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CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1105-1 AND 1105-2

FTV 1646, CR-5

Approved: [redacted]ger
Advanced Projects



Approved: [redacted]Manager
Program [redacted]

17 June 1969

TO: [redacted]

THRU:

FROM:

SUBJECT: MISSION 1105 FINAL REPORT (CR-5)

Enclosed is the Final Evaluation Report for Mission 1105.

[redacted] Manager
Advanced Projects

# FOREWORD

This report details the performance of the payload system during the operational phase of the Program [redacted] Flight Test Vehicle 1646.

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 1105 which was launched on 3 November 1968.

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# INTRODUCTION

This report presents the final performance evaluation of Corona Mission 1105. The purpose of this report is to define the performance characteristics of the CR-5 payload system and to evaluate the technical aspects of the Mission, including analysis of in-flight anomalies.

The payload system was assembled, tested, and certified for flight at the Advanced Projects (A/P) facility of Lockheed Missiles and Space Company (LMSC). A/P also provided services including pre-flight mission parameter planning, preparation of the flight program, in-flight operations support and data analysis, and mission reporting to the community. The initial evaluation of the recovered film was made by NPIC personnel at the processing facility. The Performance Evaluation Team (PET) meeting at NPIC included representatives of LMSC, ITEK Corporation, Eastman Kodak Company, and cognizant government organizations. Off-line evaluation was performed at facilities of individual contractors, using engineering photography acquired over the United States.

The quantitative data summarized in this report is originated by governmental and contractor organizations. Diffuse Terrain Density measurements are produced by the Air Force Special Projects Production Facility. The Processing Summary report and Target Density measurements are provided by [redacted]

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

SECTION 1

MISSION SUMMARY

A. MISSION DESCRIPTION

Corona Satellite Mission 1105 was planned to acquire cartographic and reconnaissance photography of selected terrain areas. Two mission segments were planned to total eighteen days of orbital operation. Each mission segment would return approximately 9000 panoramic frames and each frame would nominally cover 1160 square miles.

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

The payload was a J-3 configuration, consisting of a space structure containing two panoramic cameras and associated control/support equipment and recovery subsystems for each mission segment. The DISIC Stellar-Terrain camera, normally flown as part of the J-3 configuration, was omitted from Mission 1105.

The flight system was launched into the planned orbit from Vandenberg AFB at 21:31 GMT on 3 November 1968.

The panoramic cameras operated throughout both mission segments. Both cameras demonstrated acceptable operation during Missions 1105-1 and -2 until film depletion. At film depletion film wrap-up occurred in the film transport systems of both cameras. The aft camera stalled. The forward camera continued to rotate. The stalled aft camera caused an unusually high power drain.

Mission 1105-1 was successfully completed, after eight days of flight, with an air-catch of the recovery capsule. The second mission segment was similarly terminated after ten days of orbital flight.

Photographic performance of the panoramic cameras varied from poor to good. The best image quality of Mission 1105 is equivalent to the best imagery of Mission 1102.

Mission 1105 was the first system to use SO-380 ultra thin base (UTB) material as the primary film load. The aft looking camera film supply was terminated with 500 feet of SO-121 color film.

B. FLIGHT CONFIGURATION

| | |
|---|---|
| Mission No. | 1105 |
| Vehicle No. | 1646 |
| System No. | CR-5 |
| Forward Looking Camera Serial No. | 311 |
| Aft Looking Camera Serial No. | 310 |
| DISIC Camera Serial No. | Not Applicable |
| Lens Data | |
| Forward Looking Camera (Main Lens) | |
| Lens Serial No. | I 207 |
| Measured Slit Width (Inches) | |
| Position 1 | 0.180 |
| Position 2 | 0.229 |
| Position 3 | 0.310 |
| Position 4 | 0.337 |
| Failsafe | 0.314 |
| Optics Filter Type | |
| Primary | W-25 |
| Alternate | W-23A |
| E.O. Focal Length (Inches)(Vacuum) | 24.002 |

| | |
|---|---|
| Resolution | |
| Static (Lines/Millimeter) | |
| Filter | W-25 |
| High Contrast | 293 |
| Low Contrast | 182 |
| Dynamic (Lines/Millimeter) | |
| ITEK Post-Vibration | |
| Filter | W-25 |
| High Contrast | 255 |
| Low Contrast | 173 |
| A/P Test | |
| Filter | W-25 |
| High Contrast | 279 |
| Low Contrast | 187 |
| Distortion/Pincushion (MM) | |
| Angle Off Axis (Deg.) | |
| 3 | 0.004 |
| 2 | 0.001 |
| 1 | 0.000 |
| 0 | 0.000 |
| 359 | 0.000 |
| 358 | 0.001 |
| 357 | 0.002 |
| Aft Looking Camera (Main Lens) | |
| Lens Serial No. | I-168 |
| Optics Slit Width (Inches) | |
| Position 1 | 0.138 |
| Position 2 | 0.149 |
| Position 3 | 0.192 |
| Position 4 | 0.271 |
| Failsafe | 0.198 |

| | |
|---|---|
| Optics Filter Type | |
| Primary | W-21 |
| Alternate | W/2E+CC2C+0.4 N.D. |
| E.O. Focal Length (Inches)(Vacuum) | 24.002 |
| Resolution (Lines/MM) | |
| Static | |
| Filter | W-21 |
| High Contrast | 257 |
| Low Contrast | 150 |
| Dynamic (Lines/MM) | |
| ITEK Post-Vibration | |
| Filter | W-21 |
| High Contrast | 219 |
| Low Contrast | 132 |
| A/P Test | |
| Filter | W-21 |
| High Contrast | 265 |
| Low Contrast | 158 |
| Distortion/Pincushion (MM) | |
| Angle Off Axis (Deg.) | |
| 3 | 0.003 |
| 2 | 0.001 |
| 1 | 0.000 |
| 0 | 0.000 |
| 359 | 0.000 |
| 358 | 0.002 |
| 357 | 0.004 |

## Horizon Optics

### Forward Looking Camera

#### Take-up (Starboard)

| | |
|---|---|
| Lens Serial No. | E23795 |
| Exposure Time (Sec.) | 1/100 |
| Aperture | F/8.0 |
| Filter Type | W-23 (Auxiliary-None) |
| Oper. Focal Lenghth (MM) | 55 |
| Radial Distortion (MM) | |
| 10 Deg. Off Axis | 0.005 |
| 20 Deg. Off Axis | 0.04 |
| Tangential Distortion | 0.03 |

Resolution (Lines/MM)

| Angle Off Axis (Deg.) | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| (Radial) | 209 | 208 | 184 | 181 | 156 | 119 | 23 |
| (Tangential) | 187 | 161 | 144 | 138 | 116 | 96 | 62 |

#### Supply (Port)

| | |
|---|---|
| Lens Serial No. | E23777 |
| Exposure Time (Sec.) | 1/100 |
| Aperture | F/6.3 |
| Filter Type | W-25 (Auxiliary-None) |
| Oper. Focal Length (MM) | 55 |
| Radial Distortion (MM) | |
| 10 Deg. Off Axis | 0.01 |
| 20 Deg. Off Axis | 0.05 |
| Tangential Distortion | 0.02 |

Resolution (Lines/MM)

| Angle Off Axis (Deg.) | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| (Radial) | 166 | 165 | 145 | 127 | 124 | 119 | 32 |
| (Tangential) | 166 | 164 | 144 | 123 | 116 | 86 | 49 |

Aft Looking Camera

Take-up (Port)

| | |
|---|---|
| Lens Serial No. | E23809 |
| Exposure Time (Sec.) | 1/100 |
| Aperture | F/6.3 |
| Filter Type | W-25 (Auxiliary-None) |
| Oper. Focal Length (MM) | 55 |
| Radial Distortion (MM) | |
| 10 Deg. Off Axis | 0.01 |
| 20 Deg. Off Axis | 0.03 |
| Tangential Distortion | 0.025 |
| Resolution (Lines/MM) | |

| Angle Off Axis (Deg.) | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| (Radial) | 209 | 186 | 184 | 181 | 156 | 119 | 32 |
| (Tangential) | 209 | 185 | 181 | 155 | 130 | 109 | 62 |

Supply (Starboard)

| | |
|---|---|
| Lens Serial No. | E23753 |
| Exposure Time (Sec.) | 1/100 |
| Aperture | F/8.0 |
| Filter Type | W-25 (Auxiliary-None) |
| Oper. Focal Length (MM) | 55 |
| Radial Distortion (MM) | |
| 10 Deg. Off Axis | 0.015 |
| 20 Deg. Off Axis | 0.05 |
| Tangential Distortion | 0.024 |
| Resolution (Lines/MM) | |

| Angle Off Axis (Deg.) | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| (Radial) | 187 | 186 | 184 | 181 | 175 | 118 | 32 |
| (Tangential) | 187 | 185 | 161 | 123 | 116 | 96 | 62 |

DISIC Camera — Not Applicable

Film Types

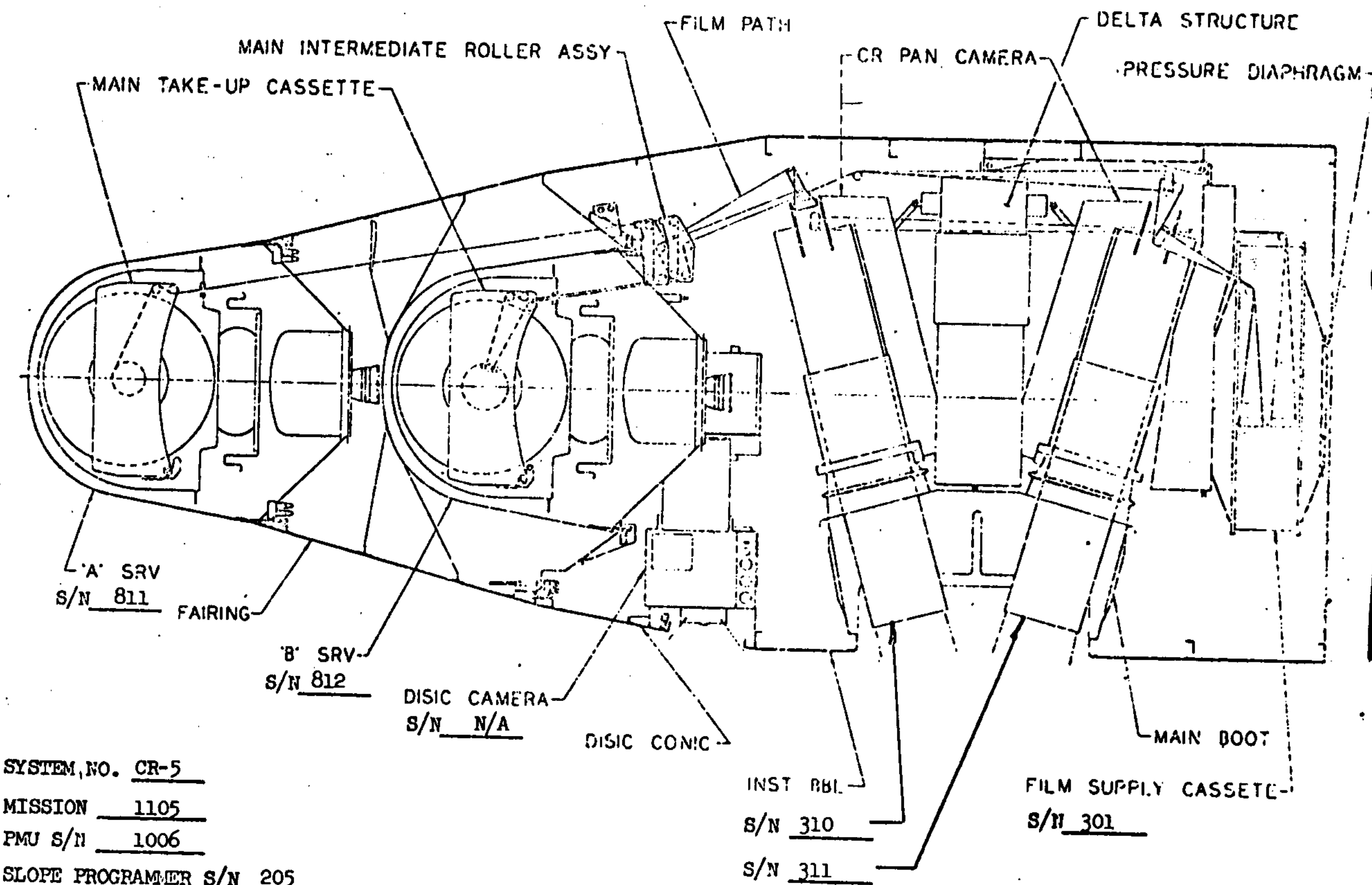
Forward Looking Camera

| | |
|---|---|
| Split Load | No |
| Film Type | SO-380 |
| Length (Ft.) | 24,000 |
| Splices | 7 |
| Length Between Splices (Ft.) | 2890-3330-3591-1458-3339-2965-3347-3080C |
| Emulsion Data | 157-5-10-6-10-8 |
| Payload Weight (Lbs.) | 86.1-78.6 |
| Spool No. | 188B |
| Box Serial No. | 32 |

Aft Looking Camera

| | |
|---|---|
| Split Load | Yes |
| Film Type | SO-380/3404/SO-121 |
| Length (Ft.) | 23,000/50/500 |
| Splices | 9 |
| Length Between Splices (Ft.) | 2235-3275-3870-3820-3285-3265-3250(50 FT 3404)-MCD-(500 FT SO-121)C |
| Emulsion Data | SO-380:157-10-10-8/3404:415-2-2 SO-121:44.1 |
| Payload Weight (Lbs.) | 86.6-79.1 |
| Spool No. | 151T |
| Box Serial No. | 32 |

PAYLOAD PROFILE AND SERIAL NUMBERS




SYSTEM, NO. CR-5

MISSION 1105

PMU S/N 1006

SLOPE PROGRAMMER S/N 205

CLOCK S/N 601

SWITCH PROGRAMMER S/N 205

[redacted]

# SECTION 2

# PRE-FLIGHT SYSTEMS TEST

## A. SUMMARY

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

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

The CR-5 system successfully passed all phases of the testing operations providing acceptable performance and a high degree of operational confidence.

## B. ENVIRONMENTAL TEST

The CR-5 system was subjected to environmental testing from 4 thru 13 June 1968 and again from 5 thru 14 September 1968.

The primary purpose of the first environmental test was to determine the corona marking characteristics of the panoramic cameras and operational performance of the system at altitude. The second test conducted in September 1968 was performed to determine the positional characteristics of the ultra thin base film plane during exposure at altitude and is termed the Aschenbrenner Grid test (AG test).

During the first test conducted in June 1968 the CR-5 flight system was subjected to internal system pressures at altitude that ranged between 1 and 64 microns by programmed on and off use of the Gas Pressure Make-up system. Three special pressure sweeps that occurred during the "B" SRV portion of the test extended the internal camera pressure range of the panoramic cameras during operation to approximately 160 microns.

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

The CR-5 system operations during the first altitude test produced the following film consumption:

First Altitude Test-Film Consumption (Cycle Counter)

| Operation | Panoramic Camera No. | |
|---|---|---|
| | #310 | #311 |
| A SRV Frames | 4050 | 4017 |
| B SRV Frames | 4254 | 4352 |
| Total Frames | 8304 | 8269 |

Corona was produced on the second to last frame of several operations by panoramic camera #310 as revealed by plus density fog patterns in film type SO-380. The most probable cause of the start-up corona appears to be the frame metering roller. Start up corona occurred with the gas pressure make-up system (PMU) off at internal camera pressures ranging from 1.8 to 5 microns. Corona density was 0.06 above the base level. Start up corona was also observed on the last frame and the first two start-up frames of film type SO-121 (color). The corona fog evidenced in SO-121 film was produced at an internal camera pressure of approximately 2 microns. Corona fog in SO-121 film appeared blue/green. No corona occurred in either film type <u>during</u> camera operation. SO-121 color film was used in camera #310 only. The corona marking produced by camera #310 was very minor and within acceptable limits. No corona was produced by camera #311.

While the second altitude test was not conducted to test for corona some minor start-up corona fog was produced by panoramic camera #310 on film type SO-380. Film type SO-121 was not used in the second altitude test.

The start-up corona, in the second altitude test conducted in September 1968, was observed with PMU off at internal system pressures between 0.8 and 4.0 microns. The last and next to last frame of several operations were affected by minor start-up corona to a maximum density of 0.55 above the base level. Corona density exceeded the acceptance maximum of 0.4 above the base level. Since the corona was minimal and occurred on only one to two start-up frames of photography during some operations a waiver was recommended. No corona was produced by the panoramic cameras during operation of the gas pressure make-up

(PMU) system in either the first or second altitude tests. Internal camera pressure with the PMU system on is in the 50 to 60 micron range.

Second Altitude Test-Film Consumption (Cycle Counter)

| Operation | Panoramic Camera # | |
|---|---|---|
| | #310 | #311 |
| A SRV Frames | 4381 | 4382 |
| B SRV Frames | 4356 | 4344 |
| Total Frames | 8737 | 8726 |

Auxiliary data recording was acceptable. Visual analysis of film from panoramic cameras #310 and #311 revealed that imagery of the serial number, time track, H.O. fiducials, start of pass mark, PG traces, and rail holes were acceptable. Microdensitometer measurements revealed that imagery of the time word from both main cameras was acceptable.

A plus density wavy mark was present intermittently throughout the film during "A" and "B" SRV operations. The mark was approximately 1/8 inch wide with a density of +0.01 to 0.015 above the base plus fog level. No physical damage is associated with the mark. The mark has been observed at ambient pressure as well as at altitude. Marking is characteristic of SO-380 UTB film in the panoramic film transport system. The density of the marking is very low and is not expected to interfer with the interpretation of flight imagery.

Rail scratches were light. Investigation revealed that light and intermittent rail scratches have been a characteristic of the CR-5 system with UTB film at ITEK Corporation and Advanced Projects.

Operations for the most part proceeded according to plan. Cycle rates were computed. The average cycle rate error during the first altitude test was approximately 0.4% throughout the "A" mission. During the "B" mission the cycle rate error remained at approximately 0.4% except for Revs 20 and 23. The error during these revs exceeded the specification limit of 1%. This anomaly was attributed to the high temperature range of the Slope Programmer which was found to be 95° to 100°F during Revs 20 and 23. Examination revealed that the Slope Programmer performance was acceptable. During the second test cycle rates were checked and were found to be well within limitations.

The clock system accuracy was computed to determine clock performance. As a result the accuracy of the clock over an eight day period was found to be within specification.

The footage potentiometers in both panoramic cameras indicated approximately 60 cycles less film consumption than the actual count. The footage potentiometers were subsequently recalibrated to bring their indicated film consumption to within the specified 50 cycle maximum deviation from the cycle counters for each panoramic camera.

The exposure control system and FMC system for both panoramic cameras were acceptable throughout environmental testing.

Exposure of the CR-5 system to the altitude environment for the second time was required in order to conduct the Aschenbrenner Grid test (AG test). The AG test was devised to determine the position of the UTB film plane during panoramic exposure at various points in the format. From the data generated, ITEK Corporation determined the suitability of the focus setting of each panoramic camera.

The following AG test data represents the performance estimate in lines/mm expected from panoramic cameras #310 and #311. The results are based on the reduction of frame 10 of operation #6 and are considered acceptable and representative of the overall performance.

AG Test Data Frame #10, Operation #6

| Flatness Variation (Inches) | Per cent Format Included | Estimated Performance Range (li/mm) |
|---|---|---|
| Pan Camera #310 (Type II Petzval) | | |
| ±0.0005 | 52 | 130-145 |
| ±0.0007 | 75 | 127-140 |
| ±0.0010 | 86 | 125-135 |
| Pan Camera #311 (Type III Petzval) | | |
| ±0.0005 | 77 | 150-185 |
| ±0.0007 | 90 | 145-185 |
| ±0.0010 | 99 | 135-180 |

From the above data plus similar AG test data for many other operations conducted during CR-5 system exposure to the thermal/altitude environment, ITEK Corporation recommended that CR-5 system be used for flight as focused.

C. LIGHT LEAK TEST

The CR-5 system was tested for light leaks on 29 July 1968. Panoramic instruments #310 and #311 were threaded with film type 3401 per the standard operating procedure. The CR-5 system was placed in flight configuration and exposed to external illumination for 90 minutes per side. At the conclusion of the test the payload was retrieved, processed to the full level, and evaluated.

Heavy fog was present on instrument #310 film to a density of 2.1. Instrument #311 film was fogged to a density of 0.4. Fog marks were located in the vicinity of the forebody/fairing interface. The unacceptable light leak was traced to the pin puller teardrop fitting on the minus "Z" axis. The light leak was corrected by the addition of a rubber light shield under the teardrop fitting at the forebody/fairing interface. Subsequent light leak testing verified that the light leak had been eliminated.

D. RESOLUTION TEST

The CR-5 system was subjected to a thru focus dynamic resolution test on 24 June 1968 using film type SO-380 (UTB). The results from this test revealed that the peak focus of both panoramic cameras occurred at +0.0015 inches from collimator zero at Advanced Projects. The cause of the change in peak focus from collimator zero was unknown. The scan head and field flattener assemblies of panoramic cameras #310 and #311 were moved away from the lens by addition of a 0.0015 inch shim to shift the peak focus of each camera to approximately the 0.000 collimator position.

A post shim resolution test performed on 27 June 1968 produced peak focus results as follows:

<u>Pan Camera #310</u>

Maximum high contrast resolution lines/mm 220 at 0.000 focal position.

Maximum low contrast resolution lines/mm 128 at 0.000 focal position.

<u>Pan Camera #311</u>

Maximum high contrast resolution lines/mm 242 at -0.001 focal position.

Maximum low contrast resolution lines/mm 185 at -0.001.

Further investigation by Boston revealed that an additional +0.0005 inch shim was desirable for panoramic camera #310.

Prior to the final resolution test pan camera #310 was shimmed +0.0005 inches. Final resolution results produced on 5 October 1968 are shown as follows:

Pan Camera #310

Maximum high contrast resolution lines/mm 265 at 0.000 focal position.

Maximum low contrast resolution lines/mm 158 at 0.000 focal position.

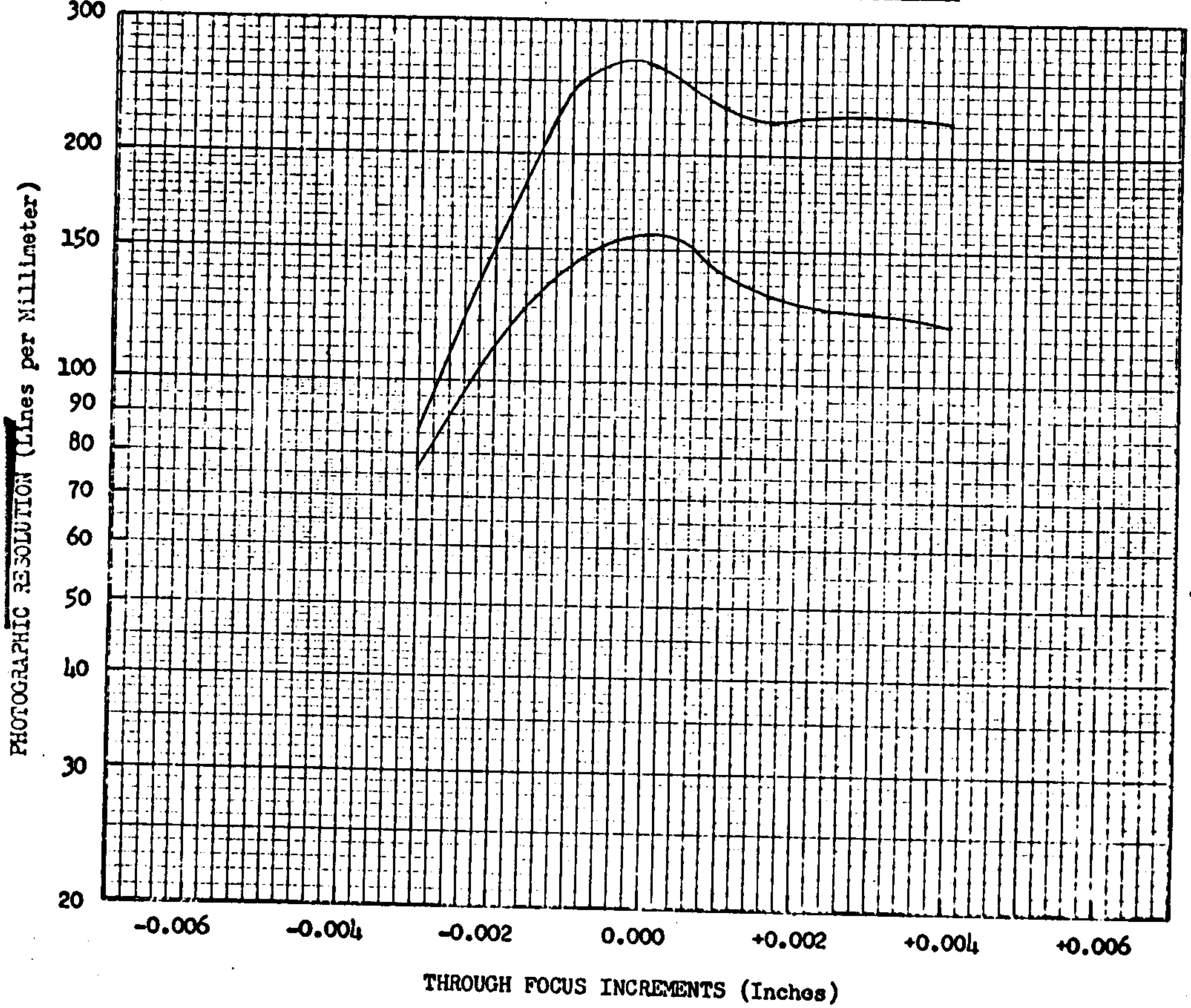
Pan Camera #311

Maximum high contrast resolution lines/mm 279 at 0.000 focal position.

Maximum low contrast resulution lines/mm 187 at -0.000 focal position.

The final through focus resolution test is graphically shown in Figures 2-1 and 2-2 for panoramic cameras #310 and #311 respectively. The CR-5 system met the specified resolution requirements and was considered acceptable without further resolution testing.

## PRE-FLIGHT DYNAMIC RESOLUTION




Camera No: 310

Payload No: CR-5

Resolution (1/mm)

High Contrast: 265

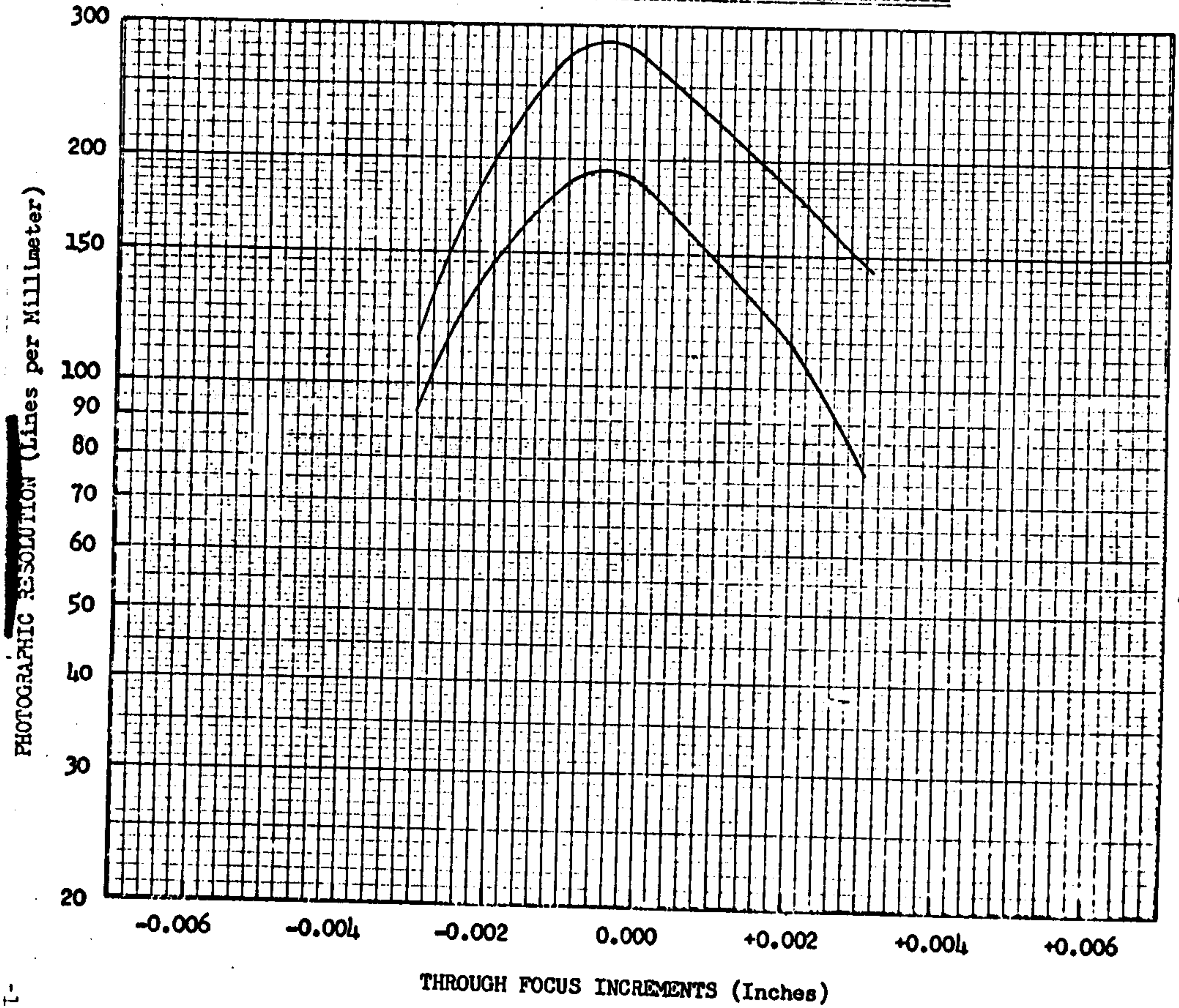
Low Contrast: 158

Film Type: SO-380 UTB

Test Date: 5 October 1968

FIGURE 2-1

## PRE-FLIGHT DYNAMIC RESOLUTION




Camera No: 311

Payload No: CR-5

Resolution (1/mm)

High Contrast: 279

Low Contrast: 187

Film Type: SO-380 UTB

Test Date: 5 October 1968

[redacted]

FIGURE 2-2

E. FLIGHT READINESS TEST

The first CR-5 Flight Readiness test was conducted on 16 October 1968. This test revealed the presence of heavy scratches in the active format area of the SO-380 payload of instrument #310. The scratches were traced to interference of the input A.O. clamp with the film during film meter. Further investigation revealed that the mechanical timing sequence of Instrument #310 was out of adjustment. As a result, the star wheel assembly of Instrument #310 was replaced. In addition, the first Readiness test revealed anomalies in the processed test film as follows.

<u>Instrument #310</u>

1. The start of pass lamp was out. This was corrected prior to the second Readiness test.
2. The instrument serial No. was faint but present on alternate formats.
3. The last frame of several instrument shutdowns contained an incorrect time word. Since this anomaly occurred for the creep frame which has little photographic value in flight, a waiver was recommended.
4. The #3 and #3A fiducials were partially blocked on the input and output auxiliary optics (A.O.). The fiducials were cleaned prior to the second Readiness test.

<u>Instrument #311</u>

1. Anomalies present in Instrument #311 were minimal and were the same as items 3 and 4 shown for Instrument #310.

A second Readiness test conducted on 20 October 1968 demonstrated acceptable Instrument #310 and #311 performance as revealed by the processed test film exhibits.

While the #3 and #3A A.O. fiducial images are somewhat weak on Instrument #310, the fiducials are present. The presence of acceptable A.O. fiducials in the #1, 2, and 4 positions is adequate to meet program objectives.

It was recommended that CR-5 system be accepted without further readiness testing.

The CR-5 cam/slit sequence and slit width values were verified as part of the first Readiness test. Evaluation of the processed SO-380 film revealed that the exposure cams do provide specified exposure slit widths in the correct sequence.

Measurements of processed slit images revealed the following slit values:

| Slit No. | Command Position | SLIT WIDTH (INCHES) Camera 310 AFT | Camera 311 FWD |
|---|---|---|---|
| 1 | 2 | 0.138 | 0.180 |
| 2 | 3 | 0.149 | 0.229 |
| 3 | 4 | 0.192 | 0.310 |
| 4 | 5 | 0.271 | 0.337 |
| Failsafe | 11 | 0.198 | 0.314 |

## F. FLIGHT CERTIFICATION

Flight film loading of the CR-5 Panoramic Cameras occurred without incident of 21 October 1968. Sensitometric examination of samples of the flight film verified satisfactory photographic characteristics.

The confidence run, to certify the CR-5 system for flight, was conducted on 23 October 1968. Rail scratches were continuous but very light on the emulsion side of both panoramic payloads. Minor acceptable brush marks were present of the backing side of the film installed in Instrument #310.

The CR-5 system was checked for light leaks following the last camera operation of the confidence run. The space structure proved to be light tight as indicated by the photomultipliers employed in the light leak test. One minor light leak was detected in the camera drum area of Instrument #310. Corrective action was not considered feasible and no further testing was recommended.

The CR-5 system was accepted for flight on 24 October 1968.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

Mission 1105 was launched normally into the planned orbit without incident. All ascent and injection events occurred as programmed. The orbit achieved was within the 3 sigma predicted dispersions. The total mission lasted for 18 days with an 8-day first segment and a 10-day second segment.

The panoramic cameras operaated satisfactorily throughout the flight. Both panoramic cameras experienced in-flight failure at film depletion at the end of the mission. Photographic performance varied from poor to good. The variable photographic performance was partially attributed to the unstable physical characteristics of ultra thin base film at lower than normal system film tension. Lower than normal film tension, established to reduce tracking strain marks, may have contributed to the soft imagery observed along the center of the SO-121 color film flown in aft-looking panoramic camera #310.

Mission 1105 flew without the DISIC camera subsystem.

B. LAUNCH

The flight was launched at 21:31 GMT on 3 November 1968 from Satellite Launch complex 1 west at Vandenberg AFB. Ascent and injection were normal. Launch was within the specified 21:30 to 22:30 launch window. The window was selected to optimize northern latitude coverage throughout the flight. Door ejection, instrumentation switchover and panoramic camera transfer to orbit mode occurred as planned.

C. ORBIT

Mission 1105 was launched into the planned orbit. All orbit parameters attained were well within the specified tolerances.

Orbit conditions computed from Rev 2 data are shown in Table 3-1.

TABLE 3-1

Mission 1105 Orbit Parameters (Rev. 2)

| Orbit Parameter | Predicted | Tolerance | Actual |
|---|---|---|---|
| Period (Min) | 88.96 | +.29, -.48 | 88.91 |
| Perigee (NM) | 80.7 | +7, -6 | 83.2 |
| Apogee (NM) | 165.4 | +13, -21 | 161.5 |
| Eccentricity | 0.0120 | +.0023, -.0034 | 0.0111 |
| Inclination (Deg) | 83.01 | +0.39, -0.16 | 83.14 |
| Arg. of Perigee (Deg) | 147 | +41, -43 | 145 |

Drag make-up (DMU) rockets were employed throughout the flight to maintain orbit period. Five DMU rockets were utilized for period recovery during Mission 1105-1. However, Rocket No. 4 apparently blew out the side of the case providing approximately 25% of nominal thrust. All seven of the remaining rockets were necessary to maintain orbital period through Mission 1105-2. Figure 3-1 shows the orbit history maintained throughout the mission. A summary of the DMU firings is shown in Table 3-2. Figure 3-2 shows the frequency distribution of operations and mean frame altitude of Mission 1105.

1105/CR-5 ORBIT HISTORY

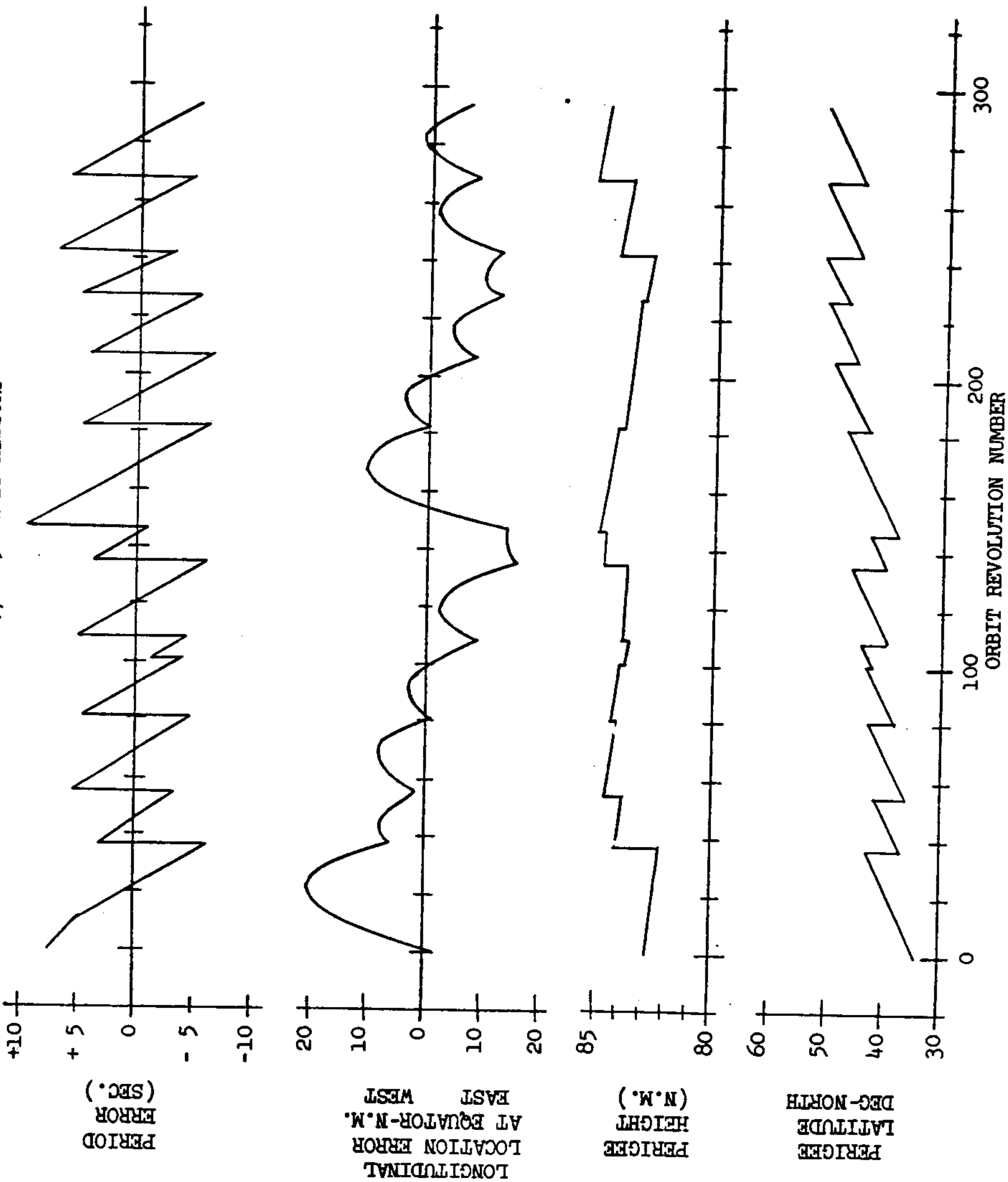



FIGURE 3-1

1105/CR-5 OPERATIONS

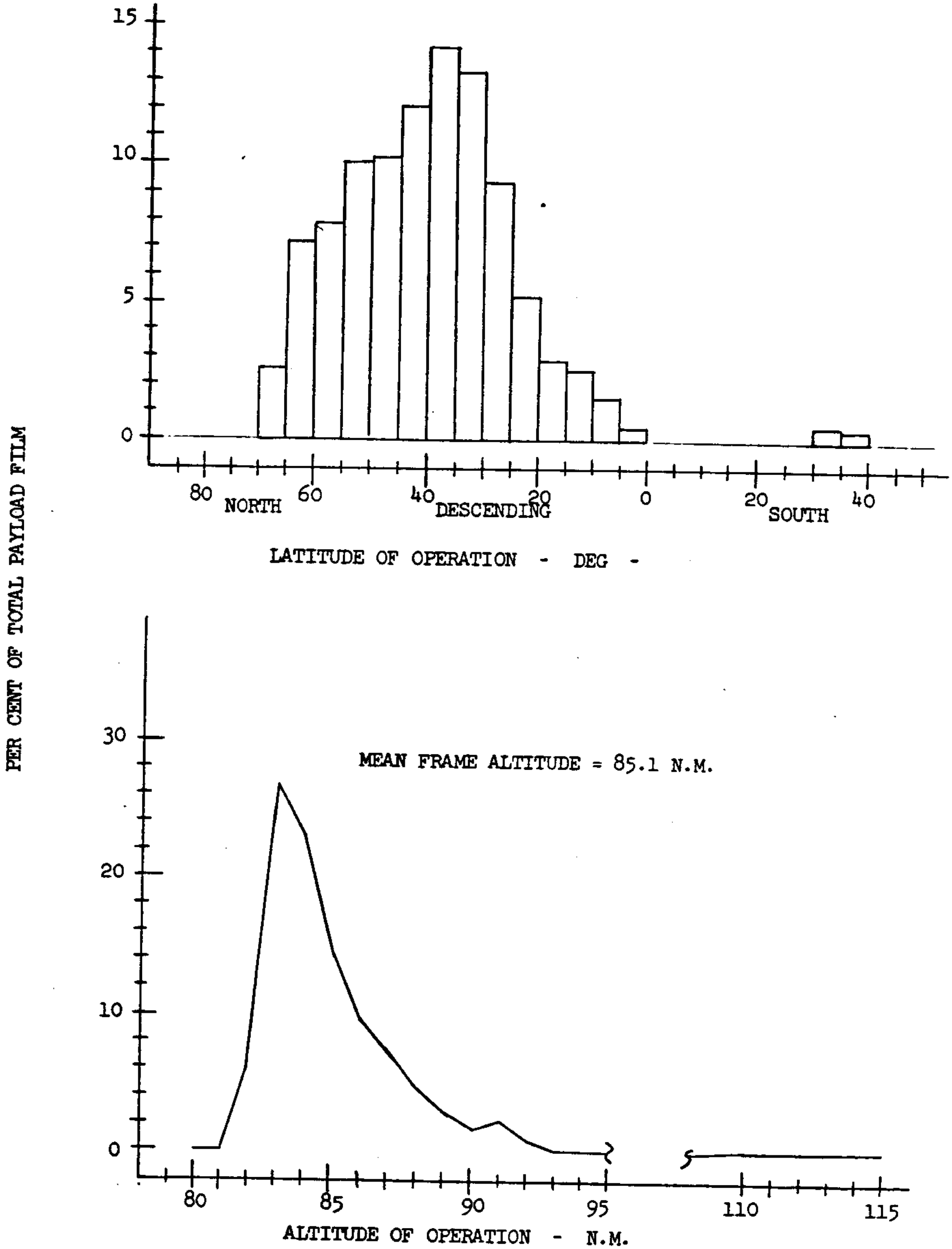







FIGURE 3-2

TABLE 3-2

Rocket Firings and Orbital Effects

| Rocket No. | Pass Fired | System Time | Period Change (Sec) | Velocity Change (Ft/Sec) | Period at Firing (Min.) |
|---|---|---|---|---|---|
| 1 | 37 | 16683 | 9.77 | 15.55 | 88.69 |
| 2 | 55 | 25948 | 9.50 | 15.25 | 88.73 |
| 3 | 81 | 77845 | 9.63 | 15.48 | 88.78 |
| 4 | 101 | 11382 | 2.65 | 4.3 | 88.74 |
| 5 | 108 | 48866 | 9.55 | 15.3 | 88.71 |
| 6 | 135 | 84345 | 10.45 | 16.75 | 88.69 |
| 7 | 146 | 78516 | 10.65 | 17.07 | 88.78 |
| 8 | 182 | 10966 | 10.83 | 17.34 | 88.68 |
| 9 | 206 | 52418 | 11.25 | 18.00 | 88.69 |
| 10 | 227 | 77774 | 10.93 | 17.51 | 88.70 |
| 11 | 242 | 71839 | 10.95 | 17.56 | 88.74 |
| 12 | 268 | 37591 | 11.15 | 17.80 | 88.72 |

D. PANORAMIC CAMERAS

The panoramic cameras operated properly throughout Mission 1105-1 and 1105-2. The first photographic operation occurred during Rev1 [redacted] acquisition. This was a short stereo confidence check. Reconnaissance operations began on Rev 5.

There were 74 in-flight photographic operations during Mission 1105-1. Night engineering operations were performed on Revs 9, 105, and 121. Daytime engineering operations programmed over the United States included Revs 16, 32, 48, 64, 80, and 95. The last photographic operation of Mission 1105-1 occurred on Rev 127.

Mission 1105-2 contained 88 in-flight operations. One night engineering operation occurred on Rev 234. Daytime engineering operations over the United States included Revs 129, 145, 161, 177, 209, 273, and 274. The last photographic take was made on Rev 283.

The aft-looking panoramic camera utilized a film change detector for control of the photographic filter from film type SO-380 (UTB) to the last 500 feet of payload which was SO-121 colored film. The film change detector and filter response were normal. The forward-looking camera employed film type SO-380 throughout both mission segments.

Both panoramic cameras experienced a failure at film depletion at the end of the mission during Rev 283. The failures occurred in the film transport system on both cameras. In the aft-looking camera (#310) a film wrap-up occurred on the frame metering roller which sheared the drive pin, but retained enough drag to stall the unit. This stalled condition caused an abnormal power consumption. The forward-looking unit (#311) failed in a similar manner but was free to continue rotation. Film wrap-up following film depletion appears to be a possible characteristic failure mode of the panoramic cameras. It also occurred on Mission 1104 forward-looking camera.

The primary adverse effect of film wrap-up at film depletion is continuous power usage prior to the second recovery. To eliminate the possibility of continuous power usage due to the failure mode the internal camera operate command will be modified on all future CR systems to remove power.

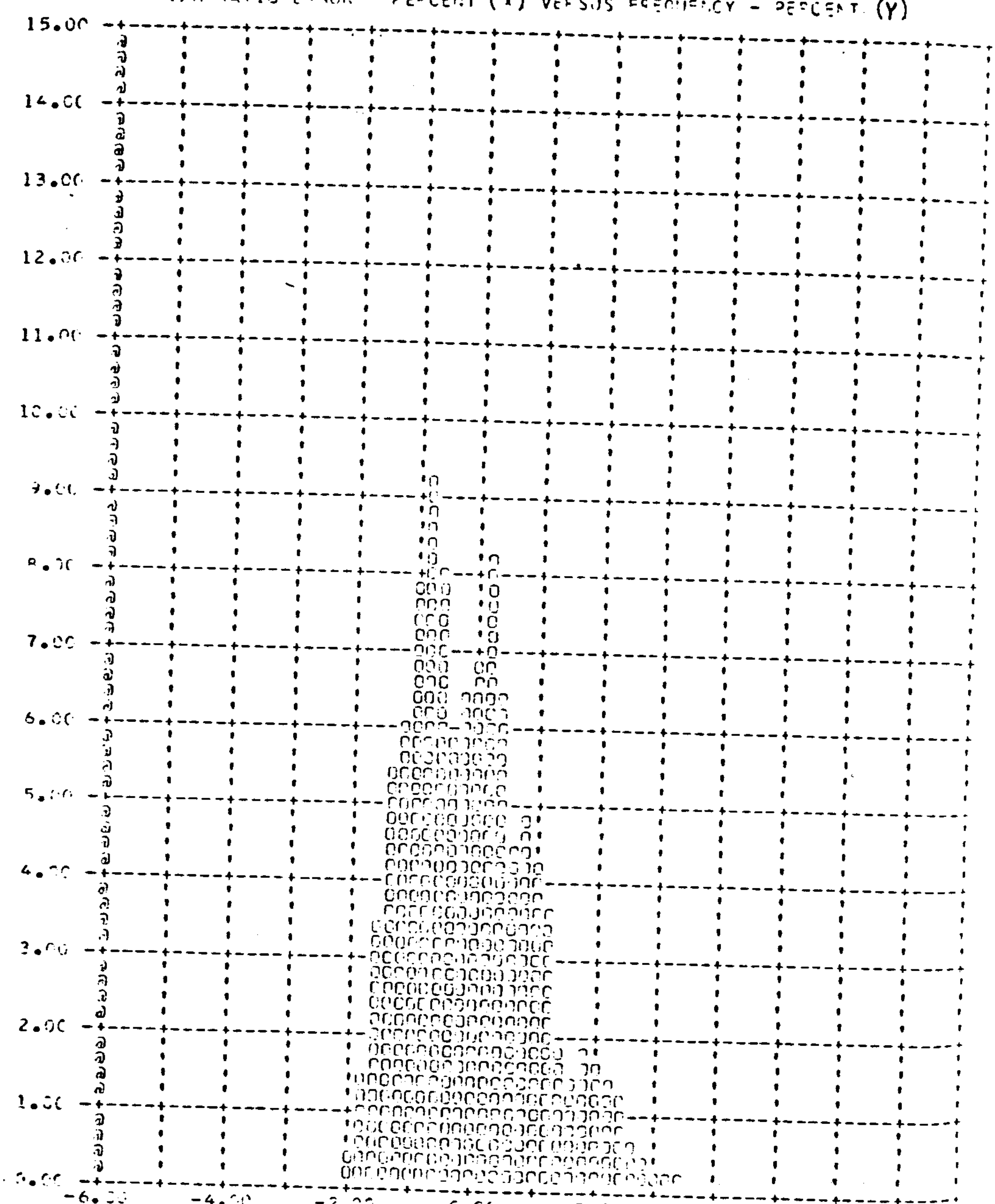
A satisfactory FMC-to-orbit match was maintained during the flight. Generally the mismatch was within ± one per cent. During operations on Revs 101 through 105 the mismatch was approximately two per cent with the latitude coverage being slightly biased from nominal. This error was a result of the below-nominal performance of the DMU rocket fired on Rev 101. The V/H match performance is shown in Figures 3-3 through 3-6.

The forward and aft looking cameras produced 4443 and 4447 frames of photography respectively during Mission 1105-1. During the second mission segment 4443 frames were produced by the forward camera while the aft camera produced 4232 frames of photography.

E. INSTRUMENTATION AND COMMAND

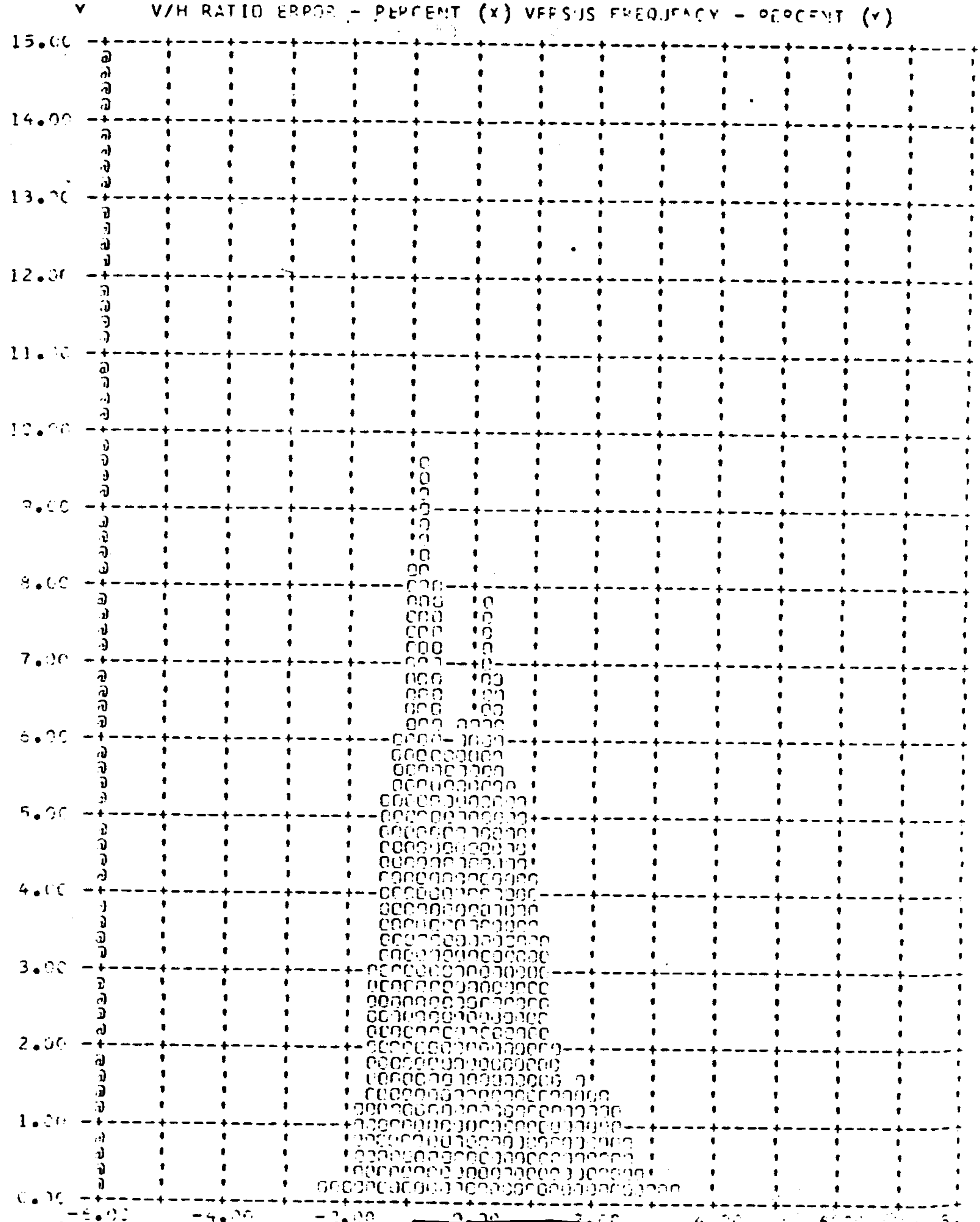
The instrumentation system operated normally throughout the flight.

The command system operation was normal. All commands issued were received and executed by the command system.



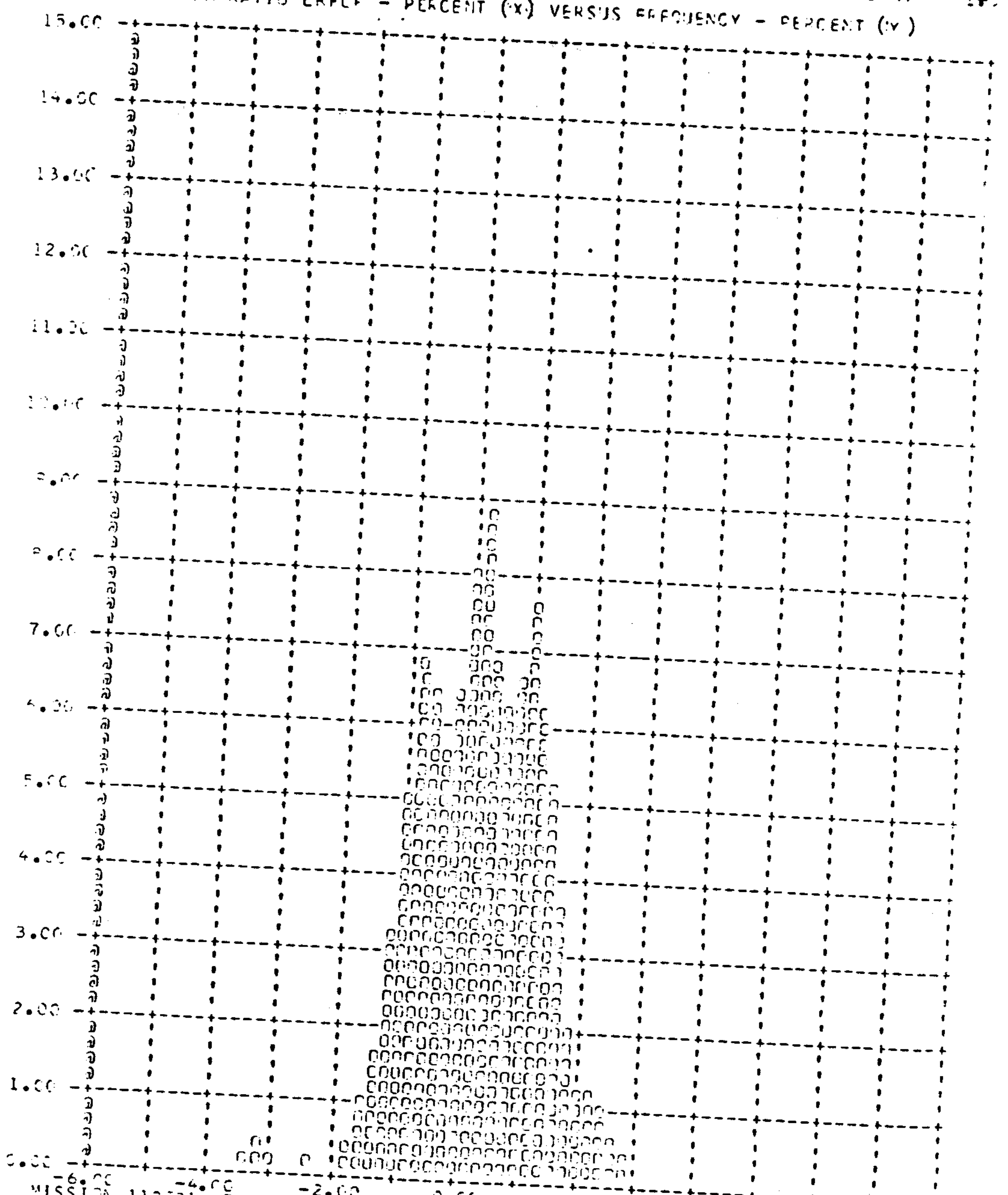

MISSION 1105A1 TOP SECRET C [redacted] - CONTROL NO. [redacted]

FIGURE 3-3 V/H Match Mission 1105-1 FWD LOOKING CAMERA



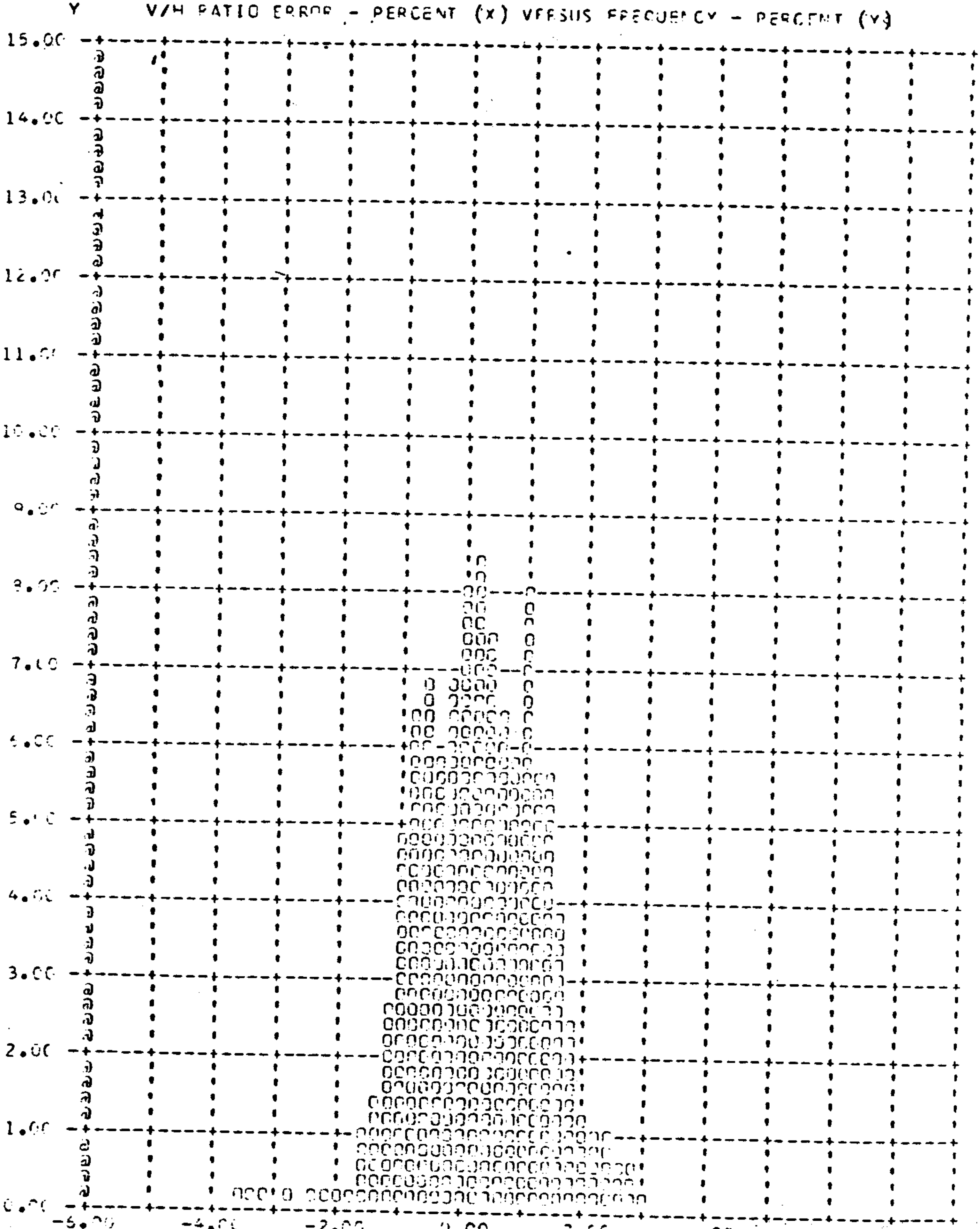

MISSION 1105A2 ~~TOP SECRET~~ C[redacted] - CONTROL NO. [redacted]

FIGURE 2-4 V/H Match Mission 1105-1 AFT LOOKING CAMERA




MISSION 1105-1 ~~TOP SECRET~~ C[redacted] - CONTROL NO. [redacted]

FIGURE 3-5 V/H Match Mission 1105-2 FWD LOOKING CAMERA




MISSION 1105-2 ~~TOP SECRET~~ C[redacted] - CONTROL NO.[redacted]

FIGURE 2-6 V/H Match Mission 1105-2 AFT LOOKING CAMERA

## F. EXPOSURE CONTROL SYSTEM

Two anomalies occurred with the exposure control programmer. The first, on Rev 2, resulted in an early time out of approximately 95 seconds of timer T1. The second anomaly occurred on Rev 17 and resulted in a failure of T1 to time out during acquisition which lasted for 50 seconds beyond the normal time-out time for T1.

During both of these anomalies Uncle 101 was commanded from Position 11 to Position 1 (slit width failsafe reset).

For the remainder of the flight a command restriction was imposed on Uncle 101 during the time out of switch programmer time T1. No further malfunction occurred.

These anomalies did not impair the operational mission as there were no operations programmed on either rev.

All other portions of the exposure control system performed normally.

## G. CLOCK SYSTEM PERFORMANCE

The clock system operated normally throughout the flight. Good correlation between clock and system time was obtained.

## H. PMU SYSTEM OPERATION

The PMU system on CR-5 was the first dual bottle PMU to be flown on the program. PMU operation was apparently normal with an average gas consumption of 5.90 delta PSI/min. with a total of 267.74 minutes of operation. There was 1420 PSI of gas remaining at the end of the mission. Figure 3-7 shows a plot of the PMU gas consumption versus operate time.

I. THERMAL ENVIRONMENT

Temperature data acquired by the [redacted] show that panoramic camera temperatures were higher than the nominal prediction but within the $70 \pm 30^{\circ}$F specified envelope. Camera temperatures averaged approximately 78 to $82^{\circ}$F at the beginning of the Mission 1105-1 to approximately $68^{\circ}$F at the end of Mission 1105-2. Figure 3-8 shows a graphical plot of the actual average camera temperatures versus the predicted temperature as a function of the beta angle in degrees.

J. RECOVERY SYSTEM PERFORMANCE

<u>Mission 1105-1 Recovery System</u>

The -1 recovery capsule was successfully recovered by air-catch on Rev. 131. All re-entry events monitored occurred within tolerance. The predicted versus actual impact points are as follows:

| | | |
|---|---|---|
| Predicted Impact | $17^{\circ}$ 28.6'N | $163^{\circ}$ 27.8'W |
| Actual Impact | $17^{\circ}$ 22'N | $164^{\circ}$ 20'W |

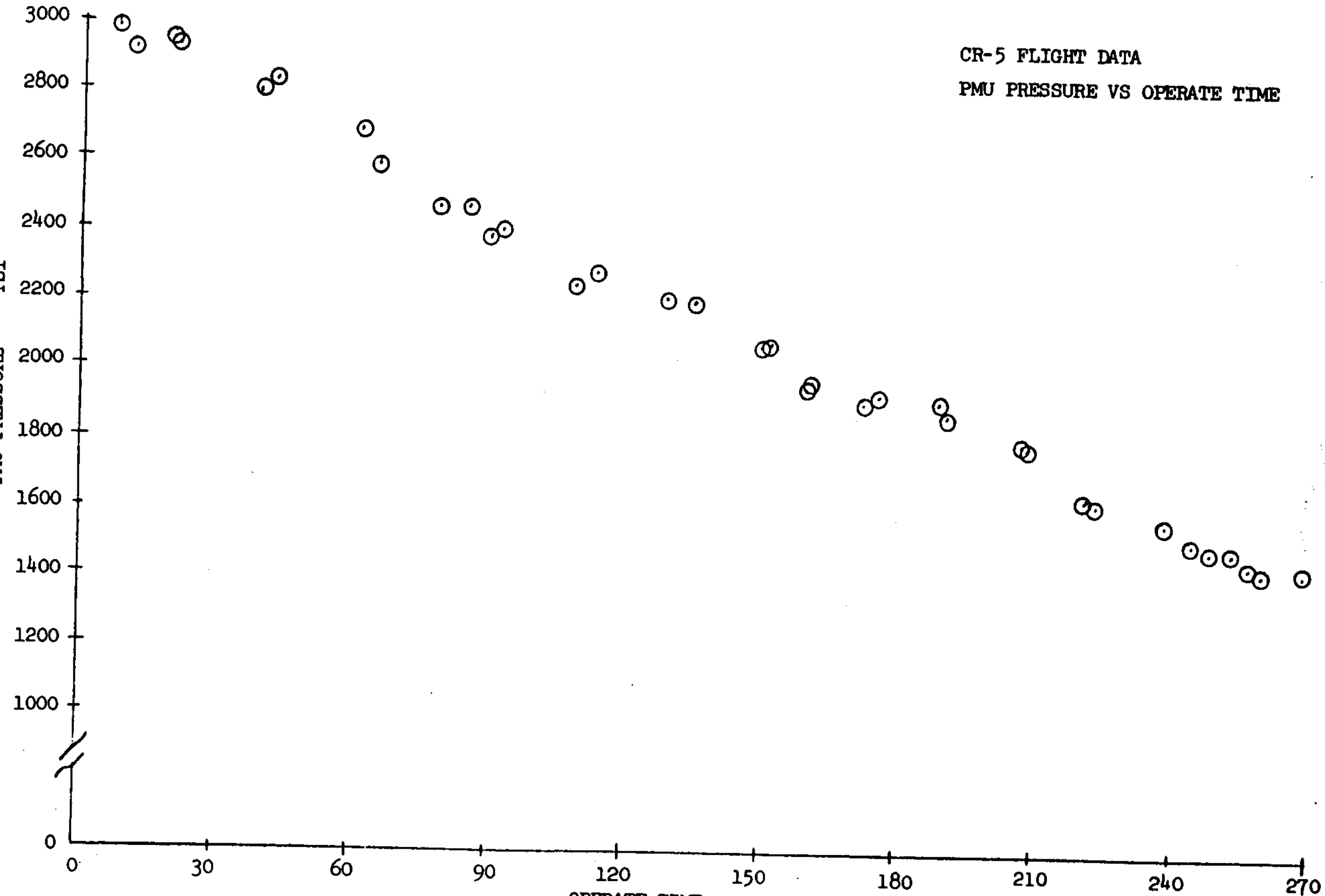
<u>Mission 1105-2 Recovery System</u>

The -2 recovery capsule was successfully recovered by air-catch on Rev 292. All re-entry events monitored occurred within tolerance. The predicted versus actual impact points are as follows:

| | | |
|---|---|---|
| Predicted Impact | $19^{\circ}$ 29.1'N | $161^{\circ}$ 45.6'W |
| Actual Impact | $19^{\circ}$ 37'N | $161^{\circ}$ 45'W |

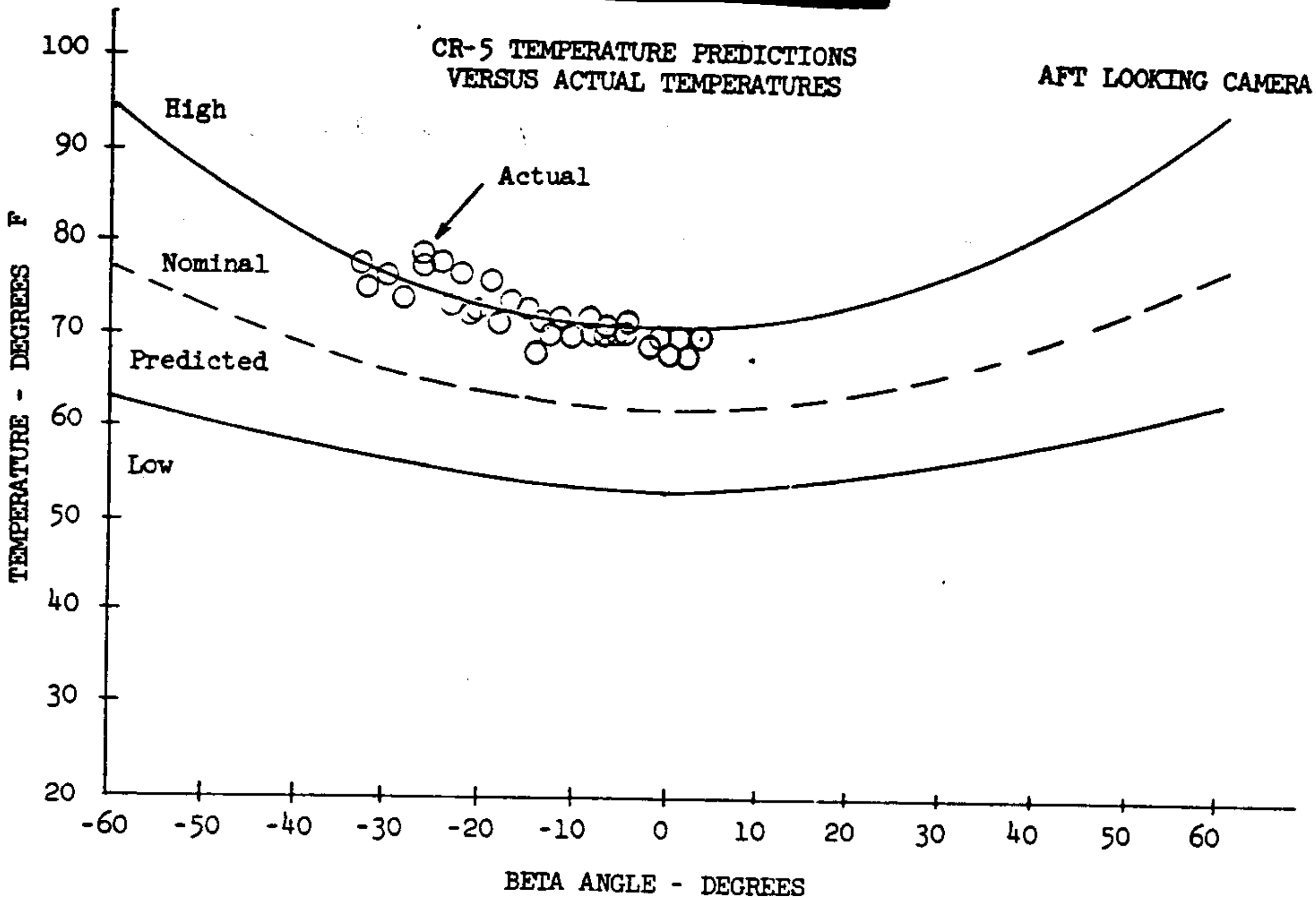
As a result of the film jam up of Instrument 310 the take-up was in a stalled condition until the time of arm. At this time the film was cut and the take-up began free running. Free running continued until electrical disconnect (76 seconds). The take-up was then braked for one

[redacted]




[redacted]

FIGURE 3-7 PMU PRESSURE VS OPERATE TIME


CR-5 TEMPERATURE PREDICTIONS
VERSUS ACTUAL TEMPERATURES
AFT LOOKING CAMERA
High
Actual
Nominal
Predicted
Low
TEMPERATURE - DEGREES F
100
90
80
70
60
50
40
30
20
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
BETA ANGLE - DEGREES

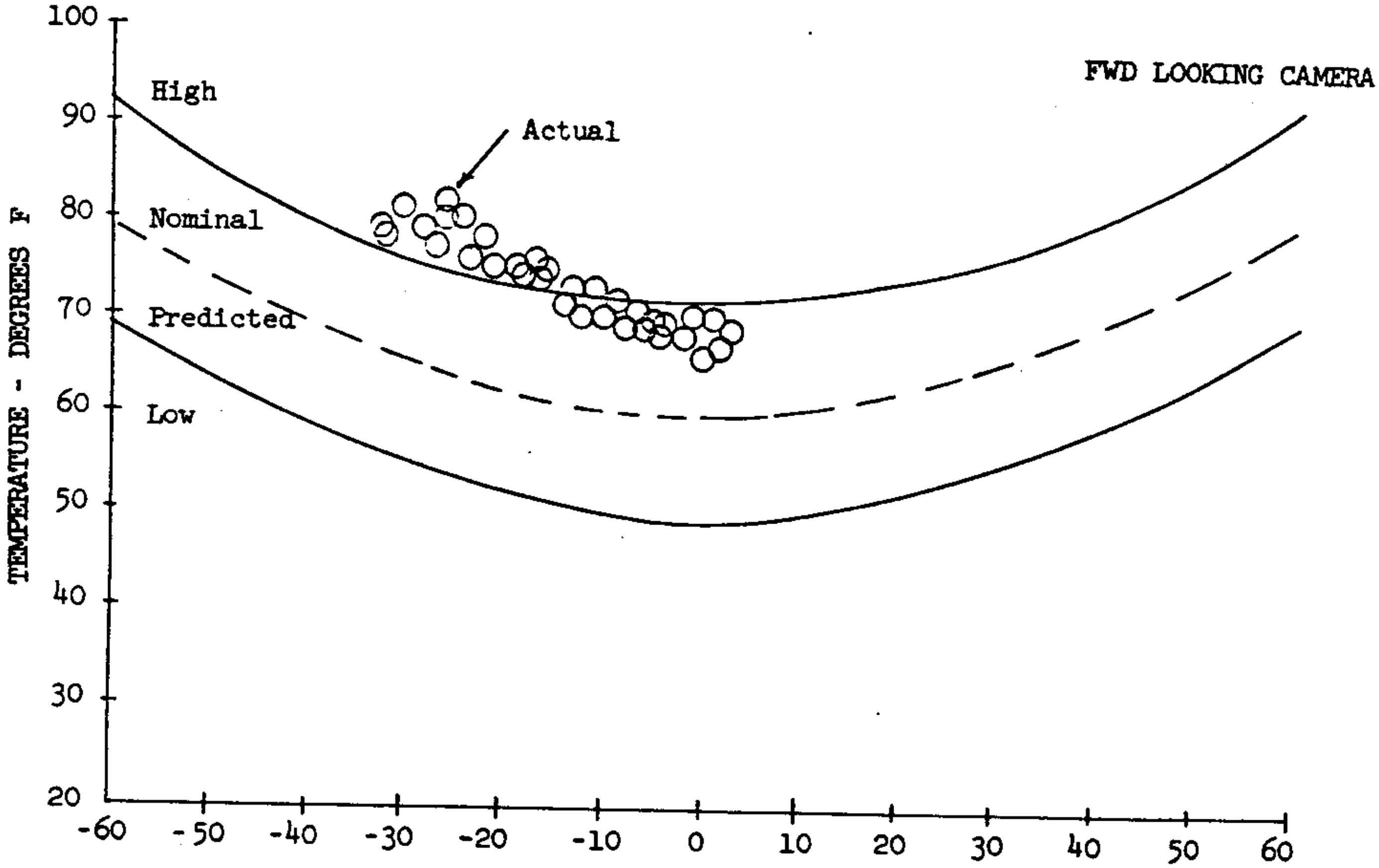

FWD LOOKING CAMERA
High
Actual
Nominal
Predicted
Low
TEMPERATURE - DEGREES F
100
90
80
70
60
50
40
30
20
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60

FIGURE 3-8

second prior to separation. It was feared that the braking would not be sufficient to overcome the free running of the take-up, resulting in an attitude error at retro causing a dispersion in the impact. It appears from the actual impact point that the braking was adequate to overcome the free running take-up preventing an attitude error at separation.

K. SRV TAPE RECORDER SYSTEM

The tape recorder systems performed satisfactorily on both mission segments. All recorded data was retrieved.

L. POST MISSION TESTING

A test plan to evaluate the exposure control programmer problem was formulated. However, due to the panoramic camera jam up resulting in a stalled current drain the batteries were depleted before the testing could be completed. It was intended to issue all commands during the exposure control programmer time-out time of T1. The only commands issued prior to battery depletion were as follows:

| Command | No. of Times |
|---|---|
| U-116 | 11 |
| U-118 | 16 |
| U-119 | 16 |
| U-121 | 20 |
| U-122 | 20 |
| U-124 | 2 |
| U-125 | 20 |
| U-102 | 2 |
| U-103 | 10 |
| U-104 | 10 |

There was no adverse effect on the exposure control programmer during this commanding.

M. RADIATION DOSAGE

Each recovery system flown on a Corona mission contains a sealed packet of Eastman Type 3401 and Royal X Pan emulsions to determine the total radiation received at the take-up cassette. Both film types have been irradiated by LMSC at various levels and the base plus fog densities recorded after controlled processing.

Following recovery the film dosimeter packets are removed at A/P and processed with a pre-flight sample of the same film type and sensitometric control film. The resulting base plus fog density measurement of the dosimeter strips is used to ascertain the total radiation level. The table below presents the base plus fog readings for the dosimeter strips and the radiation level equivalents.

| | Mission 1105-1 | | Mission 1105-2 | |
|---|---|---|---|---|
| Emulsion | B + F Density | Radiation | B + F Density | Radiation |
| Type 3401 | 0.11 | 0.1R | 0.13 | 0.2R |
| Royal X Pan | 0.22 | 0.2R | 0.25 | 0.3R |

These levels are below that which will degrade the photography.

# SECTION 4

## PHOTOGRAPHIC PERFORMANCE

A. SUMMARY

The quality of the photography produced by both panoramic cameras proved to be quite variable throughout both mission segments. Imagery varied from poor to good. Although a MIP of 100 was assigned to Missions 1105-1 and -2, this did not represent the overall quality. Both panoramic cameras operated properly for the programmed 18 day duration of the flight.

The DISIC camera, which normally supplies the Stellar and Terrain photography for the flight, was not flown with the CR-5 system. This is the first time that the DISIC camera subsystem has been deleted from the Corona J-3 series.

Aerial film flown in the panoramic cameras included;

| Forward (FWD) Camera | AFT Camera |
|---|---|
| SO-380 (UTB) - 24,000 feet | SO-380 (UTB) - 23,000 feet |
| | SO-121 (Color) - 500 feet |
| | 3404 - 50 feet |

B. PANORAMIC CAMERAS

1. Image Quality:

SO-380 (Ultra Thin Base - UTB Film)

Imagery produced by the Forward and Aft cameras was degraded in varying degrees throughout both mission segments as reported by PET in the PEIR message. The appearance of the imagery was one that resembled an out-of-focus condition at times. The quality of the imagery varies within a frame as well as between frames. Imagery from Mission 1105-1 and -2 was in general degraded relative to Mission 1104 (CR-4 System). The image quality was extremely variable and evidenced soft focus and image smearing. The best image quality of Mission 1105 was equivalent to the best photography from Mission 1102. However, the amount of such high quality imagery was limited. The overall quality was comparable to the J-1 series. The poorest quality imagery was considerably poorer than normally experienced with a J-1 camera and the best quality photography was better than the best of any J-1 mission.

The overall image quality of Mission 1105-2 was better than that of Mission 1105-1. This was attributed to the fact that forward camera performance was less variable in 1105-2 than on 1105-1, while the aft camera imagery generally remained constant throughout both portions. Further evidence of this condition was obtained by noting that the MIP frame for Mission 1105-1 was chosen from the aft camera, whereas the MIP frame from Mission 1105-2 was chosen from the forward camera. Mission 1105 was the first corona system to fly with a full load of SO-380 (Ultra Thin Base - UTB) film. The image quality variations are directly attributable to the interaction of the UTB film with the CR-5 system. Modifications were made to CR-5 to enable reliable handling of UTB. The major modification was a reduction in system film tensions. It would appear that this reduction in tension caused an in-flight variablility in film lift and dynamics in the scan head area during exposure. This variability was not observed in extensive simulated environmental testing.

Several favorable photographic conditions were evident which helped to mitigate the degrading effects. For example, the mission experienced generally clear weather over denied areas. Further, there was a large percentage of light snow cover which resulted in favorable high contrast imagery with long shadows.

Bar target and cultural areas in the domestic duplicate positive engineering film exhibits were evaluated at the A/P facility of Lockheed Missiles and Space Co. Evaluation of bar target and cultural imagery from the AFT camera photography indicate fairly normal performance for a second generation lens whereas the bar target imagery produced by the FWD camera suggests below normal performance for a third generation lens.

Cultural imagery produced by both cameras included cars, trucks, and planes. Nacelles on aircraft were present in photography from both cameras.

Evaluation of FWD and AFT camera imagery from Pass D-129 clearly revealed the 36 inch and 30 inch cables that support the Golden Gate and Bay Bridges at San Francisco, California. Structural cross brace members that measure 18 to 24 inches were also clearly visible as part of the Bay Bridge detail. At Fresno, California, Pass D-145, both cameras produced imagery that revealed a football field grid line pattern within a stadium complex. While soft imagery has been observed in photography from both cameras it appears that the information content of the imagery is also fairly high for the FWD and AFT cameras.

A relative comparison of the bar target imagery recorded by the FWD and AFT cameras was made and is shown in Table 4-1. The FWD camera evidenced noticeable smear in the scan direction as indicated in the table by the bar target ground resolution of 20 feet shown for Pass D-161. The AFT camera bar target values frequently reveal superior ground resolution when compared with the corresponding FWD camera bar target imagery. This is contrary to what was expected since the FWD camera produced a peak low contrast dynamic resolution of 187 li/mm during pre-flight testing with the third generation lens compared to the AFT camera resolution of 158 li/mm with the second generation lens.

<u>SO-121 Color Film</u>

The tail end of the AFT camera film supply contained 500 feet of color film, type SO-121. The exposure and color balance were judged to be good.

The image quality of the SO-121 record was extremely variable, and ranged from good to very poor. The amount of good quality imagery is limited and is generally restricted to the edges and ends of the format. The center portion of the format is generally poor. This condition would appear to have been caused by the film being curled away from

TABLE 4-1

MISSION 1105-1 AND -2

Visual Evaluation of Positive Bar Target Imagery from FWD and AFT Camera Engineering Operations

Film Type SO-380 UTB

| Camera, Rev, Frame # | Ground Resolution FMC/Scan (Feet) | Geographic Location | Location In Frame X | Location In Frame Y | Bar Target Type, Contrast | Weather Comments |
|---|---|---|---|---|---|---|
| FWD,D16,F7 | 9/8<br>10/9 | Edwards AFB, Cal.<br>Edwards AFB, Cal. | 56.1<br>56.7 | 3.5<br>3.5 | B-2, Hi 16/1<br>B-1, Low 4/1 | Clear |
| AFT,D16,F13 | 9/8<br>10/11 | Edwards AFB, Cal.<br>Edwards AFB, Cal. | 21.0<br>20.4 | 2.5<br>2.4 | B-2, Hi 16/1<br>B-1, Low 4/1 | Clear |
| FWD,D16,F13 | 16/- | Ontario, Cal. | 56.1 | 1.6 | T-Bar, 5/1 | Haze, scattered clouds |
| AFT,D16,F19 | 16/16 | Ontario, Cal. | 19.3 | 4.6 | T-Bar, 5/1 | Haze, scattered clouds |
| FWD,D32,F3 | 9.5/8.5 | Indian Springs, Nev. | 50.9 | 4.6 | MIL STD 150A, MED. 11/1 | Clear |
| AFT,D32,F9 | 8.5/8.5 | Indian Springs, Nev. | 26.3 | 1.0 | MIL STD 150A, MED. 11/1 | Clear |
| FWD,D32,F5 | 7.5/8.5 | Pahrump, Nev. | 30.5 | 0.9 | MIL STD 150A, MED. 11/1 | Clear |
| AFT,D32,F11 | 8.5/7.5 | Pahrump, Nev. | 46.8 | 4.8 | MIL STD 150A, MED. 11/1 | Clear |
| FWD,D32,F13 | 7/7 | Valleywells, Nev. | 40.2 | 5.2 | T-Bar, 5/1 | Clear |
| AFT,D32,F19 | 8/8 | Valleywells, Nev. | 37.0 | 0.2 | T-Bar, 5/1 | Clear |
| FWD,D48,F35 | 16/- | Stanfield, Ariz. | 56.5 | 4.4 | T-Bar, 5/1 | Thin cloud over target |
| AFT,D48,F41 | 16/16 | Stanfield, Ariz. | 21.9 | 1.1 | T-Bar, 5/1 | Thin cloud over target |
| FWD,D64,F4 | 12.5/12.5 | Fort Huachuca, Ariz. | 19.6 | 0.7 | MED C 11/1 | Thin cloud next to target |
| AFT,D64,F10 | 8/9 | Fort Huachuca, Ariz. | 57.8 | 5.8 | MED C 11/1 | Thin cloud next to target |