CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1008-1 and 1008-2

FTV 1177; J-10

1 April 1965

Approved: [redacted]
Mgr.
Advanced Projects

Approved: [redacted]
Mgr.
Program [redacted]

FOREWORD

This report details the performance of the payload section during the operational phase of the Program [redacted] Flight Test Vehicle 1177.

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

This document is the final payload test and performance evaluation report for Missions 1008-1 and 1008-2.

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LIST OF ILLUSTRATIONS

INTRODUCTION

This report presents the final performance evaluation of Missions 1008-1 and 1008-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the J-10 payload system, to identify the source of in-flight anomalies and recommend the appropriate corrective action.

The performance evaluation was jointly conducted by representatives of Lockheed Missiles and Space Company (LMSC) and ITEK at the facilities of NPIC and AFSPPL. The off-line evaluation using Corona engineering photography acquired over the United States was performed at the individual contractors plants.

The quantitative data used for this report is obtained from government organizations. The diffuse density data, visual RES values and MTF/AIM resolution are produced by AFSPPL. The vehicle attitude error values, frame correlation times are made at NPIC who also supply the Processing Summary and MTF/AIM resolution reports published by [redacted]

Computer programs developed by A/P are utilized to calculate and plot the frequency distribution of the various contributors to image smear to permit analysis and correlation of the conditions of photography to the information content and quality of the acquired pictures. Computer analysis of the exposure, processing and illumination data provides the necessary data to analyze the exposure criteria selected for the mission.

[redacted]

SECTION 1

SYSTEM PERFORMANCE

A. MISSION OBJECTIVES

The payload section of Mission 1008, placed into orbit by Flight Test Vehicle #1177 and SLV-2A booster #404, consisted of two panoramic cameras, two Stellar-Index cameras, two Mark 5A recovery capsules and a space structure to enclose the cameras and provide mounting surfaces for all equipments. Figure 1-1 presents an inboard profile of the J-10 payload system. This Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. The planned mission was two, four day photographic periods with no deactivation.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2314:04 Z (4:14:04 PDT) on 10 July 1064. Ascent and injection were normal and the achieved orbit within nominal tolerances. Tracking and command support was effected by the Air Force Satellite Control Facility consisting of tracking and command stations at [redacted] under central control of the Satellite Test Center at Sunnyvale, California. Mission 1008-1 consisted of three days operation and was completed by air recovery on 13 July 1964. The mission was one day shorter than originally planned as the programmed operations filled the take-up cassette. Mission 1008-2 was completed with an air recovery on 17 July 1964 following four days of photographic operations.

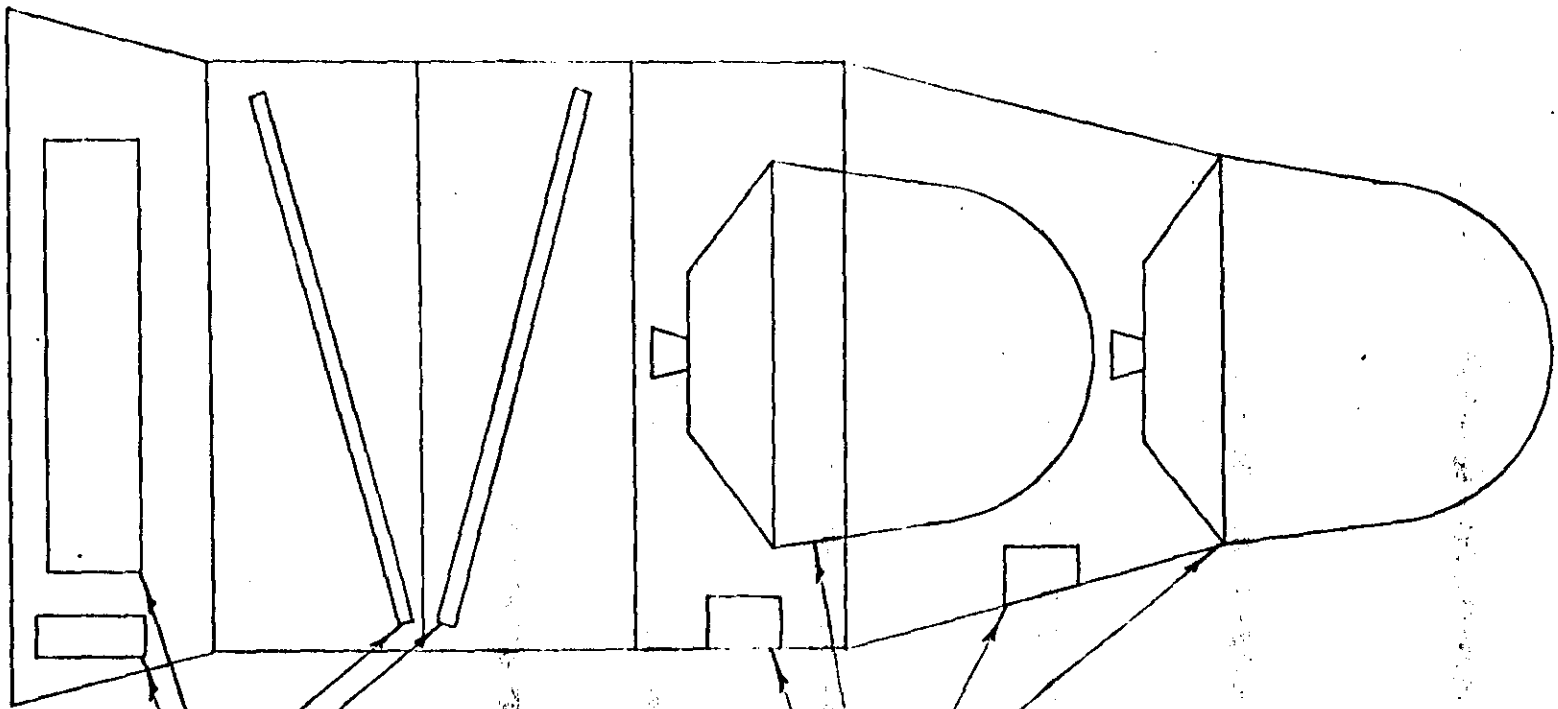
The comparison of the planned and actual orbit parameters is tabulated as follows:

[redacted]

[redacted]

SCHEMATIC INBOARD PROFILE - CORONA J SYSTEM

MISSION 1008



Master Camera No: 150

Slave Camera No: 151

Supply Cassette No: SC-12

Clock No: 514

Yaw Programmer No: N/A

"A" Recovery Subsystem No: 640

"A" Stellar-Index Camera No: D48/45/48

"B" Recovery Subsystem No: 641

"B" Stellar-Index Camera No: D33/28/33

Pressure Make-up Unit No: N/A

[redacted]

SECRET

Parameter	Planned	Orbit 7 Actuals
Period (minutes)	91.06	91.01
Perigee (n. m.)	100.01	99.44
Apogee (n. m.)	260.27	259.05
Eccentricity	0.0222	0.0220
Inclination (deg.)	85.0	85.0
Argument of Perigee (deg.)	139.3	139.2

All of the film carried was exposed and recovered. Both recoveries were nominal with impact points approximately five to fifteen miles from predictions. The Agena vehicle encountered problems in the right horizon sensor between orbit nine and twenty. After orbit twenty the sensor operated properly including a de-activate/re-activate cycle between orbits 117 and 164.

C. PANORAMIC CAMERAS

The Master and Slave panoramic cameras operated throughout both missions with no significant problems and produced excellent photographic coverage. The cloud cover and atmospheric haze observed in the photography was abnormally high. A small area on the aft camera formats during the majority of Mission 1008-1 contained a small soft focus area which was not present during Mission 1008-2.

D. STELLAR-INDEX CAMERAS

The Stellar-Index camera operated properly throughout Mission 1008-1. The star imagery and terrain detail were satisfactory for the desired attitude determination and relative orientation. The Index camera used during Mission 1008-2 experienced shutter problems during the last 75% of the mission as the shutter remained open continuously. The resulting terrain photography was unusable and the stellar photography was somewhat fogged however still usable for attitude determination.

E. OTHER SUB-SYSTEMS

The clock, instrumentation, command and thermal control sub-systems performed satisfactorily through both missions.

F. CONCLUSIONS

Mission 1008-1 and 1008-2 achieved the objective of acquiring high quality search and reconnaissance photography from orbital altitudes.

G. RECOMMENDATIONS

The evaluation and analysis of the data produced by both missions has resulted in the following recommendations:

1. Continue the analysis of Stellar-Index camera failures to preclude the re-occurrence of future data loss.

2. Incorporate additional radiation shielding on the film chute of the "A" Stellar-Index camera.

3. Investigate the cause of cloud flare and incorporate the necessary modifications to preclude re-occurrence.

4. Continue the analysis of the cause of soft focus areas in the panoramic photography.

SECTION 2

PRE-FLIGHT SYSTEMS TESTS

A. ENVIRONMENTAL TESTING

1. Test Objective

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

2. Test Summary

In order to simulate thermal and altitude conditions in orbital flight, the J-10 payload system went to the HIVOS chamber on 19 April 1964. Three days of "A" bucket operations, one day of soak, and two days of "B" bucket operations comprised the HIVOS test. The following anomalies were noted during this test: T/M Point 13-37 was open; T/M Point 13-53 was out of band low; T/M Point 11-13 was zero and had occasional 60-cycle noise; the "A" bucket S/I failed; in orbit 3 of day 2 the 28th bit of the clock came on prematurely causing a gross clock error; at transfer in the cut and wrap sequence the +24 volt unregulated monitor jumped up to 39.9 volts for one commutator readout; a few scattered instances of possible payload movement during scan period were noticed, and corona was evident on the master payload.

A second orbital simulated flight test was conducted on the J-10 payload system. This test was conducted in the TASC chamber on the first and second of May in a one-day "B" bucket mode. The following anomalies were noted during this test: a few scattered instances of possible payload movement during scan period were noticed; and the V/H pot was open for the last two orbits of the test.

For both the HIVOS and TASC tests the panoramic instrument cycle rate repeatability error did not exceed ± 3% and generally

was between ± 1% and ± 2%. The cycle rate repeatability error was predominantly slow for the HIVOS test and both slow and fast for the TASC test.

All T/M instrumentation points that had been defective during the HIVOS test were corrected for the TASC test and performed satisfactorily. Based upon the data analysis of the two tests on the J-10 payload system, it appears that the panoramic instruments are acceptable for flight.

3. Instrumentation Performance

A conflict between the film footage pots and the cycle counters was observed for both the HIVOS and TASC tests. The delta difference between film footage pot readings and cycle counter readings indicates a rather large discrepancy. These discrepancies are apparent for both the master and slave instruments and for both buckets. These delta differences are listed below:

Test	Bucket	Camera	Delta
#1 - HIVOS	A	Master	74
#1 - HIVOS	A	Slave	112
#1 - HIVOS	B	Master	137
#1 - HIVOS	B	Slave	132
#2 - TASC	B	Master	44
#2 - TASC	B	Slave	54

This frame count differential is not abnormally high for environmental testing. The anomaly is caused by the inability to match the full range impedence of the film footage pot to the recorder, the scale of the recorder which produces reading errors and the test equipment ground loops. Prior experience has shown that the on-orbit accuracy is much greater hence no action was taken to modify the flight hardware.

4. Thermal Environment

Temperatures were reduced once each day for the five days of active operation for the HIVOS test, and twice during the one-day

TASC test. Two self-heating tests were conducted during the soak period of the HIVOS test. The first test was invalid due to an operate error, but the second test was deemed valid, and graphs of sensor temperature rise versus time have been made. Table 2-1 shows the average instrument temperatures, excluding the lens scan arm sensor which is usually significantly higher, at various times throughout the two tests. Figure 2-1 has the plots of the self-heating characteristics of the sensors.

5. Pressure Environment

The internal camera pressure experienced during the HIVOS test is plotted in Figure 2-2 as a function of frame number. Pressures in the corona discharge sensitive region were present during all operations.

6. Panoramic Camera Performance

Evaluation of the film metered through the panoramic cameras during the HIVOS test showed that both the Master camera, serial number 150, and the Slave camera, serial number 151, displayed some start-up corona discharge during the "A" mission operations. The frequency of the discharge and the resulting fog level were within the acceptance criteria. The Slave camera exhibited this same level of fogging during the "B" mission operations and was considered acceptable for flight.

The Master camera film from the "B" mission contained a large amount of corona discharge fogging in a 2 pi pattern during the first 25 to 30 frames after camera start-up. The camera was not acceptable for flight and it was recommended that the metering rollers be replaced.

After the replacement of the metering rollers the J-10 system was subjected to a repeat environmental test in the TASC chamber. Evaluation of the film metered during the test showed that the corona discharge fogging of both cameras was within the acceptance criteria.

AVERAGE INSTRUMENT TEMPERATURES DURING THE TESTS NOT CORRECTED FOR SELF-HEATING HIVOS

	Day #1 - Rev. #1	Day #2 - Rev. #2	Day #3 - Rev. #9
Instrument #1	89.9	97.7	101.6
Scan Arm #1	110.1	113.9	125.4
Instrument #2	91.3	98.1	101.1
Scan Arm #2	110.1	117.7	112.6

	Day #5 - Rev. #1	Day #6 - Rev. #12
Instrument #1	88.4	75.5
Scan Arm #1	98.8	95.2
Instrument #2	84.9	74.1
Scan Arm #2	88.0	90.3

TASC

	Day #1 - Rev. #1	Day #1 - Rev. #16
Instrument #1	84.1	82.9
Scan Arm #1	100.3	99.0
Instrument #2	86.8	84.6
Scan Arm #2	105.3	99.0

TABLE 2-1

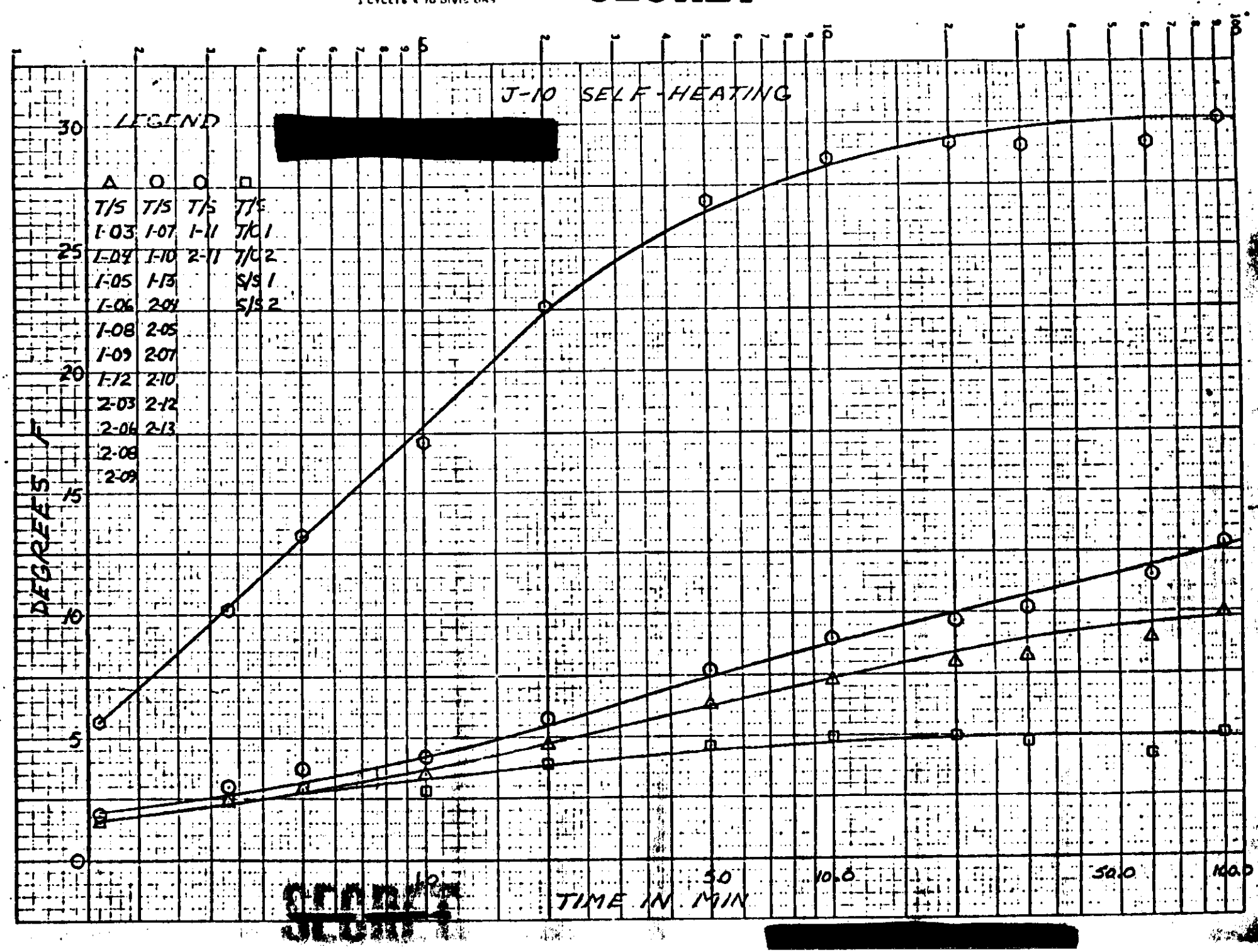
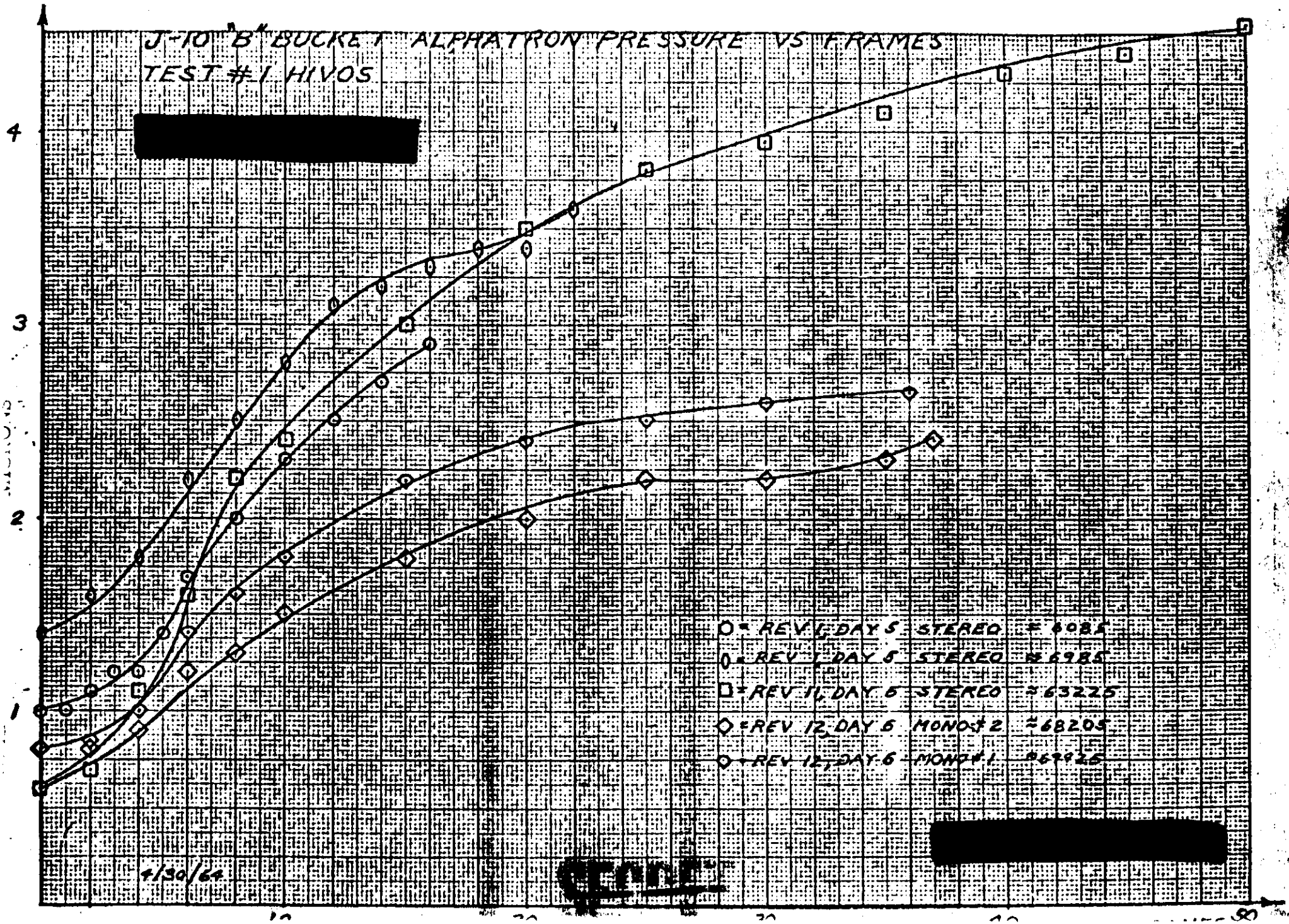

SEMI LOGARITHMIC 359-71
KEUFFEL & ESSER CO
3 CYCLES X 70 DIVISIONS
J-10 SELF-HEATING
LEGEND
[redacted]
A O O □
T/S T/S T/S T/S
1-03 1-07 1-11 T/C 1
1-04 1-10 2-11 T/C 2
1-05 1-13 S/S 1
1-06 2-04 S/S 2
1-08 2-05
1-09 2-07
1-12 2-10
2-03 2-12
2-06 2-13
2-08
2-09
DEGREES F
30
25
20
15
10
5
0
1.0
5.0
10.0
50.0
100
TIME IN MIN
[redacted]

FIGURE 2-1


MICRONS
J-10 "B" BUCKET ALPHATRON PRESSURE VS FRAMES
TEST #1 HIVOS
[redacted]
4
3
2
1
4/30/64
○ = REV 1, DAY 5 STEREO # 6085
○ = REV 1, DAY 5 STEREO # 6985
□ = REV 11, DAY 6 STEREO # 63225
◇ = REV 12, DAY 6 MONO #2 # 68205
○ = REV 12, DAY 6 MONO #1 # 69926
[redacted]
[redacted]

7. Stellar-Index Camera Performance

Stellar-Index camera #D-48 was operated during the "A" mission HIVOS test and camera #D-38 during the "B" mission. Camera D-48 exhibited some metering anomalies during the test however all other camera functions were normal. The corona discharge fogging was within the acceptance criteria hence the camera was considered flightworthy after correcting the meter problem.

Camera D-38 operated normally throughout the "B" mission test however examination of the Index camera film showed that 80% of the formats were fogged due to corona discharge. The camera was not considered acceptable for flight and it's return to Itek for rework was recommended.

Camera D-48 was installed in the "B" position during the TASC test. The stellar shutter failed in the open mode during 20% of the operations. The corona discharge fogging was within the acceptance criteria. Subsequent testing in the TEAL chamber, after shutter modifications, determined that camera D-48 was acceptable for flight.

B. RESOLUTION TEST

The dynamic resolution test of the J-10 payload system was performed at the A/P facility on 7 May 1964. Each panoramic camera photographed high and low contrast resolution targets. The resulting through focus resolution data is shown in Figure 2-3 for the Master camera and in Figure 2-4 for the Slave camera.

C. LIGHT LEAK TEST

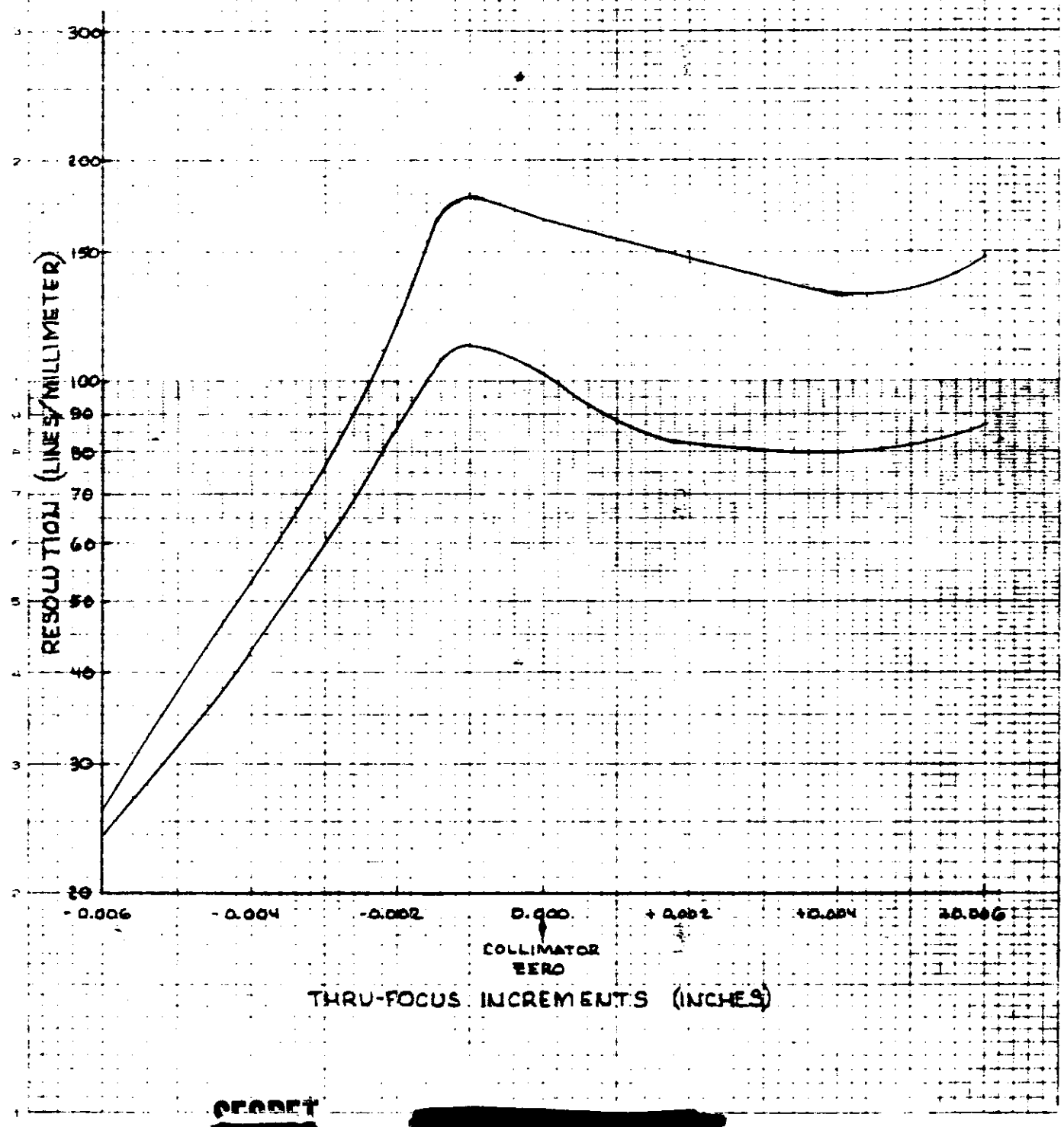
The examination of the film threaded in the J-10 system during the light leak test determined that no film fogging was present. The light tight integrity of the system was considered acceptable for flight.

[redacted]

CAMERA NO. 150

HIGH CONTRAST RESOLUTION - 178 L/MM

LOW CONTRAST RESOLUTION - 112 L/MM



SECRET

[redacted]

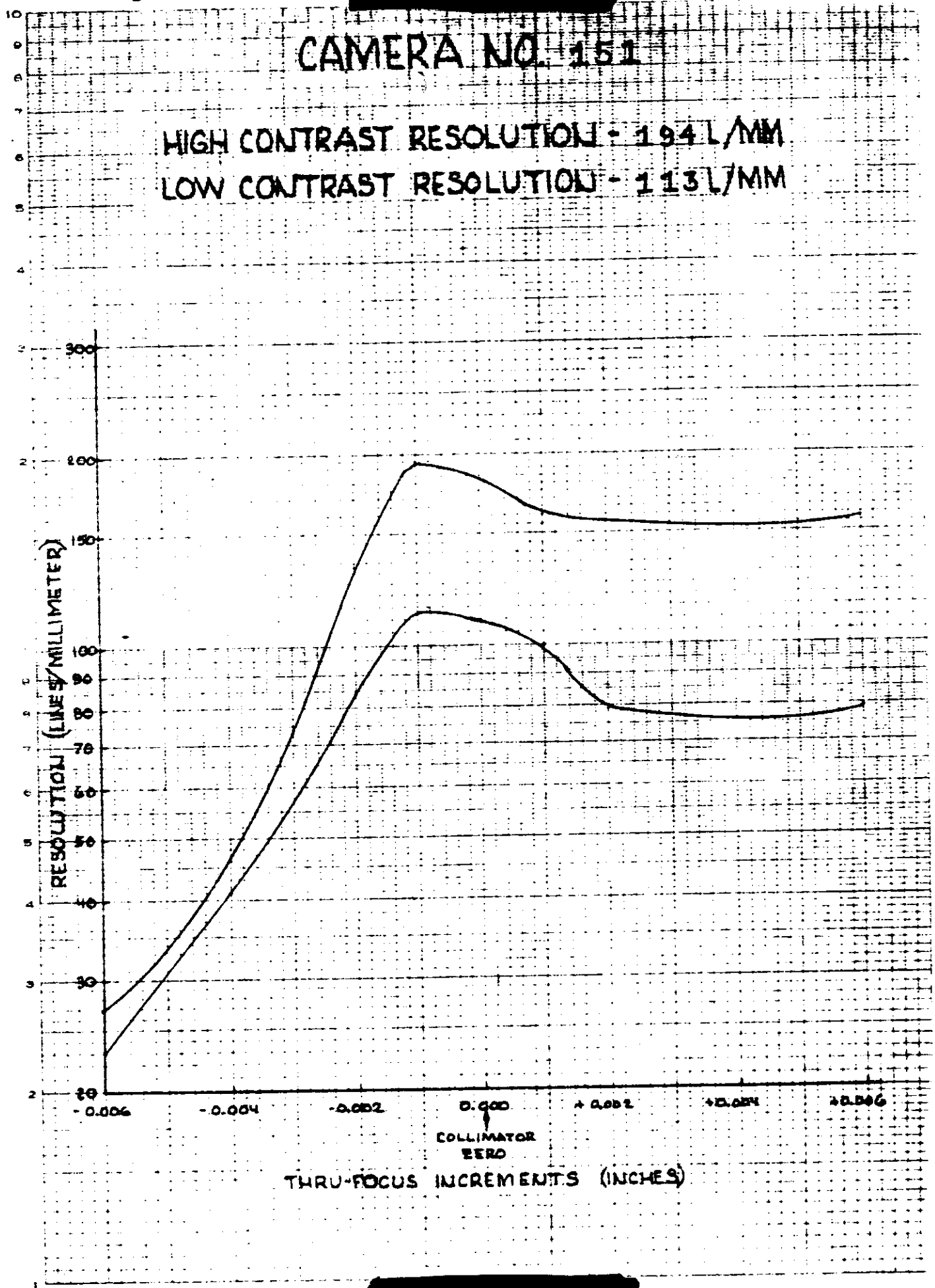

CAMERA NO. 151
HIGH CONTRAST RESOLUTION - 194 L/MM
LOW CONTRAST RESOLUTION - 113 L/MM
RESOLUTION (LINES/MILLIMETER)
300
200
150
100
90
80
70
60
50
40
30
20
- 0.006
- 0.004
- 0.002
0.000
COLLIMATOR ZERO
+ 0.002
+0.004
+0.006
THRU-FOCUS INCREMENTS (INCHES)

FIGURE 2-4

SECTION 3

FLIGHT OPERATIONS

A. INSTRUMENTATION AND TELEMETRY PERFORMANCE

The instrumentation and telemetry system performance was completely satisfactory throughout the flight. The TLM commutator was hard-wired and ran continuously for the life of the satellite. This was the second system to be hard-wired in order to overcome the start-up deficiency.

The take-up footage monitors shifted from their preflight calibrations. This shift is attributed to the difference in the impedance load and the supply voltage from the calibration to flight. The preflight calibration procedure has been changed to correct this deficiency.

B. THERMAL ENVIRONMENT

The thermal control on this mission was within tolerance. The average panoramic camera temperatures during the "A" mission ranged from 69°F. to 61°F. This was within specification limits, but was 5° to 10° lower than predictions, as shown by Figures 3-1 and 3-2.

Tables 3-1 and 3-2 present the real time thermal data. All of this data was obtained during [redacted] Tracking Station acquisitions and was corrected for self-heating where applicable.

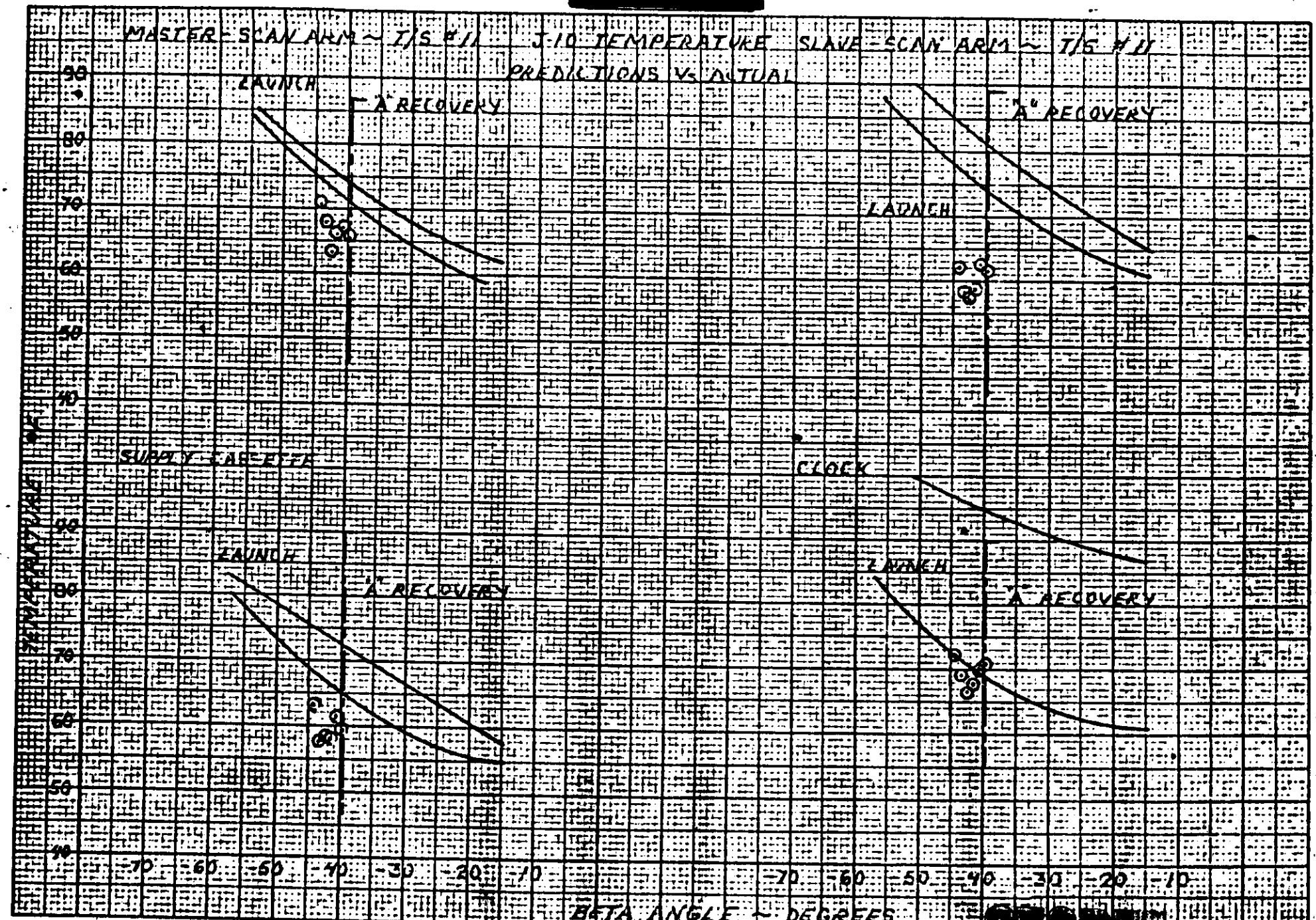
C. CLOCK PERFORMANCE

The clock performance was normal throughout both the "A" and "B" missions. A linear fit of the system time data to the clock data indicated the clock was running fast by 29 milliseconds per twenty-four hours. The maximum correction between the raw data and the fitted data was 13 milliseconds.

D. PANORAMIC CAMERA PERFORMANCE

The performance of the Master camera, S/N 150, was nominal for both the "A" and "B" missions. A total of 5852 frames were exposed which

[redacted]



[redacted]

[redacted]

MASTER-LENS ASSY - T/S #13 ± 10 TEMPERATURE PREDICTIONS VS ACTUAL SLAVE-LENS ASSY - T/S #13

MASTER-DRUM - T/S #13

SLAVE-DRUM - T/S #13

"A" RECOVERY

LAUNCH

90 80 70 60 50 40 30 20 10

-70 -60 -50 -40 -30 -20 -10

BETA ANGLE - DEGREES

[redacted]

J-10A/B, 1177 TEMPERATURE SUMMARY

SENSOR / Master	ORBIT NO. / Injection	8	16	24	31	40	47	56	63	71	79	87	94	103	110
3	67	55.5	50.5	48.6	50.2	53.6	49.6	47.5	44.0	47.6	45.0	45.0	44.0	44.0	43.0
4	74	62.5	55.0	55.5	56.5	60.6	55.3	54.3	49.0	54.4	50.0	52.0	50.0	51.0	49.0
5	71	68.3	62.2	62.5	61.8	67.6	62.3	60.1	56.0	61.5	59.0	58.0	58.0	58.0	55.0
6	65	75.3	65.7	68.3	67.6	72.3	67.0	67.1	61.0	66.2	61.0	64.0	60.0	62.0	60.0
7	66	70.8	64.7	68.8	65.0	68.5	65.0	62.6	58.0	62.3	59.0	60.0	58.0	59.0	58.0
8	68	88.4	57.5	57.8	57.1	63.0	58.8	56.6	53.0	55.8	53.0	55.0	53.0	53.0	52.0
9	69	70.6	63.3	64.8	65.3	68.8	64.6	63.6	59.0	63.8	59.0	61.0	59.0	60.0	57.0
10	68	68.5	65.0	61.5	65.0	65.0	65.8	60.3	59.0	60.0	59.0	59.0	58.0	57.0	58.0
11	99	70.8	67.7	63.1	66.0	67.2	65.3	61.2	61.0	60.5	59.0	57.0	58.0	56.0	58.0
12	79	59.0	55.0	53.1	53.6	58.3	53.0	52.0	48.0	53.3	49.0	51.0	48.0	50.0	49.0
13	69	74.3	68.2	66.1	66.1	69.6	66.1	63.8	60.0	63.5	59.0	61.0	58.0	59.0	58.0
Slave				A MISSION ←						→ B MISSION					
3	66	75.3	68.0	70.6	73.5	74.7	72.8	69.5	68.0	69.7	67.0	67.0	67.0	65.0	66.0
4	72	75.5	65.8	70.6	69.6	74.3	68.5	69.7	65.0	70.5	64.0	68.0	65.0	57.0	64.0
5	69	70.8	63.5	65.0	65.0	70.8	65.0	65.0	60.0	64.7	59.0	64.0	59.0	61.0	60.0
6	65	64.8	57.5	57.8	58.3	64.1	61.1	59.0	54.0	58.0	54.0	58.0	54.0	58.0	54.0
7	64	67.3	63.5	60.3	62.6	66.1	62.6	60.3	58.0	61.2	57.0	59.0	57.0	68.0	58.0
8	71	68.3	62.2	62.5	63.0	68.8	64.6	62.5	60.0	63.8	59.0	61.0	59.0	69.0	58.0
9	69	60.1	55.0	55.5	54.8	60.6	56.5	55.5	52.0	56.8	51.0	54.0	52.0	53.0	51.0
10	67	68.5	65.8	61.5	65.0	66.1	65.0	61.5	60.0	60.0	59.0	60.0	59.0	58.0	59.0
11	98	62.4	58.1	57.2	58.8	62.4	61.7	58.8	55.0	54.3	59.0	58.0	58.0	56.0	57.0
12	75	74.3	67.5	68.5	69.6	74.3	70.8	69.6	65.0	69.4	64.0	68.0	65.0	65.0	64.0
13	69	68.5	63.5	62.6	63.8	68.5	65.0	63.8	59.0	64.7	62.0	64.0	63.0	61.0	60.0
Supply Spool															
1	69	61.0	57.0	56.8	56.8	60.3	59.1	59.1	56.0	60.0	56.0	57.0	55.0	56.0	56.0
2	68	64.5	58.3	59.1	59.1	62.6	60.3	63.5	57.0	63.5	56.0	66.0	56.0	59.0	56.0

[redacted]

TABLE 3-1