CORONA J

PERFORMANCE EVALUATION REPORT

MISSION 1041-1 and 1041-2

FTV 1634, J-49

14 December 1967

Approved: [redacted]
Manager
Advanced Projects

Approved: [redacted]
Mgr.
Program

[redacted]

9 January 1968

TO: [redacted]

THRU:

FROM:

SUBJECT: MISSION 1041-1 and 1041-2 FINAL REPORT(J-40)

Enclosed is the Final Evaluation Report for Mission 1041-1 and 1041-2.

[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 1634.

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

This document is the final payload test and performance evaluation report for Missions 1041-1 and 1041-2, system J-40 which was launched on 9 May 1967.

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INTRODUCTION

This report presents the final performance evaluation of Missions 1041-1 and 1041-2 of the Corona Program. The purpose of this report is to define the performance characteristics of the J-10 payload system and to identify the source of in-flight anomalies.

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

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

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

SECTION 1

SYSTEM PERFORMANCE

A. MISSION OBJECTIVES

The payload section of Mission 1041, placed into orbit by Flight Test Vehicle #1634 and THORAD Booster #506, 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 equipment. Figure 1-1 presents an inboard profile of the J-40 payload system. This Corona "J" system is designed to acquire search and reconnaissance photography of selected areas of the earth from orbital altitudes. A seven day -1 mission and a seven day -2 mission was planned.

B. MISSION DESCRIPTION

The payload was launched from Vandenberg Air Force Base (VAFB) at 2152 Z (1452 PDT) on 9 May 1967. Ascent and injection were normal and the achieved orbit was within nominal tolerances. Tracking and command support was effected by the Air Force Satellite Control Facility consisting of tracking and command stations at [redacted] under central control of the Satellite Test Center at Sunnyvale, California. Mission 1041-1 consisted of a 7 day operation and was completed by air recovery on 16 May 1967. Mission 1041-2 was completed with an air recovery on 23 May 1967 following a 7 day photographic operation.

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

ORBITAL PARAMETERS

Parameter	Predicted	Orbit 45 Actuals	Orbit 150 Actuals
Period (Min.)	91.04	94.35	94.21
Perigee (N.M.)	99.8	101.1	103.2
Apogee (N.M.)	256	430.65	430
Inclination (Deg.)	85	85.05	85.05
Perigee Latitude (Deg. N.)	28.6	32.9	57.9
Eccentricity	0.0216	0.0446	0.0441

C. PANORAMIC CAMERAS

The photography was rated good by the photo-interpreters. Both cameras operated satisfactorily.

D. STELLAR-INDEX CAMERAS

There were no significant anomalies in the operation of either unit. The base plus fog densities were higher due to radiation in an unusually high apogee. The images were adequate for attitude determinations.

E. RADIATION

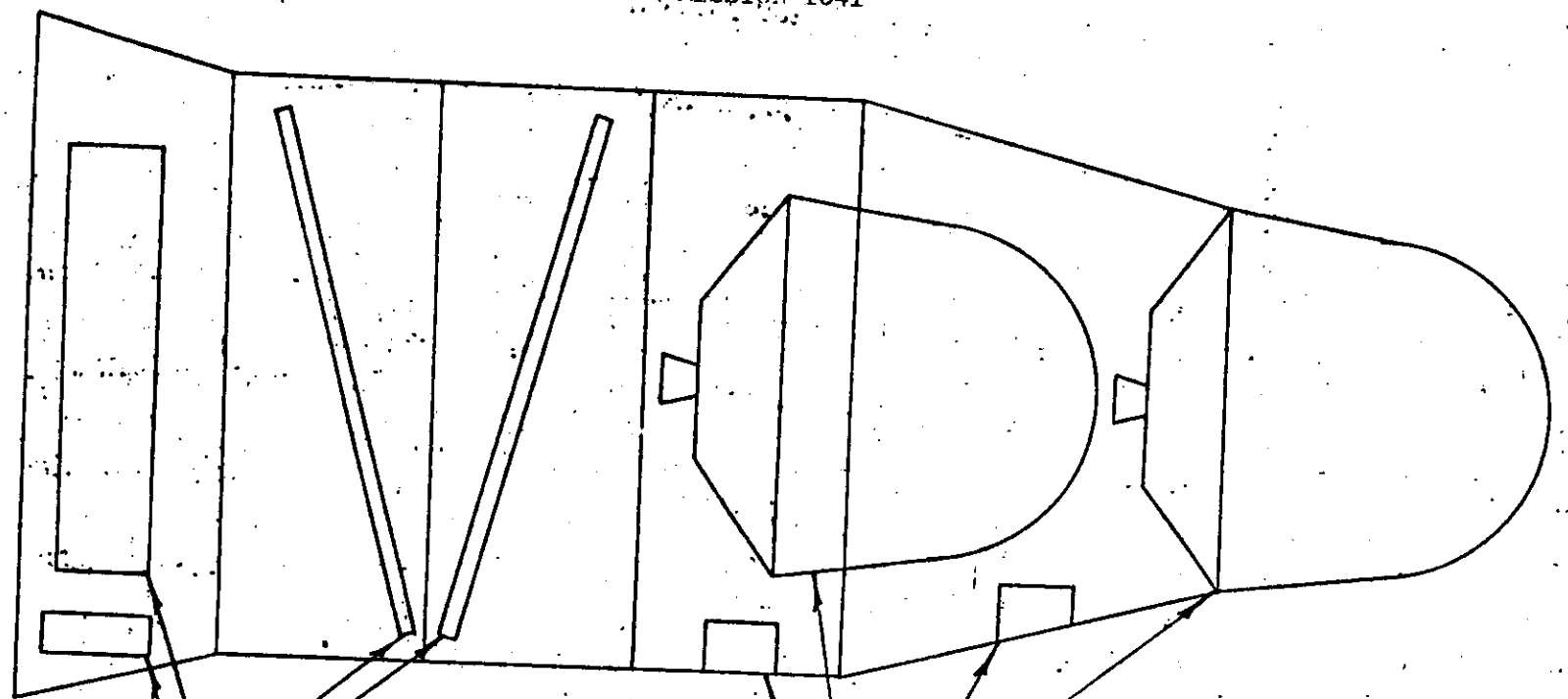
Emulsion	Mission 1041-1 B + F Density	Mission 1041-1 Radiation	Mission 1041-2 B + F Density	Mission 1041-2 Radiation
Type 3401	0.49	4.8 R	0.64	7.6 R
Royal X Pan	0.70	2.6 R	0.80	3.3 R

F. OTHER SUBSYSTEMS

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

SCHEMATIC INBOARD PROFILE - CORONA J SYSTEM J-40

MISSION 1041



Master Camera No: [redacted]

Slave Camera No: [redacted]

Supply Cassette No: [redacted]

Clock No: [redacted]

Yaw Programmer No: [redacted]

"A" Recovery Subsystem No: [redacted]

"A" Stellar-Index Camera No: [redacted]

"B" Recovery Subsystem No: [redacted]

"B" Stellar-Index Camera No: [redacted]

Pressure Make-up Unit No: [redacted]

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 susceptibility to corona discharge. Such discharge fogs the film thus degrading the operational photography.

2. Test Summary

The J-40 HIVOS test was conducted from 3 August to 10 August 1966. During this time 5638 frames were run into the "A" bucket and 4467 frames into the "B" bucket. The lowest pressure attained was one micron.

The pan films exhibited very slight start-up corona on 4 frames.

The last 200 frames on instrument 209 did not indicate any output H.O. shutter operation. The absence of fogging was probably a bulb failure in the fogging fixture since the TM monitor showed a shutter pulse. To conform to a FEWO #1028 the H.O. units were replaced on this instrument.

The S/I unit #102 did not qualify for flight due to excessive corona, marking and double exposures.

Failsafe occurred in instrument No. 2 in Rev No. 10 of the "B" bucket. Malfunction investigation was inconclusive. Due to failsafe, vehicle deactivate sequence was not performed.

Instrumentation performance was satisfactory.

The cycle rates of the two instruments were one and one-half percent apart during entire test. The Master and Slave cycle counter agreed with actual count.

The -1 Stellar/Index moniter performance was normal.

The -2 Stellar/Index moniter was satisfactory. However, there was one missed meter and two shutter pulse failures in Rev. 10.

Clock accuracy was satisfactory.

The pressure make-up system operated normally. Gas consumption, however, was too high at 9.45 PSI/Min. During PMU operates, internal pressure increased to 40-44 microns.

The command system operated normally. The V/H delay stepper failed to home on one rev. This was due to the command not being held in long enough. In Rev 10 of "A" bucket, the V/H programmer failed to start due to improper number of Br. 27 commands being issued.

Transfer from -1 to -2 was commanded by KZ-38. All transfer functions occurred normally.

The orbital sine function generator (O.S.F.G.) operated normally in both missions.

B. RESOLUTION TEST

Resolution and theodolite tests were performed on 2 September 1966. Results of the thru-focus resolution tests of pan instruments 208 and 209 showed the following characteristics:

Master Pan Instrument No. 208

Maximum high contrast resolution 178 lines/mm at 0.000 focal position.

Maximum low contrast resolution 111 lines/mm at 0.000 focal position.

Slave Instrument No. 209

Maximum high contrast resolution 187 lines/mm at 0.000 focal position.

Maximum low contrast resolution 112 lines/mm at 0.000 focal position.

Both instruments met the system requirements specification.

C. LIGHT LEAK TEST

The J-40 system was tested for light leaks on 7 August 1966. A pin hole was found and repaired on one of the Slave instrument H.O. boots. A light search then proved the system to be acceptable.

D. FLIGHT LOADING AND CERTIFICATION

The first Flight Readiness test of Panoramic Instrument #208 and 209 was completed on 1 May 1967. Excessive emulsion build up was noted in the processed imagery of the platen shrinkage markers and along the format edges of both instruments. Instrument #208 and 209 were cleaned and a second Flight Readiness test was conducted on 2 May 1967. Examination of the processed 3404 type film from both panoramic instruments revealed acceptable camera performance including clean format and shrinkage markers, tracking, normal rail scratches, horizon fiducials and shutter function, time track, serial number, binary index marks, and binary word.

Processed film exhibits from Stellar/Index cameras D-101 and D-102 demonstrated acceptable performance. Both Stellar cameras produced good reseau, fiducial, and correlation lamp imagery on film type 3401. Both Index cameras produced good reseau and correlation lamp imagery on film type 3400.

Flight film spools #24T and 13B (Box 50) were placed in the panoramic camera supply cassette but were removed and returned to [redacted] when it was observed that the film wraps were lightly stuck together principally along one film edge. A/P film storage room temperature was 68°F and 38% RH. Box 50 was transferred to the Flight Loading room for a period of 24 hours before opening Box 50 at a room temperature of 70°F and 40% RH.

The supply cassette was reloaded with flight film from Box 26 without incident.

The system pre-flight acceptance run was initiated and completed without incidence on 4 May 1967.

Customer review and final J-40 system buy-off was concluded on the afternoon of 4 May 1967.

SECTION 3

FLIGHT OPERATIONS

A. SUMMARY

FTV 1634 was an Agena Vehicle (SS-013) and a thrust augmented Thor (LV-2A, S/N-508) booster. This vehicle was configured for a tail first in orbit configuration with a dual recovery capability. Launch occurred from VAFB, Pad SLC-3 at 2152 GMT on 09 May 1967.

This payload system was flown with a new main door assembly, which will be standard equipment on systems J-40 and up. There were no problems connected with this new assembly. The J-40 command system was modified to eliminate the capability of real time command (RTC) 15 to reset the intermix sequence and the 4 step counter (operations counter). There were no operational problems encountered with this change. The remainder of the J-40 payload system conformed to the standard J-1 configuration.

The J-40 payload system was prepared for flight utilizing the full Phase III (Factory to Pad) concept.

Launch, ascent, and injection events occurred as programmed. However, a failure of the velocity meter to cut the Agena engine off resulted in burning fuel to depletion with an orbit period longer than predicted. Thus, the orbit achieved was not within 3 sigma dispersions.

Mean camera operational altitudes were approximately five (5) N.M. higher than nominal.

Instrumentation and command systems operated satisfactorily throughout the flight.

The on-orbit sine function generator (OSFG) and clock system functioned normally for the duration of the mission.

Telemetry data indicated a shutter failure on the Index camera during Rev 213. Otherwise the Stellar/Index system functioned normally.

KIK-ZORRO 38 (early -1 to -2 switchover) was performed on Rev 91 by [redacted] and all transfer functions were normal.

B. PANORAMIC CAMERA PERFORMANCE

Both Panoramic Cameras operated normally throughout the mission. Camera system dynamic operation, 99/101 clutch operation, start-up, shut-down, and transport functions were normal for all passes monitored. The cut and wrap operation and transfer to the -2 system occurred as programmed utilizing the KIK-ZORRO 38 command (early A to B switchover).

The panoramic film was exhausted on Rev 206 frame 101 on the Master and Rev 213 frame 3 on the Slave.

Panoramic Film Consumption (Frames)

	Actual	
	Master	Slave
Pre-Launch	105	114
-1 Mission	2938	2920
-2 Mission	2995	3004
Total	6038	6038

FMC Match

The initial orbit dispersion affected instrument operations in several areas. The FMC ramps utilized on this mission were never designed for orbits as eccentric as encountered on this flight. It was also necessary to bias the H-Timer to place the programmed operations over the desired targets.

Operations that were taken on the pre-flight FMC ramp settings prior to adequate orbit determination were at altitudes that were 20 to 30 per cent higher than nominal.

There were some operations taken on the wrong point on the FMC ramp after adequate orbit determination had been accomplished. These operations were on orbits on which the H-Timer was biased after the FMC ramp had started.

The actual ground tracks were moving west from the nominal ground track at a rate of 50 nautical miles (N.M.) per orbit at the equator. It was possible to compensate for this longitudinal misalignment by slewing the H-Timer in 1356 N.M. steps. Longitudinal alignment errors of up to 700 N.M. at the equator were encountered.

Latitudinal mismatch of as much as four (4) degrees were encountered even when the H-Timer was synchronized with the orbit. This resulted in biasing the H-Timer even though no longitudinal misalignment existed.

The mean altitudes of the camera operations were approximately 5 N.M. higher than nominal.

C. INSTRUMENTATION AND COMMAND SYSTEM PERFORMANCE

The command system was satisfactory for both missions. This command system was modified to eliminate the capability of resetting the intermix sequence and the four step counter by RFC 15. There were no operational problems encountered during the flight with this modification. The only instrumentation anomaly encountered during this mission was the No. 2 IMU temperature sensor which became an open T/M point during the pre-flight loading sequence.

D. CLOCK SYSTEM PERFORMANCE

Clock system operation was normal for the duration of the flight. Satisfactory time correlation between the flight clock and [redacted] time was obtained.

E. PRESSURE MAKE-UP SYSTEM PERFORMANCE

Pressure make-up system performance was normal throughout the flight. Average gas consumption was approximately 7.9 PSI/min for the 253 minutes of total operate time. The system had a surplus of 550 PSIA at the end of the mission.

F. THERMAL ENVIRONMENT

The average instrument temperatures ranged from a high of 85°F to a low of 51°F.

The thermal control paint pattern on the payload system was modified prior to launch.

SECTION 4

MISSION 1041 RECOVERY SYSTEMS

-1 MISSION

The -1 recovery capsule was successfully recovered by air catch on Rev. 93 at 0036 GMT on 16 May 1967. All re-entry events appeared normal and occurred within specified tolerances. Capsule impact was within the nominal 3-sigma dispersion.

	Latitude	Longitude
Predicted	27° 00'N	163° 35.6'W
Actual	26° 22'N	163° 17.0'W

The re-entry sequence of events is contained in Table 4-1.

-2 MISSION

The -2 recovery capsule was successfully recovered by air catch on Rev. 215 at 0008 GMT on 24 May 1967. Capsule impact was approximately 240 miles down range and 17 miles off track. Post recovery exercises indicated recovery timer events were within specifications. An investigation is continuing to determine the cause or causes of this anomaly.

	Latitude	Longitude
Predicted	28° 00'N	169° 42.2'W
Actual	24° 10'N	169° 46.0'W

MISSION 1041

RECOVERY SEQUENCE OF EVENTS

Event	Delay Time (Seconds) Actual -1	Actual -2	Nominal
*Arm	76.81	N/A	77.0 ± 1.0
*Transfer	2.00	N/A	2.0 ± 0.25
Electrical Disconnect	0.81	N/A	0.900 $^{+0.43}_{-0.30}$
Separation	---	---	---
**Spin	3.42	N/A	3.4 ± 0.30
Retro	7.60	N/A	7.55 ± 0.45
Despin	10.64	N/A	10.75 ± 0.54
T/C Separation	1.49	N/A	1.5 ± 0.15
***"G" Switch Open	539.36	N/A	539.7(-1) 538.6(-2)
Parachute Cover Off	34.4	33.35	34.0 ± 1.5
Drogue Chute Deployed	0.65	0.60	0.63 ± 0.08
Main Chute Bag Separate	11.47	10.80	10.0 $^{+3.0}_{-2.2}$
Main Chute Deployed	0.65	0.65	0.52 ± 0.13
Main Chute Disreef	4.88	4.55	4.5 ± 0.80

* From Separation
** From Electrical Disconnect
*** From Retro

TABLE 4-1

SECTION 5

MISSION 1041 PANORAMIC CAMERAS

A. COMPONENT ASSIGNMENT

Component	Master (FWD) Serial Number	Slave (AFT) Serial Number
Main Camera	208	209
Main Camera Lens	2172435	2182435
Supply Horizon Camera	303C6	313C6
Supply Horizon Camera Lens	E12861	E19101
Take-up Horizon Camera	289C5	313C5
Take-up Horizon Camera Lens	E12866	E19105
Supply Cassette	SC-52	SC-52

B. CAMERA DATA AND FLIGHT SETTINGS

Main Camera:		
Lens	24"f/3.5	24"f/3.5
Slit Width	0.225"	0.175"
Filter Type	Wratten 23A	Wratten 21
Film Type (Eastman Kodak)	3404	3404
Supply Horizon Cameras:	Port	Starboard
Lens	55 mm f/6.3	55 mm f/6.3
Aperture Setting	f/6.3	f/8.0
Exposure Time	1/100 second	1/100 second
Filter Type	Wratten 25	Wratten 25
Take-up Horizong Cameras:	Starboard	Port
Lens	55 mm f/6.3	55 mm f/6.3
Aperture Setting	f/8.0	f/6.3
Exposure Time	1/100 second	1/100 second
Filter Type	Wratten 25	Wratten 25

MISSION 1041 PAN CAMERAS

C. POST FLIGHT PERFORMANCE EVALUATION

The overall image quality of this mission is generally good. It is considered better than Mission 1038 and comparable to Missions 1039 and 1040. Several factors combined to limit to a moderate degree the value of this mission for current intelligence. The highly eccentric orbit caused some difficulty in obtaining coverage of targets while the high altitude over a small number of targets at the most northern latitudes reduced the ground resolution. Some further degradation resulted from a small area of out-of-focus imagery of the aft-looking camera. Heavy cloud cover and other atmospheric attenuation in some target areas also limited the value of this mission. However, it is noted that the photo-interpreters judged the mission as "fair to good".

The MIP ratings for the -1 and -2 missions were both 85, and the MIP frames for both mission segments were selected from the forward-looking camera material. Usually the aft-looking camera produces the better quality imagery and the MIP frames are selected from that camera. The relatively good performance of the forward camera on this mission may be partly attributed to the relatively high solar elevations encountered (45° and above). Examination of the FMC for each camera shows no significant differences. It is noted that the Performance Evaluation Team stated that "... the information content of the aft camera imagery is equivalent, and in some cases, better".

The only significant anomaly of the forward-looking panoramic camera was an open shutter failure of the starboard (output) H.O. device for one cycle (two panoramic frames). Examination of images from this H.O. both before and after the anomaly showed normal results. Although a continuous open shutter failure of the H.O. device would be catastrophic for the pan camera concerned, the present anomaly is random and no action is indicated.

On the aft-looking pan camera material there was a small out-of-focus area throughout both mission segments. The extent of this anomaly tended to increase through the mission. The cause is believed to be a film tracking bias across the platen resulting from a slight misalignment. Corrective action beyond the extensive alignment precautions presently used is not contemplated.

SECTION 6

MISSION 1041 STELLAR-INDEX CAMERAS

A. COMPONENT ASSIGNMENT

Component	-1 Mission Serial Number	-2 Mission Serial Number
Camera	D-105	D-102
Index Reseau	134	127
Stellar Reseau	133	127

B. CAMERA DATA AND FLIGHT SETTINGS

Stellar Camera:		
Lens	85 mm f/1.8	85 mm f/1.8
Exposure Time	2 seconds	1 second
Filter Type	None	None
Film Type (Eastman)	3401	3401
Index Camera:		
Lens	38 mm f/4.5	38 mm f/4.5
Exposure Time	1/500 second	1/500 second
Filter Type	Wratten 21	Wratten 21
Film Type (Eastman)	3400	3400

C. POST FLIGHT EVALUATION

Stellar Cameras

Both Stellar cameras were operational throughout their assigned mission segments. Stellar image motion, which was small throughout the mission, was generally in the roll component. The Stellar images were adequate for altitude determination.

The base plus fog densities of the Stellar films was higher than normal with the Mission 1041-2 fog densities significantly higher than those from 1041-1. It has been determined that the cause is increased radiation exposure resulting from the unusually high orbital apogee.

An unidentified image appeared in a five frame sequence of Mission 1041-1, and again in a four frame sequence of Mission 1041-2. It was noted that these sequences occurred on synchronous orbits. However, it was concluded that the object producing the images was external to the vehicle system and thus beyond the scope of engineering investigation.

There were no significant anomalies in the operation of either Stellar camera.

Index Cameras

Both Index cameras were operational throughout their assigned mission segments. The quality of images from both cameras was acceptable.

An increase in base plus fog densities, corresponding to those observed in the Stellar films, was noted on the Index films. The cause was the same: increased radiation exposure, as described in the paragraphs on Stellar Cameras.

There were no significant anomalies in the operation of either Stellar camera.

SECTION 7

PANORAMIC CAMERA EXPOSURE

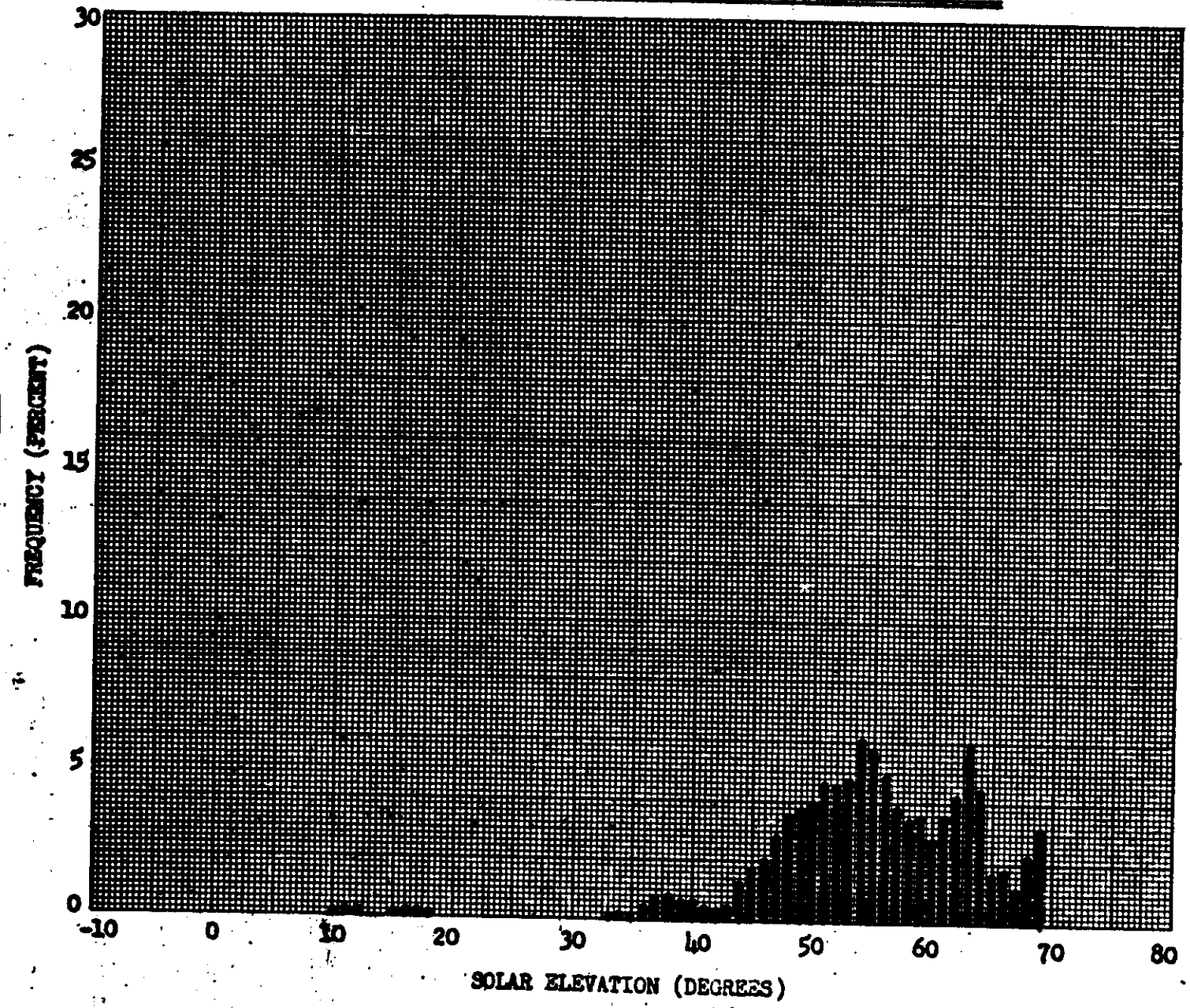
The Master camera contained a 0.225 inch slit and a Wratten 23A filter. The Slave camera had a 0.175 inch slit and a Wratten 21 filter. These conditions placed the nominal exposure near the intermediate processing curve.

The frequency distributions of the solar elevations and solar azimuths encountered during the photographic operations are shown in Figures 7-1 to 7-4.

The nominal exposure times of the Master and Slave cameras are shown as a function of latitude for passes D-1, D-93, and D-215 in Figures 7-5 to 7-10. The predicted level of processing for the original negative is based on the in-flight performance estimate and is tabulated below with the processing levels reported by [redacted]

Mission	Camera		% Primary	% Intermediate	% Full	% Transition
1041-1	FWD	Predicted	0	100	0	
		Reported	6	31	44	19
1041-1	AFT	Predicted	0	99	1	
		Reported	8	34	40	18
1041-2	FWD	Predicted	1	99	0	
		Reported	5	47	28	20
1041-2	AFT	Predicted	1	99	0	
		Reported	5	20	54	21

SOLAR ELEVATION FREQUENCY DISTRIBUTION



Mission No: 1041-1

Payload No: J-40

Camera No: 208

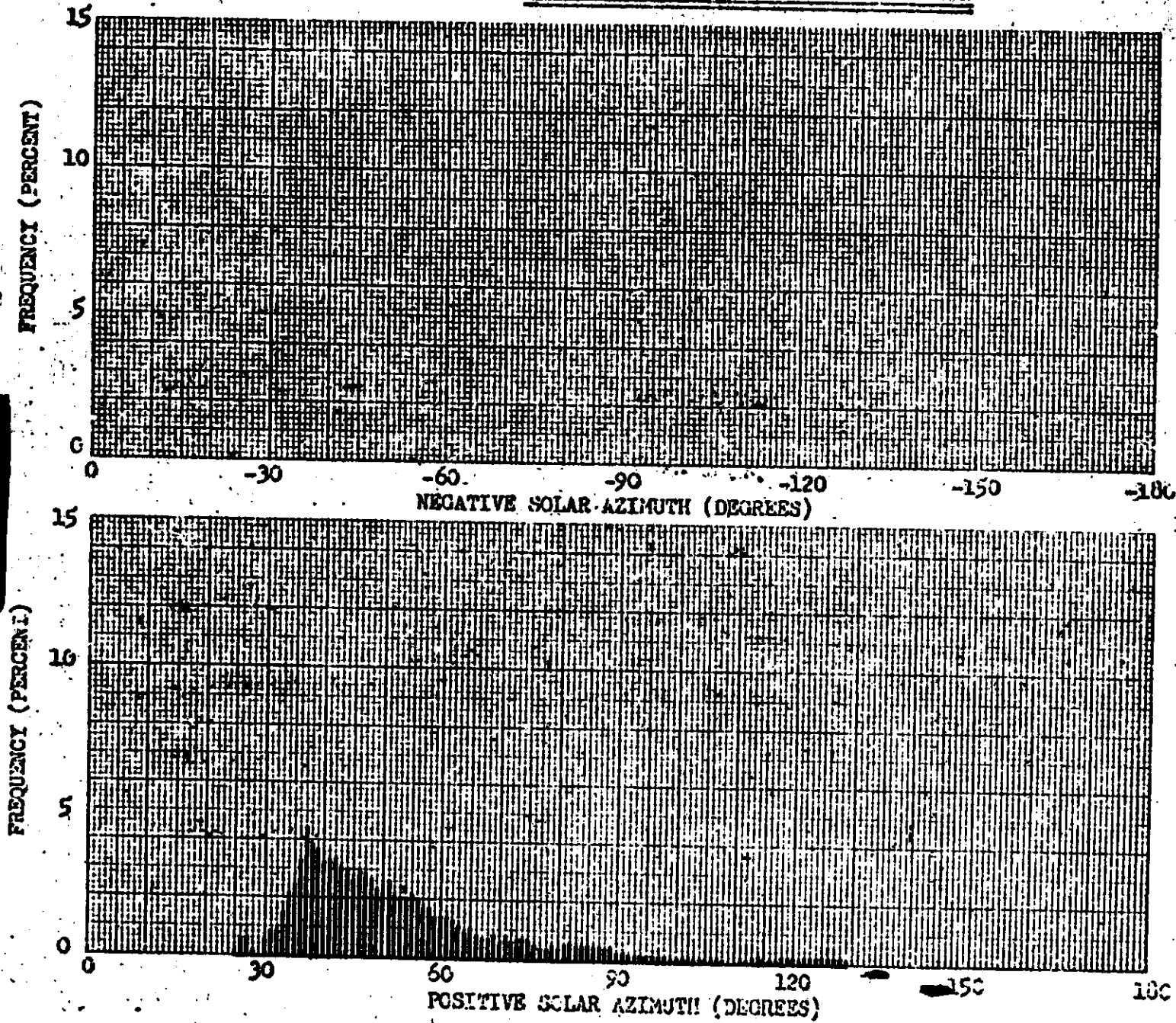
Launch Date: 5/9/67

Launch Time: 2152 Z

Inclination: 85°

FIGURE 7-1

SOLAR AZIMUTH FREQUENCY DISTRIBUTION



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Payload No: J-40

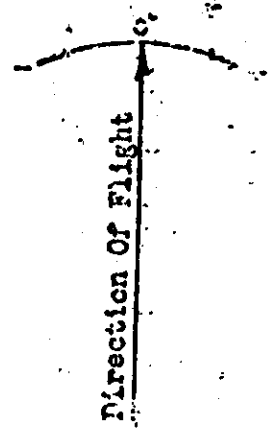
Camera No: 208

Launch Date: 5/9/67

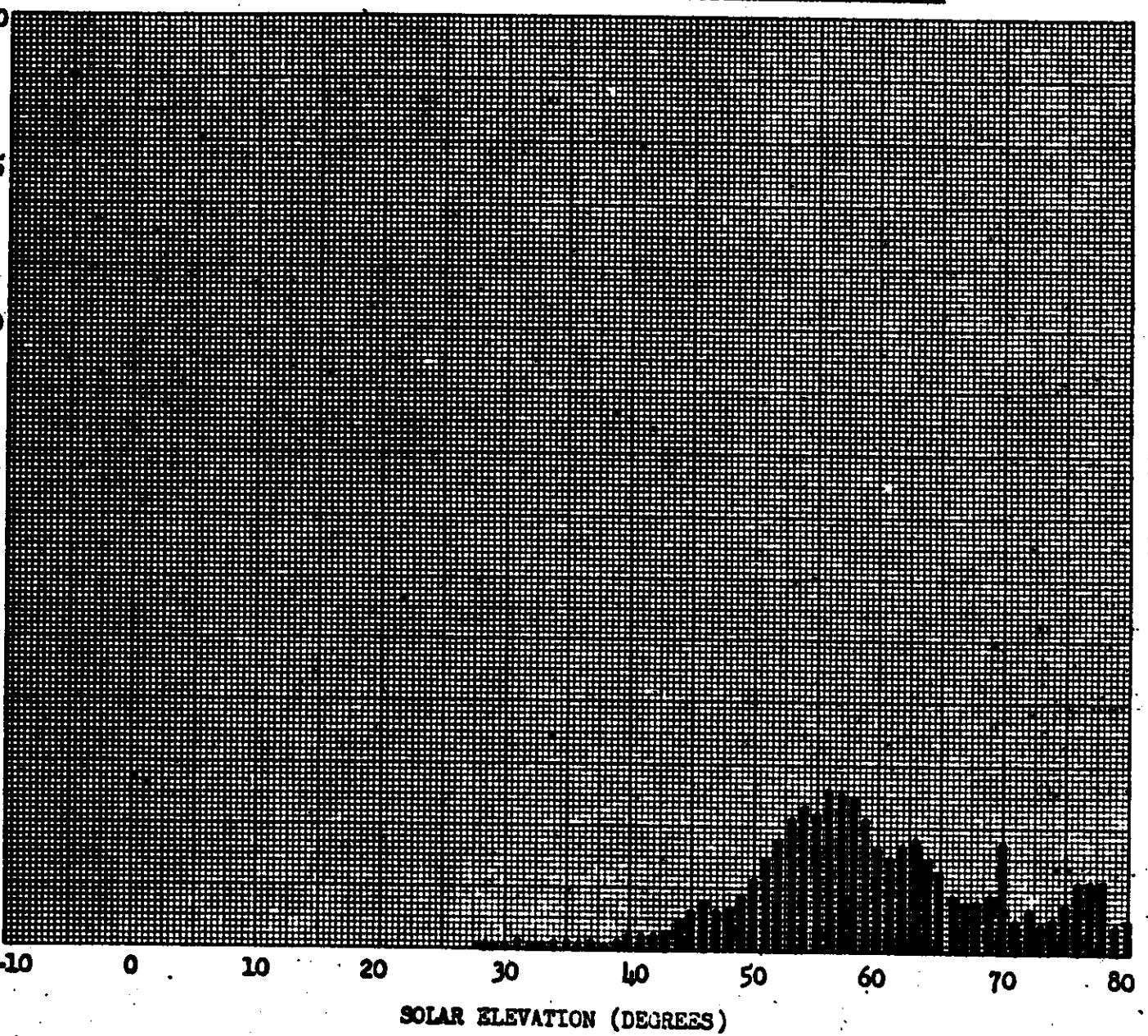
Launch Time: 2152 Z

Inclination: 85°

SIGN NOTATION



SOLAR ELEVATION FREQUENCY DISTRIBUTION



Mission No: 1041-2

Payload No: J-40

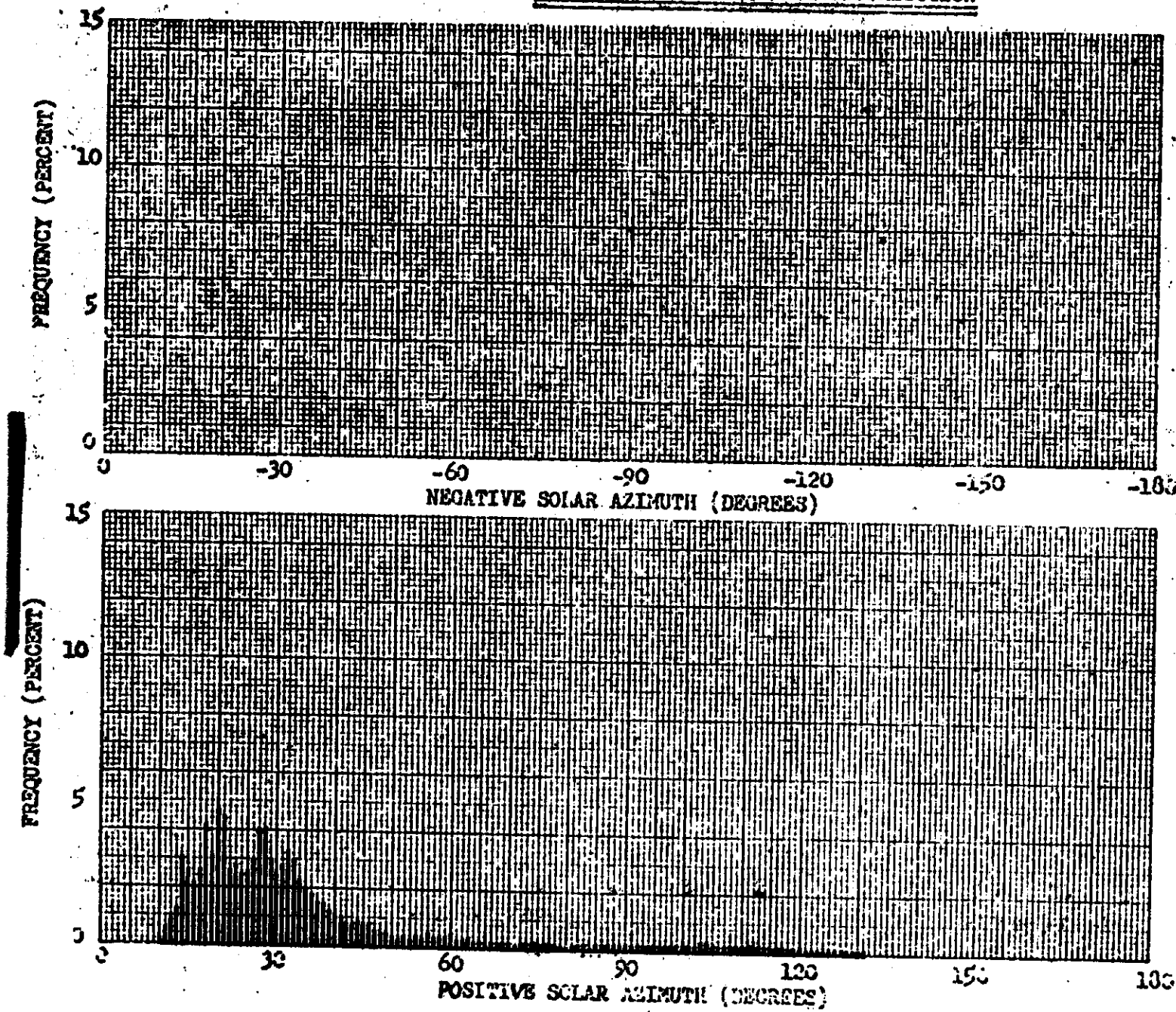
Camera No: 208

Launch Date: 5/9/67

Launch Time: 2152 Z

Inclination: 85°

SOLAR AZIMUTH FREQUENCY DISTRIBUTION



Mission No: 1041-2

Payload No: J-40

Camera No: 208

Launch Date: 5/9/67

Launch Time: 2152 Z

Inclination: 85°

SIGN NOTATION