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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1045

25 JUNE 1968

Approved: [redacted], Manager
Advanced Projects

Approved: [redacted], Manager
Program [redacted]

Declassified and Released by the N R O
In Accordance with E. O. 12958
on NOV 26 1997

FOREWARD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1640.

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 1045 which was launched on 24 January 1968.

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INTRODUCTION

This report presents the final performance evaluation of Corona Mission 1045. The purpose of this report is to define the performance characteristics of the J-45 payload system and to evaluate the technical aspects of the Mission, including analysis of inflight anomalies.

The payload system was assembled, tested, and certified for flight at the Advanced Projects (A/P) facility of Lockheed Missiles and Space Company (LMSC). A/P also provided services including preflight mission parameter planning, preparation of the flight program, inflight 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 cognizent 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 government and contractor organizations. Diffuse Density measurements are produced by the Air Force Special Projects Production Facility. Vehicle attitude readings and frame correlation times are provided by NPIC. The Processing Summary report is published by [redacted].

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

SECTION 1

MISSION SUMMARY

A. MISSION DESCRIPTION

Corona Satellite Mission 1045 was planned to acquire search, cartographic, and reconnaissance photography of selected terrain areas. Two mission segments were planned to total fifteen days of orbital operation. Both segments nominally would return over 6,000 panoramic frames, each covering approximately 1,725 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 standard J-1 configuration, consisting of a space structure containing two panoramic cameras and associated control/support equipment, with separate stellar-index cameras and recovery sub-systems for each mission segment.

The flight was launched from Vandenburg AFB during the afternoon of 24 January, 1968. All ascent and injection events were normal; the orbit achieved had parameters close to nominal. Photographic operations proceeded without incident until the middle of the first mission segment when the primary telemetry link became inoperative. Operations continued cautiously, as command settings could not be verified and there were infrequent useful indications of payload status. No malfunctions occurred, the payload operated properly throughout the mission. The first mission segment was successfully completed, after seven days of flight, with an air catch of the recovery capsule. The second segment was similarly

terminated after the fourteenth day.

Photographic performance by all cameras was good, with the best of the panoramic record comparable to the best ever attained by the J-1 system. Anomalies noted were either minor, or of a characteristic nature.

B. FLIGHT CONFIGURATION

VEHICLES: THORAD Booster (SLV-2G) 516

AGENA Satellite (SS-01B) 1640

RECOVERY (SRV-MK5): 1045-1 USE - 741

1045-2 USE - 742

PANORAMIC CAMERAS: Assembly No.		214 (Master)	215 (Slave)
MAIN:	Look Direction	Forward	Aft
	Slit (inches)	0.225	0.175
	Filter (Wratten Type)	23A	21
	Aperture (T/number	4.0	4.0
	Focal Length (inches)	24.0005	24.0005
	Lens No.	2242435	2232435

HORIZON:	Location	Input	Output	Input	Output
	Look Direction	Port	Starboard	Starboard	Port
	Exposure Time (seconds)	1/100	1/100	1/100	1/100
	Filter (Wratten Type)	25	25	25	25
	Aperture (F/number)	6.3	8.0	8.0	6.3
	Focal Length (millimeters)	55.0	55.0	55.0	55.0
	Lens No.	19103	12854	12873	12829
	Assembly No.	312G5	315G6	316G5	317G6

FILM:	Kodak Type	3404	3404
	Length (feet)	16300	16300
	Emulsion No., date	407,12/67	407,12/67
	No. Splices	2	4
STELLAR/INDEX CAMERAS		1045-1	1045-2
ASSEMBLY NO.		D 109	D 108
STELLAR:	Reseau No.	138	141
	Exposure Time (seconds	2.0	1.0
	Aperture (F/number)	1.8	1.8
	Focal Length (millimeters)	85	85
	Lens No.	11311	11417
	Film (Kodak Type)	3401	3401
	Emulsion No., Date	231,09/67	231,09/67
INDEX:	Reseau No.	137	139
	Exposure Time (seconds)	1/500	1/500
	Filter (Wratten Type)	21	21
	Aperture (F/number)	4.5	4.5
	Focal Length (millimeters)	38.49	38.49
	Lens No.	823770	821941
	Film (Kodak Type)	3400	3400
	Emulsion No. Date	147,12/67	147,12/67

COMPONENTS

Clock		612
Film Cassettes:	Supply	55
	1045-1 Takeup	T102E
	1045-2 Takeup	T107E

COMPONENTS (continued)

Pressure Makeup System 1036

Orbit Sine Function Generator 456

SECTION 2

PREFLIGHT SYSTEMS TEST

A. SUMMARY

The J payload systems are subjected to extensive preflight testing and preparation by A/P, in order to demonstrate resolution of any system problems, and to provide confidence in system capability to reliably perform the flight mission. Standard tests include photographic resolution, thermal/altitude environment, vibration environment, light leak, and a test series for flight preparation. Additional tests are performed as required.

The J-45 system successfully passed all aspects of the testing operations, providing acceptable performance and a high degree of operational confidence. Two altitude environmental tests were required, as the film from the first test was unacceptably marked by corona. The panoramic cameras were modified and the second test verified a significant reduction in corona marking.

Continuing problems were encountered during testing with cycle period deviations from nominal, and with irregular photographic scan rates ("banding"). These problems were adequately resolved in test; no cycle period problems were noted during flight, and only mild banding was intermittently detectable, with no apparent image degradation.

B. RESOLUTION TESTING

Evaluation of the resolution material from the initial test, in April 1967, indicated acceptable results for both panoramic cameras. The data demonstrated normal performance at all focal positions, with the usual minor difference between values in the FMC and scan directions. Resolution peaked at approximately 120 lines/millimeter, low contrast, for both cameras at the zero focal position. This was well above the ninety-lines-at-zero minimum criterion effective at that time.

After the above April test, additional information became available to the ITEK Company that indicated the focal shift in vacuum for certain lens systems was less than had been previously computed. It became desirable to shim the scan heads of systems then at A/P, with subsequent resolution retesting required to verify focus.

Data from the second test, in October 1967, indicated approximately 110 lines/millimeter for both cameras. Peak focus on the Master unit occurred at -0.0025 inches focal position, and at -0.0020 inches on the Slave unit. This was recommended as acceptable by ITEK; no further adjustments were performed.

C. ENVIRONMENTAL TESTING

1. FIRST TEST

The first thermal/altitude environmental test of the J-45 system was conducted from 28 February to 7 March 1967. Test results were not acceptable because of heavy corona marking on panoramic material. Data recording was unsatisfactory because of an AGE power supply problem. The Stellar/Index cameras performed acceptably.

Corona marking appeared on film from both panoramic instruments. The Master exhibited periodic "two-pi" marking during most operations with the pressure makeup system disabled, as well as the usual startup marking. The Slave displayed unusual heavy "glow" marking on the fifth and sixth frames of several operations run without pressure makeup, indicating the source at the constant-tension rollers.

Both metering rollers were changed on the Master instrument. The Slave constant-tension assembly was found to function properly, but the supply cassette stall tension was discovered to be slightly higher than normal; the tension was lowered from over 14 oz. to 12 oz.

Data Recording on material from all cameras was inadequate because of problems with the AGE power supply. Acceptability of the data recording was left to be determined from the results of the second test.

Stellar/Index camera records were considered acceptable. During the "A" portion of the test Stellar and Index units performed adequately, with relatively little corona marking. One Stellar fiducial was poor. The Index serial number was barely detectable. Formats of both units exhibited variable density, due to variations in the fogging lamp power supply.

During the "B" portion of the test, both Stellar and Index units performed acceptably, with corona marking affecting less than 10% of the frames. A small mark was noted on most Stellar frames outside the active format near one fiducial; the cause was not determined.

Operational performance was generally satisfactory except for the AGE power supply problem. During part of the "A" test and throughout the "B" test regulation of +28 volt regulated power was lost when the regulated current exceeded 6.2 amps.

The Master instrument tended to run fast during most of the test, and in many instances was beyond specification. Rates of the Slave unit were close to the calibrated values.

The command system operated normally except for a problem with the Intermix I selector, which responded intermittently to commands in the automatic mode thruout the test. It did respond to all manual commands. After test completion, investigation disclosed the problem to be located in the payload control console.

Clock accuracy was satisfactory. A special power test at the chamber disrupted power to the system, forcing accumulative error to be calculated on a daily basis; no other anomalies were noted.

The pressure makeup system operated normally. Internal pressure increased to 54 microns during PMU operates. The nominal setting was 50 microns.

The Stellar/Index shutter monitor functioned poorly throughout the test. The shutter pulse monitor output was very erratic and appeared to be oscillating. Also, the time from the shutter command to the pulse drifted excessively. Subsequent adjustments to the monitor circuitry were satisfactorily verified during bench testing.

Transfer from "A" to "B" configuration was accomplished by real-time command and all transfer and recovery sequences occurred normally.

The Yaw Programmer operation was satisfactory. It was operated for one full cycle in both the "A" and "B" modes.

2. SECOND TEST

The second thermal/altitude environmental test was conducted from 27 March to 2 April 1967. The Stellar/Index units were not installed. This retest was in a modified "B" configuration. Pressure makeup was not utilized; pressures ranged from 9 to 29 microns during the first day followed by a 2½ day soak. Pressure during subsequent operations ranged from 1 to 4½ microns, with a final pressure sweep to 80 microns. Material from this test indicated both panoramic cameras to be acceptable, although possible corona was noted during one operation. Data recording again was unsatisfactory because of the AGE power supply intermittently losing regulation and dropping voltage.

Corona marking was not positively identified on material from this test. However, severe fog did occurr on film from both instruments during the initial frames of the first operation after the extended inoperative period. The Slave film was marked at the first input idler on the camera plate. Heavy marking on the Master film occurred where it passed on the opposite side of the Slave plate (over one foot from any roller). The cause of this marking was not determined, as it could have been either corona or a light leak. Remedial action was not recommended.

The major objectives of the second test were met. The Master metering rollers did not cause either two-pi or start up marking, and the Slave "glow" marks from the constant-tension rollers did not occur. The corona characteristics of the system were considered acceptable.

Data Recording on both instruments was inadequate, due to power supply problems. Acceptability was established by using the Prestorage Baseline test material, taken when the system power was within normal tolerances.

The serial number, data block indices, and horizon camera fiducials of both instruments faded frequently throughout the test, associated with the power supply malfunction. At the times when these data were visible, they presented an acceptable appearance. One frame was noted with no clock word although the serial number and indices were present; this single occurrance was considered acceptable.

The Master time trace, although marginally acceptable, was lighter than desirable during both fast and slow operations. This was subsequently adjusted. The Slave time trace was normal, although it started 5 inches late on the first frame of one operation.

The Master rail hole images were inadequate; they were light at the test beginning, then dimmed gradually so that they were not detectable by mid-test. The images along the time trace edge were relatively darker. The images on the data block side were relatively darker near format center, fading at either end. The Slave rail hole images were present throughout the test; those along the time trace side being of adequate quality. Images on both sides were not circular, most of those along the data block side being crescent-shaped, suggesting the lamp was positioned to one side of the hole; this was later adjusted.

The lens scan lines were not detectable on the Master, and extremely faint but occasionally detectable on the Slave; these were subsequently adjusted to a proper level.

Marking of the film from both cameras was relatively light. Rail scratches were light throughout the test. Light to heavy edge fog was noted on the Master material, in some cases dense enough to obscure the clock word. The long periodic pattern of this fog suggested causation by the supply spool. Milder edge fog also appeared during the Prestorage Baseline test. The Poststorage Baseline test, which used a different supply spool, demonstrated that the film supply spools used in previous testing were lightstruck, probably during loading.

Operational performance was generally satisfactory. However, there again was an AGE power supply problem which affected data evaluation. Throughout the test the +28 volt regulated power supply again lost regulation at 6.2 amps.

Command system performance was satisfactory. The Intermix I stepper problems encountered during the first test did not recur. All functions occurred normally.

Panoramic unit cycle rates again deviated from the calibrated values, the Slave running approximately 2 percent slow. This was within the 3 percent specification. The Master was within nominal tolerances. The 99/101 clutch function was normal.

Other system functions were within normal performance tolerances; no problems were noted.

D. LIGHT LEAK TESTING

Evaluation of material from the J45 Light Leak Test, run in February 1967, indicated the Master film to be free of light leak fog. Leaking at the Slave drum caused two marks to appear within the last three frames of an operation, and faint fogging of the first frame. This marking was considered

acceptable, as camera drum leaks are seldom repairable and usually cause only minor fogging inflight.

Heavy fogging along one edge of the Master format was noted, with relatively minor fogging along the other edge. The rail lamps on both sides were subsequently adjusted so as to shield the format area from flare.

E. FLIGHT PREPARATIONS

1. Stellar/Index Camera Readiness

Film samples from the Baseline test of 10 January 1968 indicated no major anomalies on either the A or B units. Some Stellar fiducials appeared heavy, but the intersections were clear. The A Index serial number was illegible, but acceptance was recommended because this condition was unique amoung all Index camera serial numbers.

The supply cassettes were loaded and the cameras installed in the J-45 structure on 12 January. Sensitometric samples of the flight film indicated normal quality.

2. Panoramic Camera Readiness

Material from the Readiness Test on 13 January indicated two problems. First, dimming of serial numbers and horizon camera fiducials when the test console was used to light all bits of the time word. This problem was caused by the console power supply; previous tests, using a heavier-duty supply, had not shown this condition. The second problem was the continued tendency of the Master camera to have irregular photographic scan rates at slow speeds. This banding had been evident for the camera thruout systems testing. The interlock mechanism had been reworked twice in attempting to reduce the problem, and ITEK Company engineers indicated that further rework probably

would not improve the situation. Banding did not occur at the faster cycle rates as used for flight, and had not become more severe since previous tests. The system was accepted with this condition.

All other data recording on both units appeared acceptable, including the Pan Geometry data. Format edges showed sharp edges, indicating no emulsion buildup, and no evidence was found of foreign particles on the filter or field flattener.

The supply cassette was loaded on 15 January, without incident. Sensitometric samples of the film indicated normal quality. The cassette was installed into the space structure, film spliced to the leader, and system tension applied during the next day. No problems were observed.

3. System Confidence Operations

The system Confidence operation at A/P demonstrated normal system performance, with no anomalies noted. Visual verification was made of all functions observable from outside the system (with all doors removed), i.e.: horizon and stellar shutter operation, proper film threading and tracking, scratching of the film, system cleanliness, etc. All instrumentation indicated proper operation.

After final system assembly, the routine Light Search indicated a leak at a fairing fastener fitting, which was repaired and verified. Typical minor leaks at the Master main door were also revealed.

The system was shipped by truck from A/P to the "L" building at Vandenburg AFB, where a Receiving Inspection operation indicated proper functions. Further short operations were performed without incident after mating with the AGENA vehicle and after erection of the flight system, as routine items in the countdown procedure.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Launch, ascent, and orbital operations were normal. The payload system functioned properly, with very good photographic results. Vehicle functions were normal, excepting a telemetry failure which resulted in conducting operations without real-time command verification during the last 8½ days. Recovery systems functions were near-nominal, resulting in air catches of both capsules.

B. LAUNCH

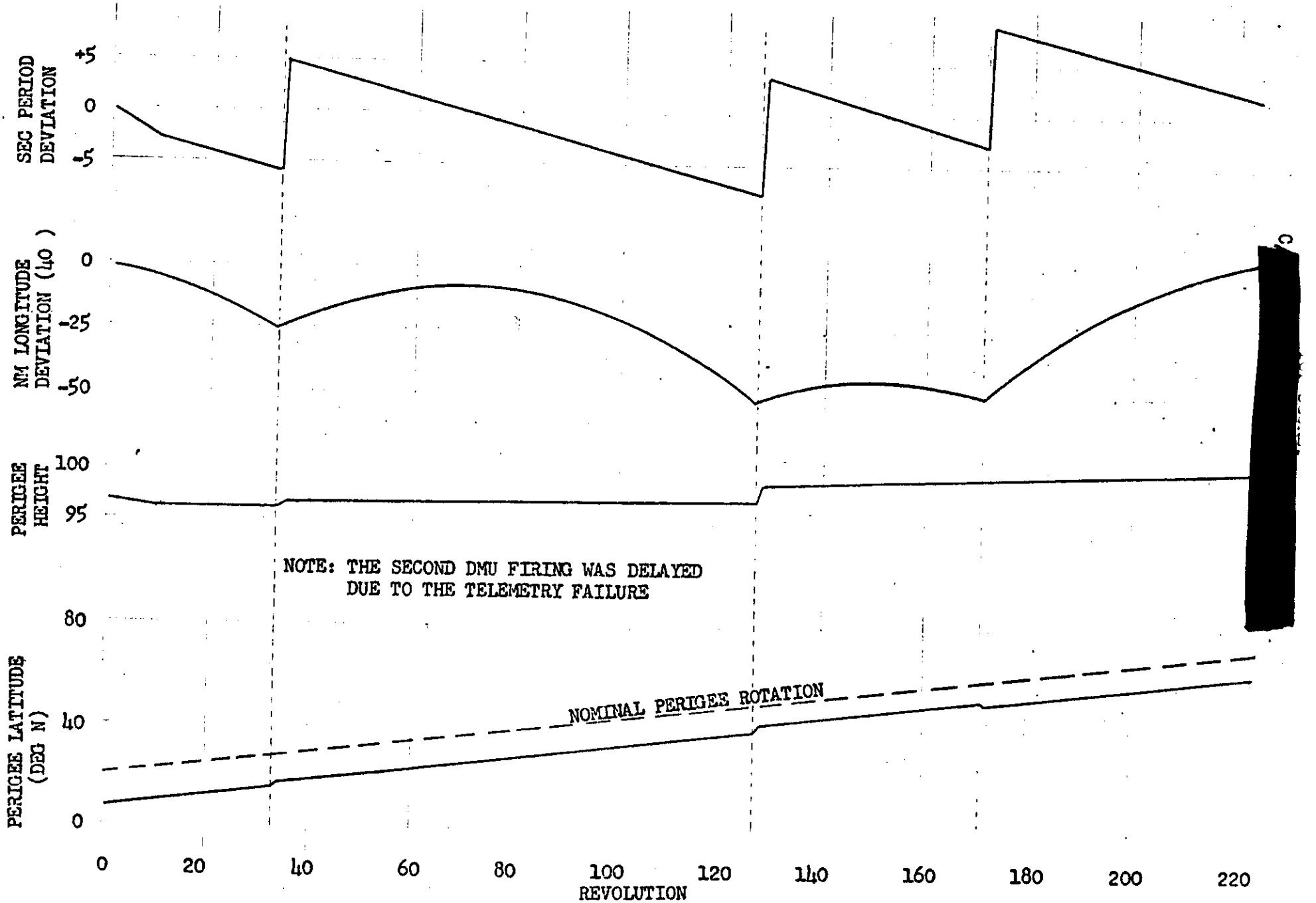
The flight was launched at 2226 Z from Satellite Launch Complex 1-east at Vandenburg AFB. Ascent and injection phases were normal, both the THORAD booster and the AGENA systems performed as programmed.

Launch was within the specified 2145 Z to 2245 Z launch window. This window, in conjunction with the camera settings, had been chosen to maximize useful panoramic coverage of northern latitudes thruout the flight.

C. ORBIT

The orbit achieved was very close to the nominal parameters, although perigee was initially dispersed 8 degrees southwards. Drag makeup (DMU) rockets were fired by ground command on revs 33, 127 and 171 in order to maintain the desired ground tracks and perigee location. The ground tracks were equally spaced in a nine-day interval, with a 90.63 minute mean orbit period. Inclination was 81½ degrees.

The chart on the following page summarizes deviations from the nominal orbit.


SEC PERIOD DEVIATION
+5
0
-5
NM LONGITUDE DEVIATION (40)
0
-25
-50
PERIGEE HEIGHT
100
95
NOTE: THE SECOND DMU FIRING WAS DELAYED DUE TO THE TELEMETRY FAILURE
80
PERIGEE LATITUDE (DEG N)
40
NOMINAL PERIGEE ROTATION
0
0
20
40
60
80
100
120
140
160
180
200
220
REVOLUTION

D. FIRST MISSION

Photographic operations began with a short stereo confidence run during the rev. 1 [redacted] acquisition. Telemetry indicated normal performance and payload status. Reconnaissance operations commenced on rev 5; 2711 frames were taken by the Master camera, and 2709 frames by the Slave, thru the end of the first mission segment. Panoramic film takeup was transferred to the second recovery vehicle by ground command on rev 103, while northbound over the United States. First recovery was effected during rev 112 southbound, resulting in a normal air catch of the film capsule 28 miles from the predicted impact point, approximately 225 miles east of Hawaii.

In addition to the preflight material, there were 74 inflight operations, with status checks on revs 1, 8, 16, and 32. Also included is one domestic pass - Edwards AFB to San Diego - on rev 63.

A vehicle command box malfunction occurred during rev 85, causing the primary telemetry link to become inoperative, the command beacon (S-band) to play continuously, and some payload monitors to remain off the second telemetry link. The only possible command status verification was during the single daily pass when instrumentation excitation was internally provided for tape recording requirements. All real-time commanding after rev 85 was accomplished only during solid acquisitions, using single mode transmission; the vehicle system responded to all commands. The situation necessitated strict accounting of transmitted commands by ground controllers as any mispositioning of vehicle command selectors between the daily verification passes would result in dislocated photographic coverage.

Also as a result of this malfunction, a hazard was apparent in filling the takeup cassettes. If they were overfilled, a film tension loss and subsequent system failure would result, with total forfeiture of the second mission segment. As a precautionary measure, the cassettes were loaded 250 frames less than nominal capacity. This resulted in over 600 feet of film still remaining on each supply spool after both missions, despite the completely full second mission cassettes.

Satisfactory FMC control was maintained thruout this mission segment. The FMC programmer was compensated by ground command during rev 4 for the slight orbit dispersion. No further adjustment was considered necessary, as indicated deviations from nominal were well below the required five percent. Postflight analysis of all available attitude and time data confirm adequate FMC control.

The thermal environment was close to that anticipated preflight. An average camera temperature range from 75 to 85 degrees was predicted for the mission start; 88 and 86 degrees was actually indicated for Master and Slave, respectively. These values declined only one degree by the end of the first segment. No abnormal temperature environment was encountered.

The radiation film pack carried in the recovery capsule indicated an unusually light radiation environment for this mission (less than 0.1 Roentgen). Fogging due to radiation was well below the level necessary to degrade the imagery.

E. SECOND MISSION

Photographic operations continued without additional problems during the second mission segement. An indicated 3115 frames were taken by the Master camera, and 3029 frames by the Slave. The recovery system functioned within tolerances during rev 223 southbound, resulting in an air catch of the film capsule 45 miles northeast of the predicted impact point, approximately 475 miles northwest of Hawaii.

A total of 81 operations were taken during this mission segement. This includes the cut/wrap (rev 103) and lens stow (rev 112) functions necessary to the first recovery, and one nightime status check. Also included are five domestic operations on revs 126, 172, 173, and 205. The two passes on rev 172 were taken to satisfy a Headquarters requirement.

The vehicle command box problem persisted thruout the mission, but no new anomalies were encountered.

Adequate FMC control was maintained thruout the mission segement. The FMC programmer was adjusted twice, on revs 128 and 184, for changes in orbit parameters due to DMU rocket firings. Other adjustments were unnecessary, as deviations from nominal FMC rates were less than the required five percent. Postflight analysis of available attitude and time data confirm adequate FMC control. The Master operated at rates very close to nominal, while the Slave tended to run approximately two percent slow. As gradual decreasing of the rates of one or both instruments is often observed inflight, this was not considered abnormal. No cycle rate anomalies similar to those noted during preflight tests were apparent during the mission.

The thermal environment was close to preflight anticipations. Camera temperatures at the mission start averaged 87 degrees for the Master and 85 degrees on the Slave. These gradually diminished to 67 and 68 degrees respectively by the mission end, as compared with the predicted range of 57 to 69 degrees. No abnormal temperature environment was encountered.

An unusually light radiation environment was also indicated by the film packet for this mission. No detrimental effects due to radiation were anticipated or discovered.

F. COMPONENT OPERATION

Clock system operation appeared normal until the telemetry link failure. Satisfactory correlation was obtained between telemetered clock data and tracking station time at [redacted]. The ratio of clock units to system time, until the loss of data, was 0.999999978979:1.0, as computed from ten acquisitions. Extrapolation of these data thru the second mission was considered adequate, at least for initial time correlation. No particular difficulties were reported in utilization of time correlations by the users.

Instrumentation and Command system difficulties have been previously noted. Prior to the failure, functions were normal. Only one monitor, the Slave camera cycle counter, did not perform satisfactorily, intermittently failing to advance the tens position.

The Yaw Programmer appeared to function normally thruout the flight. It was set, preflight, to produce a nominal maximum yaw deviation of 3.368 degrees at the equator, southbound. Postflight analysis of the Stellar data indicated minor yaw excursions from the nominal, but generally satisfactory performance.

G. VEHICLE

The on-orbit support provided by the AGENA vehicle was normal, with the exception of the telemetry problem previously mentioned. Power supply was adequate, and attitude control was very good. Active vehicle life ended 1½ days after the second recovery with the end of tape in the stored program timer. Vehicle re-entry occurred 34 days after launch.

SECTION 4

PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

Photography from the panoramic cameras was consistantly good thruout both mission segements. Quality of the aft-looking material was slightly better than that of the forward-looking, which is typical for recent systems. A MIP of 90 was awarded for each segment. This was the third system to achieve such a rating during the J1 program.(1)

Photography from both Stellar-Index cameras was consistantly good. Terrain imagery was normal; no problems were discovered. Stellar imagery was flared, as is typical for the J1 system, but was easily utilized to provide attitude data. Some frames were missing from the last operation of the first mission, because of a control malfunction.

B. PANORAMIC CAMERAS

1. Image Quality

The best photography of mission 1045 is considered comparable to the best ever attained with a J1 system. It was the first imagery that enabled photo interpreters to locate a series of denied-area microwave towers, in the aft-looking record. The overall quality varies, as is normal, with atmospheric attenuation and with sun direction relative to the target and camera positions, but was generally high.

(1) Also awarded MIP-90 were missions 1006 (very low perigee) and 1011. Subsequent to mission 1045, mission segment 1046-1 was rated 90.

C[redacted]

The good photography thruout the mission is partially attributable to favorable weather conditions and frequently clear atmosphere in areas of interest; only twenty percent cloud cover was noted. Contributing to the good quality was the focal position adjustment, as based upon new data for vacuum focal shift (see section 2B). While some observers believed that quality of the second mission generally was slightly inferior to that of the first, this could not be established by resolution measurements, which were mostly made on material from the second segement. It is possible that the gradually changing illumination conditions of target areas during the flight may have created a more favorable impression of the first mission record.

The better appearance of the aft-looking record is attributed to two factors; slit dimension and look direction. The smaller slit used on the Slave camera provides approximately 2½ percent greater tolerance to image motion; smear was detectable on the forward-looking record, but not on the aft (see item 4 - Anomalies). Look direction is involved because of the greater effect of diffuse light reflection from haze layers on the forward-looking record, hence the Wratten 23A filter and consequently large slit. Target illumination characteristics are typically more advantageous to the photo interpreter on the aft-looking record.

2. Quality Measurements

The only image quality measurements available at the time of this report are readings of five Controlled Range Network (CORN) fixed resolution targets. Seven to eight foot ground target resolution was indicated on the aft-looking original negative. Forward-looking resolution was read in the eight to twelve foot range, which is more typical of the better J1 performance in the past.

3. Data Recording

Normal auxillary data recording was generally adequate during the mission. The timing track, serial number, time word indices, S/I slur pulse, and the blanking pulse were operational thruout. Only two anomalies affecting the panoramic record were noted: a time word missing from a single frame, and severe loss of Pan Geometry data.

While J45 was manufactured as a P.G. unit, full utilization of this capability was not programmed during the mission planning phase; the lens scan lines were to be enabled only during domestic passes. Of the six actual stateside operations, the lines appeared properly only on the first. During the subsequent operations, they appear only on the forward-looking records, disappearing on the aft-looking material after two or three frames. The rail hole images on rev 1 material appeared similar to the preflight Readiness test material, but 69 precent of the images had disappeared by the end of the mission. The photography had little utility for P.G. measurements.

Because of this, and similar problems encountered on other J1/PG systems, requirements for P.G. functions have been removed for the remaining J1 cameras so equipped.

4. Anomalies

Anomalies noted on the panoramic record were generally of a characteristic nature. Minor effects of image smear were detectable on some of the forward-looking material, but only under magnification of 100X or more. In these cases, shapes of higher-contrast objects became distorted, but identifiable. The smear was limited to the intrack direction.

Very light banding occurred intermittently at the scan start end of some frames from both cameras. There was no apparent contribution to image smear in the banded areas. Very low contrast scenes, as clouds or water, were necessary to detect this effect. A tendency towards banding had been noted during preflight testing, but accepted as a minor effect. Banding is more predominant in cameras with the Pan Geometry feature, and harder to control because of mechanism balance and timing characteristics.

Minor light leaks were apparent on material which remained in the film path for extended periods between operations. Little image degradation was noted. Although undesirable, these leaks were considered typical of recent J1 systems despite a continuing test program to eliminate this problem.

C. HORIZON CAMERAS

Two anomalies affected the otherwise good performance of the four horizon cameras. Data reduction was not seriously affected.

The fiducials were missing from both Master horizon formats for a short segement of the first mission. This occurred on the third frame of the last operation on rev 8 and ended eleven horizon cycles later on the third frame of the first operation on rev 9. Other data recording on the panoramic frames associated with the center-of-format switch was normal, indicating an intermittent malfunction in the fiducial control circuit only.

Very slight veiling was noted, at the Slave starboard-looking format only, thruout the first mission. The horizon was still well-defined, and data reduction was not affected. While veiling has been observed on previous missions, investigation has failed to establish a definite cause.

The most suspect possible cause of horizon image veiling relates to the "beta" angle - the angle between the orbital plane and the earth-sun line. Veiling occurs far more frequently at beta angles greater than minus 30 degrees, indicating the sun to be well to the starboard side of the payload. It seems possible that significant localized thermal effects may accrue with large areas of the horizon light seals ("boots") exposed to direct sunlight. Initial beta for mission 1045 was -40 degrees, diminishing to -26 degrees by the end of the first segement, and to -11 degrees at mission end.

D. STELLAR - INDEX CAMERAS

1. First Mission

The Stellar-Index camera was operational thruout the first mission. The only problem noted occurred during the recovery sequence, when most of the exposed frames remaining in the film path failed to slew at the "Arm" command. There were 11½ index and 23½ stellar frames missing from the end of the mission record; only two index and three stellar frames were moved into the capsule after "Arm". The best estimate as to the cause of the malfunction is a blown fuse in the Fairing Junction Box. A possible alternate cause was a relay failure in the same unit.

Photographic quality of the terrain imagery was good, and comparable to the better recent missions.

Quality of the stellar imagery was normal. Although approximately 60% of the format area was flared, more than twenty star images were useable for attitude data reduction. These images were of good quality and usually sharp, of the point type, indicating little motion during exposure. Some minor corona fogging occurred, but did not affect reducibility of the data.

2. Second Mission

The Stellar-Index camera was operational thruout the second mission. The only anomaly noted was an apparent shutter malfunction, which occurred only during the first camera operation (seven frames). Stellar functions subsequent to this operation were normal. The affected frames were not useable for attitude reduction; roll and pitch information was provided by reduction of the horizon camera imagery.

Photographic quality of the terrain imagery was good, and comparable to the first mission. Several very small minus-density spots were caused by foreign particles adhering to the reseau plate.

Quality of the stellar imagery was comparable to the first mission, with 15 to 20 useable stellar images.

SECTION 5

PANORAMIC EXPOSURE

Exposure on the panoramic camera system is a function of the slit width used, the filter attenuation, and the scan rate. As scan rate depends upon the camera cycle rate required for FMC control to match the orbit, the primary variables for setting nominal exposure are the slit and filter.

A 0.225 inch slit and Wratten 23A filter were selected for the forward-looking camera, with a 0.175 inch slit and Wratten 21 filter for the aft. These selections were made to place exposure near the full processing level for northern operations, passing thru the intermediate and primary levels on southernly operations. These settings are typical of recent flights during winter months, and represent the best compromise obtainable among the many considerations.

Solar elevations encountered during photographic operations are summarized below. While distribution within these ranges is non-Gaussian, most frames were taken between 10 and 40 degrees elevation during both segements. This represents a general latitude band between 30 and 60 degrees North.

Solar direction, relative to system flight direction, was on the starboard side of the ground track. The ranges, below, represent normal dispersions for a winter mission.

RANGES OF EXPOSURE PARAMETERS

Sun Elevation:	1045-1		5° - 55°
	1045-2		7° - 74°
		Northern	Southern
Sun Direction:	1045-1	25° - 65°	100° - 110°
	1045-2	10° - 80°	110° - 150°
		Master	Slave
Exposure Time:	1045-1	1/225-1/315	1/290-1/405
	1045-2	1/290-1/315	1/370-1/405

The recovered film was processed using the Trenton equipment, which provides three levels of development depending upon the exposure the material has received, the gross density range indicated by an intermediate-stage infrared scanning station, and the judgement of the operators:

REPORTED PROCESSING LEVEL

	Primary	Inter.	Full	Transition	# Changes
1045-1	3%	15%	63½%	18½%	82
1045-2	5%	23%	54%	18%	93

Measurements of optical density of selected frames were taken independently at [redacted] and at AFSPPF. The consensus of both sets of data is that the material was generally correctly processed, but there existed a serious tendency towards underexposure.

	1045-1		1045-2	
	SPPL	[redacted]	SPPL	[redacted]
Correct exposure and process	68%	56%	74%	66%
Exposure: Over:	0%	0%	1%	0%
Under: 0.4 Criterion	22%	(14%)	13%	(8%)
1.2 Gradient	-	41%	-	30%
Processing: Over	5%	1%	7%	2%
Under	5%	2%	5%	2%

The normal criterion used to determine proper exposure and processing is that minimum image density should range between 0.4 and 0.9. The area of the scene to be measured is selected subjectively and is not necessarily the absolute minimum image density. This criterion has been found to be an inadequate indicator of optimum target exposure, in that information content, as the photograph as utilized by the photointerpreter, is largely based upon density variations at or near the resolution threshold of cultural targets only. The density measurements are indescriminantly made of relatively gross natural and cultural areas.

Maximum intelligence is generally derived from specific cultural target densities meeting the 0.4 to 0.9 criterion. This will usually result in minimum gross scene densities below 0.4, as the reflectance value range for natural areas tends to be lower than that for cultural areas. It becomes apparent that missions with the more desirable information will probably be reported as significantly underexposed, using current evaluation techniques.

Preliminary evaluation of the original negative by NPIC photoanalysts indicated 50 to 60 percent of the frames were "heavy" in density. This was attributed to the relatively many operations taken at snow-covered northern latitudes. This cause was also cited as contributory to the unusually high brightness ratios measured for this mission,* which appear related to the favorable impression of photographic quality.

* 2.98, the highest in more than a year.

SECTION 6

IMAGE SMEAR

A. VEHICLE ATTITUDE

Vehicle attitude performance data were derived from reduction of the Stellar photography by NPIC. These data are supplied to A/P, where computer analysis provides charts and tabulations of the distribution of attitude angle and rate deviations.

Performance of the attitude control system was normal, and comparable to recent missions. While any angular deviation will cause geometric variation in the photography and any rate deviation will tend to cause relative image motion, the deviations for this mission are not considered degrading to the panoramic photography. The table, below, summarizes both the total range of attitude variation and that experienced during ninety percent of photographic operations:

	1045-1		1045-2	
	90%	Total Range	90%	Total Range
Angle Deviation (degrees):				
Pitch	0.23	-0.22 to +0.70	0.42	-0.20 to +0.54
Roll	0.47	-0.14 to +0.68	0.25	-0.26 to +0.48
Yaw	0.26	-0.30 to +1.80	0.63	-0.14 to +1.10
Rate Deviation (degrees/hour):				
Pitch	20.3	-62 to +52	25.2	-36 to +50
Roll	27.1	-52 to +85	41.9	-90 to +65
Yaw	25.8	-72 to +50	28.8	-90 to +34

(NOTE: Above data are for all but the first six frames of each forward-looking camera operation. Data from the aft-looking camera are similar.)

B. SMEAR ANALYSIS

Data containing the time word for each panoramic photograph are supplied by NPIC to A/P. These times are correlated with the LMSC Precision Fit ephemeris to produce an analysis of FMC error, and are then combined with the vehicle attitude data to produce the net image motion compensation (IMC) errors as well as the total intrack and crosstrack ground resolution limits. These resolution limits would apply to any camera system, regardless of focal length or other system capabilities.

The effects of the slowing cycle rates of the Slave camera during the second mission, relative to the Master camera rates, were mildly apparent in intrack resolution limits and IMC error. Nevertheless, total system limits were well within the normal performance envelope. The following tabulation summarizes the system error and resolution limits:

		1045-1		1045-2	
		90%	Total Range	90%	Total Range
IMC Error, percent:					
	FWD	3.38	-6.0 to +5.5	2.68	-4.8 to +4.8
	AFT	3.78	-6.0 to +5.5	4.41	-7.0 to +3.5
Resolution Limit, feet:					
Intrack:	FWD	3.97	7.6	3.22	8.0
	AFT	3.42	6.0	4.19	9.8
Crosstrack:	FWD	1.00	1.8	2.08	4.4
	AFT	0.72	2.0	1.09	4.2

While slight FMC smear was visible under high magnification on the forward-looking (Master) photography, this was believed more the effect of the wider slit and consequent decreased tolerance to FMC error.

SECTION 7

SYSTEM RELIABILITY

Payload reliability data are based upon a sample beginning with M-7. Hence, twenty Mural program systems and all of the "J" program to date are included in the calculations. The sample origin is changed only when system modifications or new designs are introduced because reliability was one of the principal reasons for the change, as the Stellar-Index and Horizon cameras. The sample size is consistant with reliability reporting for the vehicle, for primary mission functions.

These reliability estimates deal exclusively with the electrical and mechanical functions of the payload. Vehicle-induced failures, as not achieving orbit, are excluded. Quality of the film supply is not reflected. Recoveries prior to completion of a full mission are considered as complete missions, providing that payload operations problems did not cause the early termination.

The reliability data are divided into two categories. The primary section considers those elements which contribute to retrieval of the more significant information, such as panoramic imagery and time data. The secondary section considers auxiliary camera functions, excluding those affecting primary information. The following table summarizes system reliability, estimated to a fifty percent confidence level:

FUNCTIONS:	Opportunities To Operate	Failures	Estimated Reliability
Primary (M7 and up)			
Panoramic Cameras	203	2	98.7%
Main Doors	128	0	99.5%
Command and Control	12072 (hrs)	2	96.3%
Clock	12072 (hrs)	0	99.0%
Total Payload Functions	-	-	96.8%
Recovery System	93	1	98.4%
Secondary (J5 and up)			
Horizon Cameras:			
Single Camera	121000	0	99.1%
4 units, parallel redundant	-	-	99.9%
Stellar-Index Camera	29330	4	93.5%

SUMMARY

Mission 1045 was considered highly sucessful in its photographic results; very good imagery was made available to the intelligence and cartographic communities. Few significant photographic anomalies were noted. While some difficulty was experienced with obtaining command verification and payload status during the flight, no operational problems detrimental to the mission were encountered on-orbit.

DISTRIBUTION:

COPY NO.	TO
[redacted]	[redacted]