E23799

EXPOSURE TIME (SEC) 1/100

APERTURE F/6.3

FILTER TYPE W-25

OPERATIONAL FOCAL LENGTH MM 55

RADIAL DISTORTION (MM)

10 DEG. OFF AXIS .01

20 DEG. OFF AXIS .03

TANGENTIAL DISTORTION .0288

RESOLUTION (LINES/MILLIMETER)

ANGLE OFF AXIS (DEG.)	0	5	10	15	20	25	30
(RADIAL)	187	186	184	160	139	139	43
(TANGENTIAL)	166	185	161	123	130	96	52

SUPPLY (STARBOARD)

LENS SERIAL NO. E23785

EXPOSURE TIME (SEC) 1/100

APERTURE F/8.0

FILTER TYPE W-25

OPERATIONAL FOCAL LENGTH MM 55

RADIAL DISTORTION (MM)

10 DEG. OFF AXIS .02

20 DEG. OFF AXIS .05

TANGENTIAL DISTORTION .03

RESOLUTION (LINES/MILLIMETER)

ANGLE OFF AXIS (DEG.)	0	5	10	15	20	25	30
(RADIAL)	209	208	184	181	110	150	57
(TANGENTIAL)	187	185	161	155	130	96	62

2.4 DISIC CAMERA 4

PORT STELLAR CAMERA

LENS SERIAL NO. 4P

RESEAU SERIAL NO. 4P

APERTURE F/2.8

EXPOSURE TIME (SEC) 1.5

NOMINAL FOCAL LENGTH (INCHES) 3.0

FILTER NONE

STARBOARD STELLAR CAMERA

LENS SERIAL NO. 4

RESEAU SERIAL NO. 4

APERTURE F/2.8

EXPOSURE TIME (SEC) 1.5

NOMINAL FOCAL LENGTH (INCHES) 3.0

FILTER NONE

TERRAIN CAMERA

LENS SERIAL NO.			101
RESEAU SERIAL NO.			101
FILTER TYPE			W-12
APERTURE			F/4.5
EXPOSURE TIME (SEC)			1/500
NOMINAL FOCAL LENGTH (INCHES)			3.0
RESOLUTION (HIGH CONTRAST LINES/MILLIMETER)			
ANGLE OFF AXIS (DEG.)	0	17	34
RADIAL	78	76	69
TANGENTIAL	77	68	51
FILM TYPE			3400
FILTER			W-12

FILM TYPES

FORWARD LOOKING CAMERA	NO. 305
SPLIT LOAD	YES
FILM TYPE	3404 (SO-230)
LENGTH (FT.)	16,300
SPLICES	5
LENGTH BETWEEN SPLICES (FT.)	2000-630-5815-5855-(2000)
EMULSION DATA	3404-401-1-11-7 (SO-230-11-1-11-7)
PAYLOAD WEIGHT (LBS)	88.3-83.8
SPOOL NO.	168T
BOX SERIAL NO.	30

AFT LOOKING CAMERA	NO. 304
SPLIT LOAD	YES
FILM TYPE	3404(SO-230)
LENGTH (FT.)	16,300
SPLICES	5
LENGTH BETWEEN SPLICES (FT.)	3300-4175-2322-4003-(2500)
EMULSION DATA	3404-405-4-1-3-11-7 (SO-230-11-1-11-7)
PAYLOAD WEIGHT (LBS)	87.5 - 80.1
SPOOL NO.	215B
BOX SERIAL NO.	30
DISIC CAMERA	
STELLAR CAMERA	
SPLIT LOAD	YES
FILM TYPE	3401(3400)
LENGTH (FT)	1800/(200)
SPLICES	1
LENGTH BETWEEN SPLICES (FT)	1800-200
EMULSION DATA	3401-238-5 (3400-227-8-11-7)
PAYLOAD WEIGHT (LBS)	7.1 - 1.7
TERRAIN CAMERA	
SPLIT LOAD	NO
FILM TYPE	3400
LENGTH (FT)	2000
SPLICES	0
LENGTH BETWEEN SPLICES (FT)	N/A
EMULSION DATA	156-8-7-7
TOTAL FILM WEIGHT (LBS.	20.1-2.4

SECTION 2

PRE-FLIGHT SYSTEMS TEST

As a standard procedure, the J payload systems are subjected to a series of tests with flight type film which demonstrates that the systems will perform as required in their respective missions. The principal tests include the following.

A. Exposure of the J payload to a thermal/altitude environment that approximates flight conditions.

B. System light leak test.

C. Dynamic Resolution determination that shows the high and low contrast resolution capability of each panoramic camera.

D. Flight Readiness.

E. Flight Certification.

A. ENVIRONMENTAL TEST

The CR-2 system was exposed to the first HIVOS environment from 20 September to 5 October 1967 and again from 28 October thru 1 November 1967. The primary purpose of the environmental tests was to determine the corona discharge marking characteristics of the panoramic and DISIC cameras with flight type film during dynamic operation.

The first HIVOS test was interrupted at the end of the A bucket operation during the normal DISIC cut and splice sequence. Interruption of the cut and splice sequence was caused by a New York hand

splice that separated. Splice separation prevented normal take-up of Stellar film into the B bucket. The system was returned to A/P to correct the DISIC film/splice anomaly.

While the CR-2 system was being readied for return to the chamber to complete the B bucket portion of the first HIVOS test, the films from the A bucket were retrieved, processed, and evaluated. Minor acceptable corona fog was present on film from Instrument 305. Corona fog was present on the film up to approximately 40 inches from the start of pass mark toward the take-up. Eight operations were affected by corona fog to a density of 0.08 above the base level. Instrument 304 contained no corona fog in the A bucket material.

Stellar film from the A bucket contained several kinds of fog marks in the film sample. Acceptable skew bead fog marks were present near both edges of the film. Skew marks were located outside the active star recording format area. Minor plus density fog spots were present in the active format area of the majority of port and starboard Stellar formats. Fog spots were associated with the reseau pattern. Fog spots may be caused by static discharge between the reseau plate and the film. Many starboard frames contain one low density metering roller mark per frame. The metering roller mark in the starboard format is not expected to interfere with star imagery because of the low plus density feature of the mark. Minor dendritic static was present at random locations throughout the Stellar film.

Dendritic static was attributed to the film retrieval operation. Large areas of heavy Corona fog, to a density of approximately 0.9 above the base level, affect approximately 22 percent of the Stellar formats. The percentage is based upon Stellar frame count. Stellar corona fog exceeds the CR system acceptance criteria and therefore is unacceptable. Corona fog was present on many frames that did not have the benefit of the gas pressure make-up system. PMU correlation with Stellar photography revealed that corona fog was usually not present during normal operations when the internal camera pressure exceeded approximately 50 microns. However, during the pressure sweep low density corona marking was observed at all pressures between 25 and 90 microns. The cause of the anomaly is unknown.

DISIC terrain photography was relatively free of corona discharge fog. Approximately 3.5 percent of the DISIC terrain frames recovered from the A bucket contained corona fog marks to a density less than 0.4 above the base plus fog level. Minor retrieval static was occasionally present. Occasionally a plus density streak was present at the edge of the format active area 1/16 inch wide and parallel to the edge of the film. The cause of this anomaly is unknown.

The recorded binary time word was frequently unacceptable in Instrument 304 and 305 photography. Incorrect time words were characterized by either all bits present, the index row was missing, or 3 bits were present in some of the rows of the A bucket material. Occasionally the A.O. fiducials were not present. One PG trace of Instrument 304 was faint and unacceptable.

The DISIC splice separation was corrected at A/P and the CR-2 System returned to the HIVOS chamber to complete the B bucket operations of the first HIVOS test.

Auxiliary recording imagery produced in the B bucket films from both pan cameras and the DISIC camera was comparable to the imagery reported for the A bucket. However, unacceptable continuous type corona was observed in Instrument 305 film during the two pressure sweeps; one during 3404 type film operations and the other during SO-230 type film operation from Instrument 305. Continuous type corona marks spaced at 6.25 inches were present when internal camera pressure ranged between approximately 16 to 39 microns for 3404 type film and 14 to 28 microns for SO-230 type film. Corona density reached a maximum of 0.65 for SO-230 film and 0.52 for 3404 type film. No continuous corona marks were observed when internal camera pressure ranged between 50 and 110 microns, the highest pressure attained with the PMU system on.

Prior to subjecting the CR-2 system to a second environmental test the metering rollers of Instrument 305 were removed and replaced with a new set from Boston. The new metering rollers were certified by Boston to be corona free. The binary time word circuit was examined and modified. The DISIC camera was reworked to minimize the corona discharge and static fog marks in the Stellar and terrain film.

The system was returned to the HIVOS chamber from 28 October thru 1 November 1967 for B bucket operation. Internal camera pressures ranged between 1 and 100 microns during pan camera operation. Although more than 2000 feet of 3404 type film was programmed through each pan camera, no corona discharge fog was present on the processed film exhibits.

The percentage of incorrect time words produced on Instrument 305 film was reduced from approximately 25 percent during the first HIVOS test to 1.5 percent during the second test. The percentage of incorrect time words produced on Instrument 304 film remained at approximately 5 percent. Incorrect time words were characterized by either double exposures resulting in incorrect time, or the index row was missing. Time words containing the missing index row are expected to be misread by the automatic reader. However, the magnetic tape recorded time words will provide a secondary source of time data for each panoramic camera.

Examination of processed films from the DISIC camera revealed a significant reduction in the frequency and magnitude of corona fog marks in the Stellar film. However, 30 percent of the terrain frames were affected by corona fog to a maximum density of 0.39 above the base level. The Stellar and terrain corona exceeds the acceptance criteria that states in part, "less than 10 percent of the frames shall be affected by corona fog marks".

Telemetry recording of the A.O. idler roller of Instrument 304 during HIVOS No. 2, Rev 3, Operate 1 revealed a violent upset in the rotation of the idler roller. A manufacturer's film splice became suspect. Examination of the processed HIVOS film revealed the presence of a manufacturer's splice that correlated with the telemetry disturbance. The manufacturer's splice contained significant amounts of adhesive pressed out beyond the splice and attached to the adjacent film wraps. It is believed that the manufacturer's splice stuck momentarily to the adjacent film wrap during off spooling from the supply causing a severe transient in the film path that upset the rotation of the A.O. idler roller on the supply side of Instrument 304 platen.

B. LIGHT LEAK TEST

The system Light Leak test using type 3401 film in Instruments 304 and 305 was completed on 8 November 1967, per Test Procedure CR 240301. The test film was processed to the full level and evaluated on 9 November 1967.

Film from Instrument 304 contained minor light fogging to 0.09 density above the base level. Fog was confined to the input A.O. end of the format that remained in the platen during the light soak. Film from Instrument 305 contained a light fog band 1/8 inch wide and perpendicular to the longitudinal axis of the film. Fog density was 0.05 above the base level. The band was located approximately 82 inches toward the film take-up end of the system in the platen area of Instrument 304. Photomultiplier tests revealed noticeable light leakage past the drum of Instrument 304. Instrument 304 drum light leakage is considered the source of minor light fog on film exhibits from both pan cameras. While the drum leak from Instrument 304 was significantly reduced by corrective applications of RTV, the leak was not entirely eliminated. The present drum light leak is considered acceptable and is expected to have a minor degrading effect on flight imagery when the non-operate period in flight approaches four orbits or more.

The DISIC camera light leak discovered in CR-1 Stellar flight film was corrected on DISIC camera #4. The light leak occurred between the DISIC terrain lens and the camera body. RTV was applied at this interface to seal off the light leak. A special light leak test of DISIC camera #4 demonstrated that the light leak had been eliminated.

C. RESOLUTION TESTS

Standard resolution tests of the CR-2 system were performed on 12 and 16 October 1967. The final thru focus resolution test of Instruments 304 and 305 demonstrated acceptable performance.

Instrument 304 produced a final peak low contrast resolution value of 126 lines per millimeter at a collimator focus position of -0.002 inches. Instrument 305 produced a similar peak resolution value of 134 lines per millimeter at a collimator position of -0.001 inches. Film Type 3404 was used for all resolution tests with a Wratten 21 gelatin filter and a 0.140 inch camera slit. Table 2-1 shows the CR-2 system thru focus low contrast resolution for instruments 304 and 305.

All through-focus low contrast resolution data for Instrument 304 and 305 are shown in the attached table. Resolution values shown are for Boston and A/P collimator focus positions set to compensate for a vacuum focus shift of 0.015 inches. After the first A/P test and before the final resolution test, the scan head of Instrument 304 was shimmed +0.001 inches and the scan head of Instrument 305 was shimmed +0.002 inches. The through focus resolution data from the first A/P test of Instrument 305 is shown adjusted for an A/P collimator bias of +0.001 inches relative to the Boston collimator, as reported by Boston personnel. The collimator setting difference between Boston and A/P has been corrected so that future A/P resolution tests are expected to have zero bias relative to the Boston collimator.

The system was considered acceptable for flight with Wratten 21 gelatin filters.

TABLE 2-1

CR-2 THRU FOCUS LOW CONTRAST RESOLUTION (Li/mm)

INSTRUMENT 304

Collimator Focus Position (Inches)	Boston East Coast	1st A/P Test 10-12-67 Boston	Final A/P Test Boston	10-16-67 Performance Evaluation
-0.004		---	81	79
-0.003		63	114	109
-0.002	92	88	122 P	126 P
-0.001	102	119 P	110	115
0.000	128 P	117	104	108
+0.001	102	104	111	110
+0.002	117	---	112	114
+0.003	119	---	---	---
+0.004	114	---	84	78
+0.005	97	---	---	---

INSTRUMENT 305

-0.004		---	83	81
-0.003		---	118	112
-0.002	73	---	137 P	133
-0.001	111	82	131	134 P
0.000	139 P	131	127	130
+0.001	135	139 P	123	124
+0.002	127	136	106	104
+0.003	125	---	---	---
+0.004	101	---	63	62
+0.005	97	---	---	---

Each resolution value shown is the average of 5 scan plus 5 FMC targets using the 120 inch collimator. The peak resolution value for each thru focus test is shown in the Table above underlined and followed by letter P.

D.1. DISIC #4 FLIGHT READINESS TEST RESULTS

The Flight Readiness Test was completed on 16 November 1967. Film type 3401 was used in the Stellar cameras and film type 3400 was used in the Terrain camera.

Processed test films were evaluated on 17 November with the following results. Examination of the Stellar and Terrain film revealed acceptable reseau, time word, and serial numbers. The two Stellar shutters (modified to operate only at 1/500 sec. per New York ECN BO 564) and Terrain shutter appeared to operate throughout the film test. The Stellar and Terrain active format areas were free of static marking. Minor skew roller marks were present along both edges of the Stellar film outside the active format area. Skew roller marks are not expected to interfere with the Stellar time word recording.

The port and starboard Stellar format fog levels for four consecutive pairs of exposures for Mode 1 and 2 are shown in Table 2-2. Density values include the baseplus fog level. Five density values were obtained from each Stellar format. One density measurement was made in each corner plus one in the format center.

TABLE 2-2

STELLAR FORMAT DENSITY VALUES

MODE 1 (SLAVE)

FRAME NUMBER	PORT DENSITY					STARBOARD DENSITY				
	1	2	Center(3)	4	5	1	2	Center(3)	4	5
1	.35	.34	.39	.34	.37	.35	.33	.39	.34	.33
2	.34	.37	.39	.35	.37	.33	.32	.39	.35	.33
3	.35	.37	.40	.34	.36	.35	.33	.40	.35	.33
4	.33	.37	.40	.35	.36	.35	.35	.38	.34	.33

Base Plus Fog Value 0.19

TABLE 2-2

STELLAR FORMAT DENSITY VALUES

MODE 2 (INDEPENDENT)

FRAME NUMBER	PORT DENSITY					STARBOARD DENSITY				
	1	2	Center(3)	4	5	1	2	Center(3)	4	5
1	.32	.35	.38	.34	.39	.32	.32	.37	.32	.32
2	.35	.40	.42	.35	.36	.33	.33	.39	.33	.34
3	.34	.35	.38	.33	.35	.34	.33	.37	.33	.31
4	.33	.35	.37	.34	.34	.35	.33	.38	.34	.31

Base Plus Fog Value 0.19

These Stellar format fog densities demonstrate acceptable compliance with the requirement that density values shall be approximately 0.2 above the base plus fog level. This density value has been established for the CR-2 system only, and is not the value stated in the System Requirement Specification.

The time word associated with the start of pass frame contained ghost bit imagery in addition to the normal time word. Ghosting was attributed to test conditions only and was not expected to occur in flight.

DISIC #4 was considered acceptable for flight.

D. 2. CR-2 SYSTEM FLIGHT READINESS TEST

The final Flight Readiness Test of CR-2 System, Instruments #304 and #305, was completed on 20 November 1967. The Flight Readiness Test of DISIC camera #4 was completed on 17 November 1967 with test results detailed in the referenced document.

Instruments #304 and #305 were Readiness tested with flight type 3404 film. Test film was processed to the A/P intermediate process level.

The final Readiness test of Instruments #304 and #305 revealed acceptable imagery for the 200 PPS timing track including the slur pulse. Horizon camera fiducials were all present. Horizon camera shutters appear to open and close properly as evidenced by the presence of exposure lamp imagery on each horizon camera format. Imagery of all the rail holes, pan geometry traces, and start of pass mark were excellent at all cycle rates tested ranging from 2 through 4 seconds per cycle for each pan camera.

The final Readiness test film exhibits for Instrument 304 and 305 were free of image degrading scratches, static fog and minus density streaks. Rail scratches in the final Flight Readiness test films were multiple and moderately heavy on the film exhibits from both cameras. Moderately heavy rail scratching is not expected to degrade flight imagery.

One ghosted time word was observed in the final Readiness test of Instrument #304 out of a total of 20 formats. The incorrect time word contained ghost bit imagery in addition to the normal time word. Associated with the ghosted time word was a double instrument serial number with images slightly displaced.

All of the other nineteen time words produced by Instrument #304 appeared correct. Time words with ghost bit imagery with density less than 0.3 above the base plus fog level were expected to be read correctly by the automatic data reader.

One incorrect time word containing 3 bits in several rows of low order bits was present out of the 20 cycles of the final readiness test from Instrument #305. All other time words appeared correct. Correlation of incorrect time words of this type on the film with the tape recorded time revealed that the subject incorrect time word was actually two different time words superimposed upon one another. The tape recorder consistently demonstrated that one of the time word exposures was early plus one time word that is correct. The correct time for the double exposed frame was recoverable from the tape recorder data.

Incorrect time words with the index row missing did not appear on film from either pan camera during any readiness test possibly because the cycle rate during readiness testing is of necessity slow and is approximately 4 seconds per cycle. Prior to readiness testing and specifically in HIVOS test films, less than 1 percent to 3 percent of the formats from Instrument #305 and #304 respectively contained incorrect time words with the index row missing. It has been established that the tape recorded time data may be used to determine the correct time to within 10 milliseconds for incorrect time words recorded in film with the index row missing.

Anomalies observed in one or more of the first three readiness tests but which were not present in the fourth and final readiness test included:

INSTRUMENT #304

Intermittent 200 PPS timing track, minus density streaks, heavy rail scratches. All were corrected by removing emulsion buildup from the rails, replacing the primary flight filters, and cleaning the field flattener. Occasionally the time word showed compliment row only.

INSTRUMENTS #304 and #305

1. Processing streaks in film exhibits from both instruments were eliminated by cleaning the rollers in the first four racks of the RT-12 film processor prior to the final readiness test.
2. Minor variation in bit density and sharpness.
3. Time word contained all ones due to planned ones jumper verification.

INSTRUMENT #305

Heavy rail scratches. Heavy rail scratches were alleviated by removing emulsion buildup from both instrument rails.

Nominal slit widths intended for CR-2 flight use were certified by direct measurement of slit imagery produced by strobe light exposure for Instrument #304 and #305. The time word appeared normal with the ones jumper and 30th bit complement. However, index row and compliment row are all present at lower density. Slit image measurements vs the nominal cam slit size are shown in Table 2-3.

TABLE 2-3

SLIT IMAGE MEASUREMENTS vs NOMINAL CAM SLIT SIZE

INSTRUMENT #304

Cycle Rate: 4 Sec/Cycle
Filter : Primary W-21 Gelatin

Frame Number	Slit Image Width (Inches)	Nominal Cam Slit Width (Inches)
1	0.273	.270
2	0.275	
3	.273	
4	.273	
5	.273	
1	.220	.215
2	.217	
3	.215	
1	.175	.170
2	.173	
3	.175	
4	.173	
5	.170	
1	.137	.134
2	.125	
3	.127	
4	.125	
1	.213	.215 Failsafe
2	.213	
3	.211	
4	.212	
5	.210	
6	.210	

TABLE 2-3 (Cont'd)

SLIT IMAGE MEASUREMENTS VS NOMINAL CAM SLIT SIZE

INSTRUMENT #305

Cycle Rate: 4 Sec/Cycle
Filter : Primary W-25 Gelatin

Frame Number	Slit Image Width (Inches)	Nominal Cam Slit Width (Inches)
1	.335	.340
2	.334	
3	.333	
4	.334	
5	.334	
6	.334	.340
7	.333	
8	.335	
9	.334	
1	.265	.270
2	.265	
3	.264	
4	.263	
5	.265	
1	.214	.215
2	.212	
3	.210	
4	.208	
1	.333	.340 Failsafe
2	.340	
3	.337	
4	.335	
5	.335	

Correlation of the slit settings shown with cam positions verified that the cams were constructed in a sequence opposite to that required for CR-2 flight (Mission 1102).

The alternate solutions to correct this error were:

(1) Modification of the stored flight program commands to create a reverse timing sequence.

(2) Fabrication and installation of cams having the proper slit change sequence.

The latter alternative was selected since it would eliminate potential human errors in flight and data reduction operations.

D.3. FINAL CR-2 FLIGHT READINESS AND FILM LOADING

The final CR-2 System Flight Readiness Test was rerun on 27 November 1967, to verify the functioning of new corrected exposure cams for both main instruments.

Evaluation of the processed 3404 type film exhibits from the final Readiness test of Instruments 304 and 305 revealed that the new cams did provide specified exposure slit widths in the correct sequence.

Measurements of processed slit images produced on successive frames by strobe light exposure are shown in Table 1. These measurements, when compared with the Flight Readiness test procedure, demonstrate that the functional sequence is correct. The measured slit values are considered to be within acceptable tolerances for the specified values.

TABLE 2-4

CORRELATION OF EXPOSURE SLIT WIDTH SEQUENCE,
CAM POSITION AND STEPPER SWITCH POSITION

INSTRUMENT NUMBER 304

Frame Number	Measured Width (Inches)	Stepper Switch Position	Cam Position Number	Nominal Slit Width (Inches)
1	.139			
2	.136			
3	.136	2	1	.134
4	.134			
5	.134			
6	.157			
7	.164			
8	.163	3	2	.170
9	.164			
10	.225			
11	.223			
12	.220	4	3	.215
13	.215			
14	.220			
15	.218			
16	.268			
17	.277			
18	.274	5	4	.270
19	.279			
20	.278			
21	.228			
22	.234			
23	.233			
24	.229	8	Failsafe	.250
25	.235			
26	.230			

INSTRUMENT NUMBER 305

Frame Number	Measured Width (Inches)	Stepper Switch Position	Cam Position Number	Nominal Slit Width (Inches)
1	.204			
2	.200			
3	.200	2	1	.215
4	.200			
5	.200			

INSTRUMENT NUMBER 305 (Continued)

Frame Number	Measured Width (Inches)	Stepper Switch Position	Cam Position Number	Nominal Slit Width (Inches)
1	.204			
2	.200			
3	.200	2	1	.215
4	.200			
5	.200			
6	.256			
7	.258			
8	.258	3	2	.270
9	.260			
10	.331			
11	.334			
12	.335	4	3	.340
13	.330			
14	.333			
15	.334			
16	.330			
17	.333			
18	.335	5	4	.340
19	.337			
20	.330			
21	.334			
22	.335			
23	.331	8	Failsafe	.340
24	.331			
25	.335			

Acceptable auxiliary data recording imagery was present on the film samples from Instruments 304 and 305. Acceptable imagery included the 200 pps track, PG traces, start of pass mark, A.O. fiducials, PG rail holes, and instrument serial number.

Time word imagery complied with MIL-STD 782 relative to microdensitometer measurements. Bit diameters ranged between 6.3 and 7.4 mils at the 50 percent density level. Bits are considered acceptable when bit diameter

is between 6.0 and 10.5 mils with bit density greater than 0.3 above the base plus fog level.

Most time words produced on Instrument 304 and 305 film samples appeared to be correct. However, 4.8 percent of the time words produced on Instrument 304 film have the Index row missing as well as an abnormally low density time word row. The complement row appears correct. The automatic data reader is expected to misread all time words containing the missing index row. Examination of Instrument 305 film samples revealed that 3 percent of the time words had multiple interrogates resulting in incorrect binary time.

All of the Flight Readiness film exhibits were examined for image degrading scratches. None were found. Rail scratches were severe on film from both pan cameras.

DISIC Camera No. 4 and Instruments 304 and 305 were loaded on 29 November 1967 with flight film without incident. All Flight splices were acceptable.

E. CR-2 FLIGHT CERTIFICATION

Final loading of flight film for the CR-2 system was completed on 27 November 1967. Sensitometric measurements made on samples of this flight supply film for the pan cameras and the DISIC Terrain and Stellar cameras demonstrated satisfactory photographic characteristics. Film types 3404, 3400, and 3401 were evaluated.

During dynamic operations film tracking appeared acceptable. One scratch was observed on the backing side of film from Instrument 304. The scratch was

intermittent and was first observed after the film exited the constant tension roller assembly at the supply cassette. The cause of the scratch is unknown. The scratch occurred outside the active format area beyond the PG rail holes and time word imagery and was not expected to interfere in any way with Mission 1102 performance.

The rubber boot of Instrument 305 Port Horizon camera touched lightly on the corner of the platen light shield extension during camera operation. It was concluded that the boot would not be damaged in flight by light contact with the platen light shield extension.

Rail scratches were heavy on the emulsion side of the film from both pan cameras 304 and 305.

Horizon format vignetting was expected to be minimal. The Horizon shutters appeared to open and close in the center of each fiber glass boot. One steel ring was installed in each rubber boot near the interface of the boot with each horizon camera. The steel ring was expected to prevent the possibility of the rubber boot getting into the field of view of the horizon camera. Controlled exposures of both Stellar formats were programmed into the "A" bucket for possible base line use when evaluating Mission 1102 Stellar photography. Five pairs of Stellar formats were fogged at each of the following three brightness levels, measured in foot lamberts.

	Actual	Desired
1.	0.08	0.015
2.	0.3	0.15
3.	1.5	1.5

A final photometer check for light leakage showed that the system was free of such leaks except at the main camera drums. The previous live payload light leak test showed that leakage from this source produced only very minor fogging effects.

The photographic performance of the CR-2 system was certified for flight on 2 December 1967.

programmed. The orbit achieved was well within the 3 sigma predicted dispersions.

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

The DISIC system operated normally throughout the flight as indicated by the telemetry monitors.

The FMC, exposure control, clock, pressure make-up, instrumentation, and command systems operated satisfactorily throughout the flight.

Accent vibration appeared normal and was within the qualification levels.

The thermal environment of the panoramic camera was within the predicted tolerances and ranged from an average high of 65°F for the -1 mission to an average low of 53°F for the -2 mission for both panoramic cameras. The temperature of the FMC programmer was higher than predicted and ranged from a high of 115°F to a low of 90°F. Table 3-2 presents the temperature summary for T/M sensors located as shown throughout the CR-2 system.

KIK-ZORRO 38 (Panoramic camera -1 to -2 switchover) was commanded on rev. 76. Cut, wrap, and transfer from the first to the second recovery system occurred normally. KIK-ZORRO 39 (DISIC camera -1 to -2 switchover) was commanded on rev. 81. Cut and splice and transfer to the second recovery system occurred normally.

Both recovery systems were successfully recovered by air-catch with all recovery events occurring on time and as programmed. Impact was within tolerance for both systems.

The SRV tape recorder systems operated satisfactorily throughout the flight and all recorded data was retrieved.

SECTION 3

FLIGHT OPERATIONS

A. INTRODUCTION

FTV 1642 Mission 1102 was an Agena vehicle (SS01-B) and a Thorad Booster (SLV-2G)S/N 514. The Agena flew nose first in orbit and included the following special features.

1. Twelve rocket IMU Systems with boost and de-boost capability.
2. Three Control gas spheres for attitude control.
3. UNCLE UHF digital command system.
4. Pyro-diode by-pass by Uncle 110 command.
5. Special telemetry Link IV (A/P).
6. -3 A/P payload,[redacted]
7. Five 1H batteries, one Type VI.

The payload system consisted of a CR dual recovery reconnaissance camera system (CR-2) consisting of panoramic cameras 304 and 305 and DISIC Camera No. 4.

The nominal dual mission was programmed for 15 days. The actual mission length was 13 days with a 5 day -1 mission and an 8 day -2 mission. Both recoveries were successful air catches with all of the film supply being recovered with the exception of the stellar film which was in excess of the flight programming.

B. SUMMARY

Lift-off occurred at 14:26 PST (System Time 80741.2) on 9 December 1967 from SLC-1, west pad. All launch ascent and injection events occurred as

After second recovery the Agena orbital programmer stopped and remained stopped for 16 revs. This did not adversely effect the payload system except to delay the post recovery testing by one day (16 revs). The post recovery testing consisted of: exercising the command system to assure that all commands not used in-flight were operational; operating the panoramic cameras in mono to evaluate Agena response; and to accumulate as much on-orbit running time on the panoramic cameras as possible.

All test objectives were met;however, the No. 2 panoramic camera failed after 1190 cycles of operation. The No. 1 panoramic camera completed 3941 cycles before the end of the programmed tape.

C. ASCENT PERFORMANCE

All ascent events were normal with in-flight reset (Door ejection). A/P to Orbit Mode, Instrumentation switchover, and panoramic camera to orbit mode occurred on time and as programmed. There was no evidence of panoramic camera rotation during ascent.

The pyro current monitor indicated a normal current profile at door ejection.

Ascent vibration was monitored in the areas of the Delta/Barrel Attachments and the Instrument Barrel/DISICONIC Interface.

Random vibration data from flight indicated all excitation frequencies are higher than the payload resonant frequencies obtained during Qualification Tests. The actual input levels during flight were approximately 0.5 g RMS in any 50 H_z bandwidth. The qualification levels in any 50 H_z bandwidth were 1.5 g longitudinally (minimum) and 1.0 g laterally (minimum).

Table I list of excitation frequencies are noted for information only. They were observed along the y-axis during launch and transonic and lie outside the range of concern of the system.

Longitudinal vibration during ascent ([redacted] Levels) are listed in Table 3-1 and are compared with CR-1. The frequency was 18.2 cps, and the maximum value occurred 10.2 seconds before main engine cut-off (THORAD).

TABLE 3-1

RANDOM VIBRATION EXCITATIONS

LOCATION	LAUNCH (G's Freq.)	TRANSONIC (G's Freq.)
Sta. 86	7.2/615 H_z	.8/520 H_z
Left Delta/Barrel Attachment	3.7/680 H_z	.84/40 H_z 1.49/1060 H_z
Right Delta/Barrel Attachment	2.22/750 H_z	2.05/1435 H_z 1.48/1650 H_z

[redacted] LEVELS
(X-axis only)

	CR-1 (G)	CR-2 (G)
Sta. 86	2.42	1.35
Left Delta/Barrel Attachment	3.5	1.60
Right Delta/Barrel Attachment	2.45	1.35

ASCENT TEMPERATURE SUMMARY (°F)

PAYLOAD GR-2

VEHICLE 1642

SECONDS FROM LIFT OFF (L/O)

Sensor Location	No.	L/O	+30	+[illegible]	+250	+300	+350	+350	+300	+350	+400	+470
Pan No. 1 Lens Cell	1	52	51	51	5[illegible]	[illegible]	52	50	50	50	50	50
Lens Cond	2	50	48	48	49	48	48	47	47	47	47	47
Rear Rail	3	50	50	49	49	49	49	49	50	49	49	49
Output Ac	4	51	51	51	51	51	51	51	51	51	51	51
Drive Rin	5	50	50	50	50	50	50	50	50	50	50	49
Front Rail	6	48	48	48	48	48	48	48	48	48	48	48
AVERAGE		50	50	50	50	49	49	49	49	49	49	49
Drum Support	1	50	49	49	49	49	49	49	49	49	49	49
High Efficiency Amp	2	50	50	49	50	50	50	50	51	51	51	52
Pan No. 2 Lens Cell	1	53	50	51	51	51	51	51	51	51	51	51
Lens Cond	2	52	51	49	49	50	49	49	49	50	49	49
Rear Rail	3	51	50	50	50	50	50	50	50	50	50	50
Output Ac	4	51	50	49	49	50	49	49	49	49	50	50
Drive Rin	5	52	51	52	52	52	52	52	52	52	51	52
Front Rail	6											
AVERAGE		52	50	50	50	51	50	50	50	50	50	50
Supply Cassette		60	58	59	59	59	59	59	59	59	59	59
Delta Top Left		50	47	47	47	47	48	49	50	51	53	53
Slope Programmer		67	66	67	67	66	67	67	67	67	67	68
HSI		67	67	67	67	67	67	68	67	69	67	69
SRV A Skin	1	81	81	81	81	81	81	81	81	82	84	84
Batt	2	89	89	89	89	89	89	89	89	89	89	89
T/U	3	112	112	112	112	113	113	113	112	112	112	113
Retro	4	63	59	59	61	63	63	63	65	66	66	70
SRV B T/U	1	96	96	95	96	95	96	96	96	96	96	96
Retro	2	73	70	71	72	73	73	73	73	73	73	74

TEMPERATURE SUMMARY (°F)

SECONDS FROM LIFT OFF (L/O)

PAYLOAD CR-2

VEHICLE 1642

Sensor Location	No.	L/O	+50	+100	+150	+200	+250	+300	+350	+400	+470
Blast Shield	1	47	41	41	41	47	47	47	47	52	52
	2	45	45	45	46	45	52	52	53	63	63
DISIC Platen	1	63	63	63	63	63	63	64	64	64	65
Demo Cell	2	64	64	64	64	64	64	64	64	64	64
Tubing	1	57	62	73	186	242	2[illegible]	277	252	237	234
	2	48	51	74	234	336	3[illegible]	403	389	372	367	359
	3	49	63	87	2 2	405	445	441	442	396	361	326
	4	45	66	96	221	417	444	444	404	355	317	282
	5	45	68	77	195	273	321	321	304	291	278	268
	6	46	57	67	163	135	224	220	190	180	167	158
DISICONIC	1	41	52	62	121	191	216	216	203	195	186	180
	2	41	57	73	223	322	348	388	361	344	326	318
	3	45	62	82	252	336	432	441	445	357	318	283
	4	43	54	75	224	365	413	402	346	305	270	250
	5	40	51	72	181	244	284	268	261	246	223	210
	6	42	54	59	144	169	176	176	154	139	125	115
Forward Barrel	1	66	75	81	139	171	168	182	179	176	171	176
	2	66	81	101	232	OBH	OBH	OBH	270	229	206	191
	3	63	72	84	154	265	OBH	OBH	250	214	191	173
	4	55	65	71	122	130	136	134	117	106	97	91
Aft Barrel	1	68	80	93	134	142	153	150	153	153	152	150
	2	66	81	99	136	242	274	274	256	242	240	235
	3	66	82	103	242	OBH	OBH	OBH	240	212	194	179
	4	61	73	95	201	203	266	250	202	186	186	156
	5	66	81	98	159	190	200	188	182	172	161	156
	6											

D. MISSION DESCRIPTION SUMMARY

Programmed Mission

	Programmed	Actual
Launch Time - PM PST	1:30 - 2:30	2:26
Mission Length - Total (Days)	15	13
-1	N/A	5
-2	N/A	8

TABLE 3-3

FILM CONSUMPTION - CYCLES

	Pan 304	Pan 305	Stellar Port	Stellar Stbd	Terrain	
Sample - Off Spooling	19	19	-	-	-	
Pre-Launch	148	146	326	331	115	
-1 Mission	2926	2918	3656	3662	2360	
-2 Mission	3069	3074	3942	3948	2430	
Total	6162	6157	7924	7931	4790	

TABLE 3-4

DMU ROCKET PERFORMANCE

DMU NO.	Rev. No.	Velocity Change (FPS)	Period Change (Sec.)
1	14	14.8	9.2
2	46	15.3	9.6
3	71	15.8	9.9
4	97	16.7	10.4
5	120	17.1	10.7
6	139	16.8	10.5
7	163	17.1	10.7
8	182	17.1	10.7
9	201	16.85	10.8
10	233	16.55	10.4
*11	239	19.8	12.4
12	Not Fired		

*De-Bost

Figure 3-1 shows the ground track and period error profiles for the flight. Figures 3-2 and 3-3 show the mean altitude and operations densities for the flight.

V/h Match

The V/h ramp to orbit match generally was within 2½% for Mission 1102-1 and within 4% for Mission 1102-2 over the area of interest.

DMU Operation

Nine of the 12 DMU rockets were utilized during the active portion of the flight. Two rockets were fired after the second recovery. The last rocket was not fired due to power depletion. DMU operation was normal in all cases. Table 3-4 is a summary of DMU rocket performance.