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17 November 1967

TO: [redacted]
C. Murphy
A. Johnson
[redacted]

THRU: [redacted]

FROM: [redacted]

SUBJECT: MISSION 1038-1 and 1038-2 FINAL REPORT (J-34)

Enclosed is the Final Performance Evaluation Report for Mission 1038-1 and 1038-2.

[redacted] Manager
Advanced Projects

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[redacted]

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CORONA J

PERFORMANCE EVALUATION REPORT

Mission 1038-1 and 1038-2

MTV 1629, J-34

October 10, 1967

Approved [redacted]

Advanced Projects

Approved [redacted]

[redacted]

FOREWARD

This report details the performance of the payload system during the operational phase of the [redacted] Flight Test Vehicle 1629.

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

This document is the final payload test and performance evaluation report for Mission 1038-1 and 1038-2 which was launched on 14 January 1967.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1038-1 and 1038-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the J-34 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 1038, placed into orbit by Flight Test Vehicle #1629 and SLV-2A booster #495, consisted of two panoramic cameras, two Stellar-Index cameras, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipments. Figure 1-1 presents an inboard profile of the J-34 payload system. This Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. The planned missions were 4/5/6 days -1 and 7/6/5 -2 with no inactive period.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2128:18 Z (1328:18 PST) on 14 January 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 1038-1 consisted of five days operation and was completed by air recovery on 19 January 1967. Mission 1038-2 was completed with an air recovery on 26 January 1967 following seven days of photographic operations.

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

ORBITAL PARAMETERS

Parameter	Predicted	Orbit 42 Actuals	Orbit 120 Actuals
Period (Min.)	90.104	90.088	89.919
Perigee (N. M.)	99.834	96.944	98.505
Apogee (N. M.)	204.925	208.05	204.100
Incliniation (Deg.)	80.00	80.075	80.074
Perigee Latitude (Deg. N.)	20.35	29.232	46.518
Eccentricity	0.014623	0.01546	0.01471

C. PANORAMIC CAMERAS

Both instruments operated satisfactorily. The image quality was degraded by atmospheric conditions. The slave camera starboard H.O. imagery was veiled.

D. STELLAR-INDEX CAMERAS

Both instruments produced acceptable imagery for data reduction.

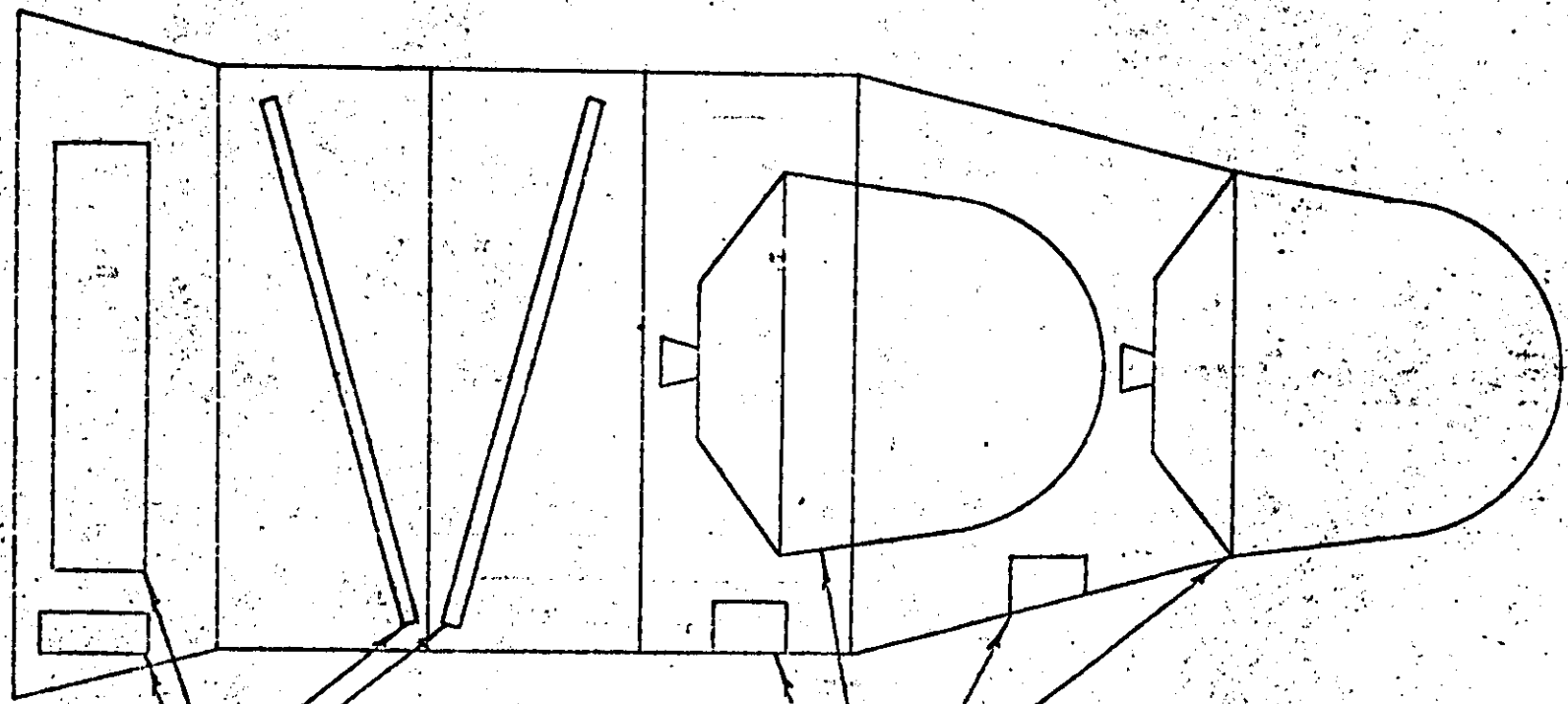
E. OTHER SUBSYSTEMS

The clock, instrumentation, command, PMU and thermal control subsystems performed satisfactorily throughout both missions.

No. [redacted]

SCHEMATIC INBOARD PROFILE - CORONA J SYSTEM

MISSION 1038



Master Camera No: 192

Slave Camera No: 193

Supply Cassette No: SC-44

Clock No: 542

Yaw Programmer No: 461

"A" Recovery Subsystem No: 719

"A" Stellar-Index Camera No: D93/86/112

"B" Recovery Subsystem No: 720

"B" Stellar-Index Camera No: D90/111/108

Pressure Make-up Unit No: 1013

FIGURE 1-1

SECTION 2

PRE-FLIGHT SYSTEMS TEST

A. ENVIRONMENTAL TESTING

1. Test Objective

As a standard procedure, the J payload systems are subjected to thermal/altitude environmental testing which simulates orbital environment. One of the purposes of this test is to demonstrate the system susceptibility to corona discharge. Such discharge fogs the film thus degrading the operational photography.

2. General Test Information

The J-34 payload system was subjected to an environmental HIVOS chamber test from 1 through 8 March 1966. A complete "J" mission was simulated. The -1 and -2 missions consisted of approximately 3000 cycles per mission per instrument. Camera internal operating pressures ranged from 0.5 microns to 80 microns. This system was the first to incorporate the new "double intermix" command system.

3. Panoramic Camera Performance

The dynamic performance of both instruments was satisfactory for the center of format switch, lens rotation and film transport. The 99/101 percent clutch ratios were 6/6 on both instruments.

Instrument cycle periods were fast during the first 8 orbits of the -1 mission and excessive coasting was noted. These anomalies occurred when temperatures were high (100°F).

The slave instrument payload had scratches which were traced to the payload riding on a roller flange after manual handling during a test interruption. Both instruments produced material completely free of corona. All recorded pan instrument data was excellent.

4. Stellar/Index Performance

The S/I instruments operated satisfactorily. Examination of the payload on D-93 showed one instance of stellar shutter malfunction (high density). Instrument D-90 had 26 frames out of 452 frames affected by corona. The corona density was within acceptable density levels. The stellar shutter D-93 was checked over and certified to be acceptable.

This "J" system was the first to provide S/I control from the slave instrument. The smear pulses on the slave payload were normal.

5. Clock Performance

The clock accuracy was satisfactory. The clock readouts were correlated with the IRIG "C" time and the results are shown in Table 2-1.

6. Command and Instrumentation Performance

The instrumentation functioned normally. The command system was satisfactory except the V/H delay stepper switch did not home with brush 14 in orbits 13, 14, 15 and 16. The transfer from -1 to -2 was accomplished by the secure real time command (KZ-38).

7. Pressure Make-Up System Performance

The PMU operated normally. The average gas consumption on both missions was 7.92 psi/min. The pressure ranged from 44 microns during operates to 0.5 microns with the instruments off.

8. Temperature Summary

Average instrument temperatures (^{o}F) for several days in both missions are listed below:

-1 Mission	Master		Slave		Beta Angle
Day	High	Low	High	Low	
1	105	70	95	70	53
2	100	72	100	72	53
3	100	65	100	66	53
4	87	64	82	65	53

-2 Mission	Master		Slave		
Day	High	Low	High	Low	
1	84	74	86	76	0
2	80	58	80	62	0
3	76	52	78	56	0
4	100	60	100	60	0

B. RESOLUTION TEST

Resolution and theodolite tests of the J-34 system were completed on 6 April 1966. Results of the thru-focus resolution tests of pan instruments 192 and 193 show the following characteristics;

MASTER PAN INSTRUMENT NO. 192

Maximum high contrast resolution 169 lines/mm at -0.000 focal position.

Maximum low contrast resolution 112 lines/mm at -0.001 focal position.

SLAVE INSTRUMENT NO. 193

Maximum high contrast resolution 165 lines/mm at -0.001 focal position.

Maximum low contrast resolution 119 lines/mm at -0.001 focal position.

The resolution test data for both instruments as shown in Figures 2-1 and 2-2, has been reviewed and appears normal in all respects. The demonstrated resolution performance meets the system requirements specification.

C. LIGHT LEAK TEST

The first live payload light leak test on the J-34 system was performed on 19 April. This test was the first in which the test exposure was increased to 90 minutes (from 60 minutes). This exposure produces on the high speed test film a density equivalent to the density that would be produced on flight film by about 90 percent of the computed direct solar illumination reaching a system in four orbits. Since portions of the system do not see this solar illumination or are affected primarily by the lower intensity albedo illumination, such conditions are considered in the evaluation of light leak effects. However, this first light leak test showed severe fogging at several points on the film from felt seals on the slave instrument drum, and minor fog from a leak at the teardrop fitting just forward of the fairing access door.

After correcting the teardrop leak and reworking the slave felt seals, a second light leak test was run on 25 April. The 90 minute soak was also used on this test. In addition, the instruments were cycled at high speed to the sit position. This procedure causes the instrument

scan arms (stovepipes) to come to rest near the start of scan position, which is the normal sit position during flight operations. In all previous J system tests, cycling to the sit position has been done at low speed which causes the scan arms to come to rest at the "home" position near the end of scan. The effect of this procedural change is that the scan arm tends to obscure leaks from the output edge of the drum. The results from the second light leak test verified correction of the teardrop leak but showed severe leaks from the felt seal at the input side of the slave instrument. These leaks also produced minor fog on the master film in the area where this film passes the slave instrument. On the basis of our regular evaluation criteria, the system freedom from light leakage was acceptable, except for the slave instrument drum area which was not acceptable.

Light leakage from the drum area of the main instrument has seen a continuous problem of the J program. It has been the primary reason for rework and retest for light leakage qualification at A/P. While some minor improvements have been made, the problem will continue until adequate drum seals are provided. Although rework of felt seals has enabled systems to pass the light leakage tests, flight results suggest that creep in the stretched felt seals has effectively undone the rework. As a result of flight performance evaluations, Boston has investigated the problem and concluded that simple modifications to the felt seals will solve the problem. Although a Boston ECO is expected in the near future, no adequate felt seals are presently available.

Since all of the severe fog from the felt seals is within three frames of the end of pass, and since no effective means for correcting the problem is available, the light leakage requirement for the salve instrument was waived and the J-34 system light leakage performance was considered acceptable for flight.

D. J-34 FLIGHT READINESS AND LOADING EVALUATION

The final Flight Readiness Test payload was processed and evaluated on 6 January 1967. The test payload showed that the functioning and data recording of both pan instruments was acceptable for flight loading.

Master Instrument No. 192 showed two notable defects. On some (but not all) frames there was distinct banding of fogged main formats. A check of timing mark spacing showed scan head velocity variations of up to 20 percent in such frames. Such variations in scan velocity occurred frequently in early "J" systems but no direct correlation with quality degradations has been established. Since a check of the scan arm-lens latch mechanism showed normal operation, the banding is considered to be within acceptable limits. Also on the Master Instrument

it was noted that a film rail partially obscured the timing marks for about one-half of the scan. This condition was not expected to have any significant effect on use of the timing record. Payload from Slave instrument No. 193 showed excellent data recording and no indication of functional defects. A slight minus density streak was noted in the pan format from scraped emulsion on the exposure slit. This scraped emulsion was removed before flight loading.

Rail scratching of both pan instrument films was average from inboard (data block) rails and much less than average from outboard rails. Although the system does not have polished rails, the only evidence of emulsion buildup was slight shadows at one or two shrinkage markers on each instrument. It is noted that humidity of the work area was much less than usual (20% to 30% rather than 40% to 50%) during readiness and loading operations. Low humidity appears to be very significant in minimizing rail scratches and accumulations of scraped emulsion.

Since this system is the first to be prepared for flight with full Phase III procedures, this was the first time that a live film bench test of S/I units was made as a part of the Flight Readiness Procedure. Ten cycle samples from each unit were processed and evaluated on 5 January. These samples showed normal operation of Stellar and Index components of S/I units D-93 and D-90, which were installed for flight in the "A" and "B" positions respectively.

Loading of the main instrument supply cassettes proceeded in a routine manner on 8 January. Sensitometric samples of all flight payloads were prepared and showed acceptable characteristics. Since flight payload from the J-38 (PG-2) system had shown abnormally high base-plus-fog density, two simulated "full" processing samples were prepared from both main instrument flight payloads. The flight samples processed at the "full" level showed lower base-plus-fog densities than the manufacturer's control sample. It is also noted that these samples showed the highest maximum densities that we have ever observed on type 3404 film. Maximum densities of 2.81 and 2.85 resulting from one of the full level processes can only be considered advantageous in that they represent an extension of the effective exposure range.

Final tracking and light leak checks were completed on 9 January. During the tracking tests, it was noted that there were distinct and continuous scratch-like streaks in the back coating of both main films. Similar, though less severe, marking has been noted during flight loading on many previous systems. Such marking has

been described by the manufacturer as an unavoidable defect in the manufacturing process which produces no defect whatsoever in image quality. Microscopic examination by Performance Evaluation of both processed and unprocessed flight samples supports the statement that image quality is not affected.

The final light leak checks showed an exceptional freedom from light leakage.

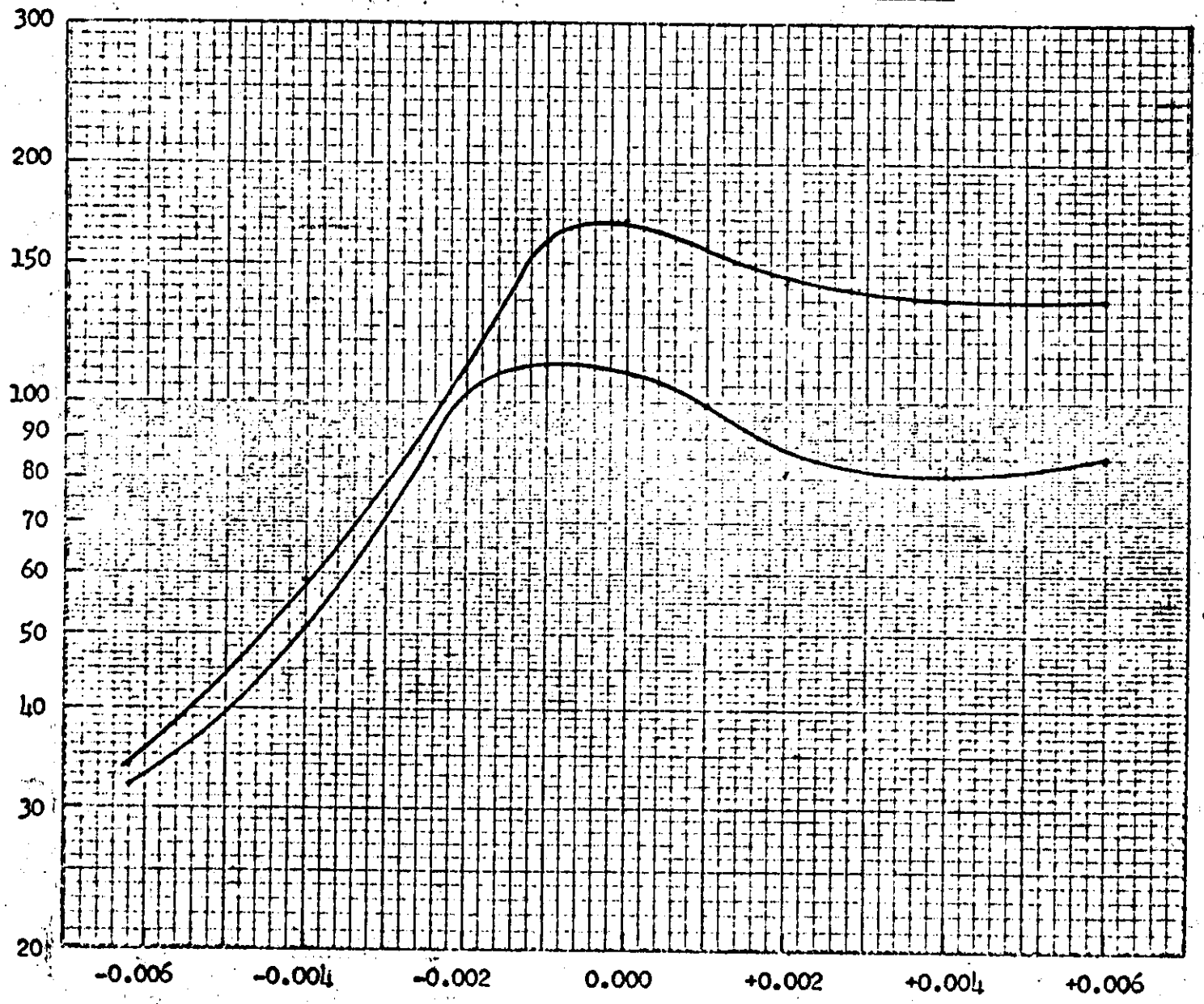
The J-34 system was certified for flight on 9 January.

E. COMMENTS

The J-34 payload system was the first system to utilize the full Phase III concept (Factory to Pad).

System testing was completed on 21 June 1966 and the payload system went into Phase II storage. The system was removed from storage on 2 August 1966 for 90 day recycle testing. The system was returned to Phase III storage on 11 August 1966. The system was removed from storage on 7 November 1966 for flight preparations. The flight date was cancelled and the system was returned to a partial Phase III storage on 29 November 1966. The system was removed for flight preparations again on 27 December 1966. All flight preparations were completed and the system was shipped to VAFB on R-3 for launch preparations. All confidence tests were completed and the system was launched on the scheduled date.

PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 192

Payload No: J-34

Resolution (l/mm)

High Contrast: 169

Low Contrast: 112

Film Type: 3404

Test Date: 4/6/66

Figure 2-1

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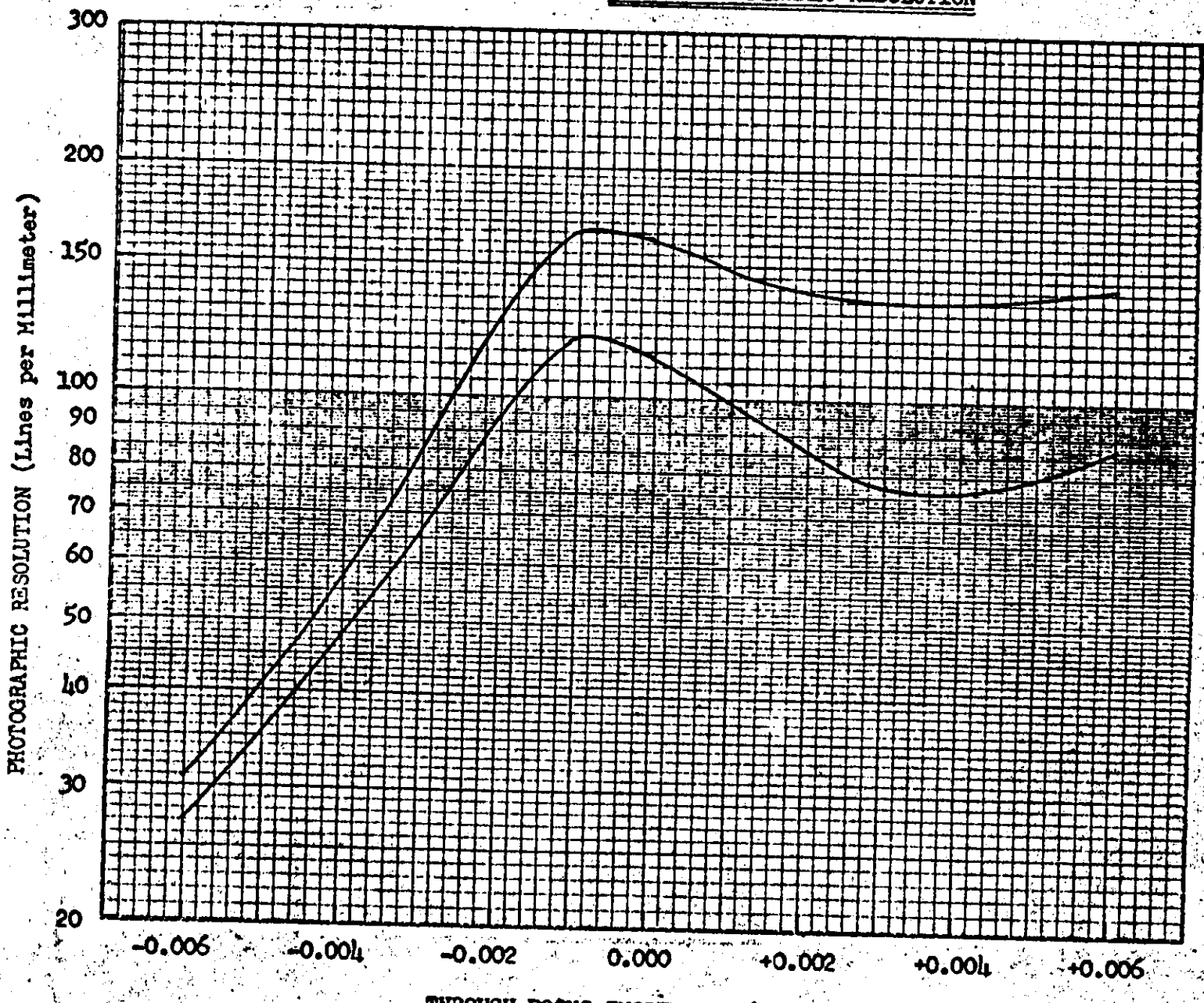
PRE-FLIGHT DYNAMIC RESOLUTION



Camera No: 193

Payload No: J-34

Resolution (1/mm)

High Contrast: 165

Low Contrast: 119

Film Type: 3404

Test Date: 4/6/66

Figure 2-2

[redacted]

J-34 HIVOS CLOCK CORRELATION

REV	IRIG DAY-HR-MIN-SEC	IRIG SECONDS	CLOCK SECONDS	DELTA IRIG	DELTA CLOCK	ERROR
1	60 8 31 46.220	5214706.220	47701.828	---	---	---
1	60 9 34 51.220	5218491.220	51486.837	3785.000	3785.009	0.009
2	60 10 1 56.320	5220116.320	53111.931	1625.100	1625.094	-0.006
2	60 11 4 51.380	5223891.380	56886.983	3775.060	3775.052	-0.008
3	60 11 31 41.420	5225501.420	58497.034	1610.040	1610.051	0.011
3	60 12 34 51.320	5229291.320	62286.933	3789.900	3789.899	-0.001
5	60 15 35 46.270	5240146.270	73141.899	10854.950	10854.966	0.016
	0 7 4 0.050=DELTA TIME			TOTAL ACCUM. ERROR		0.021
6	62 8 1 53.040	5385713.040	21273.738	---	---	---
6	62 9 4 58.380	5389498.380	25059.080	3785.340	3785.342	0.002
7	62 10 34 58.280	5394898.280	30458.986	5399.900	5399.906	0.006
8	62 11 1 53.340	5396513.340	32074.045	1615.060	1615.059	-0.001
9	62 12 31 53.380	5401913.380	37474.088	5400.040	5400.043	0.003
9	62 13 34 58.340	5405698.340	41259.049	3784.960	3784.961	0.001
10	62 14 1 53.380	5407313.380	42874.086	1615.040	1615.037	-0.003
11	63 9 4 24.840	5475864.840	111425.559	68551.459	68551.472	0.013
12	63 10 34 25.140	5481265.140	116825.851	5400.300	5400.292	-0.008
13	63 12 4 24.880	5486664.880	122225.595	5399.740	5399.744	0.004
14	63 12 31 19.800	5488279.800	123840.529	1614.920	1614.934	0.014
15	63 14 1 20.220	5493680.220	129240.940	5400.420	5400.411	-0.009
16	64 8 1 0.160	5558460.160	194020.875	64779.940	64779.935	-0.005
16	64 9 4 5.220	5562245.220	197805.932	3785.060	3785.057	-0.003
1	64 9 31 9.000	5563869.000	199429.705	1623.780	1623.773	-0.007
1	64 10 34 22.198	5567662.198	203222.911	3793.198	3793.206	0.008
2	64 11 1 7.200	5569267.200	204827.911	1605.002	1605.000	-0.002
2	64 12 4 12.080	5573052.080	208612.805	3784.880	3784.894	0.014
3	64 13 34 12.130	5578452.130	214012.848	5400.050	5400.043	-0.007
4	64 14 1 7.140	5580067.140	215627.856	1615.010	1615.008	-0.002
4	64 15 4 12.200	5583852.200	219412.916	3785.060	3785.060	0.000
	2 7 2 19.160=DELTA TIME			TOTAL ACCUM. ERROR		0.017
5	65 8 0 17.240	5644817.240	17925.564	---	---	---
5	65 9 3 22.540	5648602.540	21710.848	3785.300	3785.284	-0.016
6	65 10 33 22.260	5654002.260	27110.579	5399.720	5399.731	0.011
8	65 12 30 7.610	5661007.610	34115.938	7005.350	7005.359	0.009
8	65 13 33 22.380	5664802.380	37910.698	3794.770	3794.760	-0.010
9	65 14 0 17.350	5666417.350	39525.671	1614.970	1614.973	0.003
10	66 8 4 30.750	5731470.750	104579.153	65053.400	65053.482	0.082
10	66 9 7 35.680	5735255.680	108364.068	3784.930	3784.915	-0.015
12	66 11 4 30.760	5742270.760	115379.161	7015.080	7015.093	0.013
12	66 12 7 35.640	5746055.640	119164.029	3784.880	3784.868	-0.012
13	66 12 34 30.880	5747670.880	120779.279	1615.240	1615.250	0.010
13	66 13 37 35.680	5751455.680	124564.073	3784.800	3784.794	-0.006
14	67 9 5 25.790	5821525.790	194634.202	70070.109	70070.128	0.020
15	67 9 32 20.810	5823140.810	196249.244	1615.020	1615.042	0.022
15	67 10 35 25.920	5826925.920	200034.340	3785.110	3785.096	-0.014
16	67 11 2 20.910	5828540.910	201649.322	1614.990	1614.982	-0.008
16	67 12 5 25.880	5832325.880	205434.294	3784.970	3784.972	0.002
	2 4 5 8.640=DELTA TIME			TOTAL ACCUM. ERROR		0.091

TABLE 2-1

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

All launch, ascent, and injection events occurred as programmed, however telemetry Link II failed to turn on during ascent and was inoperative for the remainder of the flight. The orbit achieved was within the 3 sigma dispersions.

Both panoramic cameras operated satisfactorily throughout the flight. Average cycle rates for both cameras deviated from the pre-flight calibrations by less than 2 per cent.

Both the -1 and -2 Stellar/Index cameras and the clock system performed satisfactorily throughout the flight.

The AP command system failed to respond once to real time command (RTC) 11 and once more to RTC 15 during the -2 mission.

The -1 mission thrust cone skin temperature sensor was inoperative for the duration of the mission.

The pressure make-up system operated satisfactorily throughout the flight with 690 PSIA supply remaining.

The on-orbit internal temperatures were slightly higher than recent systems.

Both recovery systems operated normally throughout the flight.

Kik-Zorro 38 (early A to B switchover) was utilized on Rev 72 and performed satisfactorily.

The orbit sine function generator (OSFG) performed normally for the duration of the flight.

The -1 mission was successfully terminated on Rev 81 by air-catch recovery and the -2 mission was completed by air-catch recovery on Rev 193.

B. PANORAMIC CAMERA PERFORMANCE

Both panoramic cameras operated normally throughout the mission. Cycle period data for the engineering passes monitored are tabulated in Table 3-1. Camera system dynamic operation, 99/101 percent clutch operation, start-up, shut-down, and transport functions were normal for all passes monitored. The cut and wrap operation and transfer to the -2 system occurred as programmed, utilizing the Kik-Zorro 38 (early A to B switchover) command.

The panoramic film was exhausted on Pass 183 frame 55 and frame 71 for the Master and Slave cameras respectively.

Panoramic Film Consumption-Cycles

	Actual	
	Master	Slave
Sample off-Spooling	20	20
Pre-Launch	126	125
-1 Mission	2869	2870
-2 Mission	3029	3034
Total	6044	6049

FMC Match

The V/H ramp to orbit match was acceptable throughout the flight. The following settings for RTC's 6, 8, and 10 were utilized to obtain the optimum FMC match during the flight:

	RTC Commands			Remarks
	6	8	10	
RTC	6	5	6	Launch thru Rev 3
Positions	7	3	7	Rev 4 thru Rev 92
	6	4	7	Rev 93 thru the end of the mission

C. STELLAR/INDEX CAMERA PERFORMANCE

Both the -1 and -2 Stellar/Index cameras operated properly on all engineering passes.

D. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

The instrumentation and command systems operated properly throughout the flight with the following exceptions:

1. The -1 mission thrust cone skin temperature sensor became inoperative between the mating confidence and the launch countdown and remained inoperative for the duration of the -1 mission.

2. The AP command system failed to respond to an RTC on two different occasions during the flight. On both passes the vehicle command tone verification monitors indicated normal vehicle decoder output. Additional commands were issued and the command system responded normally on both occasions to step commands to the desired terminal positions.

   The first missed command occurred on pass 169 [redacted] RTC 11 was in position 11 and one command was issued to step RTC 11 to position one. However, the command was not executed.

   The second missed command occurred on pass 177 [redacted] RTC 15 was in position 13 and 12 commands were issued to step RTC 15 to position 9. However, the 9th command was not executed.

E. CLOCK SYSTEM PERFORMANCE

Clock system operation was normal for the duration of the flight. Good correlation between the flight clock and [redacted] Tracking Station time was obtained. Table 3-2 contains the correlation data.

F. PRESSURE MAKE-UP SYSTEM PERFORMANCE

Pressure make-up system performance was normal throughout the mission. Average gas consumption was approximately 9.0 psi/min for the 223 minutes of total operate time. The system had a surplus of 690 PSIA at the end of the mission.

G. THERMAL ENVIRONMENT

Temperature data for th[redacted]acquisitions are included in Table 3-3. The average instrument temperatures ranged from a high of 97°F on the Master and 89°F on the Slave to a low of 75°F on the Master and 69°F on the Slave.

The average J-34 payload system temperatures were approximately 10°F higher than the J-24 payload system, even though the orbits were the same. The J-34 payload system was launched at 13:38 PST on 14 January 1967 and the J-24 payload system was launched at 14:31 PDT on 22 September 1965. No explanation of this difference in average payload system temperature is available. A detailed analysis is continuing to ascertain the causes of this anomaly.

J-34 FLIGHT 01-13-67

REV. MODE	OP	RAMP R	TUR A	SECS	SYSTEM CALIB.	ACTUAL	UNIT DEV.	SYSTEM DEV.	ACTUAL	UNIT DEV.	SYSTEM DEV.	192/ DIF
					INST. 192			INST. 193				
009	A	7	3	97	4.714	4.695	1.90F	1.47F	4.525	3.60F	4.01F	-2.5
016	A	7	3	1699	2.216	2.236	0.81S	0.84S	2.245	1.32S	1.29S	0.4
032	A	7	3	1745	2.215	2.239	0.65S	0.83S	2.245	1.40S	1.37S	0.4
047	A	7	3	1771	2.214	2.243	1.30S	1.32S	2.250	1.67S	1.64S	0.3
072	B	7	3	250	4.487	4.420	1.61F	1.49F	4.400	1.52F	1.94F	-0.4
079		7	3	1696	2.212	2.240	1.24S	1.27S	2.250	1.75S	1.72S	0.4
095	B	6	4	1930	2.212	2.235	1.03S	1.05S	2.235	1.08S	1.05S	0.0
127	B	6	4	1994	2.212	2.240	1.22S	1.24S	2.250	2.17S	2.15S	0.9
143	B	6	4	1989	2.212	2.217	0.18S	0.21S	2.223	0.51S	0.48S	0.2
168	B	6	4	580	3.534	3.560	0.74S	0.75S	3.540	0.59S	0.18S	-0.5

DEV. AND DIFF. ARE IN PERCENT
THE (-) SIGN INDICATES THAT INST 1 IS SLOWER THAN INST 2
F=FAST AND S=SLOW

TABLE 3-1